Project Manual For:

Sanford High School and Technical Center

Sanford, Maine

Bid Documents

VOLUME 2 (Division 21 through Appendix A)

Project 12-067-00

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SECTION 21 01 00

BASIC FIRE PROTECTION REQUIREMENTS

(Fire Protection Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Basic Mechanical Requirements specifically applicable to Division 21 Sections, in addition to Division 01 – General Requirements.

1.02 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations.

B. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

C. All related Specification sections shall be used in conjunction with this Section.

1.03 WORK

A. Scope of work includes furnishing and installing equipment, other apparatus and accessories required for complete Fire Protection systems within proposed scope of work areas.

1.04 SUBMITTALS

A. Refer to Division 01 for submittal requirements. The following paragraphs supplement the requirements of Division 01.

B. Submit shop drawings and product data as requested by other Division 21 sections. All submittals to follow requirements of General Conditions, modifications to General Conditions, and Division 01.

C. The Contractor will be held responsible for checking and verifying all field measurements, and shall submit promptly, as to cause no delay in any work, shop drawings and schedules required for the work. The Contractor shall check and approve all submittals before forwarding to the Architect. All submittals shall be transmitted to the Architect using the submittal transmittal form contained in Division 01. The Architect will forward submittals to the Engineer. The Engineer will check and review the submittals with reasonable promptness, but only for conformance with design concept of the project and for compliance with information given in Contract Documents. The Contractor shall make any corrections required by the Engineer. The Engineer's review of submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications, unless he has, in writing, called the Engineer's attention to such deviations at the time of submission and has secured the Engineer's written approval. Additionally, the Engineer's review of submittals shall not relieve the Contractor from responsibility for any errors or omissions contained in the submittals.

D. At the onset of the submittal process the contractor shall develop and provide a Submittal Schedule indicating priorities and long lead-time items, so that the Engineer can anticipate and schedule appropriate review time. The Submittal Schedule shall be based upon equipment and material lead-times, “required by dates”, coordination with other trades, and delivery and rigging

requirements. The schedule MUST include adequate time for the Engineer to provide an appropriate review of the submitted materials, as well as time to allow for revisions and re-submittal if necessary.

1. Note that “appropriate review time” is considered to be a minimum of seven (7) business days and a maximum of fourteen (14) business days in the Engineer’s office; depending on quantity and complexity of submittals received.

E. When necessary, shop and setting drawings shall be based upon actual measurements taken at the site and upon other job conditions. Show any variations and revisions to Drawings or Specifications that are necessary for proper installation.

F. Submit copies of manufacturer's shop drawings showing illustrated cuts of item to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, installation instructions, wiring diagrams and controls and all pertinent information. Submit the quantity of copies indicated in Division 01.

G. At completion of construction, the Contractor shall furnish the Owner with one (1) unused copy of all reviewed shop drawings, manufacturer's diagrams, installation instructions, literature, etc., that were used in execution of the work.

H. The Contractor shall note that where more than one manufacturer's name is listed for the various major items of equipment and materials specified herein, the plans and specifications have been developed on the basis of equipment as manufactured by the first manufacturer name. Other manufacturers names are included to indicate the equipment manufactured by them may be considered acceptable for this project, provided that the equipment meets all requirements as to quality, size, and adaptability to space requirements, etc. It shall be the Contractor's responsibility to assure that the equipment, as manufactured by other than the first name manufacturer, shall meet all requirements as to quality, size, capacity, function, adaptability to space requirements, etc. The Engineer’s review of shop drawings for equipment as manufactured by other than the first named manufacturer shall in now way relieve the Contractor of this responsibility.

1.05 SUBSTITUTIONS

A. Any and all proposed substitutions must be approved by the Architect during the bid phase and must be indicated on the form of proposal. For specific substitution requirements, refer to Division 01.

B. Substitutions included in submittals which were not approved during the bid phase will be rejected.

1.06 COORDINATION

A. Well executed trade and system coordination are essential for this project.

B. The Contractor shall notify the Architect of conflicts which require ceiling heights to be lower than the heights indicated on the reflected ceiling plans. No work shall proceed in the areas of conflict without prior approval of the Architect.

C. Refer to Section 01 31 33 Building Information Modeling (BIM) for requirements pertaining to systems and element coordination, clash detection, and levels of documentation detail.

1. BIM for the coordination process shall be to a 400 Level of Development (LOD) in accordance with AIA E202. This level of development shall be considered suitable for

fabrication and assembly by trade contractors and specialty fabricators in order to fabricate, assemble and construct project components including mechanical, electrical, plumbing and fire protection (MEP/FP) systems.

D. Coordination drawings will be required for all work performed under this contract, as required and/or described in Division 01. Prepare and submit coordination drawings for work performed under Divisions 21 through 27 as specified in Division 01. Each contractor and associated sub-contractor shall be responsible for their respective coordination drawing effort.

1. As specified in Division 01:

   a. Prepare and submit 3-dimensional (3D) coordination and clash detection models and reports.
   b. Prepare and submit 2-dimensional drawings showing the installation intent; drawings are to be to a scale of 3/8" = 1'-0" or larger.

2. Detail mechanical, plumbing, fire protection and electrical system elements, components, equipment and materials in relationship with other systems, installations, and building components.
3. Dimension system elements and components off of column lines, and other fixed building features.
4. At a minimum, indicate the proposed locations of:

   a. Mechanical, fire protection and plumbing piping.
   b. HVAC ductwork.
   c. Electrical equipment, panel-boards, switch-gear, and controls.
   d. Cable trays and tel/data wire management systems.
   e. Major electrical, tel/data, and BAS conduit runs and conduit racks.
   f. Mechanical, electrical, plumbing and fire protection equipment and services.
   g. Control panels, motor-controllers and motor starters.
   h. Building automation system components.
   i. Access panels.

5. At a minimum, account for and show the following:

   a. Clearances for servicing and maintaining equipment, including space for disassembling equipment requiring periodic maintenance.
   b. Electrical Code required service clearances.
   c. Equipment connections and support details.
   d. Seismic bracing and anchor and guide locations.
   e. Pipe pitches, drip legs, low-point drains, and high-point vents.
   f. Other system installation and maintenance requirements.

6. Prepare reflected ceiling plans to coordinate and integrate installations.

   a. Show air outlets and inlets, light fixtures, fire alarm devices, audio-visual and communication systems components, access doors, and other above-ceiling and/or ceiling-mounted items.

7. Coordinate “in-wall” elements and systems. Coordinate all wall elevations.
8. Provide part plans, sections, elevation views, and other details as required to fully describe and coordinate installation requirements.

B. Carefully coordinate all cast-in-place concrete openings (slots, chases, holes, etc.). Obtain concrete form layouts and submittals from the General Contractor; provide comment as appropriate on the dimensional layout of openings and placement of reinforcing. Engage in this

process as soon as possible in order to avoid conflict with structural elements and to ensure openings are properly sized and located. Adjust mechanical work as necessary to accommodate structural requirements. Bring potential conflicts to the attention of the General Contractor, Architect and Engineer as soon as possible.

C. Avoid penetrations in shear walls and structural seismic elements (to the full extent practical).

1. Carefully coordinate any and all shear wall penetrations (if such cannot be avoided) with the Structural Engineer. Provide details of actual locations and required sizes of openings. Shear wall penetrations which do occur shall be kept to a minimum (both quantity and size). Bond beams shall not be penetrated unless such penetrations are specifically allowed and detailed by the Structural Engineer.

D. Carefully coordinate shafts, chases, slots, cored openings, and other vertical connections through the building and between floors.

E. Coordinate with all other trades as required, throughout the course of the project, in order to avoid conflicts and to promote the successful progression of work throughout the duration of the project.

F. Readily and actively participate in coordination meetings. Inform subcontractors, suppliers, vendors, etc., of coordination requirements and responsibilities. Inform the Owner well in advance of required shut-downs, service disruptions, system tie-ins or disconnections, etc. Schedule work sufficiently in advance to promote a smooth progression of work, and with sufficient time to redirect efforts if conflict with other's work is determined.

G. Maintain working clearances at above-ceiling components and devices requiring access and service (e.g., cable trays, air terminal control boxes, balancing valves, etc.). Coordinate with, and as necessary direct the work of, other trades to ensure proper above-ceiling access is maintained.

1. Coordinate to ensure piping, ductwork, ceiling supports, conduit and cable tray, wiring, miscellaneous hangers and supports, hanger rods, light fixtures, fire alarm devices, sprinkler piping and sprinkler heads, etc., are not mounted or installed in such a manner as to block ready access to above-ceiling components and devices requiring access.
2. Physically identify "no trespass zones" with tape, signs, or other markers in order to warn other trades to avoid spaces, locations and clearances which must be kept open.

H. Stagger duct and pipe supports, hangers, flanges, fittings, devices, etc., (both vertically and horizontally) as appropriate and necessary to avoid conflict and in order to provide for maximum space, head clearance, installation flexibility and access.

1. In order to obtain maximum possible head clearances and to the full extent practical, avoid aligning flanges, fittings, devices, etc., directly below structural beams and similar structural elements.

I. In order to resolve coordination difficulties and/or conflicts which cannot be otherwise resolved, structural beam penetrations may be allowed and only on a limited basis, and only with the review and approval of the Structural Engineer. If structural beam penetrations are required and allowed, the General Contractor will oversee the coordination and provision of such via shop fabrication and/or field cut openings. Any and all structural beam penetrations shall be in strict accordance with the Structural Engineer's written direction and details.

1. Carefully coordinate with structural openings in beams and other structural elements shown on the structural drawings. Review structural fabrication shop drawings and provide comment as appropriate on the dimensional layout of openings.

J. All under-slab piping, stub-ups, sleeves, pockets, recesses, etc., associated with the structural slabs must be precisely coordinated with the slab's structure and with above slab features and elements. Piping, conduit, equipment, devices, etc., set in or below the slab must be located with the aid of accurately dimensioned coordination drawings, which have been prepared in conjunction with the General Contractor, Division 21 through 27 contractors, the Architect, the Structural Engineer, the MEP/FP Engineer, etc.

K. Note that while all areas require careful coordination, the mechanical, electrical, plumbing, and fire protection systems in areas where systems and building structure will be exposed require precise coordination in order avoid conflict and to achieve the required/desired layout and clear heights. Carefully coordinate all systems with each other, as well as with structural and architectural elements in these areas.

1. Where mechanical, electrical, plumbing and fire protection system are to be exposed, coordinate and organize elements such that they are as high as possible, they appear regular and orderly, and they are parallel and plumb relative to major architectural features of the space; exposed elements must be laid out and installed in a manner consistent with the building/architectural geometry.
2. Where exposed, group and route system elements via common paths. Use common trapeze hangers and supports to group elements wherever possible.

1.07 PHASING AND SEQUENCING OF WORK

A. Refer to the General Conditions, other Division 01 sections, and to the Architect's phasing description and/or plans, for necessary project phasing and work sequencing.

B. Coordinate with the General Contractor in order to determine all phasing and work sequence requirements and to schedule work.

C. Minimize noise, dust, dirt, and other potentially detrimental activities. Protect systems and system components from dust, dirt, water, damage, etc.

D. Continue to inform the General Contractor and Owner of work anticipated to take place each day and/or week, sufficiently in advance of the work, for comment and potential redirection of those activities to avoid conflict and/or disruption.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

1.09 REGULATORY REQUIREMENTS

A. Building Codes: Conform to the Maine Uniform Building Code which is based on the 2009 International Building Code with the State of Maine amendments.

B. Plumbing: Conform to the Maine State Internal Plumbing Code which is based on the 2009

C. Uniform Plumbing Code with the State of Maine amendments.

D. Fire/Life Safety: State Fire Code as approved by the State Fire Marshal's office.

E. Obtain permits and request inspections from authority having jurisdiction.

F. Comply with the requirements of the City of Sanford Inspectional Services Department.

1. Conform to all Codes, Requirements, and Rules and Regulations of the City of Sanford and of the authority having jurisdiction. Comply with all City of Sanford amendments to applicable Codes and Standards.

G. Comply with the requirements and rules and regulations of the City of Sanford Health Department.

H. Refer to the Architect's building code summary and conform to the referenced Codes and Standards as appropriate.

I. Refer to the Structural Engineer's seismic design requirements and structural design criteria.

J. Obtain ALL permits and approvals, and request ALL inspections from the authority having jurisdiction, in a timely manner.

K. Submit appropriate close-out documentation to the authority(-ies) having jurisdiction at the conclusion of the project.

1.10 PROJECT/SITE CONDITIONS

A. Install work in locations shown on the Drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect before proceeding.

C. Before proceeding, determine all field conditions which will influence the installation of work; particular attention shall be given to structural work, construction sequence and phasing requirements.

1.11 RECORD DOCUMENTS

A. Refer to Division 01 for record document requirements. The following paragraphs supplement the requirements of Division 01.

B. Mark drawings to indicate revisions to piping and ductwork (size and location), both exterior and interior. Include locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair. Show actual equipment locations dimensioned from column lines, actual inverts and locations of underground piping, concealed equipment dimensioned to column lines, locations of mains and branches of piping systems, numbered valves and control devices, concealed unions, items requiring maintenance (i.e., traps, strainers, expansion compensators, tanks, air vents, etc.), and control system devices. Mark all change orders on the drawings.

C. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

D. Photograph concealed, buried, under-slab, built-in, or otherwise hidden installations, prior to concealment. Label each photograph with a type-written description of the subject at hand; include time, date, orientation, etc., of photograph. Photographs shall be digital format and shall be presented on CD-ROM discs, as well as in printed format, both in protective three-ring binders.

1.12 OPERATION AND MAINTENANCE DATA

A. Refer to Division 01 for operation and maintenance manual requirements. The following paragraphs supplement the requirements of Division 01.

B. The Contractor shall provide the following information in a bound manual:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Packing slips, shipping labels, bills of lading, etc., for materials and equipment delivered to and used on this project.

C. Two (2) copies of operations and maintenance data shall be submitted to the Architect for review: one (1) copy shall be returned to the Contractor (with any instructions for changes). After implementing any changes, five (5) copies of instructions covering all equipment shall be furnished to the Architect who will forward two (2) copies to the Owner for his information and use.

D. Append to manual, the name, address and telephone number of the Contractors and Subcontractors and for mechanical items, provide the name, address and telephone number of companies servicing installed equipment on a 24-hour basis.

1.13 COMMISSIONING

A. The Contractor performing work under Section 21 01 00 will be responsible to carry out the commissioning requirements and Owner's training specified in Division 01.

1.14 OWNER'S TRAINING

A. Owner’s training shall be executed as required by the project general conditions.

B. Training shall be presented to the Owner and their designated representatives. Owner shall be given adequate notice of training sessions to allow for proper scheduling of desired participants.

C. Training shall not commence until after substantial completion, but shall be provided prior to acceptance by the Owner.

D. Develop a learning objective and teaching outline for each module. A module shall include but is not limited to the fire service, piping distribution system, flow control valve stations, dry-pipe systems, backflow preventers, fire hose valve cabinets, and alarm valves. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment or component:

1. Basis of System Design, Operation Requirements, and Criteria: Include the following:

   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.

d. Regulatory requirements.
e. Equipment function.
f. Operating characteristics.
g. Limiting conditions.
h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Project record documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operational instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Including the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

    a. Inspection procedures.
    b. Types of cleaning agents to be used and methods of cleaning.
    c. Listing of cleaning agents and methods of cleaning detrimental to product.
    d. Procedures for routine cleaning.
    e. Procedures for preventative maintenance.
    f. Procedures for routine maintenance.
    g. Instruction on use of special tools.

8. Repairs:

    a. Diagnosis instructions.
    b. Repair instructions.
    c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    d. Instructions for identifying parts and components.
    e. Review of spare parts needed for operation and maintenance.

E. Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

F. Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

A. A professional videographer who is experienced in recording demonstration and training events is required.

1.15 PRODUCTS

A. When two or more items of same material or equipment are required (fixtures, pumps, valves, air handling units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flange types and grooved pipe types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.

B. Provide products which are compatible within systems and other connected items.

C. Products shall be specifically suited to the intended application. When requested to do so, by the Architect or Engineer, provide written statements from the manufacturer indicating proper and/or suitable application of their products.

1.16 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

B. Do not allow nameplates, tags, labels, or other identifying or explanatory information to be painted over or otherwise obscured.

1.17 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly packaged and protected to prevent damage during shipment, storage, and handling. Damaged materials, equipment, devices and/or system components shall not be installed, and shall be removed from the job site. Materials, equipment, devices and/or system components damaged after installation shall be replaced, or repaired to “like new” condition. The Owner reserves the right to reject any and all damaged materials, equipment, devices and/or system components.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect equipment and materials from damage, rain, snow, water, dust, dirt, mud, over-sprays, paint, moisture and/or excessive humidity, excessive heat or cold, excessive handling, etc. Do not allow equipment and materials to be improperly stacked, rigged, moved, or handled. Do not allow equipment or materials to be exposed to adverse weather, or any other conditions which may degrade or otherwise diminish their value and/or impair their utility.

C. Coordinate deliveries of fire protection materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

D. Each contractor is responsible to protect their work from dust, dirt, water, spray, etc., and damage caused by other contractors. If the actions of one contractor are detrimental to the work of another contractor, it is the responsibility of each contractor to bring such to the attention of the General Contractor and the affected contractor, and to make provisions and accommodations to protect the “at risk” work.

1.18 ACCESSIBILITY

A. Install equipment and materials to provide required and/or recommended access for servicing and maintenance.

B. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Note that where access is required through general construction elements, the Division 21 through 27 Contractors are to furnish all required access doors for access to equipment and system components installed under those Divisions, and are to coordinate with the General Contractor regarding access door locations and installations.

1. Locations where access panels and doors are required include, but are not necessarily limited to, fire and smoke dampers, control dampers, balancing dampers, control valves, shut-off valves, service valves, balancing valves, air vents, drains, equipment, etc., installed above gypsum board ceilings (e.g., at Suite hallways), and behind gypsum board walls.
2. Carefully review architectural drawings and mechanical plans to determine locations where access panels and doors are required in general construction elements.

C. Access doors furnished by the Division 21 through 27 Contractors shall comply with the Architect’s specifications (refer to Section 08 31 13). Allow ample space for removal of all parts that require replacement or servicing; provide access panels or doors large enough to properly service or remove equipment and system components. The minimum access panel or door size shall be 14”x14”, unless space conditions prohibit such, in which case they shall be as large as practical.

D. ALL access panel and door sizes and locations shall be coordinated with, and approved by, the Owner and Architect. Contractor shall generate a drawing identifying the size and location of proposed access panels for review and approval. Access panels and doors shall be installed in a

neat, orderly, and symmetrical manner, so as to be as aesthetically pleasing and as unobtrusive as possible. Carefully coordinate and align access panels and access doors with above ceiling and/or in-wall devices. Access panels shall not be located in bedrooms or common spaces.

1.19 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Particular attention is required with regard for rough-ins associated with under-slab and in-slab utilities, and devices.

C. Refer to equipment specifications in Divisions 02 through 27 for rough-in requirements.

1.20 FIRE PROTECTION INSTALLATIONS

A. Conform to the standards and requirements of the City of Sanford Fire Department.

1. Obtain copies of these standards and requirements prior to commencing any work.

B. Coordinate fire protection equipment and materials installation with other building components and systems.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in cast-in-place concrete and other structural components, as they are constructed.

F. Sequence, coordinate, and integrate installations of fire protection materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

G. Coordinate the rigging, hoisting, lifting, and handling of materials and equipment with the General Contractor, the Owner, and other trades.

H. Coordinate the cutting and patching of building components to accommodate the installation of fire protection equipment and materials.

I. Where mounting heights are not detailed or dimensioned, install fire protection services and overhead equipment to provide the maximum headroom possible.

J. Carefully install fire protection equipment to facilitate routine maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Coordinate service access clearances with building components and other fire protection system components. Maintain operability and functionality of access doors and panels (for example, air handling unit access doors or VAV control box covers which can not be opened due to adjacent piping will be considered unacceptable).

K. Coordinate connection of fire protection systems with exterior underground and/or overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

L. Carefully coordinate the installation of fire protection system materials and equipment above ceilings with ceiling suspension systems, light fixtures, cable trays, piping, ductwork, structural elements, seismic bracing, etc.

1. The Contractor is responsible to layout and to install all systems in a neat, orderly, and workmanlike manner, in order to provide a high quality installation which includes maximum possible accessibility and future flexibility.
2. Coordinate, layout, and install systems so as to allow and/or maintain maximum possible ceiling heights, while maintaining ready accessibility. Coordinate with the General Contractor, and other trades to determine ceiling height and clearance requirements.

M. Inform the Architect and Engineer whenever an under-slab, in-wall and/or an above-ceiling inspection is possible or appropriate, so that a punch-list of concealed equipment, systems, devices, etc., can be performed prior to closing in. Provide a minimum of two-week notice prior to the need of an inspection. If an inspection is performed in response to a request, and the work is significantly incomplete, the contractor may be back-charged for time spent on a re-inspection.

N. Painting of Fire Protection Systems and Components: Refer to Architect's painting requirements. Where exposed fire protection systems are to be painted, system components shall be fabricated, installed, cleaned and made ready for such. Coordinate with the Painting Contractor to ensure system components are properly cleaned and prepared to allow for proper application of paint. Where fire protection system components are not to be or should not be painted, coordinate with the Painting Contractor to ensure proper masking and/or other protection is provided; ensure masking and/or other protection is removed at the conclusion of the painting process. Protect fire protection systems and components which are not to be painted from overspray and/or misapplication.

1. Exposed items which may be painted include (but are not necessarily limited to):

   a. Sprinkler piping.
   b. Ductwork.
   c. Piping.
   d. Conduit.
   e. Work boxes.
   f. Valve boxes.
   g. Access doors.

1.21 REFERENCED SPECIFICATIONS

A. Refer to the following referenced specifications and all applicable sections to be included as part of the Division 21 scope of work:

1. Section 23 01 00 – Basic Mechanical Requirements
2. Section 23 12 00 – Mechanical Demolition
3. Section 23 12 10 – Expansion Compensation
4. Section 23 14 00 – Supports and Anchors
5. Section 23 17 00 – Motors and Variable Frequency Drives
6. Section 23 19 00 – Mechanical Identification
7. Section 23 24 20 – Vibration Isolation
8. Section 23 26 00 – Piping Insulation
9. Section 23 98 00 – Instrumentation
10. Section 23 99 00 – Testing, Adjusting, and Balancing

B. Referenced sections shall be included to provide a complete, functional and professionally installed Fire Protection system.

1.22 ELECTRICAL COORDINATION

A. Division 21 Responsibility:

1. Mount all electric power consuming equipment specified under Division 21; i.e., motors, and prewired control panels.
2. The electrical contractor shall be responsible for providing only the field wiring and equipment as indicated in the wiring schematics on the electrical drawings; any other wiring and/or equipment that is required and related to Division 21 work shall be the responsibility of the Plumbing Contractor.
3. Furnish all necessary wiring diagrams, instructions, advice, supervision, materials, labor, etc., as may be necessary to accomplish power wiring.
4. Furnish, install and take responsibility for accuracy and completeness of temperature control wiring, interlock wiring, and any other mechanical equipment wiring not shown on the electrical drawings.
5. Motor starters, disconnects, variable frequency drives, wiring, etc., not shown on the electrical drawings shall be provided by the Mechanical Contractor and shall comply with Division 26 requirements

B. Division 26 Responsibility:

1. Furnish and install, as indicated on the electrical drawings all motor overload protective devices, contactors, magnetic starters, complete with required pushbuttons, selector switches, and pilots.
2. Provide disconnect switches as indicated on the electrical drawings.
3. Provide all power wiring as indicated on the electrical drawings.

1.23 WARRANTIES

A. Refer to Division 01 for warranty requirements. The following paragraphs supplement the requirements of Division 01.

B. Compile and assemble all warranties for equipment specified in Division 21 into vinyl-covered three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Include product or equipment, date of beginning of warranty or bond, duration of warranty or bond, and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Provide extended warrantees for equipment and materials whose basic warranty will expire prior to the warranty period described in Division 01 because of the timing of shipment or installation. (For example, a piece of equipment with a one-year warranty which is installed 18 months prior to completion of the project shall be provided with an extended warranty to comply with the warranty period described in Division 01.) The extended warranty may be through the manufacturer or the installing contractor or vendor. However, all benefits of the original manufacturer's warranty shall be conveyed to the Owner for the specified warranty period, commencing with acceptance of the project by the Owner, or full beneficial use of the systems by the Owner.

1.24 GUARANTEE

A. The Contractor shall guarantee all work to be free from defects for a period of one (1) year after acceptance. Any and all work found defective or not in accordance with the Contract during this period shall be corrected promptly by the Contractor after written notification from the Owner. The Contractor shall repair or correct the work within ten (10) days of the written notification and if

the Contractor does not comply, the Owner may have the work corrected and charge all such work to the Contractor.

1.25 REVIT FILES

A. Following the receipt of a written request from the Contractor, RFS will furnish REVIT electronic files for fire protection drawings. Signing of the Rist-Frost-Shumway Engineering, P.C. Electronic Document File/Digital License Agreement shall be considered a prerequisite for the release of electronic REVIT files.

B. Note that BIM for the design process is generally 300 Level of Development (LOD) in accordance with AIA E202. This level of development is typically considered to include model elements equivalent to traditional construction documents. 300 LOD BIM is suited to estimating, and basic construction coordination for clash detection, scheduling and project visualization.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 21 32 50

FIRE PROTECTION

(Fire Protection Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Wet-pipe sprinkler system.

B. Dry pipe sprinkler system.

C. Standpipe system.

D. Fire department connections.

E. Automatic residential fire extinguishing system.

F. System design, installation, and certification.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REFERENCES AND REGULATORY REQUIREMENTS

A. NFPA 13 - Installation of Sprinkler Systems (2007 Edition).

B. NFPA 14 - Standpipe and Hose Systems (2007 Edition).

C. NFPA 33 - Standard for Spray Application using Flammable or Combustible Materials (2007 Edition).

D. ANSI 17.1 Safety Code for Elevator and Escalators (2007 Edition).

E. Rules and Regulations of the Sanford Fire Department.

F. All State Fire Marshal requirements.

1.04 SYSTEM DESCRIPTION

A. System to provide coverage for entire building with a wet-pipe sprinkler system.

B. System to provide coverage in automotive collision, automotive technology, building trades, CTE Exploration, Welding Fabrication, Precision Manufacturing , and Fire Fighting Science with a dry-pipe sprinkler system.

C. Provide system to NFPA 13 requirements as well as in accordance with the rules and regulations of the Sanford Fire Department and all State Fire Marshal requirements.

D. Provide a wet pipe standpipe at either side of the stage.

E. Provide floor control valves, flow switch, test and drain for each floor sprinkler system zone.

F. Verify volume and pressure of incoming water supply by arranging flow test with the Sanford Water District prior to beginning hydraulic design. Previous tests indicate that on Main Street at mayflower Drive there is a static pressure of 99 PSI and a residual pressure of 86 PSI while flowing 2,175 GPM. Fire Protection sub-contractor shall use the poorer hydraulic characteristics for their hydraulic calculations.

G. Fire protection sub-contractor shall include a 10.0 PSI cushion between the available water pressure and the sprinkler system required pressure at the required flow.

H. Interface fire protection system with building fire alarm system.

I. Provide fire department connections and valves as indicated and as required by the Sanford Fire Department.

1.05 SUBMITTALS

A. Submit under provisions of Section 21 01 00.

B. Shop Drawings: Submit layout plans at 1/8" = 1' scale of finished ceiling areas indicating sprinkler head locations coordinated with ceiling installation and detailed pipe layout and sizing. Provide hydraulic calculations and indicate system controls. Make note of any finished areas where fire protection piping may not be able to be concealed based on building design.

C. Product Data: Include product data for specific sprinkler heads, guards, deflectors, and accessories proposed for use, and identify each device type, by symbol or otherwise, on the layout plans. Submit performance ratings rough-in details, weights, support requirements, and piping connections.

D. Prior to submission of shop drawings to Architect, submit shop drawings and product data to the Sanford Fire Department for approval. Submit proof of approval to Architect with shop drawing and product data submission.

E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 21 01 00.

B. Record actual locations of sprinkler heads and deviations of piping from drawings. Indicate drain and test locations.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 21 01 00.

B. Maintenance Data: Include components of system, servicing requirements, Record Drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.08 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 13, NFPA 14, and ANSI 17.1.

B. Equipment and Components: UL listed and FM approved label or marking.

1.09 QUALIFICATIONS

A. Installer: Company specializing in performing work of this Section with minimum three years experience.

B. Design sprinkler system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Maine. Sprinkler system hydraulic calculations and distribution design shall be performed by the Sprinkler System Contractor; system design drawing(s) produced by Sprinkler System Contractor shall be sealed and signed by a qualified engineer licensed in the State of Maine; said engineer shall be the Engineer of Record for the design covered by the sealed drawing(s).

1.10 REGULATORY REQUIREMENTS

A. Hydraulic Calculations, Product Data, Shop Drawings: Bear stamp of approval of the Sanford Fire Department and State Fire Marshal.

1.11 EXTRA MATERIALS

A. Provide extra sprinkler heads under provisions of NFPA 13.

B. Provide suitable wrenches for each head type.

C. Provide metal storage cabinet in location designated by the Architect.

PART 2 – PRODUCTS

2.01 SPRINKLER HEADS

A. Manufacturers:

1. Viking
2. Tyco
3. Reliable
4. Victaulic

B. Finished Ceiling:

1. Type: Recessed pendant type with recessed escutcheon.
2. Head and Escutcheon Finish: Enamel, color white.
3. Fusible Link: Fusible solder link or frangible bulb type temperature rated for specific area hazard.

C. Exposed Area Type:

1. Type: Standard upright or pendant type or vertical sidewall type.
2. Head Finish: Brass or white (see Architectural Finishes).
3. Fusible Link: Fusible solder link or frangible bulb type temperature rated for specific area hazard.

D. Finished Ceiling Sidewall Type:

1. Horizontal type with flat plate escutcheon.
2. Head and escutcheon finish: White.
3. Fusible link: Fusible solder link or frangible bulb type temperature rated for specific area hazard.

E. Dry Sidewall Type:

1. Type: Standard dry barrel sidewall sprinkler with flat escutcheon.
2. Head and escutcheon finish: Chrome.
3. Fusible link: Fusible solder link or frangible bulb type, temperature rated for specific hazard.

F. Dry Pendant Type:

1. Type: Standard dry barrel pendant sprinkler with adjustable escutcheon.
2. Head and escutcheon finish: Chrome.
3. Fusible link: Fusible solder link or frangible bulb type, temperature rated for specific hazard.

G. Guard: Provide on heads in gymnasium, stage, in all data rooms, all storage areas, closets and on all heads 7'-0" AFF or lower.

H. Coordinate final color or finish of all sprinkler heads, escutcheons and cover plates with Architect.

I. Refer to sprinkler head schedule on the Fire Protection drawings for final sprinkler head selection.

2.02 PIPING SPECIALTIES

A. Manufacturers:

1. Viking
2. Victaulic
3. Reliable
4. Tyco

B. Wet-Pipe Sprinkler Alarm Check Valves: Check type valve with divided seat ring, rubber faced clapper to automatically actuate hydraulically operated alarms, with pressure retard chamber, variable pressure trim, drain, test, pressure actuated flow switch, and gauges.

C. Dry-pipe Sprinkler Alarm Valves: Check type valve with rubber-faced clapper, hold open latch and gasketed access plate. Air maintenance device, air compressor, low air pressure alarm switch, and pressure flow switch, port for hydraulically operated alarm when specified or pressure operated flow switch, drain, and test valves and two pressure gauges.

D. Electric Alarm: Electric-operated alarm bell, 10" diameter, 120VAC, 85 dB at 10 feet with weatherproof backbox. Potter PBA 12010 or equal.

E. Water Flow Switch: Vane type or pressure type (as indicated) switch for mounting horizontal or vertical, with two contacts rated 10 amp at 115 volt AC and adjustable delay (0-60 seconds). Potter #VSR (flow type) or #PS10-2A (pressure type) or equal.

2.03 FIRE DEPARTMENT INLET CONNECTION

A. Manufacturers:

1. Guardian Fire Equipment
2. American Fire Hose
3. Potter-Roemer

4. Croker

B. Type: Four-inch (4") 30-degree angle Storz connection with cap and chain, hard coated aluminum.

C. Drain: 3/4" automatic ball drip, run to drain.

D. Label: "Sprinkler/Standpipe Fire Department Connection" with cast brass or aluminum plate to match inlet, mounted on building.

E. Verify selection and hose connections with the Sanford Fire Department.

2.04 BACKFLOW PREVENTER

A. Manufacturers:

1. Watts
2. Febco
3. Wilkins
4. Conbraco
5. Ames

B. Double check, testable, low pressure drop type.

2.05 SPRINKLER PIPING, BURIED

A. Comply with specifications under Division 33 to match site water distribution piping.

2.06 SPRINKLER PIPING, ABOVE GROUND

A. Steel Pipe: All piping inside of the building used for the sprinkler and standpipe system two inches (2") and smaller in size shall be Schedule 40 black steel pipe with threaded ends conforming to ASTM Standard A795/A 135, latest amendment, approved for use in fire protection systems. All sprinkler and standpipe piping inside the building two and one-half inches (2-1/2") and larger in size shall be Schedule 10 black steel pipe with rolled groove ends approved for use in fire protection systems.

1. Steel Fittings: Wrought steel or forged steel welding type.
2. Malleable or Cast Iron Fittings: Screwed type, use galvanized cast iron for galvanized pipe.
3. Mechanical Grooved Couplings: Ductile iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts and washers; galvanized for galvanized pipe.
4. Plain End Couplings: Ductile iron housing pressure responsive gasket, hardened steel locking lugs and internal pipe stops.
5. Strap fittings which utilize a U-bolt and nuts will not be allowed for installation.
6. Dry pipe and pre-action system piping and fittings shall be hot-dipped galvanized.

B. Copper Tubing: ASTM B88, Type L hard drawn.

1. Fittings: Cast bronze or wrought copper and bronze, solder joint, pressure type.
2. Joints: Solder, Grade 95TA.

2.07 GATE VALVES

A. Manufacturers:

1. Stockham
2. Crane
3. Milwaukee

4. Central
5. Nibco
6. Kennedy

B. Up to and including 2-Inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, single wedge or disc, solder or threaded ends.

C. Over 2-inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged or grooved ends.

2.08 GLOBE OR ANGLE VALVES

A. Manufacturers:

1. Stockham
2. Nibco
3. Milwaukee
4. Crane

B. Up to 2-Inches: Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable composition disc, solder or screwed ends, with backseating capacity re-packable under pressure.

C. Over 2-Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.09 BALL VALVES

A. Manufacturers:

1. Milwaukee
2. Stockham
3. Watts
4. Victaulic
5. Nibco

B. Up to and Including 2-Inches: Bronze body, bronze ball, Teflon seats and stuffing box ring, lever handle and soldered or threaded ends to suit piping which valve will be installed in.

2.10 BUTTERFLY VALVES

A. Manufacturers:

1. Kennedy
2. Milwaukee
3. Central
4. Nibco
5. Victaulic

B. Bronze body, stainless steel disc, resilient replaceable seat, threaded ends, extended neck, handwheel and gear drive and integral indicating device and built-in tamperproof switch rated 10 amp at 115 volt AC.

C. Cast or ductile iron body, chrome plated ductile iron disc, resilient replaceable EPDM seat, wafer or lug ends, extended neck, handwheel and gear drive and integral indicating device, and built-in tamperproof switch rated 10 amps at 115 volt AC.

2.11 CHECK VALVES

A. Manufacturers:

1. Stockham
2. Nibco
3. Milwaukee
4. Crane
5. Victaulic

B. Up to and including 2-Inches: Bronze swing disc, solder or screwed ends.

C. Over 2-Inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

2.12 DRAIN VALVES

A. Bronze ball valve with cap and chain 3/4-inch hose thread.

2.13 STAGE FIRE HOSE CABINET AND TRIM

A. Manufacturers:

1. Potter Roemer
2. Croker
3. Guardian
4. Larsens

B. Potter Roemer #1156 surface-mounted cabinet 26" x 42" x 9¼" with full glass door and decal, #2710 hose rack with 2½" valve, 1½" reducer, 100' of 1½" lined hose and polycarbonate adjustable fog nozzle.

C. Hose threads shall be IPS for both the 2 ½” and 1 ½” outlets. Verify hose threads with the Sanford Fire Department.

2.14 AIR COMPRESSOR

A. Manufacturers:

1. General
2. Eagle
3. Emglo

B. General two-cylinder, direct drive, 460V, magnetic starter, single-phase, oil-less, permanently lubricated bearings, pressure switch, ODP motor mounted on a 10-gallon horizontal ASME pressure tank. UL listed.

C. Provide with a UL listed/FM approved air maintenance device and flexible pipe connector.

2.15 POST INDICATING VALVE

A. Manufacturers:

1. Mueller
2. Waterous
3. Kennedy Valve

B. Mueller Model A-20814 wall type indicator post. Provide non-rising stem gate valve. Post will accommodate 4- through 16-inch size post indicator valves requiring 14 to 48 turns to open that area listed or approved for fire protection system service. Post accept direct attachment of a 1/2" NPT mounting electric supervisory switching device. Provide Model PCVS-2 supervisory control valve switch which has two sets of SPDT Form C contacts. Device is UL listed and FM approved

C. Refer to Fire Protection drawings for the final location of the post indicator valve assembly. Provide isolation valve to suit.

2.16 SPRINKLER SEISMIC JOINT

A. Manufacturers:

1. Metraflex
2. Flexicraft
3. AnvilStar

B. Provide pre-fabricated flexible loops with two (2) sections of braided metal hose. Suitable for an operating pressure of 300 psi. Assembly shall be suitable for a minimum of 4” of movement in compression or extension. Provide drain/air release plug. Metraflex Fireloop or approved equal.

C. Sprinkler seismic joint shall be provided where ever a fire protection system pipe is installed horizontally across an expansion joint, a building seismic joint, building expansion joint or a building fire separation.

2.17 FLEXIBLE SPRINKLER SUPPLY FITTING

A. Manufacturers:

1. Victaulic
2. Flexhead Industries
3. Viking

B. Pre-fabricated braided flexible sprinkler connection assembly complete with stainless steel hose and mounting bracket to support hose assembly and sprinkler head to suspended ceiling.

C. System shall be approved for use with suspended ceilings per ASTM C635 and ASTM C636. System shall be FM approved and compatible with any FM/UL approved sprinkler head.

D. System shall be installed in conformance with all manufacturer’s guidelines and requirements.

E. The flexible sprinkler supply fittings may be installed throughout the facility where there are suspended ceilings, except in the following locations:

1. All kitchen/culinary lab areas and associated storage rooms and offices.
2. All dining/cafeteria areas.
3. Within the auditorium (except at suspended panels) and associated controls, storage and vestibule spaces.
4. Within the Library and associated storage rooms, offices, reception areas, corridors, and group rooms.

2.18 DOUBLE INTERLOCK PREACTION SYSTEM

A. Manufacturers:

1. Viking
2. Tyco
3. Victaulic

4. Reliable

B. Prepackaged free-standing system, complete with deluge valve, all trim, flow switches, gauges, shut-off valve, supervisory switches, manual release, control panel, smoke detectors, and all associated wiring and conduit.

C. System shall include a tank-mounted air compressor package.

D. System shall be in a floor-mounted 14-gauge steel cabinet, built per NEMA 12 standards. The cabinet shall house the entire control and trim package.

2.19 HEAT TRACE AND INSULATION

A. Manufacturers:

1. Thermon
2. Raychem
3. Tyco

B. Sprinkler piping shall be provided with heat tracing for freeze protection as specified and where shown on the drawings.

1. Furnish and install a complete UL Listed system of heaters and components approved specifically for fire protection piping heat tracing. The heat tracing system shall conform to ANSI/IEEE Standard 515.1.
2. The self-regulating heater shall consist of two nickel-plated copper bus wires embedded in a radiation cross-linked semi-conductive polymer core. The heater shall be capable of varying its heat output along its entire length, allowing the heater to cross over itself without overheating. The heater shall be covered by a polyolefin dielectric jacket rated 300 VAC at 105°C and a tinned copper braid (12 AWG equivalent wire size).
3. In addition to a tinned copper braid, the heating cable shall be covered by a polyolefin outer jacket for protection from aqueous inorganic chemicals (standard construction).
4. The heater shall operate on a line voltage of (110-120) VAC without the use of transformers.
5. The heating cable shall be suitable for use on metallic piping.
6. For additional energy conservation, the heating cable shall be controlled by a bimetallic pipe wall sensing thermostat preset at 40°F with a switch rating of 22 amps at 120/240/277 VAC based on current loads for each circuit. Where the load of the heating cable exceeds the rating of the thermostat, the heating cable shall be controlled through an appropriately sized contactor by the control thermostat.
7. All heating cable core will be permanently marked with the manufacturer's identification number for traceability.
8. Refer to the manufacturer's freeze protection design guide for design details, insulation requirements, maximum circuit lengths and accessory information and requirements.
9. Provide power distribution and monitoring panels suitable for fire protection systems to accommodate all of the heat trace circuits. Locate panels in either mechanical rooms or janitors closets as approved by the owner.
10. Manufacturer shall demonstrate experience manufacturing and designing freeze protection systems with self-regulating heating cables for fire protection systems.
11. Manufacturer's Quality Assurance Program shall be certified to the ISO 9001 Standard.
12. Refer to the manufacturer's installation instructions and design guide for proper installation and layout methods. Deviations from these instructions could result in performance characteristics different than intended.
13. All installations and terminations must conform to the National Electrical Code and any other applicable national or local code requirements.
14. Circuit breakers supplying power to the heat tracing shall be equipped with 30 mA ground-fault equipment protection; five (5) mA GFCI should not be used as nuisance tripping may result.

15. Piping shall be pressure tested prior to installation of heating cable. Thermal insulation shall not be installed until heating cable installation is complete and a megohmeter (megger) test has been passed. Heat traced lines shall be insulated promptly after the heat tracing installation.
16. The insulation shall not be installed with staples. Insulation jackets should be closed with adhesive to avoid damage to the heating cable.
17. System shall be connected to power by the electrician (see Division 26-Electrical).
18. Heating cable shall be tested with a megohmeter (megger) between the heating cable bus wires and the metallic ground braid. While a 2,500 Vdc megger test is recommended, the minimum acceptable level for testing is 500 Vdc. This test should be performed a minimum of three times:

    a. Prior to installation while the cable is still on reel(s).
    b. After installation of heating cable and completion of circuit fabrication kits (including any splice kits) but prior to installation of thermal insulation.
    c. After installation of thermal insulation but prior to connection to power.

19. The minimum acceptable level for the megger readings is 20 megohms, regardless of the circuit length.
20. Results of the megger readings shall be recorded and submitted to the General Contractor.

C. Fire protection sprinkler piping serving the spark detection and extinguishing system shall be provided with insulation as specified and where shown on the drawings in conformance with NFPA 13 requirements.

D. Provide insulation on the sprinkler piping. Coordinate the proper diameter and thickness of insulation with heat trace thickness of insulation with heat trace manufacturer.

2.20 AUTOMATIC RESIDENTIAL FIRE EXTINGUISHING SYSTEM

A. Manufacturers

1. Guardian
2. Approved Equal

B. General Description

1. The fire extinguishing system shall be capable of detecting a cooking grease fire originating on the range top, extinguish the fire, and prevent re-ignition, while at the same time, shutoff the gas or electric supply to surface elements on the kitchen range top. Each system shall be provided with a means to distribute the chemical agent, fire detection components, container for storing the chemical, valve assembly with pressure gauge, enclosure assembly for container, and appliance shutoff device. These components shall be provided factory assembled and ready for installation and installed in accordance with an approved owner's manual.

C. Certification

1. The fire extinguishing systems shall have a current U.L. listing under the category "Residential Range Top Fire Protection" in the most recent Fire Protection Equipment Directory (FPED).

D. Chemical Agent

1. Wet Chemical:

    a. Shall conform to the requirements of National Fire Protection Association (NFPA) Standard No. 17A for Wet Chemical Fire Extinguishing Systems.

E. System Components

1. System Enclosure:

a. The system enclosure shall consist of the pressurized extinguisher cylinder with wet chemical fire suppressant, central processing unit control board with terminal block connections, electronic release valve, cylinder pressure gauge, enclosure base, and enclosure cover. Operation of the extinguisher unit is controlled by the supervised electronic control panel, which is battery powered. Detection is initiated through the heat sensors, activating the alarm and the extinguisher. The electric or gas shutdown devices can either be sonically operated by the control panel, or hardwired to the central processing unit control board.

2. Cylinder And Valve Assembly

a. The extinguisher cylinder and valve assembly shall be provided fully charged with chemical and pressurized with dry nitrogen in accordance with listed requirements. A pressure gauge attached to the valve assembly shall be positioned to allow visual inspection when installed within a kitchen cabinet. Maximum allowable height of container (including the enclosure assembly) shall not exceed 12-inches. The container and valve assembly shall be of the re-serviceable type and provide maintenance requirements synonymous with that required for portable handheld fire extinguishers, according to National Fire Protection Association (NFPA) Standard 10. The container and valve assembly shall be provided factory assembled to the enclosure. Assembly shall include a pre-mounted CPU control board for the appliance shutoff device and necessary attachment for the Fire Detection Unit. The complete extinguisher cylinder and valve assembly shall be installed in a protected area above the range hood (normally, kitchen cabinets). Installations which expose extinguisher cylinder and valve assembly to direct cooking heat and grease will not be accepted.

F. Central Processing Unit Control Board

1. The CPU control board is housed/attached inside the system enclosure. The control board's circuitry is powered by a 9V DC battery and has the following features:

a. Supervised Circuitry

1) The audible 106DB alarm on the CPU control board will "alarm" to warn of possible trouble in the electronic circuitry including the heat sensors, if there is an open circuit.

b. System Operation Light

1) The red "power" light will blink approximately every 45 seconds to confirm the system is operating.

c. Audible Alarm

1) The system 106DB alarm is designed to continuously sound once the system has been activated by a stove top fire.

d. Low Battery Warning:

1) The audible alarm on the CPU control board will "chirp" approximately every 45 seconds when a low battery condition exits. If this condition exists, 9V DC battery must be replaced immediately to insure proper system operation.

e. Auxiliary Outputs:

1) Can be connected to automatic telephone dialers, monitored security alarm systems or other warning/protective equipment. Auxiliary outputs provide one (1) second impulses to activate above items. These connections are rated at 5 AMP at 250V AC.

G. Temperature activated sensor assembly:

1. The sensor assembly shall consist of two (2) metal housed detector assemblies containing diode type heat sensors, affixed to the side of the magnetic nozzle bases, and connected to the CPU control board with two (2) different wire lengths.

H. Distribution assembly:

1. The distribution assembly shall consist of two (2) Teflon lined stainless steel braided hoses and two (2) magnetic based adjustable nozzle assemblies. The use of copper tubing shall not be accepted. Hose and nozzles shall comply with NFPA Standard No. 17A for Wet Chemical Extinguishing Systems and shall have been investigated by Underwriters Laboratories, Inc. (U.L.) and listed for this service.

I. Appliance nozzles:

1. Wet System: Appliance nozzles shall be constructed of brass. Appliance nozzles with painted surfaces shall not be accepted. Appliance nozzles shall not extend below the lowest component of the range hood. Design shall provide equal distribution of chemical agent and allow chemical to flow effectively with low velocity to avoid splattering of burning grease.

J. Appliance Shutdown Device:

1. Each system shall be provided with a listed device to automatically shut-off the gas or electric supply to surface burners on the kitchen range top upon activation of the alarm from the fire detection unit via an interconnection cable. The gas or electric supply shall remain “off” until manually reset. Electrical power cutoff to kitchen range hood exhaust fan shall not be required for Underwriters Laboratories Incorporated (U.L.) listed extinguishing systems.

K. Gas Shutoff:

1. Once activated via a low voltage interconnection cable, the gas valve will remain in the closed position and will require manual reset by depressing the reset button located on the top of the gas control box. The gas control box is powered by the 110v outlet behind the range.

L. Electric Shutoff:

1. Once activated via a low voltage interconnection cable it will close the electrical current to the range and must be manually reset. You can reset the shutoff by either unplugging it from the wall & plugging it back in, or by resetting the breaker for the range.

M. Owner’s Manual:

1. Each system shall be provided with a comprehensive owner’s manual that shall contain procedures for post cleanup, parts identification, a complete wiring diagram, system installation with pictorials for step by step procedures, system limitation, and inspection & maintenance requirements. Re-servicing/recharging procedures can also be contained in the owner’s manual.

N. Optional Equipment:

1. Manual Remote Pull Station

a. Device shall be U.L. Listed or Recognized
b. Component supplied complete with wire leads and listed with the residential system.

PART 3 – EXECUTION

3.01 PREPARATION

A. Coordinate work of this Section with other trades work.

B. Verify all fire department connection and valve requirements with the Sanford Fire Department.

C. Do not proceed with work without approval from the Sanford Fire Department.

3.02 INSTALLATION

A. Install all equipment and piping in accordance with manufacturer's instructions and in full compliance with NFPA 13 and NFPA 14. Work shall include complete coverage of the facility using a combination of wet-pipe and dry-pipe sprinkler systems and wet-pipe standpipes.

B. Provide double check valve backflow preventer assembly at sprinkler system water source connection with supervised resilient wedge OS&Y gate valves on each side.

C. Locate fire department connection with sufficient clearance from walls, and obstructions to allow full swing of fire department wrench handle.

D. Locate outside electric bell on building wall as indicated.

E. In all areas with acoustic or other ceiling systems, center heads in one direction in ceiling tile and provide piping offsets as required.

F. Apply masking tape or paper cover to ensure concealed sprinkler head cover plates do not receive field paint finish, provide factory painted white heads in areas where piping or ceilings and walls will be painted.

G. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

H. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient on dry-pipe systems and drain piping.

I. All piping in finished areas shall be concealed within building construction wherever possible. Coordinate with the General Contractor and all other Trades as required. No piping will be allowed to be exposed in finished areas (except in areas without finished ceilings) without written permission of the Architect.

J. Install piping to conserve building space, and to not interfere with use of space and other work. Coordinate as required with all other Trades.

K. Group piping whenever practical at common elevations; provide hangers and seismic restraints designed per NFPA 13 & NFPA 14 and per the local building code.

L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

M. Slope drain piping and arrange systems to drain at low points. All drains shall be directed to discharge at exterior grade.

N. Do not penetrate building structural members unless indicated.

O. Provide sleeves when penetrating footings, floors, and walls. Seal pipe and sleeve penetrations to achieve fire resistant equivalent to fire separation required.

P. Install valves with stems upright or horizontal, not inverted.

Q. Provide indicating; slow closing gate, ball, or butterfly valves for shut-off or isolating service.

R. Provide supervisory switches on all system control valves.

S. Provide drain valves at main shut-off valves, low points of piping and apparatus.

T. Hydrostatically test entire system, flow test all alarms.

U. A permanent placard shall be provided at the base of each riser stating the design criteria of the system for hydraulically designed systems.

3.03 SYSTEM DESIGN

Location	System Type/Hazard
Offices, general purpose classrooms, dining and areas of similar occupancy	Wet-pipe, Light Hazard. 0.10 gpm/sq.ft./1500 sq.ft.
Chemistry labs, biology labs, lab prep, general lab classrooms and kitchen service areas.	Wet-pipe, Ordinary Hazard, Group I. 0.15 gpm/sq.ft./1500 sq.ft.
Library stacks, mechanical rooms, storage rooms, electric rooms, stage.	Wet-pipe, Ordinary Hazard, Group II. 0.20 gpm/sq.ft./1500 sq.ft.
Automotive, building trades, CTE Exploratory, welding fabrication, precision manufacturing, incubator, firefighting science.	Dry-pipe, Ordinary Hazard, Group I. 0.15 gpm/sq.ft./1,950 sq.ft.

3.04 COORDINATION WITH ELECTRICAL CONTRACTOR

A. Coordinate with Electrical Contractor for interface of sprinkler system with building fire alarm system.

B. Coordinate with the Electrical Contractor to provide the following alarm zones to the fire alarm system:

1. Wet Sprinkler Zones
2. Dry Sprinkler Zones
3. Also all sprinkler and standpipe system trouble/tamper alarm signals.

3.05 TESTING

A. All sprinkler system piping and equipment installed under this Contract shall be tested per NFPA 13 and demonstrated to be fully operational.

B. All standpipe system piping and equipment installed under this contract shall be tested per NFPA 14 and demonstrated to be fully operational.

C. Testing procedures shall be witnessed by the Sanford Fire Department.

D. Furnish certified sprinkler system test reports to the Sanford Fire Department.

END OF SECTION

SECTION 22 01 00

BASIC PLUMBING REQUIREMENTS

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Basic Mechanical Requirements specifically applicable to Division 22 Sections, in addition to Division 01 – General Requirements.

1.02 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations.

B. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

C. All related Specification sections shall be used in conjunction with this Section.

1.03 WORK

A. Scope of work includes furnishing and installing equipment, other apparatus and accessories required for complete plumbing systems.

1.04 SUBMITTALS

A. Refer to Division 01 for submittal requirements. The following paragraphs supplement the requirements of Division 01.

B. Submit shop drawings and product data as requested by other Division 22 sections. All submittals to follow requirements of General Conditions, modifications to General Conditions, and Division 01.

C. The Contractor will be held responsible for checking and verifying all field measurements, and shall submit promptly, as to cause no delay in any work, shop drawings and schedules required for the work. The Contractor shall check and approve all submittals before forwarding to the Architect. All submittals shall be transmitted to the Architect using the submittal transmittal form contained in Division 01. The Architect will forward submittals to the Engineer. The Engineer will check and review the submittals with reasonable promptness, but only for conformance with design concept of the project and for compliance with information given in Contract Documents. The Contractor shall make any corrections required by the Engineer. The Engineer's review of submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications, unless he has, in writing, called the Engineer's attention to such deviations at the time of submission and has secured the Engineer's written approval. Additionally, the Engineer's review of submittals shall not relieve the Contractor from responsibility for any errors or omissions contained in the submittals.

D. At the onset of the submittal process the contractor shall develop and provide a Submittal Schedule indicating priorities and long lead-time items, so that the Engineer can anticipate and schedule appropriate review time. The Submittal Schedule shall be based upon equipment and material lead-times, “required by dates”, coordination with other trades, and delivery and rigging requirements. The schedule MUST include adequate time for the Engineer to provide an

appropriate review of the submitted materials, as well as time to allow for revisions and re-submittal if necessary.

1. Note that “appropriate review time” is considered to be a minimum of seven (7) business days and a maximum of fourteen (14) business days in the Engineer’s office; depending on quantity and complexity of submittals received.

E. When necessary, shop and setting drawings shall be based upon actual measurements taken at the site and upon other job conditions. Show any variations and revisions to Drawings or Specifications that are necessary for proper installation.

F. Submit copies of manufacturer's shop drawings showing illustrated cuts of item to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, installation instructions, wiring diagrams and controls and all pertinent information. Submit the quantity of copies indicated in Division 01.

G. At completion of construction, the Contractor shall furnish the Owner with one (1) unused copy of all reviewed shop drawings, manufacturer's diagrams, installation instructions, literature, etc., that were used in execution of the work.

H. The Contractor shall note that where more than one manufacturer's name is listed for the various major items of equipment and materials specified herein, the plans and specifications have been developed on the basis of equipment as manufactured by the first manufacturer name. Other manufacturers names are included to indicate the equipment manufactured by them may be considered acceptable for this project, provided that the equipment meets all requirements as to quality, size, and adaptability to space requirements, etc. It shall be the Contractor's responsibility to assure that the equipment, as manufactured by other than the first name manufacturer, shall meet all requirements as to quality, size, capacity, function, adaptability to space requirements, etc. The Engineer’s review of shop drawings for equipment as manufactured by other than the first named manufacturer shall in now way relieve the Contractor of this responsibility.

1.05 SUBSTITUTIONS

A. Any and all proposed substitutions must be approved by the Architect during the bid phase and must be indicated on the form of proposal. For specific substitution requirements, refer to Division 01.

B. Substitutions included in submittals which were not approved during the bid phase will be rejected.

1.06 COORDINATION

A. Well executed trade and system coordination are essential for this project.

B. The Contractor shall notify the Architect of conflicts which require ceiling heights to be lower than the heights indicated on the reflected ceiling plans. No work shall proceed in the areas of conflict without prior approval of the Architect.

C. Refer to Section 01 31 33 Building Information Modeling (BIM) for requirements pertaining to systems and element coordination, clash detection, and levels of documentation detail.

1. BIM for the coordination process shall be to a 400 Level of Development (LOD) in accordance with AIA E202. This level of development shall be considered suitable for fabrication and assembly by trade contractors and specialty fabricators in order to fabricate,

assemble and construct project components including mechanical, electrical, plumbing and fire protection (MEP/FP) systems.

D. Coordination drawings will be required for all work performed under this contract, as required and/or described in Division 01. Prepare and submit coordination drawings for work performed under Divisions 21 through 27 as specified in Division 01. Each contractor and associated sub-contractor shall be responsible for their respective coordination drawing effort.

1. As specified in Division 01:

   a. Prepare and submit 3-dimensional (3D) coordination and clash detection models and reports.
   a. Prepare and submit 2-dimensional drawings showing the installation intent; drawings are to be to a scale of 3/8" = 1'-0" or larger.

2. Detail mechanical, plumbing, fire protection and electrical system elements, components, equipment and materials in relationship with other systems, installations, and building components.
3. Dimension system elements and components off of column lines, and other fixed building features.
4. At a minimum, indicate the proposed locations of:

   a. Mechanical, fire protection and plumbing piping.
   b. HVAC ductwork.
   c. Electrical equipment, panel-boards, switch-gear, and controls.
   d. Cable trays and tel/data wire management systems.
   e. Major electrical, tel/data, and BAS conduit runs and conduit racks.
   f. Mechanical, electrical, plumbing and fire protection equipment and services.
   g. Control panels, motor-controllers and motor starters.
   h. Building automation system components.
   i. Access panels.

5. At a minimum, account for and show the following:

   a. Clearances for servicing and maintaining equipment, including space for disassembling equipment requiring periodic maintenance.
   b. Electrical Code required service clearances.
   c. Equipment connections and support details.
   d. Seismic bracing and anchor and guide locations.
   e. Pipe pitches, drip legs, low-point drains, and high-point vents.
   f. Other system installation and maintenance requirements.

6. Prepare reflected ceiling plans to coordinate and integrate installations.

   a. Show air outlets and inlets, light fixtures, fire alarm devices, audio-visual and communication systems components, access doors, and other above-ceiling and/or ceiling-mounted items.

7. Coordinate “in-wall” elements and systems. Coordinate all wall elevations.
8. Provide part plans, sections, elevation views, and other details as required to fully describe and coordinate installation requirements.

E. Carefully coordinate all cast-in-place concrete openings (slots, chases, holes, etc.). Obtain concrete form layouts and submittals from the General Contractor; provide comment as appropriate on the dimensional layout of openings and placement of reinforcing. Engage in this

process as soon as possible in order to avoid conflict with structural elements and to ensure openings are properly sized and located. Adjust mechanical work as necessary to accommodate structural requirements. Bring potential conflicts to the attention of the General Contractor, Architect and Engineer as soon as possible.

F. Avoid penetrations in shear walls and structural seismic elements (to the full extent practical).

1. Carefully coordinate any and all shear wall penetrations (if such cannot be avoided) with the Structural Engineer. Provide details of actual locations and required sizes of openings. Shear wall penetrations which do occur shall be kept to a minimum (both quantity and size). Bond beams shall not be penetrated unless such penetrations are specifically allowed and detailed by the Structural Engineer.

G. Carefully coordinate shafts, chases, slots, cored openings, and other vertical connections through the building and between floors.

H. Coordinate with all other trades as required, throughout the course of the project, in order to avoid conflicts and to promote the successful progression of work throughout the duration of the project.

I. Readily and actively participate in coordination meetings. Inform subcontractors, suppliers, vendors, etc., of coordination requirements and responsibilities. Inform the Owner well in advance of required shut-downs, service disruptions, system tie-ins or disconnections, etc. Schedule work sufficiently in advance to promote a smooth progression of work, and with sufficient time to redirect efforts if conflict with other's work is determined.

J. Maintain working clearances at above-ceiling components and devices requiring access and service (e.g., cable trays, air terminal control boxes, balancing valves, etc.). Coordinate with, and as necessary direct the work of, other trades to ensure proper above-ceiling access is maintained.

1. Coordinate to ensure piping, ductwork, ceiling supports, conduit and cable tray, wiring, miscellaneous hangers and supports, hanger rods, light fixtures, fire alarm devices, sprinkler piping and sprinkler heads, etc., are not mounted or installed in such a manner as to block ready access to above-ceiling components and devices requiring access.
2. Physically identify "no trespass zones" with tape, signs, or other markers in order to warn other trades to avoid spaces, locations and clearances which must be kept open.

K. Stagger duct and pipe supports, hangers, flanges, fittings, devices, etc., (both vertically and horizontally) as appropriate and necessary to avoid conflict and in order to provide for maximum space, head clearance, installation flexibility and access.

1. In order to obtain maximum possible head clearances and to the full extent practical, avoid aligning flanges, fittings, devices, etc., directly below structural beams and similar structural elements.

L. In order to resolve coordination difficulties and/or conflicts which cannot be otherwise resolved, structural beam penetrations may be allowed and only on a limited basis, and only with the review and approval of the Structural Engineer. If structural beam penetrations are required and allowed, the General Contractor will oversee the coordination and provision of such via shop fabrication and/or field cut openings. Any and all structural beam penetrations shall be in strict accordance with the Structural Engineer's written direction and details.

1. Carefully coordinate with structural openings in beams and other structural elements shown on the structural drawings. Review structural fabrication shop drawings and provide comment as appropriate on the dimensional layout of openings.

M. All under-slab piping, stub-ups, sleeves, pockets, recesses, etc., associated with the structural slabs must be precisely coordinated with the slab's structure and with above slab features and elements. Piping, conduit, equipment, devices, etc., set in or below the slab must be located with the aid of accurately dimensioned coordination drawings, which have been prepared in conjunction with the General Contractor, Division 21 through 27 contractors, the Architect, the Structural Engineer, the MEP/FP Engineer, etc.

N. Note that while all areas require careful coordination, the mechanical, electrical, plumbing, and fire protection systems in areas where systems and building structure will be exposed require precise coordination in order avoid conflict and to achieve the required/desired layout and clear heights. Carefully coordinate all systems with each other, as well as with structural and architectural elements in these areas.

1. Where mechanical, electrical, plumbing and fire protection system are to be exposed, coordinate and organize elements such that they are as high as possible, they appear regular and orderly, and they are parallel and plumb relative to major architectural features of the space; exposed elements must be laid out and installed in a manner consistent with the building/architectural geometry.
2. Where exposed, group and route system elements via common paths. Use common trapeze hangers and supports to group elements wherever possible.

1.07 PHASING AND SEQUENCING OF WORK

A. Refer to the General Conditions, other Division 01 sections, and to the Architect’s phasing description and/or plans, for necessary project phasing and work sequencing.

B. Coordinate with the General Contractor in order to determine all phasing and work sequence requirements and to schedule work.

C. Minimize noise, dust, dirt, and other potentially detrimental activities. Protect systems and system components from dust, dirt, water, damage, etc.

D. Continue to inform the General Contractor and Owner of work anticipated to take place each day and/or week, sufficiently in advance of the work, for comment and potential redirection of those activities to avoid conflict and/or disruption.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

1.09 REGULATORY REQUIREMENTS

A. Building Codes: Conform to the Maine Uniform Building Code which is based on the 2009 International Building Code with the State of Maine amendments.

B. Plumbing: Conform to the Maine State Internal Plumbing Code which is based on the 2009 Uniform Plumbing Code with the State of Maine Amendments.

C. Fire/Life Safety: State Fire Code as approved by the State of Maine Fire Marshal's Office.

D. Obtain permits and request inspections from authority having jurisdiction.

E. Comply with the requirements of the City of Sanford Inspectional Services Department.

1. Conform to all Codes, Requirements, and Rules and Regulations of the City of Sanford, and of the authority having jurisdiction. Comply with all City of Sanford amendments to applicable Codes and Standards.

F. Comply with the requirements and rules and regulations of the City of Sanford Health Department.

G. Refer to the Architect's building code summary and conform to the referenced Codes and Standards as appropriate.

H. Refer to the Structural Engineer's seismic design requirements and structural design criteria.

I. Obtain ALL permits and approvals, and request ALL inspections from the authority having jurisdiction, in a timely manner.

J. Submit appropriate close-out documentation to the authority(-ies) having jurisdiction at the conclusion of the project.

1.10 PROJECT/SITE CONDITIONS

A. Install work in locations shown on the Drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect before proceeding.

C. Before proceeding, determine all field conditions which will influence the installation of work; particular attention shall be given to structural work, construction sequence and phasing requirements.

1.11 RECORD DOCUMENTS

A. Refer to Division 01 for record document requirements. The following paragraphs supplement the requirements of Division 01.

B. Mark drawings to indicate revisions to piping and ductwork (size and location), both exterior and interior. Include locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair. Show actual equipment locations dimensioned from column lines, actual inverts and locations of underground piping, concealed equipment dimensioned to column lines, locations of mains and branches of piping systems, numbered valves and control devices, concealed unions, items requiring maintenance (i.e., traps, strainers, expansion compensators, tanks, air vents, etc.), and control system devices. Mark all change orders on the drawings.

C. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

D. Photograph concealed, buried, under-slab, built-in, or otherwise hidden installations, prior to concealment. Label each photograph with a type-written description of the subject at hand; include time, date, orientation, etc., of photograph. Photographs shall be digital format and shall be presented on CD-ROM discs, as well as in printed format, both in protective three-ring binders.

1.12 OPERATION AND MAINTENANCE DATA

A. Refer to Division 01 for operation and maintenance manual requirements. The following paragraphs supplement the requirements of Division 01.

B. The Contractor shall provide the following information in a bound manual:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Packing slips, shipping labels, bills of lading, etc., for materials and equipment delivered to and used on this project.

C. Two (2) copies of operations and maintenance data shall be submitted to the Architect for review: one (1) copy shall be returned to the Contractor (with any instructions for changes). After implementing any changes, five (5) copies of instructions covering all equipment shall be furnished to the Architect who will forward two (2) copies to the Owner for his information and use.

D. Append to manual, the name, address and telephone number of the Contractors and Subcontractors and for mechanical items, provide the name, address and telephone number of companies servicing installed equipment on a 24-hour basis.

1.13 COMMISSIONING

A. The Contractor performing work under Section 22 01 00 will be responsible to carry out the commissioning requirements and Owner's training specified in Division 01.

1.14 OWNER'S TRAINING

A. Owners training shall be executed as required by the project general conditions.

B. Training shall be presented to the owner and their designated representatives. Owner shall be given adequate notice of training sessions to allow for proper scheduling of desired participants.

C. Training shall not commence until after substantial completion, but shall be provided prior to acceptance by the Owner.

D. Develop a learning objective and teaching outline for each module. A module shall include but is not limited to the water service, backflow preventers, water distribution systems, domestic water heaters, thermostatic mixing valves, sewage ejectors and sump pumps. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.

d. Regulatory requirements.
e. Equipment function.
f. Operating characteristics.
g. Limiting conditions.
h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Project record documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

    a. Inspection procedures.
    b. Types of cleaning agents to be used and methods of cleaning.
    c. List of cleaning agents and methods of cleaning detrimental to product.
    d. Procedures for routine cleaning
    e. Procedures for preventive maintenance.
    f. Procedures for routine maintenance.
    g. Instruction on use of special tools.

8. Repairs: Include the following:

    a. Diagnosis instructions.
    b. Repair instructions.
    c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    d. Instructions for identifying parts and components.
    e. Review of spare parts needed for operation and maintenance.

E. Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

F. Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

G. A professional videographer who is experienced in recording demonstration and training events is required.

1.15 PRODUCTS

A. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air handling units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flange types and grooved pipe types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.

B. Provide products which are compatible within systems and other connected items.

C. Products shall be specifically suited to the intended application. When requested to do so, by the Architect or Engineer, provide written statements from the manufacturer indicating proper and/or suitable application of their products.

1.16 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

B. Do not allow nameplates, tags, labels, or other identifying or explanatory information to be painted over or otherwise obscured.

1.17 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly packaged and protected to prevent damage during shipment, storage, and handling. Damaged materials, equipment, devices and/or system components shall not be installed, and shall be removed from the job site. Materials, equipment, devices and/or system components damaged after installation shall be replaced, or repaired to “like new” condition. The Owner reserves the right to reject any and all damaged materials, equipment, devices and/or system components.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect equipment and materials from damage, rain, snow, water, dust, dirt, mud, over-sprays, paint, moisture and/or excessive humidity, excessive heat or cold, excessive handling, etc. Do not allow equipment and materials to be improperly stacked, rigged, moved, or handled. Do not allow equipment or materials to be exposed to adverse weather, or any other conditions which may degrade or otherwise diminish their value and/or impair their utility.

C. Coordinate deliveries of plumbing materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

D. Each contractor is responsible to protect their work from dust, dirt, water, spray, etc., and damage caused by other contractors. If the actions of one contractor are detrimental to the work of another contractor, it is the responsibility of each contractor to bring such to the attention of the General Contractor and the affected contractor, and to make provisions and accommodations to protect the “at risk” work.

1.18 ACCESSIBILITY

A. Install equipment and materials to provide required and/or recommended access for servicing and maintenance.

B. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Note that where access is required through general construction elements, the Division 22 through 27 Contractors are to furnish all required access doors for access to equipment and system components installed under those Divisions, and are to coordinate with the General Contractor regarding access door locations and installations.

1. Locations where access panels and doors are required include, but are not necessarily limited to, fire and smoke dampers, control dampers, balancing dampers, control valves, shut-off valves, service valves, balancing valves, air vents, drains, equipment, etc., installed above gypsum board ceilings (e.g., at Suite hallways), and behind gypsum board walls.
2. Carefully review architectural drawings and mechanical plans to determine locations where access panels and doors are required in general construction elements.

C. Access doors furnished by the Division 22 through 27 Contractors shall comply with the Architect’s specifications (refer to Section 08 31 13). Allow ample space for removal of all parts that require replacement or servicing; provide access panels or doors large enough to properly service or remove equipment and system components. The minimum access panel or door size shall be 14”x14”, unless space conditions prohibit such, in which case they shall be as large as practical.

D. ALL access panel and door sizes and locations shall be coordinated with, and approved by, the Owner and Architect. Contractor shall generate a drawing identifying the size and location of all proposed access panels for review and approval. Access panels and doors shall be installed in a neat, orderly, and symmetrical manner, so as to be as aesthetically pleasing and as unobtrusive

as possible. Carefully coordinate and align access panels and access doors with above ceiling and/or in-wall devices. Access panels shall not be located in common spaces.

1.19 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Particular attention is required with regard for rough-ins associated with under-slab and in-slab utilities, and devices.

C. Refer to equipment specifications in Divisions 02 through 27 for rough-in requirements.

1.20 PLUMBING INSTALLATIONS

A. Conform to the standards and requirements of the City of Sanford.

1. Obtain copies of these standards and requirements prior to commencing any work.

B. Coordinate plumbing equipment and materials installation with other building components and systems.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in cast-in-place concrete and other structural components, as they are constructed.

F. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

G. Coordinate the rigging, hoisting, lifting, and handling of materials and equipment with the General Contractor, the Owner, and other trades.

H. Coordinate the cutting and patching of building components to accommodate the installation of plumbing equipment and materials.

I. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

J. Carefully install plumbing equipment to facilitate routine maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Coordinate service access clearances with building components and other plumbing system components. Maintain operability and functionality of access doors and panels (for example, air handling unit access doors or VAV control box covers which can not be opened due to adjacent piping will be considered unacceptable).

K. Coordinate connection of plumbing systems with exterior underground and/or overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

L. Carefully coordinate the installation of plumbing system materials and equipment above ceilings with ceiling suspension systems, light fixtures, cable trays, piping, ductwork, structural elements, seismic bracing, etc.

1. The Contractor is responsible to layout and to install all systems in a neat, orderly, and workmanlike manner, in order to provide a high quality installation which includes maximum possible accessibility and future flexibility.
2. Coordinate, layout, and install systems so as to allow and/or maintain maximum possible ceiling heights, while maintaining ready accessibility. Coordinate with the General Contractor, and other trades to determine ceiling height and clearance requirements.

M. Inform the Architect and Engineer whenever an under-slab, in-wall and/or an above-ceiling inspection is possible or appropriate, so that a punch-list of concealed equipment, systems, devices, etc., can be performed prior to closing in. Provide a minimum of two-week notice prior to the need of an inspection. If an inspection is performed in response to a request, and the work is significantly incomplete, the contractor may be back-charged for time spent on a re-inspection.

N. Painting of Plumbing Systems and Components: Refer to Architect's painting requirements. Where exposed mechanical systems are to be painted, system components shall be fabricated, installed, cleaned and made ready for such. Coordinate with the Painting Contractor to ensure system components are properly cleaned and prepared to allow for proper application of paint. Where plumbing system components are not to be or should not be painted, coordinate with the Painting Contractor to ensure proper masking and/or other protection is provided; ensure masking and/or other protection is removed at the conclusion of the painting process. Protect plumbing systems and components which are not to be painted from overspray and/or misapplication.

1. Exposed items which may be painted include (but are not necessarily limited to):

   a. Sprinkler piping.
   b. Ductwork.
   c. Piping.
   d. Conduit.
   e. Work boxes.
   f. Valve boxes.
   g. Access doors.

1.21 REFERENCED SPECIFICATIONS

A. Refer to the following referenced specifications and all applicable sections to be included as part of the Division 22 scope of work:

1. Section 23 01 00 – Basic Mechanical Requirements
2. Section 23 12 00 – Mechanical Demolition
3. Section 23 12 10 – Expansion Compensation
4. Section 23 14 00 – Supports and Anchors
5. Section 23 17 00 – Motors and Variable Frequency Drives
6. Section 23 24 20 – Vibration Isolation
7. Section 23 19 00 – Mechanical Identification
8. Section 23 26 00 – Piping Insulation
9. Section 23 98 00 – Instrumentation
10. Section 23 99 00 – Testing, Adjusting, and Balancing

B. Referenced sections shall be included to provide a complete, functional and professionally installed plumbing system.

1.22 ELECTRICAL COORDINATION

A. Division 22 Responsibility:

1. Mount all electric power consuming equipment specified under Division 22; i.e., motors, and prewired control panels.
2. The electrical contractor shall be responsible for providing only the field wiring and equipment as indicated in the wiring schematics on the electrical drawings; any other wiring and/or equipment that is required and related to Division 22 work shall be the responsibility of the Plumbing Contractor.
3. Furnish all necessary wiring diagrams, instructions, advice, supervision, materials, labor, etc., as may be necessary to accomplish power wiring.
4. Furnish, install and take responsibility for accuracy and completeness of temperature control wiring, interlock wiring, and any other mechanical equipment wiring not shown on the electrical drawings.
5. Motor starters, disconnects, variable frequency drives, wiring, etc., not shown on the electrical drawings shall be provided by the Mechanical Contractor and shall comply with Division 26 requirements

B. Division 26 Responsibility:

1. Furnish and install, as indicated on the electrical drawings all motor overload protective devices, contactors, magnetic starters, complete with required pushbuttons, selector switches, and pilots.
2. Provide disconnect switches as indicated on the electrical drawings.
3. Provide all power wiring as indicated on the electrical drawings.

1.23 WARRANTIES

A. Refer to Division 01 for warranty requirements. The following paragraphs supplement the requirements of Division 01.

B. Compile and assemble all warranties for equipment specified in Division 22 into vinyl-covered three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Include product or equipment, date of beginning of warranty or bond, duration of warranty or bond, and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Provide extended warrantees for equipment and materials whose basic warranty will expire prior to the warranty period described in Division 01 because of the timing of shipment or installation. (For example, a piece of equipment with a one-year warranty which is installed 18 months prior to completion of the project shall be provided with an extended warranty to comply with the warranty period described in Division 01.) The extended warranty may be through the manufacturer or the installing contractor or vendor. However, all benefits of the original manufacturer's warranty shall be conveyed to the Owner for the specified warranty period, commencing with acceptance of the project by the Owner, or full beneficial use of the systems by the Owner.

1.24 GUARANTEE

A. The Contractor shall guarantee all work to be free from defects for a period of one (1) year after acceptance. Any and all work found defective or not in accordance with the Contract during this period shall be corrected promptly by the Contractor after written notification from the Owner. The Contractor shall repair or correct the work within ten (10) days of the written notification and if the Contractor does not comply, the Owner may have the work corrected and charge all such work to the Contractor.

1.25 REVIT FILES

A. Following the receipt of a written request from the Contractor, RFS will furnish REVIT electronic files for plumbing drawings. Signing of the Rist-Frost-Shumway Engineering, P.C. Electronic Document File/Digital License Agreement shall be considered a prerequisite for the release of electronic REVIT files.

B. Note that BIM for the design process is generally 300 Level of Development (LOD) in accordance with AIA E202. This level of development is typically considered to include model elements equivalent to traditional construction documents. 300 LOD BIM is suited to estimating, and basic construction coordination for clash detection, scheduling and project visualization.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 221113

FACILITY WATER DISTRIBUTION PIPING

(Trade Bid Required)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Furnish and install the pipe materials, fittings, and appurtenances of the type(s) and size(s), and in the location(s) shown on the Drawings and as specified herein. Comply with all applicable local, State and Federal regulations

1.02 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Section 312000 - Earth Moving

B. Section 312500 – Erosion and Sedimentation Control

1.03 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Supplementary conditions and General Requirements (if any), apply to the work specified in this Section.

B. City of Sanford Water District Specifications.

C. Section 1-B - School Bid Depository Condition and Regulations

1.04 SUBMITTALS

A. Product Data: Before delivering pipe to site submit name of proposed manufacturers for each type of pipe to Architect for review.

B. Submit manufacturer's certification that the product meets requirements of the Specification.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except where the type of class or use of pipe is explicitly indicated on plan or specified herein, the Contractor may provide any of the kinds of pipe specified. However, in the interest of future

maintainability, only one type of pipe will be approved for a given utility for general use in all those areas where the Contractor has choice. For any given pipe material, use pipe of the same manufacturer through the project.

B. Pipe and appurtenant materials for the extensions and service connections to the City of Sanford Water and Sewer District's main to shall conform to the specifications of the City of Sanford Water District's and requirements

C. If any discrepancy exists between Section 221113 and the City of Sanford Water District Specifications, the Water District's Specifications shall govern.

D. Pipe and fittings within the project shall conform to the Sanford Water District's standard specifications and requirements and applicable State and Federal Regulations. If any discrepancy exists between Section 221113 and the City of Sanford Water District's standard specifications and requirements, the Water District's Specifications shall govern

2.02 DUCTILE IRON PIPE

A. Ductile iron pipe shall be push-on type and meet requirements of AWWA/ANSI C111/A21.11 for push-on pipe. Pipe shall be cement lined to meet AWWA/ANSI C104/A21.4 with lining twice the thickness specified in the specifications or any revisions thereto, and coated twice with a bituminous seal coating acceptable to the U.S EPA for use in potable water piping. Pipe shall be delivered in uniform lengths. Pipe shall be U.S. or Canada manufactured and in full conformance with AWWA/ANSI C151/A21.51.

B. Outside of pipe to be bituminous coated with factory applied with minimum of 2 mils dry film thickness.

C. Joints shall meet requirements of AWWA C-111 (latest revision).

D. Interior seal coated, bituminous paint oil cut, emulsion not acceptable, thickness minimum of 2 mils dry film thickness.

E. Class 52 wall thickness, 6-inch diameter through 12-inch diameter inclusive.

F. State nominal laying length and mark shorter lengths near bell.

G. Mechanical joint pipe to be furnished with gland, gaskets and Cor-Ten bolts and nuts.

H. Acceptable Manufacturer: Atlantic States or approved equal.

2.03 DUCTILE IRON FITTINGS

A. All fittings shall be U.S. or Canada manufactured. Fittings shall be Ductile Iron, Class 350, and in full conformance with AWWA/ANSI C151/A21.51.

B. Fittings shall be cement lined AWWA C104 (latest revision) or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116.

C. Interior seal coated AWWA C104 with minimum of 4 mils dry film thickness.

D. Exterior bituminous coated, 4 mils minimum dry film thickness or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116.

E. Sleeves shall not be cement lined, but shall be bituminous coated inside to 4 mils dry film thickness. All sleeves shall be long body type.

F. Mechanical joint with accessories furnished: D.I. glands, gaskets, Cor-Ten T-bolts and nuts.

G. Pressure Ratings:

1. Class 350 pressure rating in accordance with AWWA C153 – 3”-24” sizes.

H. The “compact design” fittings must provide adequate space for the MJ joint and accessories to be installed without special tools (i.e. Lowell wrench can be used).

I. Acceptable Manufacturer: Tyler (Union), U.S. Pipe or approved equal.

2.05 PIPE AND FITTINGS FOR SERVICE CONNECTIONS

A. Size and type to meet local and State codes and standards.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A), water tube, annealed temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, compression fittings. Furnish only wrought-copper fittings if indicated.

C. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A), water tube, drawn temper.

1. Copper, Compression Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, compression fittings. Furnish only wrought-copper fittings if indicated.

2.06 FIRE HYDRANTS

A. Size and type to meet Sanford Water District Specifications.

B. Acceptable manufacturer: Mueller Super Centurion 250 A-421, per Sanford Water District Specifications, not substitutions.

2.07 GATE VALVES

A. Design:

1. Meet requirements of AWWA C-515.

2. Valves to be designed for minimum 250 psi working pressure and 300 psi testing pressure.

3. Interior Valves for Fire Protection System: Flanged joints with rising stem; furnish with post indicators.

4. Buried Valves: Mechanical joints, non-rising stem, turn right (clockwise) to open.

5. Bituminous coated.

6. UL listed and F.M. approved.

7. Design permits repacking in wide-open position while in service without leakage.

B. Fabrication:

1. Ductile iron resilient wedge type gate.

2. Cast manufacturer's name and catalog number in valve body.

3. Acceptable Manufacturer: AFC 2500 or approved equal.

2.08 VALVE BOXES

A. Acceptable Manufacturers: U.S. or Canadian made Bibby St. Croix, Tyler (Union) or approved equal product of the size indicated on the plans.

B. Design:

1. Ductile iron, bituminous coated, adjustable sliding type with heavy 2-inch drop type ductile iron covers.

2. Construct to prevent the direct transmission of traffic loads to the pipe or valve.

C. Fabrication:

1. The Upper or Sliding Section of the Box: 24-in. top, 36 in. bottom slide type, cast iron, provided with a flange having sufficient bearing area to prevent undue settlement.

2. The Lower Section of the Box: Designed to enclose the operating nut and stuffing box of the valve and rest on the valve bonnet.

3. Adjustable through at least 6 in. vertically without reduction of the lap between sections to less than 4 in.

4. Length: Shall be adjustable from 4.5 to 5.5 feet necessary to suit the ground elevation.

5. Inside Diameter of Box: At least 5¼ in.

6. Covers: Close fitting and substantially dirt-tight, and top of cover flush with the top of the box rim.

7. The word "WATER" shall be cast in the covers.

2.09 FLEXIBLE COUPLINGS

A. Ductile iron, as manufactured by Ford, Smith-Blair, Romac, or Architect approved equal.

2.10 BALL VALVE CORPORATION STOPS

A. Design: Meet AWWA standard designation C 800.

B. Bronze with a lapped, ground key.

C. Inlet Thread: Steep taper type.

D. Outlet Connections: As required to suit the type of pipe or tubing connected.

E. Threaded inlet and compression copper outlet with I.P. thread under tube nut, or an approved equal product.

2.11 CURB STOPS

A. Curb boxes shall have cast iron tops and bottoms with steel adjustable barrels that are good quality and of sufficient thickness (schedule 40) to allow the barrel to be cut and rethreaded. The adjustment shall be 4.5 to 5.5 feet. The curb box plug shall be brass with a rope thread and a pentagon nut. Boxes shall be protected with a bituminous coating and shall be complete with 1/2-inch diameter by 24-1/16 inch bevel on each side of rod. Rods shall be of stainless steel and have a brass cotter key.

B. Acceptable Manufacturers: Mueller, Ford or McDonald Brass or approved equal product manufacturer. United States or Canadian manufactured only.

2.12 TAPPING SLEEVES AND VALVES

A. Acceptable Manufacturers: Mueller Co. or A.P. Smith, or Architect approved equal. United States or Canadian manufactured only.

B. Design: Meet the latest AWWA Specifications.

C. Fabrication:

1. Tapping Sleeves:
   a. Two-part castings, flanged on the vertical centerline.
   b. Surface area of each flange: Thoroughly machine.
   c. Sleeve flanges: Fit with stainless steel tapping sleeves, covering the entire surface area of each flange and providing a watertight join for full length of the sleeve.
   d. Bolts used to assemble the sleeves: Pass directly through each flange and through each gasket.
   e. Provide with raised beads at the base of each bell, to aid in centering the sleeve on the pipe and to provide a stop for caulking.
   f. Sleeve outlets: Provide counterbored flanges to insure proper centering of the tapping valve.

2. Tapping Valves:
   a. Flanged by mechanical joint.
   b. Meet specifications for gate valves.

3. Installing: Check the dimensions of the pipe on which the tapping sleeves are to be installed, prior to ordering the sleeve.

2.13 PIPE INSULATION

A. Styrofoam SM insulation as manufactured by Dow Chemical Co.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install all pipe and fittings in strict accordance with the manufacturer's instructions and recommendations, and in conformance with Sanford Water District's standards.

2. Install all pipes and fittings in accordance with the lines and grades shown on the Drawings and as required for a complete installation. Minimum depth of cover for water main shall be 5' - 6".

3. Install adapters, as required, when connecting pipes constructed from different materials.

B. Pipe Laying:

1. Firmly support the pipe and fittings on bedding material as shown on the Drawings and as specified in the appropriate Sections of these Specifications.

2. Do not permanently support the pipe or fittings on saddles, blocking stones, or any material which does not provide firm and uniform bearing along the outside length of the pipe.

3. Thoroughly compact the material under the pipe to obtain a substantial unyielding bed shaped to fully support the pipe.

4. Excavate suitable holes for the joints so that only the barrel of the pipe received bearing pressure from the supporting material after placement.

5. Lay each pipe length so it forms a close joint with the adjoining length and bring the inverts to the required grade.

6. Do not drive the pipe down to grade by striking it with a shovel handle, timber, rammer, or any other unyielding object.

7. When each pipe length has been properly set, place and compact enough of the bedding material between the pipe and the sides of the trench to hold the pipe in correct alignment.

8. After filling the sides of the trench, place and lightly tamp bedding material to complete the bedding as shown on the Drawings.

9. Take all necessary precautions to prevent flotation of the pipe in the trench.

C. Temporary Plugs:

1. When pipe installation work in trenches is not in progress, close the open ends of the pipe with temporary watertight plugs.

2. If water is in the trench when work is resumed, do not remove plugs until all danger of water entering the pipe is eliminated.

3. Do not use the pipelines as conductors for trench drainage during construction.

D. Jointing Push-On Pipe:

1. Connect pipe in accordance with the latest manufacturer's instructions and recommendations.

2. Clear each pipe length, coupling and fitting of all debris and dirt before installation.

3. Shove home each length of pipe against the pipe previously laid and hold securely in position. Do not pull or cramp joints.

4. Make all pipe joints as watertight as possible with no visible leakage and no sand, silt, clay, or soil of any description entering the pipeline at the joints.

5. Immediately after making a joint, fill the holes for the joints with bedding material, and compact.

E. Jointing Bolted Joints:

1. Before the pieces are assembled, remove rust-preventative coatings from machined surfaces.

2. Pipe Ends, Sockets, Sleeves, Housings, and Gaskets: Thoroughly clean and smooth burrs and other defects.

F. Jointing Mechanical Joints:

1. Thoroughly brush surfaces against which the gasket will come in contact with a wire brush prior to assembly of the joint.

2. Clean and lubricate the gasket, bell, and spigot by washing with soapy water.

3. Slip gland and gasket, in that order, over the spigot, and insert the spigot into the bell until it is correctly seated.

4. Seat gasket evenly in the bell at all points, centering the spigot, and press the gland firmly against the gasket.

5. After all bolts have been inserted and the nuts have been made up finger tight, progressively and uniformly tighten diametrically opposite nuts all around the joint to the proper tension by means of a torque wrench.

6. The correct range of torque as indicated by a torque wrench and the length of wrench (if not a torque wrench) used by an average man to produce such range of torque, is as follows:

TORQUE RANGE VALUES

Range of torque	60-90 ft.-lb.
Length of wrench	10 in.

7. If effective sealing of the joint is not attained at the maximum torque indicated above, disassemble the joint, thoroughly clean, and reassemble.

8. Do not overstress bolts to tighten a leaking joint.

G. Pipe Cutting:

1. Cut in accordance with manufacturer's recommendations.

2. Cut the pipe with a hand saw, metal-inserted abrasive wheel (except asbestos-cement pipe), or pipe cutter with blades (not rollers).

3. Examine all cut ends for possible cracks caused by cutting.

H. Pipe Insulation:

1. Install 2 in. thick x 4 ft. wide between pipe and culvert or over pipe when noted on plans.

2. Between culvert and pipe, extend insulation 6 ft. each side of the culvert along the pipe.

3. For dual pipe trenches the insulation shall be 8 ft. wide.

4. Provide 6 in. sand blanket above and below insulation or as shown on Drawings.

I. Pipe Deflection Allowances: Per manufacturer's recommendations or Sanford Water District recommendations, whichever is more stringent.

J. Valve Installation:

1. Install in accordance with the specifications for the pipe to which they are to be connected.

2. Make up valve joints in accordance with the Contract Drawings.

3. The valves shall bear no stresses due to loads from the adjacent pipe.

4. Inspect, clean, and lubricate before installation.

K. Bracing and Blocking:

1. Block and anchor all bends, 22½° or greater, tees, plugs, etc. with concrete to prevent movement of the pipe in the joints due to internal or external pressures.

2. Use thrust blocks behind all hydrants.

3. Use 2'x2'x4' concrete blocks manufactured from Pepin Concrete or approved equal. If blocks are poured, wrap joints and bolts with poly before pouring concrete.

4. Place concrete around fittings to the walls of the trench, as shown on the Drawings, so placed that joints may be caulked or tightened, if necessary.

5. Do not backfill until the concrete has set.

6. If the soil does not provide firm support for thrust block placement, provide retainer clamps and tie rods as shown on the Drawings and/or directed by the Owner's Representative.

7. Thrust restraint glands for mechanical joint fittings manufactured by Megalug or Grip Ring.

L. Hydrant Installation:

1. Set hydrants, buried valves and valve boxes plumb, and center with each valve box directly over the valve.

2. Carefully tamp earth fill around the valve box to a distance of 4 ft. on all sides of the box, or to the undisturbed trench face, if less than 4 ft.

3. Set as shown on the Drawings or as directed by the Architect.

4. Clean interiors of all foreign matter before installation and inspect in opened and closed positions.

M. Air Vents and Blowoffs, Corporation Stops, Curb Stops, Valve Boxes, Copper Tubing and Styrofoam Insulation: Install in accordance City of Sanford Water District requirements, the Drawings and as directed by the Architect.

N. Vertical Separation From Sanitary Sewer:

1. Whenever water mains must cross sewers, lay at such an elevation that the top of the sewer is at least 18 in. below the bottom of the water main.

2. When the elevation of the sewer cannot be buried to meet the above requirements, center one full length of water main over the sewer so that both joints will be as far from the sewer as possible.

O. Water Service Leads and Stops:

1. Provide and install corporation valves, water service leads, and curb stops for proposed building connections as shown on the Drawings, or where directed by the Architect.

3.02 PRESSURE TESTING AND DISINFECTION

A. Pressure testing and disinfection shall be in accordance with AWWA C600 and AWWA C651 standards.

B. Pressure testing and disinfection shall be performed in strict accordance with Sanford Water District requirements.

C. Pressure testing and disinfection shall be performed in the presence of the representative of the City of Sanford Water District and the Architect.

END OF SECTION

ATTACHMENT A

Sanford Water District Water Piping Specifications

SANFORD WATER DISTRICT
WATER PIPING SPECIFICATIONS

1. WATER MAIN PIPE

Water main pipe shall be Ductile Iron pipe, push-on type and meet AWWA/ANSI C111/A21.11 for push -on pipe. Pipe to be designed as follows

PIPE SIZE	THICKNESS IN INCHES	THICKNESS CLASS	RATED WORKING PRESSURE
6”	0.31	52	350
8”	0.33	52	350
12”	0.37	52	350

Water pipe shall be cement lined AWWA/ANSI C-104/A21.4 with the lining twice the thickness specified in specifications or any revisions thereto, and coated twice with a bituminous seal coating. The bituminous coating shall be acceptable to the U.S. EPA for use in potable water piping. Outside of pipe to be bituminous coated. The pipe shall be delivered in uniform lengths. Pipe shall be North American manufactured. Pipe shall be manufactured in full conformance with AWWA/ ANSI C151/A21.51.

Accepted Manufacturer:
- **a.)** Atlantic States
- **b.)** Or approved equal

2. WATER MAIN FITTINGS (TEES, ELBOWS, ECT.)

All fittings shall be North American. Fittings shall be Ductile Iron, Class 350, and mechanical joint to be used with ductile iron pipe, and be supplied complete with all accessories, and are produced in strict accordance with all applicable terms and provisions of AWWA/ANSI C-153/A21.53

Approved Manufacturers:
- **b.)** Tyler (Union)
- **c.)** U.S. Pipe
- **d.)** Or approved equal

3. WATER MAIN COUPLINGS

Couplings center sleeve shall be Ductile iron pipe per ASTM A536, Grade 65-45-12. End Rings shall also be Ductile iron meeting or exceeding ASTM536, Grade 65-45-12. Gasket SBR rubber for water service. Meets or exceeds ASTM D2000

MBA 710. Bolts and Heavy Hex Nuts. High strength, low alloy steel, trackhead bolts. Steel meets AWWA C111. Finish Shop coat paint. Nylon, epoxy.

Approved Manufacturer:

b.) Ford
b.) Smith-Blair
c.) Romac
d.) Or approved equal

4. WATER MAIN GATE VALVES

Gate valves shall be North American. Shall be ductile iron body (full wall) resilient seat wedge Ductile iron per AWWA C-515. O-rings type stuffing box with double buna o-rings, 2" operating nut, mechanical joint ends, with accessories. Valve body and bonnet shall be fusion bonded epoxy coated inside and out per AWWA C-550. Valves meet or exceed the requirements of AWWA C-515 and will be UL listed and FM approved. Valves shall be designed for 250 PSI working and 300 PSI test pressure and shall be **open right** if specified for **Sanford** and **open left** if specified for **Springvale.**

Accepted Manufacturer:

a.) AFC 2500
b.) Or approved equal

5. VALVE BOXES

Valve boxes shall be Ductile iron, Bituminous coated, adjustable sliding type with heavy 2" drop type ductile iron covers. Length shall be adjustable from 4-1/2 to 5-1/2 feet. Top barrel shall be non - flange design. The base shall be bell type design. North American made.

Approved Manufacturer:

a.) Bibby St'Croix
b.) Tyler (Union)

6. HYDRANTS

The **Sanford Water District** has standardized on the following model.

Make and Model:	Mueller Super Centurion 250 A-421
Threads:	National Standard
Outlets:	Two 2-1/2" diameter hose connections

	One 4-1/2” diameter steamer connection
Valve Opening:	4-1/2” diameter (non draining)
Hub:	Mechanical Joint W/Accessories (aqua grip)
Depth of Bury:	5’ - 6”
Direction of Opening;	Open Right (**Sanford**)
	Open Left (**Springvale**)

Hydrants shall be designed for 250 PSI working pressure and shall conform in every respect to the AWWA latest standards. Hydrants shall be given two coats of quality paint before shipment.

Accepted Manufacturer: Mueller

7. **COPPER AND BRASS GOODS** (Service Lines)

a.) Copper Pipe shall be type K Coils. (60’ lengths)
b.) Corporations stop shall be ball valve style with AWWA 800 tapered threads and a compression end CPPJ x CPPJ as manufactured by Ford or approved manufacturer.
c.) Curb stops shall be brass, ball valve style, open left, no waste port and have compression type ends. As manufactured by Ford or approved manufacturer.

Approved Manufacturer:
a.) Ford
b.) McDonald Brass Co.

8. CURB BOXES

Curb boxes shall have cast iron tops and bottoms with steel adjustable barrels that are good quality and of sufficient thickness (schedule 40) to allow the barrel to be cut and rethreaded. The adjustment shall be 4-1/2 - 5-1/2 feet. The curb box plug shall be brass with a rope thread and a pentagon nut. Boxes shall be protected with a bituminous coating and shall be complete with 1/2” dia. x 24” x 1/16” bevel on each side of rod. Rods shall be of stainless steel and have a brass cotter key.

Approved Manufacturers

a.) Bibby St’ Croix
b.) Clow
c.) Mueller
d.) Or approved Manufacturer

9. SERVICE SADDLES

Service saddles shall have a ductile iron body per ASTM A536. The saddle shall have an outlet for the service connection that will allow an NPT or AWWA thread to be tapped into it. The saddle shall have two stainless steel bales. Bales, nuts and washers 304 Stainless Steel. Nuts fluoropolymer coated.

The gasket shall be a TaperSeal outlet gasket that has an hydro-mechanical lip that seals better on the pipe surface as the line content pressure increases. The gasket shall be made of Nitrile (Buna N) and NSF 61 listed. The gasket shall be compounded to resist: water, oil acids, alkalies, most (aliphatic) hydrocarbon fluids and many other chemicals. The gasket shall have a temperature range of -20ºF to +180ºF. The gasket shall be fully cemented into a cavity to hold it in place around the outlet during installation.

Approved manufacturer(s):

Smith-Blair
Or approved equal

Size (inches)	O.D. Range (inches)
4-5	4.74-5.14
6	6.84-7.60
8-10	8.54-10.10
12-14	12.62-14.32

SECTION 221300

SEWERS, DRAINS AND SITE PIPING
(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 1-B - School Bid Depository Condition and Regulations

1.02 SUMMARY

A. This Section includes the following:

1. Provide storm drain system and sanitary sewer foundation drainage system and miscellaneous site piping by means of trenched or trenchless installation, casing pipe, service leads, hereinafter referred to as "pipe" as shown on the plans, details, and specified herein. This section includes:
   a. Storm drain pipes
   b. Subdrainage pipe
   c. Sanitary Sewer pipe
   d. Electrical/telecom conduit
   e. Miscellaneous site piping
   f. Stormwater Treatment Chambers

C. Related Work Specified in Other Sections:

1. Section 312000 “Earthwork” includes excavation, bedding, and backfill.
2. Section 331000 ”Manholes, Catch Basins and Precast Concrete”

D. Related Documents

1. Sanford Sewerage District Standard Specifications
2. Explorations and Geotechnical Engineering Services report prepared by S.W. Cole Engineer, Inc. dated October 14, 2015.

1.03 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, and accessories.

B. Manufacturer’s Certificate: Certify that products meet or exceed specified local requirements.

C. Shop drawing by Manufacturer of Stormwater Treatment Chamber System

1.04 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. General: Provide fittings of same type and class of materials as pipe. Provide commercially manufactured wyes or tees for service connections. Fittings must have single piece gasket.

B. Footing Drainage Pipe:

1. Perforated and solid pipe for subsurface drains shall be heavy-duty corrugated polyethylene tubing conforming to ASTM F 405. Pipe and fittings shall be made of polyethylene compounds that meet or exceed the requirements of Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM D 1248. The pipe and fittings shall be free of foreign inclusions, cracks, creases, unpigmented or nonuniformly pigmented areas, or other visible defects. Fittings and/or couplings shall be split and/or screw-on with corrugations to match the pipe corrugations. Fittings supplied by manufacturers other than the manufacturer of the pipe shall not be used.

2. Perforated and solid pipe for subsurface drains shall be PVC meeting ASTM D3034 or ASTM D3033, strength requirement SDR 35, push-on joints ASTM D3212, gaskets ASTM F-477. The pipe and fittings shall be free of foreign inclusions, cracks, creases, unpigmented or nonuniformly pigmented areas, or other visible defects. Fittings and/or couplings shall have push-on gasketed joints. Fittings supplied by manufacturers other than the manufacturer of the pipe shall not be used.

C. Storm Drain Pipe:

1. Corrugated smooth interior polyethylene pipe conforming to AASHTO Designation M252 and M294 equal to HI-Q pipe as manufactured by Hancor, Inc., or ADS N-12 as manufactured by Advanced Drainage Systems, Inc. Joints shall be bell-and-spigot meeting the watertight requirements of AASHTO M252 or AASHTO M294. Watertight joints shall meet the ASTM D3212 10.8 psi (74kPa) laboratory test. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

2. Reinforced Concrete Pipe: ASTM C 76, Class IV unless another class type is required by depth of burial, installed with flexible plastic, bitumen gaskets at joints.

a. Gaskets: ASTM C443-07. Installed in strict accordance with pipe manufacturer's recommendations.

D. Sewer Pipe:

1. All sewer pipe construction shall comply with the standards and specification of the Sanford Sewerage Districts.

2. PVC meeting ASTM D3034 or ASTM D3033, strength requirement SDR 35, push-on joints ASTM D3212, gaskets ASTM F-477.

E. Electric/Tel-Data Conduit: Schedule 40 PVC pipe.

2.02 STORMWATER TREAMENT CHAMBERS

A. Chambers shall be StormTech SC-740, as manufactured by Stormtech, A Division of ADS, Inc. of 70 Inwood Road Suite 3, Rocky Hill, CT 06067 (888)892-2694 or engineer approved equal.

B. Chambers shall conform to the requirements of ASTM F2418, "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers."

C. Only chambers that are approved by the engineer will be allowed.

D. The chamber manufacturer shall provide design data that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. The 50-year creep modulus data specified in ASTM 2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.

E. Installation shall be in accordance with the details shown on the drawings and shall be in accordance with the manufacturer's latest installation instructions.

F. Chamber rows shall provide continuous, unobstructed internal space with no internal support panels in order to provide ease of access for inspection and maintenance functions.

G. All stormwater chamber systems shall incorporate designated chamber rows enclosed in geotextile fabric for sediment capture and maintenance. The fabric shall be located as per the manufacturer's details and shall be as follows:

1. Fabric between the chamber bottom and the stone foundation shall be AASHTO M288 Class 1 Woven for stabilization and filtration.
2. Fabric between the top of the chamber and the embedment stone shall be AASHTO M288 Class 2 Non-woven for separation.

H. Chamber providers other those approved must be approved by the Architect. Approved chamber providers are:

Stormtech, A Division of ADS, Inc (StormTech Chambers) 70 Inwood Drive, STE 3 Rocky Hill, CT 06067 (888)892-2694	Advance Drainage Systems, Inc. (StormTech Chambers) 4640 Trueman Boulevard Hilliard, Ohio 43026 (800) 821-6710

2.03 MISCELLANEOUS

A. Flexible Couplings:

1. Non-pressure: Neoprene sleeve with stainless steel bands Architect approved equal to those manufactured by Fernco.
2. Pressure: Equal to Rockwell cast couplings.

B. Insulation: Styrofoam SM as manufactured by Dow Chemical.

PART 3 - EXECUTION

3.01 INSTALLATION OF GRAVITY PIPE AND FITTINGS

A. Methods: Install in accordance with manufacturer's recommendations. Use a laser beam for line and grade unless otherwise permitted by the Engineer. Secure each length of pipe with bedding before placing next length. Plug open ends when work is suspended. Bed pipe as shown on drawings. A 30-inch minimum cover over the top of PVC pipe should be provided before the trench is wheel-loaded.

B. Grade and Line: Lay pipe to line and grade shown on the drawings. If grade is not shown, determine elevations of start and finish points for each run of pipe. Lay pipe to a uniform grade between these points.

C. Line and grade may be adjusted by the Engineer as required by field conditions.

D. Conditions: Lay pipe in the dry. Do not use installed pipe to remove water from work area.

E. Flush all pipes and remove debris. Flushing method approved by Architect. Gravity flushing is not acceptable.

F. Connections to manholes and catch basins: Provide short length of pipe so that joints are located within 3 feet of inside surface of manholes and catch basins for other than PVC pipe.

3.02 INSTALLATION OF REINFORCED CONCRETE PIPE

A. Reinforced concrete pipe shall be obtained only from a manufacturer of established good reputation in the industry. The pipe shall have a smooth and even interior surface, free from projections, indentations, or irregularities of any kind.

B. The joint shall be such that, when joined, the pipes will form a continuous and uniform line without projections, off-sets or irregularities and be capable of satisfying the specified leakage requirements.

C. Pipes shall be joined with rubber or rubber type gaskets that conform to the requirements established in ASTM Designation 443-67.

D. Each length of pipe shall be provided with proper ends made either of concrete formed on machined rings to ensure accurate joint surfaces or of metal rings. The diameters of the joints surface, depended upon to compress the gasket, shall not vary from the theoretical diameters by more than 1/16 inch. The joint shall be sealed by the rubber gasket so that the joint will remain tight under all conditions of service.

E. The rubber gasket shall be applied in accordance with the manufacturer's recommendations.

F. After the pipes are aligned in the trench and are ready to be jointed, all joint surfaces shall be cleaned. Immediately before jointing the pipe, the inside surface of the groove shall be thoroughly lubricated with a recommended lubricant. Pipe shall then be coupled immediately by carefully pushing each pipe into place without damage to pipe or gasket. The position of the gasket in the joint shall then be inspected to be sure it is properly put together and is tight.

G. Pipes shall be coupled by any suitable arrangement of come-along, winch, jack, or other power equipment that can exert sufficient force to couple pipe to its tightest position.

H. All pipe thirty-six inches (36-inch) in diameter or larger shall be sealed on the inside with cement mortar or with gunite by the grout-weld method using a pneumatic machine of the Nicholson, Bondactor, or equal type. Cement mortar if used shall be applied by trowel and the joint shall be thoroughly filled and finished smoothly with the inside surface of the pipe. The grout-weld seal shall be applied only by experienced and skilled workmen in accordance with the instructions of the manufacturers of the machine.

I. The pipe shall be laid accurately to line and grade. Pipe bedded in compacted crushed stone shall not be supported on blocking, wedges, brick, or anything except the bedding material. Pipe on concrete cradle shall be supported on solid concrete blocks or precast concrete saddles which become part of the completed cradle.

J. Each length of pipe shall be shoved home against the pipe previously laid, and held securely in position. Joints shall not be "pulled" or "cramped". Holes provided for jointing shall be filled and compacted.

K. Pipe from which a core has been cut and the resulting hole repaired shall be placed with the cored hole located forty-five degrees above or below the horizontal centerline of the pipe.

L. To prevent the entrance of earth and other materials when pipe laying is not actually in progress, the open ends of pipe shall be closed by suitable temporary bulkheads. The Contractor shall take all necessary precautions to prevent floatation of the pipe because of flooding of the trench. If water is in the trench when work is resumed, the bulkheads shall not be removed until the danger of earth and other materials entering the pipe has passed.

M. All pipe joints and structures shall be made water tight. There shall be no visible leakage, spurting or gushing of water, sand, silt, clay or soil of any description entering the pipe lines at the joints or structures. Where there is evidence of water or soil entering the pipeline, connecting pipes or structures, defects shall be repaired.

3.03 INSTALLATION OF PVC SEWER PIPE

A. Pipes shall be coupled by any suitable arrangement of come-along, winch, jack, or other power equipment that can exert sufficient force to couple pipe to its tightest position.

B. All pipe thirty-six inches in diameter or larger shall be sealed on the inside with cement mortar or with gunite by the grout-weld method using a pneumatic machine of the Nicholson, Bondactor, or equal type. Cement mortar if used shall be applied by trowel and the joint shall be thoroughly filled and finished smoothly with the inside surface of the pipe. The grout-weld seal shall be applied only by experienced and skilled workmen in accordance with the instructions of the

manufacturers of the machine.

C. The pipe shall be laid accurately to line and grade. Pipe bedded in compacted crushed stone shall not be supported on blocking, wedges, brick, or anything except the bedding material. Pipe on concrete cradle shall be supported on solid concrete blocks or precast concrete saddles which become part of the completed cradle.

D. Each length of pipe shall be shoved home against the pipe previously laid, and held securely in position. Joints shall not be "pulled" or "cramped". Holes provided for jointing shall be filled and compacted.

E. Pipe from which a core has been cut and the resulting hole repaired shall be placed with the cored hole located forty-five degrees above or below the horizontal centerline of the pipe.

F. To prevent the entrance of earth and other materials when pipe laying is not actually in progress, the open ends of pipe shall be closed by suitable temporary bulkheads. The Contractor shall take all necessary precautions to prevent floatation of the pipe because of flooding of the trench. If water is in the trench when work is resumed, the bulkheads shall not be removed until the danger of earth and other materials entering the pipe has passed.

G. All pipe joints and structures shall be made water tight. There shall be no visible leakage, spurting or gushing of water, sand, silt, clay or soil of any description entering the pipe lines at the joints or structures. Where there is evidence of water or soil entering the pipeline, connecting pipes or structures, defects shall be repaired

3.04 INSTALLATION OF HIGH DENSITY POLYETHYLENE PIPE

A. Install in strict accordance with pipe manufacturer’s recommendations and in accordance with general pipe installation specifications included in Paragraph 3.01

B. Joints shall be constructed in accordance with manufacturer's installation instructions.

C. All Bell-and-Spigot pipe joints shall be thoroughly cleaned. Joint lubricant, supplied by the manufacturer, shall be liberally applied to the entire interior of the bell and gasket on the spigot prior to assembly.

3.05 STORMWATER TREATMENT CHAMBERS

A. Install as shown on the plans and in strict accordance with manufacturer's recommendations.

3.04 TESTING OF SANITARY SEWERS

A. General: Test all sanitary sewer pipes after backfilling.

B. Gravity Sewer – Cleaning and Testing

1. After completing backfill of the wastewater line, the Contractor shall, at no additional cost to the Owner, conduct a line acceptance test using low pressure air. The test shall be performed according to stated procedures and in the presence of the Engineer
2. Cleaning & Testing Piping – General:

a. Thoroughly clean all piping prior to testing. Remove all dirt, dust, oil, grease and other foreign material. Exercise care while cleaning to avoid damage to linings and coatings.

b. When the installation is complete, test all pipelines in the presence of the Sanford Sewerage District and in accordance with the requirements of the local and state plumbing codes and the appropriate sections of the Sanford Sewerage District Specifications, at the Contractor's expense. When requested by the Sanford Sewerage District or local plumbing inspector, building gravity drains shall be tested prior to backfilling or concealing. All other piping must be tested after backfilling.

3. Force main Hydrostatic Pressure Test:

a. The section of pipe to be tested shall be filled with water of approved quality, and all air shall be expelled from the pipe. If blowoffs are not available at high points for releasing air the Contractor shall make the necessary excavations, backfilling and taps at such points and shall plug said holes after completion of the test.

b. The section under test shall be maintained full of water for a period of 24 hours prior to the combined pressure and leakage test being applied.

c. Perform pressure and leakage test at the test pressure shown on the Pipe Schedule. If no test pressure is indicated, perform pressure and leakage test at 1-Yz times the maximum system pressure or 100 psi whichever is greater (based on the elevation of the lowest point of the section under test and corrected to the gauge location).

d. While maintaining this pressure, the Contractor shall make a leakage test by metering the flow of water into the pipe. If the average leakage during a two-hour period on buried pipelines exceeds a rate of 10 gallons per inch of diameter per 24 hours per mile of pipeline the section shall be considered as having failed the test. All pipes within structures and chambers and all flanged joints shall have no visible leakage.

e. If the section fails to pass the pressure and leakage test, the Contractor shall do everything necessary to locate, uncover, and repair or replace the defective pipe, fitting, or joint, all at his own expense and without extension of time for completion of the work. Additional tests and repairs shall be made until the section passes the specified test.

4. Connection to Work by Others.

a. If work involves connection of pipe lines to pipes or structures provided by others, pressure tests pipe line prior to making connection.

b. After successfully passing the pipe line pressure test, make the necessary connections to the work by others, and pressure test connection.

c. The connection shall be pressurized to the pipe line test pressure, for a minimum of 4 hours. The connection shall have no visible leakage.

d. Correct any leakage at no cost to the owner and retest until connection passes.

5. Final Sewer Testing

a. Final sewer testing work includes the performance of testing and inspecting each and every length of sewer pipe, pipe joints and each item of appurtenance construction.
b. Perform testing at a time acceptable to the Sanford Sewerage District, which may be during the construction operations, after completion of a substantial and convenient section of the work, or after completion of pipe laying operation.
c. Contractor to provide all labor, pumps, pipe, connections, gages, measuring devices and all other necessary apparatus to conduct tests.
d. Perform tests in accordance with Sanford Sewerage District Specifications for Final Sewer Testing.

C. Deflection Test for PVC gravity sewer pipe: Test 100% of pipe with a "GO-NO-GO" gauge allowing a 5% maximum deflection.

3.03 UTILITIES TO BE ABANDONED

A. Closing Abandoned Utilities: Close open ends of abandoned underground utilities which are not indicated to be removed. Provide sufficiently strong closures acceptable to Engineer to withstand hydrostatic or earth pressure which may result after ends of abandoned utilities have been closed.

3.04 INSULATION

A. Install insulation as shown on Drawings.

END OF SECTION

SECTION 221301

CHECK VALVES
(Trade Bid Required)

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submit product literature that includes information on the performance and operation of the valve, materials of construction, dimensions and weights, elastomer characteristics, headloss, flow data and pressure ratings.

B. Provide shop drawings that clearly identify the valve materials of construction and dimensions.

1.2 QUALITY ASSURANCE

A. Manufacturer

1. Supplier shall have at least ten (10) years of experience in the design and manufacture of elastomeric check valves.

2. Manufacturer shall have designed, fabricated and have at least five (5) current installation of aelastomeric check valves in the 72" (1800mm) size. Manufacturer must provide documentation, including project name, location, and references.

3. Manufacturer shall have conducted independent hydraulic testing to determine headloss, jet velocity and vertical opening height characteristics on a minimum of three (3) sizes of CheckMate™ valves ranging from 6" (150mm) through 24" (600mm). The testing must have been conducted for free discharge (pressurized and open channel flow discharging to atmosphere) and submerged conditions.

1.3 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations

1.4 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 – PRODUCTS

A. Elastomeric check valves

B. Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. CheckMate® Valve Series CM-SL slip-in check valve by Tideflex Technologies®, a Division of Red Valve Company, Carnegie, PA 15106. All valves shall be manufactured in the U.S.A.
2. Approved equal.

C. Check Valves are to be all rubber and the flow operated check type with slip-in cuff or flange connection. The entire valve shall be ply reinforced throughout the body, disc and bill, which is cured and vulcanized into a one-piece unibody construction. A separate valve body or pipe used as the housing is not acceptable. The valve shall be manufactured with no metal, mechanical hinges or fasteners, which would be used to secure the disc or bill to the valve housing. The port area of the disc shall contour down, which shall allow passage of flow in one direction while preventing reverse flow. The entire valve shall fit within the pipe I.D. Once installed, the valve shall not protrude beyond the face of the structure or end of the pipe.

D. The downstream end of the valve must be circumferentially in contact with the pipe while in the closed positions.

E. Slip-in style valves will be furnished with a set of stainless steel expansion clamps. The clamps, which will secure the valve in place, shall be installed inside the cuff portion of the valve, based on installation orientation, and shall expand outwards by means of a turnbuckle. Each clamp shall be pre- drilled allowing for the valve to be pinned and secured into position in accordance with the manufacturer's installation instructions. Flange style valves will be furnished with a stainless steel, ANSI 125/150 drilled, retaining ring unless specified otherwise.

F. Manufacturer must have flow test data from an accredited hydraulics laboratory to confirm pressure drop and hydraulic data. Company name, plant location, valve size patent number, and serial number shall be bonded to the check valve.

2.2 FUNCTION

A. When line pressure exceeds the backpressure, the line pressure forces the bill and disc of the valve open, allowing flow to pass. When the backpressure exceeds the line pressure, the bill and disc of the valve is forced closed, preventing backflow.

2.3 MANUFACTURER

A. All valves shall be of the slip-in or flanged to the pipe sizes shown in drawings.

PART 3 – Execution

3.1 INSTALLATION

A. Valve shall be installed in accordance with manufacturer's written Installation and Operation Manual and approved submittals.

3.2 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION

SECTION 22 41 00

PLUMBING PIPING

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Pipe and pipe fittings.

B. Plumbing valves.

C. Sanitary sewer piping system.

D. Acid waste and acid vent piping system.

E. Domestic and non-domestic water piping system.

F. Tepid water system.

G. Roof drainage system.

H. Gas piping.

I. Compressed air piping system.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

A. Perform Work in accordance with the Maine State Internal Plumbing Code, as adopted and amended by the Maine Plumbing Board.

B. All components in the plumbing system designed for delivering water for human consumption must comply with the no lead requirements of NSF/ANSI 61, Annex G. System components shall have a weighted average of not more than 0.25% lead.

C. Conform to NFPA 54 for gas piping in conformance with the Code of Maine rules.

1.04 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9.

1.05 SUBMITTALS

A. Submit product data under provisions of Section 22 01 00.

B. Include data on pipe materials, pipe fittings, valves, and accessories.

C. Submit a plumbing piping schedule identifying the description of service, location of service (identified if buried), the proposed pipe material with associated size for each service, and the proposed fittings and joints for each service.

D. Include welders' certification of compliance with ANSI/ASME Sec. 9.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 22 01 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

PART 2 – PRODUCTS

2.01 SANITARY SEWER, SANITARY VENT, AND STORM SEWER PIPING BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.

1. Fittings: Cast iron.
2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gasket system.
3. All Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and NSF or receive prior approval of the Engineer.

2.02 SANITARY SEWER AND SANITARY VENT, ABOVE GRADE

A. Copper Pipe: ASTM B306, DWV, for piping less than 3" diameter.

1. Fittings: ASME B16.23, cast bronze or ASME B16.29 wrought copper, chrome plated.
2. Joints: ASTM B32, solder, Grade 50B.

B. Cast Iron Pipe: ASTM A74, service weight for piping 3" in diameter and over.

1. Fittings: Cast iron.
2. Joints: ASTM C564, neoprene gasket system.
3. All Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and NSF or receive prior approval of the Engineer.

C. Cast Iron Pipe: CISPI 301, hubless, service weight.

1. Fittings: Cast iron.
2. Joints: Neoprene gasket system and stainless steel clamp-and-shield assemblies. All couplings for hubless cast iron soil pipe shall conform to CISPI 310 and be certified by NSF International.
3. All Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and NSF or receive prior approval of the Engineer.

D. PVC Pipe: ASTM D2665, ASTM D2949 - Schedule 40.

1. Fittings: PVC DWV, ASTM D3311.
2. Joints: Hub and Spigot solvent welded.
3. Install pipe in conformance with ASTM-D2321.
4. The installation of PVC piping will be prohibited from use in the kitchen, culinary arts and all support spaces. Final locations where PVC piping will be allowed for installation shall be reviewed and approved by the Architect and Engineer prior to installation.

2.03 STORM SEWER PIPING, ABOVE GRADE

A. Copper Pipe: ASTM B306, DWV, for piping less than 3" diameter.

1. Fittings: ASME B16.23, cast bronze or ASME B16.29, wrought copper, chrome plated.
2. Joints: ASTM B32, solder, Grade 50B.

B. Cast Iron Pipe: ASTM A74, service weight for piping 3" in diameter and over.

1. Fittings: Cast iron.
2. Joints: ASTM C564, neoprene gasket system.
3. All Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Spoil Pipe Institute and NSF or receive prior approval of the Engineer.

C. Cast Iron Pipe: CISPI 301, hubless, service weight.

1. Fittings: Cast Iron.
2. Joints: Neoprene gasket system and stainless steel clamp-and-shield assemblies. All couplings for hubless cast iron soil pipe shall conform to CISPI 310 and be certified by NSF International.
3. All Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Spoil Pipe Institute and NSF or receive prior approval of the Engineer.

D. PVC Pipe: ASTM D2665, ASTM D2949 - Schedule 40.

1. Fittings: PVC DWV, ASTM D3311.
2. Joints: Hub and Spigot solvent welded.
3. Install pipe in conformance with ASTM-D2321.
4. The installation of PVC piping will be prohibited from use in all acoustically sensitive areas including the auditorium, stage, back stage, video production, control room and all associated support spaces. Final locations where PVC piping will be allowed for installation shall be reviewed and approved by the Architect and Engineer. Prior to installation.

2.04 WATER SERVICE PIPING

A. Comply with Site Utility specifications to match site water distribution piping.

2.05 WATER PIPING, BELOW GRADE

A. Copper Tubing: ASTM B88, Type K, soft drawn.

1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.
2. Joints: ASTM B32, lead-free (less than 0.2%) solder.

B. PEX-AL-PEX Tubing: ASTM F1281, NSF 61, in Schedule 40 PVC conduit.

1. Fittings: Brass ASTM F-1974.
2. Joints: Compression.
3. PVC conduit shall utilize long sweep bends.

C. CTS SDR-9-PEX Tubing: ASTM F876/F877, NSF-PW, in Schedule 40 PVC conduit.

1. Fittings: Brass ASTM F-1807.
2. Joints: Crimp-style barbed fittings.
3. PVC conduit shall utilize long sweep bends.
4. Cap risers out of slab with rubber boots and stainless steel hose clamps.

2.06 WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASTM B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
2. Joints: ASTM B32, lead-free (less than 0.2%) solder.
3. Fittings: Roll grooved copper, 300 psi rated, UL listed.
4. Joints: Ductile iron grooved couplings with flush seal gasket, 300 psi rated, UL listed.

B. PEX Distribution System: ASTM F877, SDR 9 Tubing.

1. Fittings: ASTM F 1807, Metal insert type with copper or stainless steel crimp rings and matching Pex tube dimensions.
2. Manifold: Multiple outlet plastic or corrosion-resistant metal assembly complying with ASTM F877 with plastic or corrosion-resistant metal valve for each outlet.

C. CPVC Piping: ASTM F441/F441M, Schedule 40 and Schedule 80.

1. Fittings: CPVC socket fittings, ASTM F438 for Schedule 40 and ASTM 439 for Schedule 80.
2. Fittings: CPVC threaded fitting, ASTM F437, Schedule 80.

2.07 PUMPED DRAIN PIPING BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D-1785, Type I PVC Schedule 40.

1. Fittings: Schedule 40 PVC ASTM D-2466 socket fittings.

   a. Use 45-degree fittings only on changes in direction.

2. Joints: Solvent welded.

2.08 PUMPED DRAIN PIPING ABOVE GRADE (EXCEPT IN RETURN AIR CEILING PLENUMS)

A. PVC Pipe: ASTM D-1785, Type I PVC Schedule 40.

1. Fittings: Schedule 40 PVC ASTM D-2466 socket fittings:

   a. Use 45-degree fittings only on changes in direction.

2. Joints: Solvent welded.

2.09 PUMPED DRAIN PIPING ABOVE GRADE WITHIN RETURN AIR CEILING PLENUMS

A. Schedule 40 hot-dipped galvanized steel pipe.

1. Fittings: ASTM A-53 grooved ductile iron with ASTM A-153 hot dipped galvanized coating.
2. Joints: ASTM A-53 grooved, ductile iron with ASTM A-153 hot dipped galvanized coating.

2.10 ACID WASTE AND ACID VENT PIPING ABOVE GRADE

A. Polypropylene Pipe: ASTM F1412, Schedule 40 fire retardant pipe.

1. Fittings: ASTM F1412, ASTM 2657, or ASTM D4101 polypropylene.
2. Joints: ASTM F 1412, with polypropylene gasket and stainless steel Series 300 outer band bolts, nuts, and washers.

2.11 ACID WASTE AND VENT PIPING ABOVE GRADE WITHIN RETURN AIR CEILING PLENUMS

A. Polyvinylidene Fluoride (PVDF) Pipe: ASTM 3222, ASTM E-84, Schedule 40.

1. Fittings: ASTM D3222 socket fitting.
2. Joints: ASTM D3222 with PVDF gasket and stainless steel Series 300 outer band bolts, nuts and washers.

2.12 ACID WASTE AND ACID VENT PIPING BELOW GRADE

A. Polypropylene Pipe: ASTM F 1412, Schedule 40 fire retardant type.

1. Fittings: ASTM F 1412 polypropylene socket fittings.
2. Joints: ASTM F 1290 electro-fusion joints with stainless steel resistance wire coils.

2.13 COMPRESSED AIR PIPING

A. Steel Pipe:

1. Fittings: ASTM A53 or A120, Schedule 40 black malleable iron.
2. Joints: Threaded.

2.14 WELDING GAS PIPING - ARGON AND C25

A. Copper tubing: ASTM B88, Type K, Hard drawn.

1. Fittings: ASTM B16, 18 cast bronze or ASME B16-22 wrought copper and bronze.

2. Joints: ASTM B32 Lead-Free (less than 0.2%) solder or copper press fittings with appropriately listed EPDM sealing element.

2.15 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2-Inches and Under:

1. Ferrous pipe: 150 psig malleable iron threaded unions.
2. Copper tube and pipe: 150 psig bronze unions with soldered joints.

B. Pipe Size Over 2-Inches:

1. Ferrous pipe: 150 psig forged steel slip-on flanges; 1/16-inch thick preformed neoprene gaskets.
2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16-inch thick preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.16 STOP VALVES

A. Brass stop valves suitable for bubble-tight water service shutoff, chrome plated in finished areas. Key-operated in all public building areas, lever handle operated in all building service areas.

2.17 GATE VALVES

A. Manufacturers:

1. Stockham
2. Grinnell
3. Milwaukee
4. Crane

B. Over 2-Inches: Bronze body, bronze trim, non-rising stem, handwheel, single wedge 200 psi W.O.G. rating, flanged ends.

C. Valves shall have stem extensions suitable to allow for insulation of the valve body to the thickness of adjoining pipe without interfering with valve wheel operations.

2.18 BALL VALVES

A. Manufacturers:

1. Apollo
2. Milwaukee
3. Stockham
4. Watts

B. Up to and including 3-Inches: Bronze two-piece body, 600 psi WOG/125 psi WSP, steel plated ball, Teflon seats and stuffing box ring, lever handle, and soldered or threaded ends to suit piping which valve will be installed in.

C. Valves shall have stem extensions suitable to allow for insulation of the valve body to the thickness of adjoining pipe without interfering with valve wheel operations.

2.19 BALL VALVES - PEX

A. Manufacturers:

1. Nibco
2. Watts
3. Apollo

B. Inline shut-off ball valve with Pex end connections, made of DZR Brass and features a lever handle.

C. ASTM F877, ASTM F1807 and NSF/ANSI 61 compliant.

2.20 BALL VALVES - CPVC

A. Manufacturers:

1. Nibco
2. Georg Fischer

3. Spears

B. Up to and including 2”, valve pressure raring 250 psi at 73 deg. F, full port, EPDM O-Rings, ASTM F1970, NSF/ANS 61.

C. Size 3” to 6”, valve pressure rating 30 psi at 73 deg. F, full port EPDM O-Rings, ASTM F1970, NSF/ANSI 61.

D. Valves shall be Schedule 80 CPVC and shall be installed in conformance with manufacturer’s guidelines.

2.21 ACCEPTABLE MANUFACTURERS - BALANCING VALVES

A. Bell & Gossett
B. Armstrong
C. Taco
D. Illinois
E. Tour & Anderson

2.22 BALANCING VALVES

A. Valves 3-inches and smaller shall be of bronze body/brass ball construction. All valves shall have differential pressure read-out ports across valve seat area. Read-out ports shall have internal EPT inserts and check valves. Balancing valves shall have memory stop feature to allow valve to be closed for service and reopened to set point without disturbing balance position. Balancing shall provide bubble-tight shutoff at 125 psig and shall have a maximum temperature rating of 250 deg. F. Valves shall have calibrated dial with graduated markings to allow for flow adjustment to design conditions. All balancing valves shall be similar and equal to Bell & Gossett Model CB and shall be approved for domestic water.

2.23 SWING CHECK VALVES

A. Manufacturers:

1. Stockham
2. Grinnell
3. Milwaukee
4. Crane

B. Up to and including 2-Inches: Bronze swing disc, 200 psi W.O.G. solder or screwed ends.

C. Over 2-Inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

2.24 STRAINERS

A. Manufacturers:

1. Watts
2. Sarco
3. Mueller

B. Size 2-Inch and Under: Screwed brass or iron body for 125 psi WSP/200 W.O.G., "Y" pattern with 1/32-inch stainless steel perforated screen.

C. Sizes 2½-Inch and Larger: Flanged iron body rated for 175 psig working pressure, "Y" pattern with 1/16-inch stainless steel perforated screen.

D. Approved for potable water.

2.25 NATURAL GAS PIPING, FITTINGS, AND VALVES ABOVE GRADE

A. Steel Pipe: ASTM A53 or A106 seamless, Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type.
2. Joints: ANSI B31.1 welded or threaded in accordance with NFPA 54.
3. Valves: Ball or plug U.L. listed for service and pressure as applicable.

    a. Ball valves up to and including 2 inches: Bronze two-piece body, chrome plated ball, blowout proof stem, 25% reinforced TFE or Delrin seats, 250 psi LP gas - UL listed, 125G-AGA-B16.33 rated.
    b. Plug valves 2½" and larger: Gray iron, two-bolt cover Type 350 psig, flanged, ANSI Class 125 Rockwell Fig. 143 or equal.

4. Flanges, unions, and couplings:

    a. Unions: UP to and including 2-inch, 150 lb. malleable iron or 150 lb. flat faced slip-on welded.
    b. Flanges: 2½-inch and larger, 150 lb. ANSI/ASME B16.1 flat faced slip-on or weldneck.
    c. Couplings: Up to and including 2-inch, 150 or 300 lb. malleable iron threaded.

5. Flange gaskets, full face metal or metal-jacketed asbestos conforming to NFPA 54.
6. Thread compound shall be resistant to the action of liquefied petroleum gas or to any other chemical constituents of the gas to be conducted through the piping.

2.26 NATURAL GAS PIPING, BURIED

A. Steel Pipe: ASTM A53 or A106 seamless, Schedule 40 black, polyethylene jacketed.

1. Fittings: ASTM A234, forged steel welding type, with AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
2. Joints: ANSI B31.1, welded.

2.27 NATURAL GAS PIPING, BURIED WITHIN BUILDING

A. Corrugated stainless steel tubing (CCST) ASTM-A240 with fire retardant polyethylene jacket ASTM-E84.

1. Fittings: ANSI/IAS LC-1 yellow brass auto-flare fittings.
2. Joints: Auto-flare NFPA 54, BOCA, ICC.
3. Run pre-sleeved in polyethylene jacket with shrink cuffs and vent port.

2.28 SIESMIC/EXPANSION JOINTS

1. Manufacturers:
2. MetraFlex
3. FlexiCraft
4. Approved Equal

B. All piping passing through building seismic joints, building expansion joints and building fire separations shall contain a flexible expansion loop designed for seismic movement. Flexible loops shall be located at, or near the building joint. A vertical support hanger, located within four (4) pipe diameters, shall be installed on each side of the flexible loop. Each hanger to be transversely and longitudinally braced per local codes. Seismic bracing shall not pass through building seismic joint and shall not connect or tie together different sides or parts of building structure. Flexible loops shall be capable of move in the ±X, ±Y, and ±Z planes. The installed expansion joint must be suitable for a minimum of 4" of movement in compression or extension.

C. Flexible loops attached to fuel gas lines, shall be specifically manufactured for fuel gas applications and certified by the American Gas Association. Product shall be similar to Metraflex AGA/CSA gas Metraloop or approved equal.

D. Flexible loops for domestic water shall be similar to Metraflex Copper Metraloop or approved equal.

E. Flexible loops for sanitary waste and vent piping and storm piping shall be similar to Metraflex sanitary "poop-loop".

PART 3 – EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever joining dissimilar metals.

C. Route piping in orderly manner and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide clearance for installation of insulation and access to valves and fittings.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

I. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to Section 09 90 00.

J. Install valves with stems upright or horizontal, not inverted.

K. Balancing of hot water recirculation system shall be per specification Section 23 99 00.

3.03 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install ball valves for throttling, bypass, or manual flow control services.

D. Install stop valves at each plumbing fixture water connection.

E. Install other valve types and piping specialties as indicated on the Drawings.

3.04 ERECTION TOLERANCES

A. Establish invert elevations, slopes for sanitary drainage to comply with the current edition of the Uniform Plumbing Code. Slopes for storm drainage to be 1/8 inch per foot minimum. Maintain gradients (unless otherwise indicated on the Drawings).

B. Slope water piping and arrange to drain at low points.

3.05 KITCHEN EQUIPMENT INSTALLATIONS AND COORDINATIONS

A. Exposed mechanical connections to fixtures in the kitchen and related food service areas, including exposed piping, shall be chrome plated.

B. The Food Service Equipment Vendor shall furnish all water faucets and sink outlets with level type wastes (usually 2" IPS size), and vacuum breakers for all equipment items that are designed to introduce water at less than 2" above flood level of the chamber or tank. The Plumbing Contractor shall provide plumbing rough-in and make final connection to all domestic hot and cold water inlets and all sanitary waste outlets for all kitchen equipment. The Plumbing Contractor shall provide all necessary shutoff valves, traps, grease traps, etc., for a complete installation. Coordinate with the Food Service Equipment Vendor and Section 11 40 00.

C. Stubs for equipment should come out of walls wherever possible. All connecting piping should be neatly assembled by the Plumbing Contractor up away from the floor at least 12" and with a minimum of exposed horizontal runs.

D. Interconnecting piping must not be reduced in size to a pipe smaller than the inlet size on the equipment or faucet.

E. Floor drains shall be utilized for any one or a combination of purposes such as area drain for general cleaning, to receive indirect waste lines from food preparation sinks, dishwasher, hot food wells, cold pans, coffee drains, ice machines, etc. Floor drains must be carefully located by the Plumbing Contractor during the roughing-in stage. They must be correctly set for height so that the floors will pitch smoothly and evenly into them without creating a hazardous "hills and valleys" condition.

3.06 DISINFECTION OF DOMESTIC AND NON-DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, pressure tested, flushed and clean.

B. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 ppm.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent (15%) of outlets.

E. Maintain disinfectant in system for 24 hours.

F. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SERVICE CONNECTIONS

A. Connect to sanitary sewer, storm sewer, and domestic water utilities outside of building where indicated on the Drawings.

B. Connect to natural gas utility outside of building where indicated on the Drawings.

3.08 TESTING

A. All natural gas piping shall be tested in accordance with NFPA 54 and the City of Sanford’s requirements

B. All other plumbing shall be tested in accordance with the Maine State Internal Plumbing Code and the City of Sanford's requirements.

END OF SECTION

SECTION 22 43 00

PLUMBING SPECIALTIES

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Backflow preventers.

B. Water meters.

C. Floor drains, funnel floor drains, and roof drains.

D. Line pressure trap primer valves.

E. Electronic trap priming manifolds.

F. Cleanouts.

G. Wall hydrants.

H. Water hammer arrestors.

I. Backwater valve.

J. Water pressure reducing valves.

K. Relief valves.

L. Gas emergency shutoff box.

M. Floor sinks.

N. Recessed valve box.

O. Thermostatic mixing valves.

P. Grease interceptor.

Q. Solids interceptor.

R. Hair interceptor.

S. Sand and sediment interceptor.

T. Compressed air system specialties.

U. Neutralizing tank.

V. Electric heat tracing temperature maintenance system.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

A. Perform Work in accordance with the Maine State Internal Plumbing Code, as adopted and amended by the State of Maine.

B. All components in the plumbing system designed for delivering water for human consumption must comply with the no lead requirements of NSF/ANSI 61, Annex G. System components shall have a weighted average of not more than 0.25% lead.

C. Conform to applicable codes for installation of backflow preventers.

D. Contractor shall be responsible for coordinating with the authority having jurisdiction relative to local requirements for backflow prevention and water metering equipment. Provide specific equipment manufacturers and models as required, and comply with required means of installation. Any discrepancies between this specification and local requirements shall be brought to the attention of the Architect.

E. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices and water metering devices.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 22 01 00.

B. Submit product data indicating general layout, dimensions, and size and location of connections.

C. Submit manufacturer's installation instructions under provisions of Section 22 01 00.

D. Record actual locations of equipment, cleanouts, backflow preventers, and interceptor.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 22 01 00.

B. Indicate frequency of treatment required for interceptors.

C. Include installation instructions, spare parts lists, exploded assembly views.

PART 2 – PRODUCTS

2.01 BACKFLOW PREVENTERS

A. Domestic Water Reduced Pressure Backflow Preventers: ANSI/ASSE 1013 and AWWA C506; bronze body with bronze and plastic internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm

failure; non-threaded vent outlet; assembled with two ball valves, strainer, and four test cocks; Model 009, 3/4" to 2"; Model 909 for 2½" and larger as manufactured by Watts or approved equal.

Note: Main domestic water backflow preventer shall be as approved by the Sanford Water District. Purchase backflow preventer from Sanford Water District.

2.02 WATER METERS

A. Manufacturers:

1. Neptune
2. Badger

Note: Manufacturer and model of main domestic water must be approved by Sanford Water District. Purchase meter from Sanford Water District.

B. Main domestic water meter shall be as approved by the Sanford Water District. Meter shall be provided with readout units as required, and with remote metering kit. Mount remote metering readout device where directed by the water district.

C. Makeup water meters shall be magnetic drive type with readout in gallons.

2.03 FLOOR DRAINS, FUNNEL FLOOR DRAINS, AND ROOF DRAINS

A. As scheduled on the Drawings.

B. Zurn, Jay R. Smith, Wade and Watts are acceptable manufacturers.

2.04 LINE PRESSURE TRAP PRIMER VALVES

A. Acceptable Manufacturers:

1. PPP
2. Watts
3. Jay R. Smith
4. Sioux Chief

B. Machined brass body with O-ring seals, operates under pressure drop of 5 psig, operating range: 35-75 psig integral vacuum breaker ASSE #1018 approved.

C. Provide distribution units as required for service to multiple floor drains.

D. Install per manufacturer's instructions.

E. Model #PR-500 as manufactured by PPP, Inc.

2.05 ELECTRONIC TRAP PRIMING MANIFOLDS (1 TO 4 TRAPS)

A. The electronic trap priming manifolds shall be capable of equally priming from 1 to 4 individual floor drain traps. Electronic trap priming manifolds shall supply a minimum of 2 ounces of potable water per opening at 20 psig once in each 24-hour period.

B. Units shall be factory assembled and prepped, and shall include a bronze body 1/2" male NPT, WOG rated ball valve, electronic brass body 1/2" subminiature solenoid valve, air gap, 1/2" female NPT outlet fitting for connection to single floor drain or distribution unit.

C. Electronic components shall include single-point power connection at 120/1/60, manual override switch, minimum 5 amp breaker, 24-hour geared timer with relay and 5-second dwell function.

D. All components shall be factory assembled, tested and supplied in a 16-gauge steel enclosure suitable for surface or recess mounting. In addition, all components must comply with nationally recognized standards.

E. Acceptable manufacturer is PPP, Inc. Model MPB-500.

2.06 ELECTRONIC TRAP PRIMING MANIFOLDS (4 TO 30 TRAPS)

A. The electronic trap priming manifolds shall be capable of equally priming from 4 to 30 individual floor drain traps. Electronic trap priming manifolds shall supply a minimum of 2 ounces of potable water per opening at 20 psig once in each 24-hour period.

B. Units shall be factory assembled and prepped, and shall include a bronze body 3/4" female NPT, WOG rated ball valve, 3/4" water hammer arrester, copper barrel with brass piston and Type "L" copper sweat connection, electronic brass body 3/4" solenoid valve, and Type "L" copper manifold with brass 1/2" compression fitting and orifice opening for precision water distribution to each floor drain trap.

C. Electronic components shall include single-point power connection at 120/1/60, manual override switch, minimum five (5) amp breaker, 24-hour geared timer with relay and 5-second dwell function.

D. All components shall be factory assembled, tested and supplied in a 16-gauge steel enclosure suitable for surface or recess mounting. In addition, all components must comply with nationally recognized standards.

E. Acceptable manufacturer is PPP, Inc.

2.07 CLEANOUTS

A. Interior Finished Floor Areas: Lacquered cast iron, adjustable floor cleanout, round with gas- and water-tight ABS tapered threaded plug and adjustable scoriated cover in service areas or round with depressed cover to accept floor finish in finished floor areas; Model ZN-1400 manufactured by Zurn.

B. Interior Finished Carpeted Areas: Cast iron body with adjustable nickel bronze top and carpet marker; Model ZN-1400-CM manufactured by Zurn.

C. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw; Model ZN-1441 manufactured by Zurn.

D. Interior Unfinished Accessible Areas: Caulked or threaded type.

E. Zurn, Jay R. Smith, Wade or Watts are acceptable manufacturers.

2.08 WALL HYDRANT

A. Exterior Cold Water: ANSI/ASSE 1019; non-freeze, self-draining type with hinged box cover and hose thread spout, lockshield and removable key, and integral vacuum breaker; Model Z-1320 manufactured by Zurn.

B. Interior Cold Water: Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed, with lock shield and removable key, and integral vacuum breaker; Model Z-1330 by Zurn.

C. Exterior or Interior Hot and Cold Water: Combination hot and cold water non-freeze, encased wall hydrant for flush installation. Complete with bronze casing, all bronze interior parts, non-turning operating rods with free-floating compression closure valves, replaceable bronze seat and seat washer, integral vacuum breaker and combination 3/4" female inlet. Nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover; Model Z-1325 by Zurn.

D. Zurn, Jay R. Smith, Wade or Watts are acceptable manufacturers.

2.09 WATER HAMMER ARRESTORS

A. ANSI A112.26.1; sized in accordance with PDI WH-201, pre-charged suitable for operation in temperature range -100 to 300 deg. F and maximum 250 psig working pressure; Model Z-1700 by Zurn, size as indicated on the water hammer schedule by connected fixture units on all cold water piping main branches to fixtures.

B. Acceptable manufacturers are Zurn, Jay R. Smith, Wade or Watts.

2.10 BACKWATER VALVE

A. Dura-coated cast iron body with no-hub inlet and outlet, gasketed bolted cover, automatic type ABS valve. Seat and flapper which hangs closed during non-operation. Model Z-1090 manufactured by Zurn.

B. Zurn, Jay R. Smith, Josam, or Wade are acceptable manufacturers.

C. Backwater valve shall be housed in a pre-cast concrete box 24" x 24" x 36" deep, complete with 1/4" thick diamond plate cover and frame 24" square.

2.11 WATER PRESSURE REDUCING VALVES

A. Manufacturers:

1. Watts
2. Sarco
3. Mueller

B. Up to 2-Inches: Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded ends. Provide separate strainer ahead of valve.

C. Over 2-Inches: Cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged, 200 psi maximum, 150 deg. F maximum temperature, 30 to 80 psi range.

2.12 RELIEF VALVES

A. Manufacturers:

1. Watts
2. Sarco
3. Mueller

B. ANSI Z21.22 bronze body, Teflon7 seat, steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled. Sized to match system protected.

2.13 GAS EMERGENCY SHUTOFF BOX

A. Gas emergency shutoff box shall be constructed of 18-gauge steel with white baked enamel finish and provided with two galvanized steel brackets to anchor box to wall. Rough-in dimensions shall be approximately 14" wide x 10" high x 3" deep.

B. Box shall have standard 1/4-turn ball valve shutoffs.

C. The front face of the box shall be a sliding opaque door labeled:

"EMERGENCY GAS SHUTOFF"

ROOM #

Door shall be capable of sliding right or left and have a pull ring that can "snap-out" by pulling ring forward.

D. The emergency shutoff box shall be provided with anodized aluminum trim with the ability to adjust for variations in wall thickness of up to 1-inch below flush.

2.14 RECESSED VALVE BOX

A. Washing Machine: Plastic preformed rough-in box with brass long shank valves with wheel handles, socket for waste, slip-in finishing cover, Model WM2961 by Zurn.

B. Acceptable manufacturers are Zurn, Jay R. Smith, or Josam.

2.15 THERMOSTATIC MIXING VALVES

A. Thermostatic mixing valve assembly shall be a combined high-low assembly of two mixing valves. Assembly shall include a large type thermostatic wall mixing valve, inlet check stops, outlet volume/shut-off valve, pressure regulating valve with pressure gauges, small type thermostatic water mixing valve, integral check stops, outlet volume/shut-off valve, dial thermometer (0 - 140 deg. F). Rough bronze finish, factory assembled and tested.

B. Mixing valve capacity shall be as indicated on the Drawings.

C. Mixing valve manufacturer shall provide on-site representation upon completion of installation to verify valve(s) is properly installed in conformance with manufacturer’s recommendations and to provide any on-site adjustments as required.

D. Acceptable manufacturers are Leonard, Symmons and Powers.

2.16 GREASE INTERCEPTORS

A. Acid-resistant, coated interior and exterior fabricated steel grease interceptor, with internal air relief bypass, bronze cleanout plug and visible double-wall trap seal with removable combination pressure equalizing/flow diffusing baffle and sediment tray. Gasketed non-skid secured cover with enzyme part opening having bronze plug, complete with flow control fitting. Model Z-1170 manufactured by Zurn, size as indicated on the Drawings.

B. Zurn, Jay R. Smith, Wade or Watts are acceptable manufacturers.

2.17 SOLIDS INTERCEPTORS

A. Acid-resistant coated interior and exterior, for on-floor installation with removable primary and secondary floor diffusing/intercepting screens, sediment bucket, and top access gasketed cover; Model Z-1181 manufactured by Zurn.

B. Zurn, Jay R. Smith, Wade or Watts are acceptable manufacturers.

2.18 HAIR INTERCEPTORS

A. Hair interceptor shall have a perforated stainless steel straining element, cast iron flanged cleanout cover gasketed to provide a watertight seal. Provide chrome plated finish. Model Z1176-CP manufactured by Zurn.

B. Zurn, Jay R. Smith, Wade or Watts are acceptable manufacturers.

C. Hair interceptors shall be provided at all Cosmetology sinks.

2.19 SAND AND SEDIMENT INTERCEPTOR

A. Acid resistant coated interior and exterior fabricated steel sand and sediment interceptor. Four inch (4”) threaded inlet and outlet connection and four 2-inch threaded individual vent connections complete with scoriated non-skid removable cover Model 1187 as manufactured by Zurn.

B. Include optional integral extension assembly for recessed installation and optional anchor flange.

C. Zurn, J.R. Smith, Wade or Watts are acceptable manufacturers.

2.20 OIL INTERCEPTOR

A. Large capacity, acid resistant coated interior and exterior fabricated steel oil interceptor with bronze cleanout plug and visible double-wall trap seal, removable combination pressure equalizing/flow diffusing baffle and sediment bucket, horizontal baffle, adjustable oil draw off and vent connections either side. Complete with secured, gasketed, non-skid cover with removable lift handles and flow control fittings. Regularly furnished with inlet and outlet in high position. Model Z1188 as manufactured by Zurn.

B. Include acid resistant coated interior and exterior fabricated steel extension section for recessed installation. Include anchor flange.

C. Include heavy-duty traffic cover rated at 10,000 lbs. maximum load.

D. Zurn, J.R. Smith, Wade or Watts are acceptable manufacturers.

2.21 COMPRESSED AIR SYSTEM SPECIALTIES

A. Filter at Each Air Station: ASME-coded particulate filter with 6 oz. bowl capacity, plastic bowl with bowl guard, 90 scfm flow rate at 1 psig loss at 100 psig, 3/8" NPT size, 20 micron element.

B. Regulator at Each Air Station: ASME-coated regulator, 5-125 psig gauge, 1/4" NPT port size, 100 CFM at 100 psig inlet.

C. Lubricator: Siphon tube filter provides clean lubricant downstream. Lubricant can be filled while under pressure. Quick-disconnect bowl guard with integral plastic bowl and safety latch. Provide with adjustable oil feed and petcock drain in bowl.

D. Combination filter and regulators, and filter, regulator and lubricators will be approved for use.

E. Quick-Disconnect Fitting at Each Air Station: Brass or bronze construction, suitable for 150 psig, compatible with recoiling hose and safety bow gun.

F. Safety Blowgun with Recoiling Hose: One-quarter (1/4) inch inside diameter nylon recoiling hose, suitable for 150 psig at temperature range 20 deg. F to 170 deg. F. Blowgun shall be hand lever operated and shall meet OSHA standards for maximum 30 psig outlet pressure.

2.22 NEUTRALIZING TANKS

A. High-density polyethylene free-standing and self-supporting cylindrical tank for vertical installation, with gasketed, bolt-down cover. Provide optional manway access cover.

B. Tank shall be manufactured by Zurn, Town and Country or Orion.

C. Tank shall have 4-inch inlet, 4-inch outlet, and 2-inch vent connections.

D. Each tank shall be provided with a minimum of 50 lbs. of regular limestone chips, as required to fill chamber. Plumbing sub-contractor shall provide Owner a total of 250 lbs. of total additional limestone to be used for maintenance purposes.

2.23 HEAT TRACE AND INSULATION

A. Manufacturers:

1. Raychem
2. Thermon
3. Tyco

B. System Description

1. System for temperature maintenance of domestic hot water supply systems with energy efficient time based control, monitoring, and Building Management System (BMS) communication capabilities.

C. Submittals

1. Product Data

a. Heating cable data sheet
b. UL, CSA, FM approval certificates for hot water temperature maintenance systems
c. Hot water temperature maintenance design guide

d. System installation and operation manual
e. System installation details
f. Connection kits and accessories data sheet
g. Controller data sheet
h. Controller wiring diagram

D. Quality Assurance

1. Regulatory Requirements and Approvals

a. The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified and FM Approved for hot water temperature maintenance.
b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended use.

E. Warranty

1. Extended Warranty

a. Manufacturer shall offer a ten (10) year warranty for all heating cables and components. Provide one (1) year warranty for all heat trace controllers.
b. Contractor shall submit to owner results of installation tests required by the manufacturer.

F. Basis of Design

1. Hot Water Temperature Maintenance System

a. Raychem HWAT self-regulating heating cables with plasticizer diffusion shield, heavy tinned copper braid and polyolefin outer jacket.
b. Raychem RayClic and accessories.
c. Raychem HWAT-ECO-B digital controller
d. DigiTrace ProtoNode multi-protocol device server.
e. The HWAT system complies with local energy codes, including California Title 24, due to a time based control methodology (HWAT or ECO-B) and an energy efficient thermal insulation schedule.

G. Products

1. Self-Regulating Heating Cable

a. Heating cable shall be Raychem HWAT self-regulating heating cable manufactured by Pentair Thermal Management.

1) Model Numbers: HWAT-R2

b. The heating cable shall consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two (2) 16 AWG nickel-plated copper bus wires that varies its power output in response to pipe temperature changes.
c. The heating cable shall have a modified polyolefin inner jacket for dielectric integrity.
d. The heating cable shall have a plasticizer diffusion shield.
e. The heating cable shall have a thicker gauge (5/24) tinned copper braid for ground path and mechanical ruggedness.
f. The heating cable shall have a color coded polyolefin outer jacket.

g. The heating cable shall have a self-regulating factor of at least 70 percent for HWAT-R2. The self-regulating factor is defined as the percent reduction of the heating cable power output going from a 40°F pipe temperature to 150 deg. F pipe temperature.
h. The heating cable shall operate on line voltages of 208, 220, 240 or 277 volts without the use of transformers.
i. The heating cable shall be UL part of a UL Listed, CSA Certified and FM Approved system.
j. The outer jacket of the heating cable shall have the following markings:

1) Heating cable model number
2) Agency listings
3) Meter mark
4) Lot/Batch ID

2. Heating Cable Connection Kits

a. Heating cable connection kits shall be Raychem RayClic connection kits.
b. Manufacturer shall provide power connection, splice/tee and end seal kits compatible with selected heating cable.
c. Installation shall not require the installing contractor to cut into the heating cable core to expose the bus wires.
d. Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized.
e. Connection kits shall be UL Listed and CSA Certified.

3. Heating Cable Installation Accessories

a. High temperature, glass filament tape for attachment of heating cable to fire sprinkler piping. Cable ties are not permitted. (PTM Catalog Number: GT-66)
b. Plastic Piping – provide an aluminum self-adhesive tape over the heating cable on all plastic piping if required. (PTM Catalog Number: AT-180)
c. Labels – Provide warning labels every 10 feet on exterior of insulation, opposite sides of pipe. (PTM Catalog Number: ETL).

4. Energy Efficient Time Based Control

a. Single Circuit Local Digital Controller

1) Local digital controller shall be the Raychem HWAT-ECO-B.
2) Digital controller shall operate on 208 – 240 V.
3) Pre-programmed duty cycles based on ambient temperature ranging from 60 – 80°F.
4) The pre-programmed duty cycles shall be based on Raychem HWAT heating cables only. No other heating cables may be used with the HWAT-ECO-B controller.
5) Flexible temperature control from 105 – 140°F.
6) Three programmable temperature set points for maximum energy efficiency.

a) Maintain
b) Economy
c) Off

7) Controller shall have heat cycle setting.
8) Heating cable manufacturer shall provide a local digital controller with 24/7 pre-programmed time based profiles specific to the selected heating cable application such as schools, hospitals and prisons.
9) Controller shall have remote temperature setting through 0 – 10 Vdc BMS interface.

10) Controller shall have a pipe temperature sensor, low/high pipe temperatures alarms and high temperature cut-out.

    a) To maximize the energy efficiency of the HWAT system by verifying that the hot pipe temperature is at the correct temperature (low temperature alarm).
    b) To monitor and alarm if the pipe temperature is hotter than intended (high temperature alarm and cut-out)

11) Multiple HWAT-ECO-B controllers can be networked together (master/slave association):

    a) Allows BMS to interface with a master HWAT-ECO-B to control cloned circuits.
    b) Minimizes the number of HWAT-ECO-B controllers that must be individually programmed.

12) Controller shall have 24 A switching capacity rating.
13) Enclosure type shall be NEMA 12 (ABS).
14) Controller shall have NO/NC alarm contacts. Controller shall alarm on:

    a) Loss of power
    b) Controller reinitialized
    c) Internal controller temperature too high
    d) Pipe temperature too high
    e) Pipe temperature too low
    f) Master/slave error

15) Digital controller shall have c-UL-us approvals specifically for use with the HWAT-R2 heating cable.

5. Thermal Pipe Insulation

    a. Pipes must be thermally insulated in accordance with the HWAT Design Guide requirements.
    b. Thermal insulation must be a type that is flame retardant (closed-cell or fiberglass) with waterproof covering.

H. Installation

1. Comply with manufacturer's recommendations in the HWAT System Installation and Operation Manual.
2. Apply the heating cable linearly on the pipe after piping has successfully completed any pressure tests. Secure the heating cable to piping with fiberglass tape.
3. Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.
4. Grounding of controller shall be equipment according to Division 26.
5. Connection of all electrical wiring shall be according to Division 26.
6. Pipes must be thermally insulated in accordance with the HWAT design guide requirements.

I. Field Quality Control

1. Initial start-up and field testing (commissioning) of the system shall be performed by factory technician or factory representative per the owner's requirements.

a. The system shall be commissioned in accordance to the HWAT Installation and Operation manual.
b. All commissioning results will be recorded and presented to the owner.

2.24 WELDING GAS CYLINDER MANIFOLDS

A. Manufacturer's

1. Linde
2. Spectra Gases
3. Western Enterprises

B. General Description:

1. 2900 Standard Grade, oxygen, inert and fuel gas fully automatic control cabinet. The inlets and outlet are 1/2" NPT (F).

C. Theory of Operation:

1. 2900 Series Automatic Manifold Cabinet can be used with low-pressure to low-pressure cylinders, low-pressure with high-pressure cylinders, or high-pressure with high-pressure cylinders. This feature allows you to use one control box whether you use HP or LP cylinders and the ability to switch gas package based on your gas user growth or other economic considerations without the manifold becoming obsolete. Also included is leak detection on the stand-by side, and the ability to dictate an operating side as always primary. The system monitors both inlets and the delivery pressure during operation. When the switchover set point is reached, a signal is sent to the changeover valve and the depleted supply is switched out, replaced with the standby supply. The LED's indicate the status of the individual banks of gas. The green LED indicates which supply bank is in use. The amber LED indicates the standby bank that is ready for use and the red LED indicates the empty bank that needs re-supply. The standby condition occurs when either side has a pressure that is 25% higher than the switchover set point. An empty condition occurs when either or both banks pressure equals the calibrated switchover pressure. When first applying a right or left bank pressure to the system, it will be the in use supply. The second bank will be shown as the standby bank. When the in use bank reaches the switchover point, the standby LED will go green and the in use bank will change from green to red indicating that bank needs re-supply. Also relay contacts will actuate to give an optional remote panel the empty condition.
2. The system stores the inlet pressure after it detects the change from empty status to standby status. If the standby supply decreases by 25% while in standby mode, a leak has been detected. The front panel standby and empty LED's will light to indicate the leak condition. Once the leak has been stopped, the set button on the front panel is pressed to clear the condition and establish the new baseline.
3. If an alarm condition exists, a set of relay contacts will activate the 2900 series remote status panel of the condition and/or provide dry contact closure for any customer defined alarms to supply an alarm condition. The system has a battery backup to maintain operation during a temporary loss of power.
4. The parameters for switchover are stored in non-volatile memory and will not change even if all power is lost to the manifold. Upon power up, the unit will return to its last state and maintain the previous switchover setting.
5. Switchover pressures can be set independently for the left and right supplies. Simply turns on the switchover select switch, set the display switch to the right, adjust desired pressure, and press the "set" button. Set the display switch to the left, press the "set" button; turn the switchover select switch to off.

D. Operational Cabinet Controls and Display

1. Pressure Regulators:

   a. Intermediate pressures are factory set and require no normal field adjustments. The delivery regulator is factory set at 50 PSIG for final test purpose and is manual adjusted to the desired cabinet outlet pressure by using hex or screwdriver slot adjustment screw.

2. Front Panel Operator Display and Switch Components

   a. LCD Display:

      1) LCD screen is a digital read-out of the right and left inlet pressure and outlet pipeline delivery pressures in PSIG format. Also is used to display switch over pressure selection for right and left inlets when the switchover pressure select operation (described below) is selected and used.

   b. System Status LED's:

      1) Six-system status LED's, three for each cylinder bank: (Green, Amber, and Red.)
      2) Green: Bank operation is normal and "in-use"
      3) Amber: Standby signal to signify reserve bank is ready for use.
      4) Red: Signals depleted cylinder bank, requires changing out.
      5) Amber/Red: Leak Indicator that the reserve bank has lost 25% of the original pressure.

   c. Display Pressure Select Switch:

      1) Right: Displays right bank pressure contents.
      2) Left: Displays left bank pressure contents.
      3) Delivery: Displays outlet pressure from cabinet.

   d. Inlet Gas priority Select Switch:

      1) Used selection of which bank has priority as the primary provider of gas:

         a) FIFO: Factory setting for normal operations when using the same type gas packages on both banks. In this setting, the primary side will alternate sides as the cylinder banks are depleted and replenished.
         b) Left: Selects the left bank as the priority side. In this position, the left bank becomes the primary or in-use supplier of gas at startup and returns to the primary when the cylinders on this side are changed out after being depleted. Generally, this is used if you have low-pressure on this side with a high-pressure reserve on the right inlet.
         c) Right: Select the right side as the priority primary side.

   e. Switchover Pressure Select (Switch, Button, and Knob):

      1) Change factory switch over pressure and to clear leak detection indicator.
      2) ON/OFF Switch: Normally in off position. Activated when changing switchover pressure.
      3) (The set pressures in which the manifold will changeover from one cylinder bank to the other).
      4) Adjust Knob: Used to select desired switchover pressure setting.

5) Set Button: Sets the selected switch over pressures and doubles as the re-set button when clearing a leak detection condition.

f. Cabinet Enclosure Standards & Construction:

1) Enclosures are intended for indoor or outdoor use providing protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and undamaged by the formation of ice on the enclosure.

g. Standards:

1) UL 508 File No. E61997: Type 4X
2) NEMA/EEMAC Type 4X
3) Enclosure flammability rating per UL 508
4) Window flammability rating UL 508
5) CSA File No. LR42186: Type 4X
6) IEC 60529, IP66

h. Construction:

1) Molded fiberglass polyester, (14"x12"x8")
2) Seamless foam in-place gasket to assure watertight and dust-tight seal.
3) Scratch resistant GE Lexan Marguard® window cover. (Full view)
4) Monel hinge pin & latch bails.
5) Knockout padlock provisions in each latch
6) Front control panel hinge - Stainless steel
7) Front Panel material & Coating - Aluminum, painted and silk-screened

E. Internal Materials of Construction:

1. Regulators:

a. Body: Brass
b. Bonnet: Die cast
c. Diaphragm: Neoprene
d. Nozzle: Brass
e. Seat: PTFE or polyurethane

2. Deliver Pressures: (2900 Model)

a. Standard: 400 PSIG, 200 PSIG, 125 PSIG, 50 PSIG, 25 PSIG

3. Flow Rate:

a. Standard: 2000 CFH @ 400 PSIG (2900 Model)

4. Tubing: 316L Stainless Steel
5. Fittings: Brass
6. Pressure Gauge: Brass
7. Transducer: Stainless Steel
8. Solenoid Valve:

a. Balanced poppet type, high-flow direct acting valve. Fuel gas solenoid has explosion proof coil with conduit hub connection.

9. Brass (2900 Model)

    a. Body: Brass
    b. Core Tube: Stainless Steel
    c. Stem and Insert: Stainless Steel
    d. Core and plugnut: Stainless Steel
    e. O-ring Holder: Stainless Steel
    f. Seals and Disc: Viton
    g. Rider Ring: PTFE
    h. Electrical: 12V DC
    i. Standards: CSA, UL, & CE

10. Thread Sealant: Brass (2900 Model)

    a. Teflon Tape

11. Power Supply:

    a. International power range: 90-264V AC single phase, 50-60 Hz 1 amp. Fuel gas models include a separate power module and cable to interconnect control cabinet to power module.

12. Inlets & Outlets: (2900 Model)

    a. 1/2" NPT (F)

13. Max. Inlet Pressure: 3000 PSIG
14. Temp. Range: 0 to 140 F
15. Storage Range: -20 to 180 F
16. Cleaning:

    a. Meets CGA G-4.1, "Cleaning Equipment for Oxygen Service" and CGA 02 "Directory of Cleaning Agents for Oxygen Service".

17. Relay Board:

    a. Relay board has two sets of dry contacts, split left and right for interconnecting to a remote alarm signal.

18. Telemetry Contacts:

    a. Contacts interfacing with the left and right transducer signals for telemetry are available as an option.

19. Remote Alarm:

    a. RW-12V: The 12V remote alarm includes two system status LED's and an audible buzzer with a push to silence button housed in a 6" x 3" x 2" black plastic enclosure. A green LED is used for system normal status and red is used for empty indication for any cylinder bank. The alarm is receives its power from the control enclosure. (Interconnecting cable supplied by customer)

    b. RWLR-12V: The 12V remote alarm includes four system status LED's (two for each left and right bank) and an audible buzzer with a push to silence button housed in a 6" x 3" x 2" black plastic enclosure. Green LED's are used for "System Ready", and red is used

for "Empty" indication for any cylinder bank. The alarm receives its power from the control enclosure. (Interconnecting cable supplied by customer)

PART 3 – EXECUTION

3.01 PREPARATION

A. Coordinate cutting of roof and floor construction to receive drains at required invert elevations.

3.02 INSTALLATION

A. Install items in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Install water hammer arrestors complete with accessible isolation valve on cold water supply piping to lavatories, and sinks as scheduled on the Drawings by fixture units.

D. Install all plumbing specialties as indicated on the Drawings and as required for complete systems in conformance with all applicable codes.

E. Install take-offs to each air station from top of main, with ball valve after take-off.

END OF SECTION

SECTION 22 44 00

PLUMBING FIXTURES

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Water Closets.

B. Urinals.

C. Lavatories.

D. Flush valves.

E. Fixture carriers.

F. Drinking fountains and water coolers.

G. Emergency eye wash and shower stations.

H. Mop receptors.

I. Shower systems.

J. Laundry sink.

K. Barrier-free shower unit.

L. Laboratory fixtures.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 22 01 00.

B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 22 01 00.

B. Include fixture trim exploded view and replacement parts lists.

PART 2 – PRODUCTS

2.01 PLUMBING FIXTURES, TRIM, AND ACCESSORIES

A. Plumbing fixtures, trim, and accessories are scheduled on the Drawings. Acceptable manufacturers for each type of fixture, trim, and accessories are indicated in this Section. The manufacturer listed on the Drawings is the basis of design. Products by other listed manufacturers which are similar in quality, size, capacity, function, adaptability to space requirements, etc. will be considered acceptable for this project. It shall be the Contractor's responsibility to assure that the design intent is fulfilled. The Engineer's review of shop drawings for equipment as manufactured by other than the first named manufacturer shall in no way relieve the Contractor of this responsibility.

B. High efficiency water closets, urinals and associated flush valves shall be of the same manufacturer and designed to operate as a complete package to assure efficiency of assembly is achieved.

C. All components in the plumbing system designed for delivering water for human consumption must comply with the no lead requirements of NSF/ANSI 61, Annex G. System components shall have a weighted average of not more than 0.25% lead.

2.02 ACCEPTABLE MANUFACTURERS - WATER CLOSETS AND URNIALS

A. American Standard

B. Kohler

C. Toto

D. Sloan

2.03 ACCEPTABLE MANUFACTURERS - FLUSH VALVES

A. American Standard

B. Kohler

C. Toto

D. Sloan

2.04 ACCEPTABLE MANUFACTURERS - WATER CLOSET SEATS

A. Olsonite

B. Church

2.05 ACCEPTABLE MANUFACTURERS - FIXTURE CARRIERS

A. Zurn

B. Jay R. Smith

C. Josam

2.06 ACCEPTABLE MANUFACTURERS - LAVATORIES

A. Kohler

B. American Standard

C. Toto

2.07 ACCEPTABLE MANUFACTURERS - LAVATORY SENSOR FAUCETS

A. Toto

B. Chicago

C. Sloan

2.08 ACCEPTABLE MANUFACTURERS - LAVATORY MANUAL FAUCETS

A. Chicago

B. Kohler

C. Zurn

2.09 ACCEPTABLE MANUFACTURERS - DRINKING FOUNTAINS AND WATER COOLERS

A. Elkay

B. Halsey-Taylor

C. Filtrine

D. Oasis

2.10 ACCEPTABLE MANUFACTURERS - MOP RECEPTORS

A. Fiat

B. Stern Williams

C. Florestone

2.11 ACCEPTABLE MANUFACTURERS - SHOWER PRESSURE REGULATING MIXING VALVES

A. Leonard

B. Symmons

C. Chicago Faucet

2.12 ACCEPTABLE MANUFACTURERS - SHOWER UNIT

A. Aquarius

B. Aqua Bath

C. Kohler

D. American Standard

2.13 ACCEPTABLE MANUFACTURERS - EMERGENCY EYEWASH AND SHOWER STATIONS

A. Guardian

B. Encon

C. Bradley

2.14 ACCEPTABLE MANUFACTURERS - SINKS

A. Elkay

B. Kohler

C. American Standard

2.15 ACCEPTABLE MANUFACTURERS - SINK FAUCETS

A. Chicago

B. Kohler

C. American Standard

D. Moen

2.16 ACCEPTABLE MANUFACTURERS – LABORATORY GAS FIXTURES

A. Chicago

B. Water Saver

C. Zurn

2.17 ACCEPTABLE MANUFACTURERS - LABORATORY FAUCETS AND FIXTURES

A. Chicago

B. Water Saver

C. Zurn

2.18 FIXTURE SCHEDULE

A. All fixtures and accessories are scheduled on the Drawings.

2.19 P-TRAPS

A. Acceptable Manufactures:

1. McGuire

2. Sanitary Dash
3. Jameco

B. Cast brass adjustable P-trap with cleanout plug, ground joint and 17 gauge minimum weight extension with escutcheon. All p-traps and tailpieces installed in exposed locations shall be chrome plated.

C. Provide McGuire No 8090 1 ¼" x 1 ½" on lavatories and No. 8089 1 ½" x 1 ½" on sinks.

2.20 STOPS AND SUPPLIES

A. Acceptable Manufactures:

1. McGuire
2. Watts
3. T&S Brass

B. Stops and supplies of the same manufacturer as the fixture or faucet trim will be acceptable if available.

C. Provide McGuire Model 170-LK loose Key Angle stop with 5-inch long nominal copper sweat extension.

PART 3 – EXECUTION

3.01 INSPECTION

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

B. Verify adjacent construction is ready to receive rough-in work of this Section.

3.02 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with stop valves, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with floor-mounted wall carriers and bolts unless otherwise specified.

E. Seal fixtures to wall and floor surfaces with acrylic sealant color to match fixture. Sealant shall be as specified in Section 07 90 00.

F. Mount fixtures to the heights scheduled on the Drawings and in accordance with the current handicapped accessible codes where applicable.

3.03 ADJUSTING AND CLEANING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion clean plumbing fixtures and equipment.

C. Solidly attach water closets to carriers.

3.04 FIXTURE ROUGH-IN SCHEDULE

A. Rough-in fixture piping connections in accordance with schedule on drawing of minimum sizes for particular fixtures.

END OF SECTION

SECTION 22 45 00

PLUMBING EQUIPMENT

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Domestic water heater.

B. Recirculation pump.

C. Plumbing expansion tank.

D. Sump pump.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 22 01 00.

B. Include dimensions of tanks, tank lining methods, anchors, attachments, tappings, and drains.

C. Submit manufacturer's installation instructions under provisions of Section 22 01 00.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 22 01 00.

B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.05 REGULATORY REQUIREMENTS

A. Conform to Maine State Internal Plumbing Code requirements for water heater.

B. All components in the plumbing system designed for delivering water for human consumption, must comply with the no lead requirements of NSF/ANSI 61, Annex G. System components shall have a weighted average of not more than 0.25% lead.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - DOMESTIC WATER HEATER

A. PVI

B. Ace

C. Sellers

2.02 DOMESTIC WATER HEATER

A. Furnish and install Two PVI EZ Plate Boiler Water - water heaters, Model #900 L 300 ATRPF as manufactured by PVI Industries, Incorporated of Fort Worth, Texas.

B. Each water heater will provide 900 gph from 40º F to 140º F when supplied with 15gpm boiler water flow at 180° F in and 79.1° F boiler water return temperature. Storage capacity 300 gallons.

C. Heat Exchanger Construction

1. Water heating system will employ a heat exchanger utilizing boiler water to heat potable water and potable water will be circulated between this heat exchanger and a sidearm storage tank. Building system cold and hot water connections will be made to the storage tank.
2. The heat exchanger will be a double-wall, plate-and-frame design utilizing counter flow paths for the potable water and the boiler water. The exchanger will be ASME stamped, section VIII and rated for 150 psi operating pressure at 230°F. The plates will be 316L stainless steel.
3. The heat exchanger will be mounted on a separate skid for field connection to the sidearm storage tank. Heat exchanger to tank piping will factory pre-assembled and shipped separately for field installation. All piping to and from the potable water side of the exchangers will be non-ferrous
4. Potable water piping to the heat exchanger will include a bronze y-strainer with a blow down valve.
5. Potable water piping will include isolation valves to allow clean in place. Dedicated clean-in-place ball valves will be provided. Potable water piping to the heat exchanger will include a bronze circulator properly sized for the heat transfer requirements and pressure drop through the factory pre-assembled piping.

D. Storage Tank Construction

1. The storage tank shall be ASME Section IV stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.
2. All tank fittings shall be non-ferrous. Tank shall be equipped with a ball-type drain valve. Tank design will include a man way sized access to the tank interior. Tank will include a combination temperature and pressure relief valve.
3. The storage tank shall be an unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2and ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”
4. Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.

5. All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted.
6. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.
7. Water contacting tank surfaces will be non-porous and exhibit 0% water absorption.
8. Lined or plated storage tanks will not be acceptable.
9. The water heater will not require anode rods and none will be used. Tanks that employ either sacrificial or impressed current anodes will not be acceptable.

E. Temperature Control

1. The storage will include an electronic operating thermostat with digital temperature readouts. If equipped with the optional serial cable, the operator will be connectable to BAS utilizing Modbus RTU protocol. BAS will be able to read sensed temperatures and temperature alarm status and over-write the operating set point to engage nighttime setback of stored water temperature if desired.
2. A call for heat will be initiated when the main operating probe located in the storage tank senses stored water temperature below the set point temperature programmed into the operating control. The operating control will then energize the circulating pump to flow water from the tank and into the plate exchanger. On low temperature boiler water systems (boiler water supply 180° F or lower), boiler water may be flowing through the heating side of the exchanger at all times. If this is the case, energizing the pump alone will be sufficient to cause temperature rise to occur in the potable water. When the storage tank regains set point temperature, the circulating pump will be de-energized. On higher temperature boiler water systems (boiler water supply greater than 180° F), a boiler water control valve will be included on the heating side of the exchanger. On a call for heat, this valve will be positioned to allow boiler water to flow through the heat exchanger. When the tank temperature is satisfied, this valve will be re-positioned to divert or stop flow.

F. Water Heater Trim

1. As a minimum, the heater will be equipped with the following:

   a. Bronze Circulating Pump,
   b. Immersion Temperature limiting device,
   c. Terminals for remote on-off control,
   d. Manual reset Temperature limiting devise,
   e. Electronic Low water cut off,
   f. Tank pressure gauge,
   g. Boiler water control valve
   h. A protocol gateway for BacNet MSTP/IP will be provided.

G. Finishing

1. The heating section and the storage tank shall be completely factory packaged on individual skids and will be plumbed together at the job site. The tank- to-exchanger plumbing will be factory pre-built but shipped separately for field assembly. The entire heating package shall fit properly in the space provided and installation shall conform to all local, state, and national codes.

H. Start-Up

1. Start up on the unit will be performed by factory trained and authorized personnel. A copy of the startup report will be provided to the owner.

I. Warranty

1. Heat exchanger: Three years coverage for manufacturing or material defects, leaks, and/or the production of rusty water
2. Storage tank: Twenty-five year coverage (15 years full, 10 years prorated) for manufacturing or material defects, corrosion, leakage and/or the production of rusty water. All other heater parts: 1 year.
3. The heater shall have a first year service policy, which shall cover labor and freight costs under certain conditions for warranty covered services.

2.03 ACCEPTABLE MANUFACTURERS - RECIRCULATING PUMPS

A. Bell & Gossett

B. Taco

C. Armstrong

2.04 RECIRCULATING PUMPS

A. Pumps shall be constructed with bronze casing, rated for 125 psig working pressure. Pump shall be fitted with bronze impeller, alloy steel shaft with integral thrust collar and two oil-lubricated bronze sleeve seal rotating against a stationary ceramic seat, and a flexible drive coupling.

2.05 ACCEPTABLE MANUFACTURERS - PLUMBING EXPANSION TANK

A. Amtrol Inc.

B. Watts

C. Bell & Gosset

D. Approved equal

2.06 PLUMBING EXPANSION TANK

A. Pre-pressurized diaphragm-type well tank with sealed-in air charge. FDA compliant, NSF listed, non-metallic water reservoir.

B. Welded steel tank, with deep-drawn steel domes. All welds shall be finished smooth to prevent damage to diaphragm and liner. Tank exterior shall be finished with appliance-like enamel paint.

C. Seamless flexible heavy-duty butyl diaphragm, conforming to FDA requirements for potable water supply components.

D. 100% non-metallic water reservoir. Rigid water reservoir consisting of a polypropylene liner and acceptance fitting which is 100% corrosion resistant. Water reservoir shall comply with and be listed for NSF Standard 14 requirements.

E. Silver brazed, copper-lined acceptance fitting.

F. Factory pre-charge corresponding to pump cut-in pressure.

G. Brazed, tamper-proof air valve.

H. 75 psig working pressure; pressure tested to 125 psig.

2.07 ACCEPTABLE MANUFACTURERS - ELEVATOR SUMP PUMPS WITH OIL DETECTION

A. Stancor

B. Weil

C. Zoeller

2.08 ELEVATOR SUMP PUMPS WITH OIL DETECTION

A. Performance: Refer to drawing schedule for performance requirements.

B. Type: Submersible vertical centrifugal non-clog effluent pump.

C. Casing: Cast iron base and top with Type 304 stainless steel motor housing.

D. Impeller: Cast iron vortex impeller 1-1/2" solids capacity.

E. Seals: Mechanical seals in oil-filled compartment with secondary lip seals.

F. Overload Protection: Built-in.

G. Level Controls: Float type Pump On/Pump Off, High Level.

H. Oil Detection and Oil Lockout Controls:

1. Controller in NEMA 4X fiberglass box.
2. Stainless steel oil sensor probe.
3. Alarms and lights for:

    a. Oil.
    b. High liquid.
    c. High amps.

4. Multi-pin connector junction box and cord.
5. Sensor, power, detector, and control cord.
6. Remote alarm circuit for building control system interface.
7. Coordinate installation with Electrical Subcontractor.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and in compliance with all applicable codes.

B. Provide factory representative to provide start-up combustion test and commissioning of the domestic hot water heaters. Provide a written report demonstrating its proper set-up and operation.

C. Combustion test report shall include:

1. Percent oxygen (O_2).
2. Percent excess air.
3. Fuel gas temperature at outlet.
4. Ambient temperature.
5. Net stack temperature.
6. Percent stack loss.
7. Percent combustion efficiency.

END OF SECTION

SECTION 23 01 00

BASIC MECHANICAL REQUIREMENTS

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Basic Mechanical Requirements specifically applicable to Division 23 Sections, in addition to Division 01 – General Requirements.

1.02 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations.

B. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

C. All related Specification sections shall be used in conjunction with this Section.

1.03 WORK

A. Scope of work includes furnishing and installing equipment, other apparatus and accessories required for complete mechanical systems.

1.04 SUBMITTALS

A. Refer to Division 01 for submittal requirements. The following paragraphs supplement the requirements of Division 01.

B. Submit shop drawings and product data as requested by other Division 23 sections. All submittals to follow requirements of General Conditions, modifications to General Conditions, and Division 01.

C. The Contractor will be held responsible for checking and verifying all field measurements, and shall submit promptly, as to cause no delay in any work, shop drawings and schedules required for the work. The Contractor shall check and approve all submittals before forwarding to the Architect. All submittals shall be transmitted to the Architect using the submittal transmittal form contained in Division 01. The Architect will forward submittals to the Engineer. The Engineer will check and review the submittals with reasonable promptness, but only for conformance with design concept of the project and for compliance with information given in Contract Documents. The Contractor shall make any corrections required by the Engineer. The Engineer's review of submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications, unless he has, in writing, called the Engineer's attention to such deviations at the time of submission and has secured the Engineer's written approval. Additionally, the Engineer's review of submittals shall not relieve the Contractor from responsibility for any errors or omissions contained in the submittals.

D. When necessary, shop and setting drawings shall be based upon actual measurements taken at the site and upon other job conditions. Show any variations and revisions to Drawings or Specifications that are necessary for proper installation.

E. Submit copies of manufacturer's shop drawings showing illustrated cuts of item to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, installation instructions, wiring diagrams and controls and all pertinent information. Submit the quantity of copies indicated in architectural specifications.

F. At completion of construction, the Contractor shall furnish the Owner with one (1) unused copy of all reviewed shop drawings, manufacturer's diagrams, installation instructions, literature, etc., that were used in execution of the work.

G. The Contractor shall note that where more than one manufacturer's name is listed for the various major items of equipment and materials specified herein, the plans and specifications have been developed on the basis of equipment as manufactured by the first manufacturer name. Other manufacturers names are included to indicate the equipment manufactured by them may be considered acceptable for this project, provided that the equipment meets all requirements as to quality, size, and adaptability to space requirements, etc. It shall be the Contractor's responsibility to assure that the equipment, as manufactured by other than the first name manufacturer, shall meet all requirements as to quality, size, capacity, function, adaptability to space requirements, etc. The Engineer’s review of shop drawings for equipment as manufactured by other than the first named manufacturer shall in now way relieve the Contractor of this responsibility.

1.05 SUBSTITUTIONS

A. Any and all proposed substitutions must be approved by the Architect during the bid phase and must be indicated on the form of proposal. For specific substitution requirements, refer to architectural specifications.

1.06 COORDINATION

A. Prepare and submit coordination drawings for all work performed under Division 23 as specified in architectural specifications.

B. Coordinate with all other trades as required throughout the project.

C. Refer to Section 01 31 33 Building Information Modeling (BIM) for requirements pertaining to systems and element coordination, clash detection, and levels of documentation detail.

1. BIM for the coordination process shall be to a 400 Level of Development (LOD) in accordance with AIA E202. This level of development shall be considered suitable for fabrication and assembly by trade contractors and specialty fabricators in order to fabricate, assemble and construct project components including mechanical, electrical, plumbing and fire protection (MEP/FP) systems.

D. Coordination drawings will be required for all work performed under this contract, as required and/or described in Division 01. Prepare and submit coordination models and drawings for work performed under Divisions 21 through 27 as specified in Division 01. Each contractor and associated sub-contractor shall be responsible for their respective coordination drawing effort.

1. As specified in Division 01:

a. Prepare and submit 3-dimensional (3D) coordination and clash detection models and reports.
b. Prepare and submit 2-dimensional drawings showing the installation intent; drawings are to be to a scale of 3/8" = 1'-0" or larger.

c. Detail all mechanical, plumbing, fire protection and electrical system elements, components, equipment and materials in relationship with other systems, installations, and building components.
d. Dimension system elements and components off of column lines, and other fixed building features.
e. At a minimum, indicate the proposed locations of ALL:

1) Mechanical, fire protection and plumbing piping;
2) HVAC ductwork;
3) Electrical equipment, panel-boards, switch-gear, and controls;
4) Cable trays and tel/data wire management systems;
5) Tel/data racks, panels, and equipment;
6) Major electrical, tel/data, and BAS conduit runs and conduit racks;
7) Mechanical, electrical, plumbing and fire protection equipment and services;
8) Food service equipment and kitchen fixtures;
9) Grease traps/interceptors;
10) Refrigerant piping associated with food service equipment;
11) Control panels, motor-controllers and motor starters;
12) Automatic temperature control and building automation system components;
13) Components, devices and materials of other systems' (e.g., beverage tubing/conduit, central vacuum system – if such is provided, etc.).
14) At a minimum, account for and show the following:

a) Clearances for servicing and maintaining equipment, including space for disassembling equipment requiring periodic maintenance.
b) Electrical Code required service clearances.
c) Equipment connections and support details.
d) Seismic bracing and anchor and guide locations.
e) Pipe pitches, drip legs, low-point drains, and high-point vents.
f) Other system installation and maintenance requirements.

f. Prepare reflected ceiling plans to coordinate and integrate installations.

1) Show air outlets and inlets, light fixtures, fire alarm devices, fire protection system components (e.g. sprinkler heads), audio-visual and communication systems components, access doors, and other above-ceiling, ceiling-mounted and/or in-ceiling items.
2) Clearly indicate ceiling construction type, materials, framing, supports, etc.

g. Coordinate "in-wall" elements and systems. Coordinate all wall elevations.
h. Provide part plans, sections, elevation views, and other details as required to fully describe and coordinate installation requirements.

E. Carefully coordinate all cast-in-place concrete openings (slots, chases, holes, etc.). Obtain concrete form layouts and submittals from the General Contractor; provide comment as appropriate on the dimensional layout of openings and placement of reinforcing. Engage in this process as soon as possible in order to avoid conflict with structural elements and to ensure openings are properly sized and located. Adjust mechanical work as necessary to accommodate structural requirements. Bring potential conflicts to the attention of the General Contractor, Architect and Engineer as soon as possible.

F. Avoid penetrations in shear walls and structural seismic elements (to the full extent practical).

1. Carefully coordinate any and all shear wall penetrations (if such cannot be avoided) with the Structural Engineer. Provide details of actual locations and required sizes of openings. Shear wall penetrations which do occur shall be kept to a minimum (both quantity and size). Bond beams shall not be penetrated unless such penetrations are specifically allowed and detailed by the Structural Engineer.

G. Carefully coordinate shafts, chases, slots, cored openings, and other vertical connections through the building and between floors.

H. Coordinate with all other trades as required, throughout the course of the project, in order to avoid conflicts and to promote the successful progression of work throughout the duration of the project.

I. Readily and actively participate in coordination meetings. Inform subcontractors, suppliers, vendors, etc., of coordination requirements and responsibilities. Inform the Owner well in advance of required shut-downs, service disruptions, system tie-ins or disconnections, etc. Schedule work sufficiently in advance to promote a smooth progression of work, and with sufficient time to redirect efforts if conflict with other's work is determined.

J. Maintain working clearances at above-ceiling components and devices requiring access and service (e.g., cable trays, air terminal control boxes, balancing valves, etc.). Coordinate with, and as necessary direct the work of, other trades to ensure proper above-ceiling access is maintained.

1. Coordinate to ensure piping, ductwork, ceiling supports, conduit and cable tray, wiring, miscellaneous hangers and supports, hanger rods, light fixtures, fire alarm devices, sprinkler piping and sprinkler heads, etc., are not mounted or installed in such a manner as to block ready access to above-ceiling components and devices requiring access.
2. Physically identify "no trespass zones" with tape, signs, or other markers in order to warn other trades to avoid spaces, locations and clearances which must be kept open.

K. In order to resolve coordination difficulties and/or conflicts which cannot be otherwise resolved, structural beam penetrations may be allowed and only on a limited basis, and only with the review and approval of the Structural Engineer. If structural beam penetrations are required and allowed, the General Contractor will oversee the coordination and provision of such via shop fabrication and/or field cut openings. Any and all structural beam penetrations shall be in strict accordance with the Structural Engineer's written direction and details.

1. Carefully coordinate with structural openings in beams and other structural elements shown on the structural drawings. Review structural fabrication shop drawings and provide comment as appropriate on the dimensional layout of openings.

L. All under-slab piping, stub-ups, sleeves, pockets, recesses, etc., associated with the structural slabs must be precisely coordinated with the slab's structure and with above slab features and elements. Piping, conduit, equipment, devices, etc., set in or below the slab must be located with the aid of accurately dimensioned coordination drawings, which have been prepared in conjunction with the General Contractor, Division 21 through 27 contractors, the Architect, the Structural Engineer, the MEP/FP Engineer, etc.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

1.08 REGULATORY REQUIREMENTS

A. Building Codes: Conform to:

1. Maine Uniform Building and Energy Code.
2. 2009 International Building Code (IBC 2009), as adopted and amended by the State of Maine.

B. Mechanical Code: Conform to ASHRAE 62.2-2007, as adopted and amended by the State of Maine.

C. Plumbing Code: Conform to 2009 Uniform Plumbing Code (UPC 2009), as adopted and amended by the State of Maine.

D. Energy Conservation Code: Conform to 2009 International Energy Conservation Code (IECC 2009), as adopted and amended by the State of Maine.

E. Life Safety Code: Conform to 2009 NFPA-101, as adopted and amended by the State of Maine.

F. Fire Code: Conform to 2009 NFPA-1, as adopted and amended by the State of Maine.

G. Obtain permits and request inspections from authority having jurisdiction.

1.09 PROJECT/SITE CONDITIONS

A. Install work in locations shown on the Drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect before proceeding.

1.10 RECORD DOCUMENTS

A. Refer to Division 01 for record document requirements. The following paragraphs supplement the requirements of Division 01.

B. Mark drawings to indicate revisions to piping and ductwork (size and location), both exterior and interior. Include locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair. Show actual equipment locations dimensioned from column lines, actual inverts and locations of underground piping, concealed equipment dimensioned to column lines, locations of mains and branches of piping systems, numbered valves and control devices, concealed unions, items requiring maintenance (i.e., traps, strainers, expansion compensators, tanks, air vents, etc.), and control system devices. Mark all change orders on the drawings.

C. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

1.11 OPERATION AND MAINTENANCE DATA

A. Refer to Division 01 for operation and maintenance manual requirements. The following paragraphs supplement the requirements of Division 01.

B. The Contractor shall provide the following information in a bound manual:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

C. Two (2) copies of operations and maintenance data shall be submitted to the Architect for review: one (1) copy shall be returned to the Contractor (with any instructions for changes). After implementing any changes, five (5) copies of instructions covering all equipment shall be furnished to the Architect who will forward two (2) copies to the Owner for his information and use.

D. Append to manual, the name, address and telephone number of the Contractors and Subcontractors and for mechanical items, provide the name, address and telephone number of companies servicing installed equipment on a 24-hour basis.

1.12 COMMISSIONING AND OWNER'S TRAINING

A. The Contractor performing work under Section 23 01 00 will be responsible to carry out the commissioning requirements and Owner's training. Specified in Division 01.

B. Refer to individual equipment sections for specific training requirements beyond those indicated here.

C. The Contractor shall provide a written agenda for each training session, as well as provide all supplemental training materials, literature, etc., necessary to cover the topics to be discussed.

D. Training shall not commence until after substantial completion, but shall be provided prior to acceptance by the Owner.

1.13 PRODUCTS

A. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air handling units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flange types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.

B. Provide products which are compatible within systems and other connected items.

1.14 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.15 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.16 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Note that where access is required through general construction elements, the Mechanical Contractor is to furnish all required access doors for access to mechanical equipment, and is to coordinate with the General Contractor regarding access door locations and installations. Access doors furnished shall comply with Architectural specification. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

1.17 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 02 through 27 for rough-in requirements.

1.18 MECHANICAL INSTALLATIONS

A. Coordinate mechanical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

I. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, light fixtures, and other installations.

J. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.19 CLEANING

A. Refer to Division 01 for general requirements for final cleaning.

B. Refer to Section 23 54 50 for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

C. Refer to Section 22 41 00 for requirements for disinfecting domestic water piping.

D. Refer to Section 23 89 00 for requirements for cleaning ductwork.

E. Refer to Section 23 99 00 for requirement for air filter replacements.

1.20 ELECTRICAL COORDINATION

A. Division 23 Responsibility:

1. Mount all electric power consuming equipment specified under Division 23; i.e., motors, and prewired control panels.
2. Mount all duct-mounted smoke detectors (these devices will be provided by the Electrical Contractor).
3. The electrical contractor shall be responsible for providing only the field wiring and equipment as indicated in the wiring schematics on the electrical drawings; any other wiring and/or equipment that is required and related to Division 23 work shall be the responsibility of the Mechanical Contractor.
4. Furnish all necessary wiring diagrams, instructions, advice, supervision, materials, labor, etc., as may be necessary to accomplish power wiring.
5. Furnish, install and take responsibility for accuracy and completeness of temperature control wiring, interlock wiring, and any other mechanical equipment wiring not shown on the electrical drawings.
6. Motor starters, disconnects, variable frequency drives, wiring, etc., not shown on the electrical drawings shall be provided by the Mechanical Contractor and shall comply with Division 26 requirements.

B. Division 26 Responsibility:

1. Furnish and install, as indicated on the electrical drawings all motor overload protective devices, contactors, magnetic starters, complete with required pushbuttons, selector switches, and pilots.
2. Provide disconnect switches as indicated on the electrical drawings.
3. Provide all power wiring as indicated on the electrical drawings.

1.21 WARRANTIES

A. Refer to Division 01 for warranty requirements. The following paragraphs supplement the requirements of Division 01.

B. Compile and assemble all warranties for equipment specified in Division 23 into vinyl-covered three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Include product or equipment, date of beginning of warranty or bond, duration of warranty or bond, and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.22 GUARANTEE

A. The Contractor shall guarantee all work to be free from defects for a period of one (1) year after acceptance. Any and all work found defective or not in accordance with the Contract during this period shall be corrected promptly by the Contractor after written notification from the Owner. The Contractor shall repair or correct the work within ten (10) days of the written notification and if the Contractor does not comply, the Owner may have the work corrected and charge all such work to the Contractor.

1.23 REVIT FILES

A. Following the receipt of a written request from the Contractor, RFS will furnish REVIT electronic files for mechanical drawings. Signing of the Rist-Frost-Shumway Engineering, P.C. Electronic Document File/Digital License Agreement shall be considered a prerequisite for the release of electronic REVIT files.

B. Note that BIM for the design process is generally 300 Level of Development (LOD) in accordance with AIA E202. This level of development is typically considered to include model elements equivalent to traditional construction documents. 300 LOD BIM is suited to estimating, and basic construction coordination for clash detection, scheduling and project visualization.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 23 12 10

EXPANSION COMPENSATION

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Pipe alignment guides.

B. Pipe anchors.

C. Flexible pipe expansion joints.

D. Flexible pipe connections.

E. Pipe loops, offsets, and swing joints.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 23 01 00.

B. Submit pipe anchor details and fabrication drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Metraflex

B. Keflex

C. Flex-Hose

D. American Boa

E. Mason

F. Proco

2.02 PIPE ALIGNMENT GUIDES

A. Construct with carbon steel or copper, as appropriate. Provide with four bolt holes in base plate and finish with factory primer. Provide clamp-on spider carrier within bolted, swing cover alignment ring. Select guide material to avoid dissimilar adjacent metals; provide dielectric break

at dissimilar metals. Select alignment guides with consideration for pipe insulation requirements; guide size shall account for specified insulation thickness.

B. Nylon guide block with mounting bracket for copper tubing within radiation enclosures and similar applications.

2.03 PIPE ANCHORS

A. Construct with carbon steel or copper, as appropriate. Provide with four bolt holes in base plate and finish with factory primer. Select anchor material to avoid dissimilar adjacent metals. Refer to details on Drawings for more information. Submit anchor details for Engineer review prior to fabrication.

2.04 FLEXIBLE PIPE EXPANSION JOINTS

A. Flexible pipe expansion joint loops designed to impart no thrust load on the pipe anchors. Loops shall consist of two (2) sections of flexible hose with braided shrouds, two (2) 90 deg. elbows, and one (1) 180 deg. return, or three (3) sections of flexible hose with braided shrouds with four (4) 90 deg. elbows. Loops shall be provided with plugged drain and/or air vent port(s).

B. All materials of construction, pressure ratings, and end fittings shall be appropriate for the application. Loops shall have a minimum working pressure of 150 PSI at 450 deg. F. Loops shall be fabricated of stainless steel hose and braids with carbon steel elbows, or of bronze hose and braids with copper elbows, as appropriate for the application. Provide dielectric breaks between dissimilar materials.

C. Loops shall be installed in a neutral, pre-compressed, or pre-extended condition as appropriate for the application. Loops installed in any position other than hanging straight down shall be supported as recommended by the manufacturer. Loops installed inverted shall be fitted with an air vent; loops installed in any other position shall be fitted with a drain.

D. Install expansion joints as required and in strict accordance with the manufacturer's requirements and recommendations. Provide pipe anchoring and guiding as appropriate.

2.05 FLEXIBLE PIPE CONNECTIONS - BRAIDED EXTERIOR SLEEVE TYPE

A. For steel piping applications, fabricate flexible inner hose and external braids of stainless steel. For copper piping applications, fabricate flexible inner hose and external braids of bronze.

B. All materials of construction, pressure ratings, and end fittings shall be appropriate for the application. Flexible pipe connections shall have a minimum working pressure of 150 PSI at 450 deg. F. Provide dielectric breaks between dissimilar materials.

C. Refer to Section 23 24 20 for additional information.

2.06 FLEXIBLE PIPE CONNECTIONS - RUBBER TYPE

A. Double-sphere type, fabricated with neoprene and nylon, and suitable for working pressures of 150 PSI at 250 deg. F.

B. All materials of construction, pressure ratings, and end fittings shall be appropriate for the application. Provide dielectric breaks between dissimilar materials.

C. Provide flexible connections suitable for exposure to weather, extreme ambient temperatures (-20 deg. F to 120 deg. F), ultraviolet, etc., when flexible pipe connections are required at exterior equipment.

D. Refer to Section 23 24 20 for additional information.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine piping layout and notify Architect of additional anchors, pipe guides, or expansion loops and/or joints required to adequately protect system.

3.02 INSTALLATION

A. Accomplish structural work and provide equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints, and provide flexible pipe type expansion joints where required.

B. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so that movement takes place along axis of pipe only.

1. Note that anchoring and guiding details on the Drawings are intended to show potential methods for anchoring and/or guiding piping, and are not intended to be considered applicable to all situations or conditions. The Contractor is responsible to anchor and/or guide piping as appropriate to the situation and to seek Engineer input and review prior to fabricating anchors and/or guides.

C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation devices. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor the other end.

D. Provide flexible pipe connections and/or expansion joints suitable to connect to adjoining piping as specified for pipe joints. Use pipe sized units. Fabricate or provide pipe expansion loops, offsets, swing joints, flexible connections, and/or expansion joints as indicated on the drawings.

E. Construct piping spool pieces to the exact size required for insertion of flexible connections, expansion joints, etc.

END OF SECTION

SECTION 23 14 00

SUPPORTS AND ANCHORS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Pipe, duct, and equipment hangers, supports, and associated anchors.

B. Equipment bases and supports.

C. Sleeves and seals.

D. Flashing and sealing equipment and pipe stacks.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SEISMIC RESTRAINTS

A. Conform to Section 1613 of the 2009 IBC and ASCE Standard 7-05 “Minimum Design Loads for Buildings and Other Structures”.

B. Seismic Design Parameters: The Structural Engineer has determined the following seismic design parameters.

1. Seismic Occupancy Category: III
2. Seismic Design Category: C
3. Spectral Response Coefficients

   a. Short Period Response Acceleration (S_{DS}) = 0.361
   b. 1-Second Period Response Acceleration (S_{D1}) = 0.130

C. Component Importance Factor: All mechanical and electrical system components shall be assigned a component importance factor (I_p) as indicated below.

1. The component importance factor (I_p) shall be 1.5 for the following:

   a. Systems are required to remain in place and function for life-safety purposes following an earthquake. Including but not limited to:

      1) Fire protection systems.
      2) Smoke control systems.
      3) Systems required for maintaining proper air pressure in patient isolation rooms to prevent the transmission of infectious diseases.
      4) Systems required for maintaining proper air pressure, temperature and humidity in surgical suites, bio-hazard labs and clean rooms.

5) Medical gas systems.
6) Steam systems.

b. Systems contain hazardous or flammable material in quantities that exceed the exempted amounts for an open system listed in Chapter 4 of 2009 IBC. Including but not limited to:

1) Natural gas systems.
2) Fuel oil systems.
3) Boilers and vent/chimney systems.

c. Systems that are in or attached to a building assigned to Seismic Occupancy Category IV, and are required for the continued operation of the facility.

2. The component importance factor (I_p) shall be 1.0 for all other mechanical and electrical system components.

D. Exemptions: Seismic restraints shall not be required for the following conditions.

1. Mechanical and electrical system components in Seismic Design Category A.
2. Mechanical and electrical system components in Seismic Design Category B.
3. Mechanical and electrical system components in Seismic Design Category C when the Component Importance Factor (I_p) is equal to 1.0.
4. Mechanical and electrical system components in Seismic Design Categories D, E and F when all of the following apply:

a. Component Importance Factor (I_p) is equal to 1.0.
b. Have flexible connections between the components and all associated duct, piping and conduit.
c. Are mounted at 4 feet or less above a floor level.
d. Weigh 400 pounds or less.

5. Mechanical and electrical system components in Seismic Design Categories D, E and F when all of the following apply:

a. Component Importance Factor (I_p) is equal to 1.0.
b. Have flexible connections between the components and all associated duct, piping and conduit.
c. Weigh 20 pounds or less.

E. Seismic restraint schedule for project.

Systems	**Component Importance Factor (I_p)**	**Seismic Restraints Required (R) Not Required (NR)**
Fire Protection Sprinkler Piping	1.5	R
Natural Gas Piping	1.5	R
Atrium Smoke Control System	1.5	R
Boilers	1.5	R

Systems	Component Importance Factor (I_p)	Seismic Restraints Required (R) Not Required (NR)
Boiler Chimney/Vent	1.5	R
HVAC Equipment	1.0	NR
HVAC Ducts	1.0	NR
HVAC Piping	1.0	NR

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit data sheets relative to seismic restraints and detailing compliance with the specification. Provide detailed schedules of flexibly and rigidly mounted systems by referencing numbered descriptive drawings. Include vibration isolator requirements as identified under Section 23 24 20 - Vibration Isolation.

C. Shop Drawings:

1. Submit fabrication details for equipment bases, including dimensions, structural member sizes, and support point locations.
2. Provide all details of support for wall and ceiling suspended components.
3. Where walls, floors, slabs, or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for each components must be included and approved prior to installation. Include spacing, static loads, and seismic loads at each attachment and support point.
4. Provide specific details of seismic restraints and anchors. Include quantity, size, and locations for each component.

D. Seismic Analysis and Certification:

1. The seismic restraint design, consisting of calculations, restraint selection, installation details, and other documentation shall be performed by a professional engineer licensed in the state where the project is located. Submit all documentation with professional seal and signature.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - PIPE HANGERS AND SUPPORTS

A. Anvil International

B. Carpenter & Paterson

C. Bergen-Power Pipe Supports

D. Cooper B-Line

E. Approved equal

2.02 PIPE HANGERS AND SUPPORTS

A. Hangers for all insulated pipes shall be sized and installed so they are outside the insulation jacket.

B. Hangers for Pipe Sizes 1/2 to 1-1/2-Inch: Carbon steel, adjustable swivel, ring type or adjustable, clevis.

C. Hangers for Pipe Sizes 2 to 4-Inches (except fire protection piping): Carbon steel, adjustable, clevis.

D. Hangers for Pipe Sizes 5-Inches and Over (except fire protection piping): Adjustable steel yoke, cast iron roll, double hanger.

E. Hangers for Un-insulated Copper Piping: Copper plated carbon steel or fitted with lead inserts.

F. Hangers for Fire Protection Pipe Sizes up to 4-Inches: Carbon steel, adjustable swivel, ring type.

G. Hangers for Fire Protection Pipe Sizes 5-Inches and Over: Carbon steel, adjustable, clevis.

H. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for hot pipe sizes 5-inches and over.

I. Wall Support for Pipe Sizes to 3-Inches: Cast iron hook.

J. Wall Support for Pipe Sizes 4-Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 5-inches and over.

K. Vertical Support: Steel riser clamp. Provide sheet lead inserts for all copper pipe risers.

L. Floor Support for Pipe Sizes to 4-Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

M. Floor Support for Hot Pipe Sizes 5-Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

N. Shields for Insulated Pipes Installed with Ring Type or Clevis Type Hangers: Galvanized steel shields over insulation in 180° segments. For pipe sizes 3 inches and smaller, shield shall be 18-gauge minimum and minimum 6-inches long. For pipes sizes over 3-inches, shield shall be 16-gauge minimum, and minimum 12 inches long.

O. Saddles for all Insulated Pipes Installed with Roll Type Hangers: Pipe covering protective saddles which shall be a minimum of 12-inches long and shall be of the same thickness as the insulation thickness. Saddles for hot pipes shall be carbon or alloy steel. Saddles for cold pipes shall be hard block non-conducting type.

P. Supports for piping, conduit and ductwork routed exposed on roofs: "zero penetration" pipe stands, supports and/or hanger assemblies specifically designed for exterior roof piping, conduit, and ductwork installations. Roof stands, supports, and/or hanger assemblies shall be designed to rest on roof membrane without penetrating roofing, and shall include base plates with smooth, rounded edges to prevent gouging or cutting of roof membranes. Pipe stands and supports shall incorporate rollers and/or roller bearings to allow pipe movement without causing movement of roof stand or support. Alternately, hanger style stands/supports shall consist of strut and leg assemblies with suspended roller bearing and/or clevis type pipe hangers for suspending piping above the roof from the horizontal member of the hanger assembly. Hanger/support assemblies

for ductwork shall include vertical legs with horizontal members on which ductwork rests and is fastened to. The design of the hanger/support assemblies shall be such that thermal expansion and contraction of pipes and ductwork is absorbed in order to prevent movement of the hanger/support assembly and thereby prevent damage to the roof membrane. Stands, supports, and/or hanger assemblies shall be of the style/type, size and configuration appropriate for the pipe, conduit, and/or ductwork carried, and for the specific application and requirements of this project. Stands, supports, and/or hanger assemblies shall be made of polycarbonate material, hot-dipped galvanized steel, and/or stainless steel. Roof stands, supports, and/or hanger assemblies shall be manufactured by Miro Industries, or engineer approved equal.

1. Supporting piping, conduit, ductwork, and/or mini-split air conditioning units with wood blocking and/or wood "sleepers" is not acceptable.

2.03 DUCTWORK HANGERS AND SUPPORTS

A. Ductwork Hangers and Supports: Shall consist of steel rods, galvanized steel bands, and angle irons. Size and install hangers and supports in accordance with "HVAC Duct Construction Standards" (second edition) published by the Sheetmetal and Air Conditioning Contractors National Association, Inc., (SMACNA).

2.04 HANGER RODS

A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.05 INSERTS

A. Inserts: Carbon steel flat bar type or malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.06 C-CLAMPS

A. C-Clamps: Malleable iron clamp; hardened steel cup point set screw and locknut; size c-clamps to suit threaded hanger rod.

2.07 EQUIPMENT BASES AND SUPPORTS

A. Concrete Equipment Bases: To be installed under Section 03 30 00. Coordinate with appropriate contractor as required.

B. Steel Equipment Bases and Supports: Fabricate from structural steel members to suit the equipment supports. Conform to manufacturer's recommendations where applicable.

2.08 FLASHING

A. Metal Flashing: 26-gauge galvanized steel.

B. Lead Flashing: 5 lb/sq ft sheet lead for waterproofing; 1 lb/sq ft sheet lead for soundproofing.

C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

D. Caps: Steel, 22-gauge minimum; 16-gauge at fire-resistant elements.

2.09 SLEEVES

A. Size sleeves large enough to allow for continuous insulation wrapping and to allow for movement due to expansion and contraction.

B. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18-gauge galvanized steel.

C. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Form with steel pipe or 18-gauge galvanized steel.

D. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL listed.

E. Sleeves for Round Ductwork: Form with galvanized steel.

F. Sleeves for Rectangular Ductwork: Form with galvanized steel or wood.

G. Fire Stopping and Stuffing Insulation: Glass fiber type, non-combustible. Firestopping and stuffing insulation for mechanical penetrations shall be provided by the Mechanical Contractor. This work shall be accomplished in accordance with Section 07 84 00.

H. Caulk: Acrylic sealant shall be as specified in Section 07 90 00. Caulk sealing for mechanical equipment installations shall be provided by the Mechanical Contractor.

2.10 FINISH

A. Prime coat all exposed steel hangers and supports. Hangers and supports located in mechanical rooms, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 – EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as follows:

Pipe Size	Maximum Hanger Spacing	Hanger Diameter
1/2 to 1-1/4 inch	6'-0"	3/8"
1-1/2 to 2 inch	10'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
4 to 6 inch	10'-0"	5/8"
PVC (All Sizes)	4'-0"	3/8"
Cast Iron Bell & Spigot	5'-0" and at joints	1/2"
Cast Iron No-Hub	5'-0" and at joints	1/2"

B. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.

C. Place a hanger within 12-inches of each horizontal elbow.

D. Use hangers with 1-1/2-inch minimum vertical adjustment.

E. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Support riser piping independently of connected horizontal piping.

H. Provide rigid anchors for pipes where vibration isolation components are installed.

3.02 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork hangers and supports in accordance with "HVAC Duct Construction Standards" (second edition) as published by SMACNA.

3.03 HANGER RODS

A. All hanger rods shall be hung from C-clamps on steel beams or bar joists, from inserts in concrete, or from coach screw threaded rods in wood construction.

B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4-inches, and for multiple or trapeze hangers carrying any pipe over 3-inches.

3.04 EQUIPMENT BASES AND SUPPORTS

A. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment to contractor responsible for concrete equipment bases.

B. Construct steel bases and supports of structural steel members. Conform to the latest edition of Standard Specifications for Buildings and Bridges of the American Society for Testing Materials.

3.05 FLASHING

A. Where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs and where the installation of roof curbs is required, flashing shall be performed by the Construction Manager. Coordinate with the Construction Manager as required.

B. Flash plumbing vent pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 × 24-inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash and seal.

C. Flash floor drains in floors with topping over finished areas with membrane flashing; 10-inches clear on sides with minimum 36 × 36-inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor, shower, and mop sink drains watertight to adjacent materials.

E. Provide flashing for curbs for mechanical roof installations. Flexible sheet flash and counterflash with sheet metal; seal watertight.

3.06 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Extend sleeves through floors one inch above finished floor level in all wet areas (i.e. kitchens, toilet rooms, mechanical rooms, etc.). Caulk all sleeves and penetrations watertight and provide floor plates.

C. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping or stuffing insulation (as required based on wall type) and caulk seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of duct penetrations.

D. Install chrome plated steel escutcheons at finished surfaces.

END OF SECTION

SECTION 23 17 00

MOTORS AND VARIABLE FREQUENCY DRIVES

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Single-phase, constant-speed electric motors.

B. Three-phase, constant-speed electric motors.

C. Three-phase, variable-speed, Inverter-duty "corona-free" motors.

D. Variable frequency drives.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and the Architect's Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 230100.

B. Submit motor information, including nameplate efficiency, for each piece of motor-operated equipment and variable frequency drive.

C. Submit confirmation that the variable frequency drive and inverter-duty corona-free motor locations and wiring distances comply with manufacturer's written installation instructions.

D. Submit IEEE Standard 519-1992 Calculations and Simulations Data.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 REGULATORY REQUIREMENTS

A. Conform to NEMA specifications.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - SINGLE-PHASE AND THREE-PHASE CONSTANT SPEED MOTORS

A. ABB

B. Yaskawa/Magnetek

C. Baldor

D. Toshiba

E. General Electric

F. Westinghouse

G. Wagner

2.02 SINGLE-PHASE AND POLY-PHASE, CONSTANT-SPEED MOTORS

A. Electrical Service: Refer to the Drawings for required electrical characteristics.

B. Motors: Design for continuous operation in 40 deg. C environment and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.

D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

E. Motors shall be open drip-proof type (ODP), or totally enclosed fan cooled (TEFC), as indicated.

2.03 SINGLE-PHASE POWER MOTORS

A. Single-phase motors shall be capacitor start or split phase type, designed for 120-volt, single-phase, 60-Hz. operation, and shall have built-in thermal overload protection.

1. Single-phase motors shall be tested and designed in accordance with IEEE Standard 114.
2. Single-phase motors shall have a minimum service factor of 1.25.

2.04 POLY-PHASE POWER MOTORS

A. Poly-phase, 60-Hz., motors shall be "Premium Efficiency" type, with minimum efficiencies which meet or exceed the latest "Recommended Premium Efficiency Specifications" included in the Consortium for Energy Efficiency, Inc. (CEE) "Premium Efficiency Motors Initiative".

1. Poly-phase motors shall be tested and designed in accordance with IEEE Standard 112.
2. Poly-phase motors shall have a minimum service factor of 1.15.

2.05 ACCEPTABLE MANUFACTURERS - POLY-PHASE, VARIABLE-SPEED, INVERTER-DUTY "CORONA-FREE" MOTORS

A. ABB

B. Yaskawa/Magnetek

C. Baldor

D. Toshiba

E. General Electric

F. Westinghouse

G. Wagner

2.06 POLY-PHASE, VARIABLE-SPEED, INVERTER-DUTY "CORONA-FREE" MOTORS

A. Application: On all equipment driven by adjustable frequency drives.

B. All inverter-duty "corona-free" motors shall be compatible with the adjustable frequency drives provided on the project.

C. The corona inception voltage (CIV) of inverter-duty "corona-free" motors shall be over 2800 volts.

D. Each inverter-duty "corona-free" motor shall have on its visible nameplate indication of inverter-duty "corona-free."

E. Comply with applicable general construction and requirements for motors identified under Articles 2.02, 2.03, and 2.04 above.

2.07 ACCEPTABLE MANUFACTURERS - ADJUSTABLE FREQUENCY DRIVES

A. ABB

B. Yaskawa/Magnetek

C. Allen Bradley (Rockwell Automation)

2.08 ADJUSTABLE FREQUENCY DRIVES - 1/2 TO 2 1/2 HP

A. The variable frequency drives (VFDs) shall be microprocessor-based pulse width modulating adjustable AC drive. The drive shall utilize Insulated Gate Bipolar Transistors (IGBT) power switching technology.

B. All printed circuit boards shall be completely tested and burned in before being assembled into the completed VFD. The VFD shall then be subjected to a preliminary functional test, eight-hour burn in, and computerized final test.

C. The VFD shall contain the CE marking and be UL, Canadian UL and CSA approved. The VFD manufacturer shall have an ISO 9001 quality system.

D. General Requirements:

1. Input: 120 VAC or 240 VAC +10% -10%, 1 phase, 60 Hz as scheduled).
2. Output: 1-phase or 3-phase, 0-250 Hz as scheduled, or as appropriate for the application).
3. All VFDs shall have the following features:

    a. Keypad Control panel for programming the VFD.
    b. Output frequency adjustable from 4-8 kHz.
    c. Power loss ride through feature.
    d. Overcurrent, overvoltage, undervoltage, overtemperature, output ground fault, output short circuit, input phase loss and motor overload protective features.

e. PID set point controller.
f. Seven preset speeds.
g. Flying start.
h. Auto Restart.
i. Seven application macros: factory, ABB standard, 3-wire, alternate, motor operated potentiometer, Hand-Auto, PID control and pre-magnetizing.
j. Two acceleration and two deceleration ramps.

4. All VFDs shall have the following adjustments:

a. Five programmable digital inputs.
b. Two programmable analog inputs.
c. One programmable analog output.
d. Two programmable relay outputs.
e. Ramp or coast to a stop.
f. Two critical frequency lockout points.
g. Serial communication for panel or external control: Modbus protocol.

E. The following operating information displays are standard on the VFD digital display:

1. Output frequency
2. Output current

F. Speed Command Input shall be:

1. Programmable analog input of :

a. Voltage reference: 0(2) to 10 V, 190 k ohm single ended.
b. Current reference: 0(4) to 20 mA, 500 ohm single ended.
c. Potentiometer: 10 VDC-0/+2%, 10 mA (1k to 10 k ohm).

G. The VFD shall have the following protection circuits:

1. Long-term overcurrent trip 110% of the VFD's variable torque rating.
2. Short-term overcurrent trip 150% of the VFD's variable torque rating.
3. Overvoltage trip 140% of the VFD's rated voltage.
4. Undervoltage trip 70% of the VFD's rated voltage.
5. Over-temperature +90 deg. C.
6. Ground fault.
7. The electronic motor overload protection shall protect the motor based upon motor current out put exceeding the nominal current of the motor over a prolonged time period.

H. The VFD shall be provided with the following:

1. NEMA 1 enclosure consisting of a metal back plate with a conduit plate and a plastic cover. The drives heatsink shall be flange mounted to the backplate with the heatsink fins outside the enclosure.
2. Panel remote mounting cable and gasket kit (for mounting keypad up to 3-meters away from VFD).
3. RS232/485 adaptor for serial communications in Modbus protocol for operation, programming, trending and diagnostics at the BMS.

2.09 ADJUSTABLE FREQUENCY DRIVES - 3 HP - 400 HP

A. Equipment, motor, and frequency drive manufacturers shall provide the necessary documentation for the Contractor to verify the requirements of paragraphs 2.06.A and 2.06.B.

B. General:

1. This specification is to cover a complete Adjustable Frequency motor Drive (AFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. The drive shall be specifically designed and manufactured for variable torque applications. It is required that the drive manufacturer have an existing sales representative exclusively for HVAC products, with expertise in HVAC systems and controls. They also must have an independent service organization.
2. The drive and all necessary controls as herein specified shall be supplied by the drive manufacturer. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten years.

C. Quality Assurance:

1. Referenced Standards:

   a. Institute of Electrical and Electronic Engineers (IEEE)

      1) Standard 519-1992, IEEE Guide for Harmonic Content and Control.

   b. Underwriters Laboratories:

      1) UL508C

   c. National Electrical Manufacturer's Association (NEMA)

      1) ICS 7.0, AC Adjustable Speed Drives

   d. IEC 16800 Parts 1 and 2

2. Testing:

   a. All printed circuit boards shall be completely tested and burned-in before being assembled into the completed AFD. The AFD shall then be subjected to a computerized systems test (cold), burn-in, and computerized systems test (hot). The burn-in shall be at 104 deg. F (40 deg. C), at full rated load.
   b. All testing and manufacturing procedures shall be ISO 9001 certified.

3. Failure Analysis:

   a. AFD manufacturer shall have an analysis laboratory to evaluate the failure of any component. The failure analysis lab shall allow the manufacturer to perform complete electrical testing, x-ray of components, and decap or delaminate of components and analyze failures within the component.

4. Qualifications:

   a. AFDs and options shall be UL listed as a complete assembly.
   b. AFDs and options shall be cUL listed as a complete assembly.
   c. AFDs and options shall be CE labeled as a component.

D. Submittals:

1. Submittals shall include the following information:

   a. Outline dimensions.
   b. Weight.
   c. Compliance to IEEE 519 - harmonic analysis for this particular jobsite including total harmonic voltage distortion and total harmonic current distortion. The AFD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. The analysis shall include all AFDs provided under Division 15, including all AFDs provided integral to mechanical equipment, and all existing AFDs installed throughout the facility. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519 (latest version), guide for Harmonic Control and Reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior to AFD installation.
   d. Prior to installation, the AFD manufacturer shall provide the estimated total harmonic distortion (THD) caused by the AFDs. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power provider and the user.
   e. If the voltage THD exceeds 5%, the AFD manufacturer is to recommend the additional equipment required to reduce the voltage THD to an acceptable level.

E. Warranty:

1. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of manufacturer. The warranty shall include all parts, labor, travel time and expenses.

F. Design and Construction:

1. The adjustable frequency drives (AFDs) shall be solid state, with a Pulse Width Modulated (PWM) output. The AFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The AFD shall employ a full wave rectifier (to prevent input line notching), Integral Line Reactor(s), Capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as the output switching device. The drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
2. Specifications for 3 HP to 400 HP at 480 volts and 2 to 100 HP at 240 volts:

   a. Input 380/415/440/460/480 VAC ±10%, three-phase, 48-63 Hz or input 200/208/220/230/240 VAC ±10%, three-phase, 48-63 Hz.
   b. Output Frequency 0 to 250 Hz. Operation above 60 Hz shall require programming changes to prevent inadvertent high-speed operation.
   c. Environmental operating conditions: 0 to 40 deg. C, 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.
   d. Enclosure shall be rated NEMA 1.

3. All AFDs shall have the following standard features:

   a. All AFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus. The keypad shall be removable, capable of remote mounting, and shall have its own non-volatile memory. The keypad shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple AFDs.

b. The keypad shall include Hand-Off-Auto membrane selections. When in "Hand", the AFD will be started and the speed will be controlled from the up/down arrows. When in "Off", the AFD will be stopped. When in "Auto", the AFD will start via an external contact closure and the AFD speed will be controlled via an external speed reference. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Auto" and "Hand" modes.
c. The AFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.
d. The AFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
e. The AFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to set point without safety tripping or component damage (flying start). The AFD shall also be capable of DC injection braking at start to stop a reverse spinning motor prior to ramp.
f. The AFD shall be equipped with an automatic extended control power loss ride-through circuit, which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Typical control power loss ride-through for a fan load shall be 2 seconds minimum. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
g. If the input reference (4-20mA or 2-10V) is lost, the AFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
h. The customer terminal strip shall be isolated from the line and ground.
i. The drive shall employ current limit circuits to provide trip free operation:

    1) The Slow Current Regulation limit circuit shall be adjustable to 150% (minimum) of the AFDs' normal duty current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
    2) The Current Switch-off limit shall be fixed at 350% (minimum, instantaneous) of the AFDs' normal duty current rating.

j. The overload rating of the drive shall be 110% of its normal duty current rating for one (1) minute in every 10 minutes.
k. The AFD shall have an integral Line Reactor(s) to reduce the harmonics to the power line and to increase the fundamental power factor. Three-phase line reactors shall be rated a minimum 3% impedance and shall be factory mounted and wired in AFD enclosure. Additional equipment shall be provided as required by IEEE 579 analysis.
l. The AFD shall be capable of sensing a loss of load (broken belt/no water in pump) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
m. The AFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

4. All AFDs to have the following adjustments:

    a. Two (2) programmable critical frequency lockout ranges to prevent the AFD from operating the load continuously at an unstable speed.

b. PID set point controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the AFD, using the microprocessor in the AFD for the closed loop control. The AFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The auxiliary power supply shall have overload and over current protection. The PID set point shall be adjustable from the AFD keypad, analog inputs, or over the communications bus.
c. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference or for reference and actual (feedback) signals for PID controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 ma and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz. Process variables shall be modifiable by math functions such as multiplication and division between the two signals (fan tracking), high/low select, as well as inverted follower.
d. Five (5) programmable digital inputs for maximum flexibility in interfacing with external devices. One digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). Upon remote, customer reset (re-closure of interlock) drive is to resume normal operation.
e. One (1) programmable analog output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
f. Two (2) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable. Relays shall be capable of programmable on and off delay times.
g. Seven (7) programmable preset speeds.
h. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
i. The AFD shall Ramp or Coast to a stop, as selected by the user.

5. The following operating information displays shall be standard on the AFD digital display. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of two operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

a. Output Frequency
b. Motor Speed (RPM, %, or Engineering units)
c. Motor Current
d. Calculated Motor Torque
e. Calculated Motor Power (kW)
f. DC Bus Voltage
g. Output Voltage
h. Heatsink Temperature (°F)
i. Analog Input Values
j. Analog Output Value
k. Keypad Reference Values
l. Elapsed Time Meter (resettable)
m. kWh meter (resettable)
n. mWh meter
o. Digital input status
p. Digital output startup

6. The AFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alphanumeric codes are not acceptable).

    a. Overcurrent trip 350% instantaneous (170% RMS) of the AFD's variable torque current rating.
    b. Overvoltage trip 130% of the AFDs' rated voltage
    c. Undervoltage trip 65% of the AFDs' rated voltage
    d. Over-temperature +90 deg. C
    e. Ground Fault either running or at start
    f. Adaptable Electronic Motor Overload (I2t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits, which are not speed dependant, are unacceptable. The electronic motor overload protection shall be UL Listed for this function.

7. Speed Command Input shall be via:

    a. Keypad.
    b. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal.
    c. Floating point input shall accept a three-wire input from a Dwyer Photohelic (or equivalent type) instrument.
    d. Serial communications.

8. Serial communications:

    a. The AFD shall have an RS-485 port as standard. The standard protocol shall be Modbus.
    b. The AFD shall be able to communicate with PLCs, DCSs, and DDCs. Serial communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, and accel/decel time adjustments. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information. Additionally, remote (LAN) VFD fault reset shall be possible. A minimum of 15 field parameters shall be capable of being monitored.
    c. The AFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. The serial communications interface shall allow for DO (relay) control and AO (analog) control. In addition, all drive digital and analog inputs shall be capable of being monitored by the DDC system.
    d. Optional Field Bus Communication Protocols Johnson Controls, Inc. N2 Protocol bus option: This option pre-configures the AFDs' RS 485 port for N2 Protocol operation.
    e. The AFD shall be connectable to a PC based software tool capable of operating, programming, monitoring the drive as well as diagnosing faults.

9. Integral Disconnect

    a. Provide either of the following for all drives (including those with optional bypass) that will disconnect all input power from the drive and all internally mounted options:

        1) Input disconnect switch and fast acting fuses
        2) Input circuit breaker

    b. The integral disconnect shall be door-mounted and shall be padlockable in the OFF position.

10. Bypass - Electrically interlocked AFD and bypass contactors and door mounted selector switch for the ability to run the motor across line voltage during VFD maintenance. Includes door interlocked fused disconnect or circuit breaker, VFD power input service switch, class 10 motor overload protection 50hp and below, class 20 motor overload protection and 60hp and above, fused 115 VAC control power transformer, Normal/Off/Bypass selector switch, in bypass indicator light, and MOL/External Fault indicator light. Fast acting semi-conductor fuses exclusive to the AFD - fast acting semi-conductor fuses allow the AFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs which have no such fuses, or that incorporate fuses common to both the AFD and the bypass will not be accepted. In such designs, a fuse clearing failure would render the bypass unusable. Provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes.

    a. The bypass system shall be designed for stand-alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair/replacement. Serial communications shall remain functional even with the VFD removed. Bypass systems that do not maintain full functionality with the drive removed are not acceptable.
    b. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus RTU; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet MS/TP.

        1) Serial communication capabilities shall include, but not be limited to: bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the BAS to monitor feedback such as, current (Amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The BAS shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and/or via a Form-C relay output - keypad “Hand” or “Auto” selected, bypass selected, and broken belt indication. The BAS system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.
        2) The bypass serial communications shall allow control of the drive/bypass (system) digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The system digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. All system analog and digital I/O shall be capable of being monitored by the BAS system.

    c. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the BAS and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause a warning or system shutdown.
    d. The digital inputs for the system shall accept 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 mA of 24 VDC for use by others to power external devices.

e. There shall be a coordinated run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open before the motor can run. When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman's override / smoke control mode.

f. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to activate a Form-C relay output, and / or over the serial communications protocol.

g. The bypass control shall include a programmable time delay bypass start including keypad indication of the time delay. A Form C relay output commands the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

h. There shall be a keypad adjustment to select manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:

   1) Over current
   2) Over voltage
   3) Under voltage
   4) Loss of analog input

i. The following operators shall be provided:

   1) Bypass Hand-Off-Auto
   2) Drive mode selector
   3) Bypass mode selector
   4) Bypass fault reset

j. The bypass shall include the ability to select the operating mode of the system (VFD/Bypass) from either the bypass keypad or digital input.

k. The bypass shall include a two line, 20 character LCD display. The display shall allow the user to access and view:

   1) Energy savings – in US dollars
   2) Bypass motor amps
   3) Bypass input voltage– average and individual phase voltage
   4) Bypass power (kW)
   5) Bypass faults and fault logs
   6) Bypass warnings
   7) Bypass operating time (resettable)
   8) Bypass energy (kilowatt hours – resettable)
   9) I/O status
   10) Parameter settings / programming
   11) Printed circuit board temperature

l. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.

1) Power-on (Ready)
2) Run enable
3) Drive mode selected
4) Bypass mode selected
5) Drive running
6) Bypass running
7) Drive fault
8) Bypass fault
9) Bypass H-O-A mode
10) Automatic transfer to bypass selected
11) Safety open
12) Damper opening
13) Damper end-switch made

m. The Bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs. This I/O allows for a total System (VFD and Bypass) I/O count of 24 points as standard. The bypass I/O shall be available to the BAS system even with the VFD removed.

n. The on-board Form-C relay outputs in the bypass shall programmable for any of the following indications.

1) System started
2) System running
3) Bypass override enabled
4) Drive fault
5) Bypass fault
6) Bypass H-O-A position
7) Motor proof-of-flow (broken belt)
8) Overload
9) Bypass selected
10) Bypass run
11) System started (damper opening)
12) Bypass alarm
13) Over temperature

o. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

p. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFD's analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps.

q. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

r. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User's Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties. All keypad control, serial communications

control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.

s. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for "Run-to-Destruction". The user may also force the unit into Override 2 via the serial communications link.

G. Bypasses are required for all AFDs.

H. Line Reactor(s) are required for all AFDs.

I. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire/smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.

J. Installation:

1. Installation shall be the responsibility of the Mechanical Contractor. The Contractor shall install the drive in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.
2. Power wiring shall be completed by the Electrical Contractor. The Contractor shall complete all wiring in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

K. Start-up:

1. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Owner, and a copy kept on file at the manufacturer.

L. Product Support:

1. Factory trained application engineering and service personnel that are thoroughly familiar with the drive products offered, shall be locally available at both the specifying and installation locations.

M. Warranty:

1. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of manufacturer. The warranty shall include all parts, labor, travel time and expenses.

PART 3 - EXECUTION

3.01 APPLICATION

A. Motors drawing less than 250 watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Install all motors in accordance with manufacturer's recommendations.

C. Provide variable frequency drives where indicated on the drawing schedule, and where required to attain specified sequence of operation.

END OF SECTION

SECTION 23 19 00

MECHANICAL IDENTIFICATION

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Identification of mechanical products installed under Division 23.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 23 01 00.

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Seton

B. National

C. Ideal

2.02 MATERIALS

A. Color: Unless specified otherwise, conform to ANSI/ASME A13.1.

B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

C. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1½-inch diameter.

D. Metal Tags: Brass with stamped letters and numerals; tag size minimum 1½-inch diameter with smooth edges.

E. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.

F. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

G. Plastic Tape Duct Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

H. Underground Plastic Pipe Markers: Bright colored, continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mils thick, manufactured for direct burial service.

I. Concealed Equipment Markers: Plastic type tag intended for mounting on acoustic ceiling system grid.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.

B. Plastic or Metal Tags: Install with corrosive-resistant chain.

C. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.

D. Plastic Tape Pipe Markers: Install in accordance with manufacturer's instructions.

E. Underground Plastic Pipe Markers: Install 6- to 8-inches below finished grade, directly above buried steam and condensate piping.

F. Concealed Equipment Markers: Install on acoustic ceiling grid system grid, directly below concealed equipment.

G. Equipment: Identify air handling units, heat transfer equipment, and tanks with plastic nameplates. Small devices, such as pumps, may be identified with metal tags.

H. Controls: Identify control panels and major control components outside panels with plastic nameplates.

I. Piping: Identify all new piping and all existing piping to remain, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Clearly identify flow direction, and fluid being conveyed. Install in clear view and align with axis of piping. Locate identification not to exceed 30 feet on straight runs including risers and drops, adjacent to each valve and "T," at each side of penetrations of the structure or enclosure, and at each obstruction.

J. Ductwork: Identify ductwork with plastic tape duct markers or with stenciled painting. Identify as to air handling unit number, flow direction, and area served. Locate identification at each air handling unit, not to exceed 30 feet on straight runs including risers and drops, at each side of penetrations of the structure or enclosure, and at each obstruction.

K. Concealed Equipment: Identify mechanical equipment which routinely requires service and which is concealed above acoustic ceiling systems with plastic tags mounted on the acoustic ceiling system grid. Locate tags below concealed equipment. Use different color tags for each type of

equipment concealed (i.e., variable air volume/constant air volume boxes, fans, pumps, etc.). Tag colors shall be selected by the Architect.

3.03 VALVE TAGS AND LISTS

A. Provide on all valves installed under this Section a 1½-inch diameter metal tag. The tags shall be attached to the valve handle or stem with brass chains and properly secured. All valve tag numbers shall be prefixed by letters corresponding to the media in the piping system.

B. The valve numbers shall correspond with numbers indicated for valves and controls on the Record Drawings and on a minimum of two (2) printed valve lists. These printed lists shall state the tag number and location of each valve and the section, fixture or equipment which it controls, and other necessary information, such as requiring the opening or closing of another valve where one valve is to be opened or closed.

C. Printed lists shall be prepared in a form to meet the approval of the Architect, framed under glass and displayed in rooms designated by the Architect.

END OF SECTION

SECTION 23 24 20

VIBRATION ISOLATION

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Vibration isolation elements.

B. Equipment isolation bases.

C. Flexible pipe connections.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

C. Refer to Specification Section 23 14 00 for seismic restraint requirements.

1.03 QUALITY ASSURANCE

A. All vibration isolator devices shall have calibration markings or some method to determine, after installation and adjustment, the actual deflection under the imposed load.

B. Substitution of internally isolated equipment in lieu of the isolation specified in this section is acceptable provided all conditions of this section are met.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit a brochure containing descriptive data for isolators and equipment bases. Group isolator and equipment base submittals together by machine served. Submittals shall include seismic restraint requirements as identified under Section 23 14 00 - Hangers and Supports. For all isolation equipment and bases:

C. Itemized list of isolated equipment and detailed schedule showing isolator and referencing material drawing number.

D. Provide catalog cut sheets.

E. Provide detail sheets for each product type and model to be installed.

F. Indicate static loads and static deflections for each isolator.

G. Indicate restraints, pre-compression information, coatings and other features required elsewhere in this specification.

H. Pertinent equipment tags shall appear on all submittal sheets.

I. Shop Drawings:

1. Show equipment base construction for each machine. Include dimensions, structural member sizes and support point locations.
2. Indicate isolation devices selected with complete dimensional and deflection data.
3. Show all methods of suspension and support for ceiling hung equipment.
4. Detail methods of isolation for ducts and pipes penetrating walls and slabs.
5. Submit manufacturers' installation instructions.

1.05 MANUFACTURER RESPONSIBILITY

A. The manufacturer of vibration isolation equipment shall:

B. Determine vibration isolation sizes and locations.

C. Guarantee specified isolation system deflections.

D. Provide installation instructions, drawings, and field supervision to ensure proper installation and performance of systems.

E. Coordinate weights, sizes, types, configurations, etc., with equipment manufacturers supplying equipment to be mounted on vibration isolation.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - VIBRATION ISOLATION ELEMENTS AND EQUIPMENT ISOLATION BASES

A. Mason Industries

B. Peabody Noise Control, Inc.

C. Vibration Mountings and Controls, Inc.

2.02 VIBRATION ISOLATION ELEMENTS

A. Type 1: Free standing spring mounts.

1. Mason Industries - Types SLF, SLFH, SLR
2. Peabody Noise Control Inc. - Model FDS
3. Vibration Mountings and Controls, Inc. - Series ASC, ALC, AWC, AWH

NOTE: Differences between models are base and load plate and bolting arrangements. Identify proper model and indicate its use on shop drawings.

B. Type 2: Ribbed or waffle neoprene pads.

1. Mason Industries - Type Super W (maximum load 80 psi for 50 Durometer pad).
2. Peabody Noise Control Inc. - Model NPS, NPD (maximum load 80 psi).
3. Vibration Mountings and Controls, Inc. - Shear- Flex Pads (maximum load 70 psi).

NOTE: Load on each pad to equal or be slightly less than the maximum manufacturer specified load rating in psi.

NOTE: Separate pads by 16-gauge steel shim stock, when multiple pad layers are specified.

C. Type 3: Steel spring hangers.

1. Mason Industries - Types 30N, PC30
2. Peabody Noise Control Inc. - Model SRH
3. Vibration Mountings and Controls, Inc. - Series RSH

NOTE: For high temperature applications, submit similar hanger designs not having neoprene or elastomeric elements.

D. Type 4: Neoprene hangers/supports.

1. Mason Industries - Types HD, ND.
2. Peabody Noise Control Inc. - Model RHC
3. Vibration Mountings and Controls, Inc. - Series RHC, RHE

E. Type 5: Glass fiber block isolators.

1. Mason Industries - Type HL.
2. Peabody Noise Control, Inc. - Model
3. Vibration Mountings and Controls, Inc. - Series "Fabri-Flex."

2.03 EQUIPMENT ISOLATION BASES

A. Type A: Steel base rail frame with travel limited spring isolators.

1. Mason Industries - Types Rails (many types available depending upon equipment configuration).
2. Peabody Noise Control, Inc. - Model SFB.
3. Vibration Mountings and Controls, Inc. - Series WFR.

2.04 ACCEPTABLE MANUFACTURERS - FLEXIBLE PIPE CONNECTIONS

A. Keflex

B. Mason

C. Metraflex

D. Proco

2.05 FLEXIBLE PIPE CONNECTIONS - METAL TYPE

A. For steel piping construct with stainless steel inner hose and braided exterior sleeve.

B. For copper piping construct with bronze inner hose and braided exterior sleeve.

C. Use connectors suitable for minimum 125 psig and 450 deg. F.

D. Construct spool pieces to exact size for insertion of flexible connection.

2.06 FLEXIBLE PIPE CONNECTIONS - RUBBER TYPE

A. Double-sphere type, constructed with neoprene and nylon.

B. Use connectors suitable for 150 psig and 220 deg. F.

C. Construct spool pieces to exact size for insertion of flexible connection.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install vibration isolators on motor-driven equipment as indicated in the drawings or as elsewhere specified.

B. Adjust all isolators so that supported equipment is level.

C. Adjust all isolators so that isolator load plates are level.

D. Fabricate and install steel bases with a minimum clearance above the floor or housekeeping pad of 2".

E. Ensure that all vibration isolated equipment floats freely while operating without contacting isolator limits or other equipment.

F. Back-off and secure restraint bolts by 1/8" to allow free equipment vertical motion when equipment is filled and operating.

G. Securely bolt base plates to supporting structure and securely bolt load plates to equipment frames on all wind sway-restrained isolators.

H. Clear all debris out from beneath inertia blocks and equipment frames.

I. Replace and remount, at no cost to the Owner, damaged or improperly sized isolators.

J. Provide heat shields to protect elastomeric isolator components if exposed to high temperatures.

K. Piping and/or ductwork penetrations through floors and walls shall not be rigidly connected to the building structure. Provide sleeves with clearances between pipe or duct and the building structure. Pack space between sleeve and pipe or duct with suitable firestopping or stuffing insulation and seal both sides of penetrations with resilient non-hardening sealant.

L. Flexible duct connections shall be provided at all fans and air handling units shall have a minimum clear gap of 3-inches between metal collars. (Flexible duct connections shall not be required on air handling units where provisions for internal vibration isolation are provided by the unit manufacturer.)

3.02 GENERAL REQUIREMENTS

A. Piping Vibration Isolation:

1. Support piping with vibration isolation type hangers or floor mounts (as required by mounting conditions) as indicated below:

   a. All piping in mechanical rooms and elsewhere within a pipe length of 50 feet from vibration isolated equipment. Piping support isolators at the first three support points adjacent to the isolated equipment shall achieve a deflection that is at least one half the deflection of the isolators provided for the connected equipment. Where deflection requirements for

such isolators exceed 0.5", spring isolators shall be used. For lesser deflection requirements and supports beyond the first three support points, neoprene isolators shall be used. Minimum deflection for all piping support isolators shall be no less than 0.25".

b. Spring piping support isolators shall be Type 3. Neoprene piping support isolators shall be Type 4.

2. Install flexible pipe connections where indicated on the Drawings and on piping connected to equipment supported by vibration isolation elements. Use pipe sized units unless indicated otherwise.
3. Install flexible pipe connections suitable for conveying refrigerant and as recommended by the condensing unit manufacturer at the refrigerant piping associated with air-cooled condensing units.

3.03 EQUIPMENT REQUIREMENTS

A. Provide equipment bases and vibration isolation for equipment as indicated below:

Equipment	Base Type	Isolator Type	Static Deflection
Outdoor AHU, On Roof Curb	Vibration isolated roof curb.	Internal isolation by manufacturer.	2” roof curb springs
Outdoor AHU, on External Frame	External Frame	Type 1	2"
In-line Cabinet Fans	None.	Type 4.	0.25"
In-line pumps, type HWP	Concrete inertia base with spring mounts.	Type 1	1.5” inertia bas springs
In-line pumps, Type CP	None.	Type 4 vibration isolation hangers either side of pump.	0.25"
ET-1, DWH-1, DWH-2	Integral to unit.	Type 5 pads under unit.	0.25"
PUHs and CUHs	None.	Type 4.	0.25”

END OF SECTION

SECTION 23 26 00

PIPING INSULATION

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Aboveground piping insulation.

B. Pipe insulation covers and accessories.

C. Handicapped lavatory and sink piping insulation kits.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 QUALITY ASSURANCE

A. Applicator: Company specializing in piping insulation application with three years minimum experience.

B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, and UL 723.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 23 01 00.

B. Include product description, list of materials, and thickness for each service.

C. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS – ABOVEGROUND PIPING INSULATION

A. Subject to compliance with requirements, provide products of one of the following:

1. Armacell
2. Certainteed
3. Foster Products
4. IMCOA
5. Johns Manville
6. Knauf Insulation
7. Owens-Corning

2.02 ABOVEGROUND PIPING INSULATION

A. Type A: Fiberglass Piping Insulation; ASTM C547; "K" value of 0.24 at 75 deg. F mean temperature.

B. Type B: Elastomeric Piping Insulation; ASTM C 518, C 177, E 96 (procedure A), & D 1056; Type I & II, 'K' value of 0.27 at 75 deg. F mean temperature.

C. Type C: Calcium Silicate: ANSI/ASTM C533; asbestos-free; "K" value of 0.40 at 250 deg. F

2.03 ABOVEGROUND PIPING INSULATION COVERS

A. All Service Jacket (ASJ) cover shall be white Kraft bonded to aluminum foil, fiberglass reinforced (ASTM E 96 (procedure A), D 781, & D 828). Pipe fitting covers shall be one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations with fiberglass inserts.

B. Aluminum jacket pipe insulation shall be 0.010" thick, corrugated finish, with a one mil polyethylene film/forty pound Kraft paper integral vapor barrier affixed to the interior of the cover in conformance with ASTM B-209.

C. Two piece fittings shall be pre-formed and sized for the specified pipe & insulation thickness.

2.04 ABOVEGROUND PIPING INSULATION ACCESSORIES

A. Type B, elastomeric insulation located outdoors shall be covered with two coats of paint manufactured specifically for covering Elastomeric insulation, WB Armaflex Finish or equal.

B. Adhesives: Compatible with insulation.

C. Bedding Compounds: Non-shrinking, permanently flexible, compatible with insulation.

D. Vapor Barrier Coating: Non-flammable, fire resistant, polymeric resin, compatible with insulation.

E. Insulating Cement: ANSI/ASTM C195, hydraulic setting mineral wool.

F. Finishing Cement: ASTM C449.

G. Wire Mesh: Corrosive-resistant metal; hexagonal pattern.

2.05 ACCEPTABLE MANUFACTURERS - HANDICAPPED LAVATORY AND SINK PIPING INSULATION KITS

A. Truebro, Inc.

B. Acceptable substitutes

2.06 HANDICAPPED LAVATORY AND SINK PIPING INSULATION KITS

A. Handicapped lavatory and sink drain piping and P-trap and angle valves, cold and hot water assemblies shall be insulated with fully molded Handi-Lav-Guard insulation kits especially designed for handicapped lavatories and A.D.A. conforming.

B. Material shall be 3/16" thick molded closed cell vinyl with nylon fasteners, white finish and be self-extinguishing per ASTM D635 with K value of 1.l7 BTU - in/hr - ft^2 - deg. F.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install materials after piping has been tested and approved.

3.02 SCHEDULE – ABOVE GROUND PIPING INSULATION

Piping Type	Insulation Type	Insulation Thickness (in inches) for Various Pipe Sizes					
		1" and less	1¼" to 1½"	2"	2½" to 4"	5" to 6"	8" and Greater
Heating Hot Water	A	1-1/2”	1-1/2”	2"	2"	2"	2"
Domestic and Non-domestic Hot Water and Hot Water Circulation	A	1"	1"	1"	1-1/2”	1-1/2”	1-1/2”
Domestic and Non-Domestic Cold Water	A	1"	1"	1"	1"	1"	1"
Cold Condensate Drains	A	1"	1"	1"	1"	1"	1"
Storm Water Piping	A	1"	1"	1"	1"	1"	1"
Refrigerant Suction and Discharge	B	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"
Roof Drain Bowls	B	1"	1"	1"	1"	1"	1"

3.03 INSTALLATION - ABOVE GROUND INSULATION

A. General:

1. Install materials in accordance with manufacturer's instructions.
2. Should this project include the use of any mechanical coupling type piping systems, all insulation products provided under this Section shall be compatible with such systems.
3. Continue insulation through penetrations.
4. On exposed piping, locate insulation and cover seams in least visible locations.
5. On pipes conveying fluids below ambient temperature, insulate fittings, valves, unions, flanges, strainers, air separators, flexible connections, and expansion joints.
6. On pipes conveying fluids above ambient temperature, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation at such locations.
7. Neatly finish insulation at supports, protrusions, and interruptions.

B. Type A Pipe Insulation:

1. Covers shall have vapor barrier jackets, factory-applied. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with PVC fitting covers.
2. Pipes conveying fluids above ambient temperature: Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with PVC fitting covers tacked or PVC tape on all PVC fitting seams.

3. Pipes conveying fluids below ambient temperature: Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with PVC fitting covers with PVC tape on all PVC fitting seams. Seal all ends with vapor barrier coating.
4. Exposed piping: Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with PVC fitting covers with PVC tape on all PVC fitting seams. In addition provide full PVC jacketed system for all piping to a height of 8'-0" above finished floor.
5. Exterior applications: Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with full aluminum jacketing system with seams located on bottom side of horizontal piping.

C. Type B Pipe Insulation:

1. Insulation shall be mitered, pre-adhered and longitudinally slit inside throat to fit over all traps, tees and elbows or bends over 90°.
2. All butt joints and mitered seams shall be adhered with full coverage of adhesive on both surfaces. Insulation shall not be stretched when adhering.
3. Adhere insulation directly to the pipe where recommended by manufacturer. Insulation should not be adhered to the pipe at the extreme low points in any piping run.
4. Non-conducting blocks shall be installed under all insulated lines at unistrut clamps, clevis hangers, or locations where insulation may be compressed.
5. Seams shall be sealed with compatible contact adhesive.
6. Hangers clamped directly to the pipe shall be insulated over the hanger; insulation shall be fully adhered to the hanger.
7. All insulation installed outdoors shall be protected with two coats of WB Armaflex weather resistant coating.

3.04 INSTALLATION - HANDICAPPED LAVATORY PIPING INSULATION KITS

A. Provide handicapped lavatory installation kits on all handicapped lavatories with exposed water and drain piping.

B. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 23 28 00

EQUIPMENT INSULATION

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Equipment insulation.

B. Jackets and accessories.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 QUALITY ASSURANCE

A. Applicator: Company specializing in insulation application with three years minimum experience.

B. Materials: Flame-spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, and UL 723.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 23 01 00.

B. Include product description, list of materials, and thickness for each service.

C. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manville.

B. Owens-Corning.

C. Armstrong.

D. Knauf.

2.02 INSULATION

A. Type A: Flexible mineral fiber blanket; ANSI/ASTM C553; "k" value of 0.24 at 75 deg. F; 2.0 lb/cu. ft. density.

B. Type B: Calcium silicate; ANSI/ASTM C533; asbestos free; "k" value of 0.40 at 250 deg. F; 14 lb./cu. ft. density.

C. Type C: Cellular foam; flexible; plastic; "k" value of 0.28 at 75 deg. F.

2.03 ACCESSORIES

A. Bedding Compounds: Non-shrinking, permanently flexible, compatible with insulation.

B. Vapor Barrier Coating: Non-flammable, fire resistant, polymeric resin, compatible with insulation.

C. Insulating Cement: ANSI/ASTM C195, hydraulic setting mineral wool.

D. Finishing Cement: ASTM C449.

E. Wire Mesh: Corrosive-resistant metal; hexagonal pattern.

F. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Do not insulate factory insulated equipment.

C. Apply insulation as close as possible to equipment by grooving, scoring and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires or bands.

D. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface.

E. Cover insulation with metal mesh and finish with heavy (1/4" thick) coat of insulating cement and 6-ounce fiberglass cloth pasted on for equipment containing fluids below ambient temperature, provide vapor barrier coating.

F. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

G. When equipment with insulation requires periodical opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

3.02 SCHEDULE

EQUIPMENT	INSULATION TYPE	THICKNESS (INCH)
Air Separators	Type B	1-1/2"
Expansion Tanks	Type A	1"
Radiant Ceiling Heating Panels	Type A	1-1/2"

END OF SECTION

SECTION 23 29 00

DUCTWORK INSULATION

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Ductwork insulation.

B. Jackets and accessories.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 QUALITY ASSURANCE

A. Applicator: Company specializing in ductwork insulation application with three years minimum experience.

B. Materials: UL listed; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 23 01 00.

B. Include product description, list of materials, and thickness for each service.

C. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - INSULATION

A. Subject to compliance with requirements, provide products of one of the following:

1. Armacell
2. Certainteed
3. Foster Products
4. IMCOA
5. Johns Manville
6. Knauf Insulation
7. Owens-Corning

2.02 INSULATION

A. Type A: Flexible glass fiber; ANSI/ASTM C612; commercial grade; "k" value of 0.29 at 75 deg. F; 0.002-inch foil scrim facing for air conditioning ducts Service temperature range: 35 deg. F to 250 deg. F.

B. Type B: Rigid glass fiber; ANSI/ASTM C612, "k" value of 0.24 at 75 deg. F, 0.002-inch foil scrim facing for air conditioning ducts. Service temperature range: -20 deg. F to 450 deg. F.

C. Type C: Fiberglass duct liner with factory-applied edge coating rated for 5,000 ft./min. velocity. The liner shall meet Life Safety Standards as established by NFPA 90A and 90B and should not support microbial growth as tested in accordance with ASTM G21 and G22. The duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than 0.70 as tested per ASTM C423 using a Type "A" mounting, and a thermal conductivity no higher than 25 at 70 deg. F mean temperature.

   1. In lieu of fiberglass duct liner, expanded closed-cell flexible elastomeric thermal insulation, specifically designed, manufactured, tested, and listed for use in air conveying systems (exposed to the air stream) may be used. Such insulation shall be Armstrong "AP Armaflex SA Duct Liner," or approved equal.

D. Type D: Light-weight, non-asbestos, high temperature, inorganic, ceramic fiber blanket, totally encapsulated in foil/scrim, and having a service temperature range up to 2300º F, may be used. Such fireproofing/fire resistive insulation shall be FireMaster Duct Wrap as distributed by 3M, or equivalent by Nelson Fire Stop Products or approved equal.

   a. Fireproofing/fire resistive duct wrap shall be directly applied to commercial grease hood duct systems to allow zero inch clearance to combustible construction, and to provide a two-hour fire resistive duct enclosure. Fire resistive duct wrap shall be applied in a continuous, multi-layer wrap from the point the duct enters a concealed space to its exit from the building. Fire resistive wrap shall satisfy all applicable codes and standards, and the requirements of the authority having jurisdiction.
   b. The fire-resistive wrap shall be accompanied by all appropriate manufacturer accessories, including, but not limited to, high performance and high temperature tapes, banding materials, insulation pins and washers, through-penetration fire stopping materials, grease duct access door covers, and miscellaneous hardware.

E. Type E: Mass loaded vinyl with 2-inch thick fiberglass decoupler on the opposite side of the vinyl; ASTM D-9075, with STC value of 26. Model B-10 lag by Sound Seal, Division of United Process, Inc., or approved equal

2.03 JACKETS

A. Indoor Jackets: Pre-sized glass cloth, minimum 7.8 oz/sq.yd.

B. Outdoor Jackets: 0.045-inch thick EPDM.

2.04 ACCESSORIES

A. Adhesives: Waterproof fire-retardant type; Foster No. 81-13, Minnesota Mining EC-1329, or approved equal.

B. Lagging Adhesive: Fire resistive to ASTM E84.

C. Impale Anchors: Galvanized steel, 12-gauge, self-adhesive pad.

D. Joint Tape: Glass fiber cloth, open mesh.

E. Tie Wire: Annealed steel, 16-gauge.

F. Insulation Bands: 3/4-inch wide, 0.015-inch thick galvanized steel.

G. Finishing Cement: ASTM C449.

H. Fibrous Glass Cloth: Compatible with insulation.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install materials after ductwork has been tested and approved.

B. Clean surfaces for adhesives.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.

C. Interior Ductwork Insulation (Type A) Application:

1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
2. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

D. Interior Ductwork Insulation (Type B) Application:

1. Insulation shall be adhered to duct with adhesive applied in 6-inch wide strips twelve (12) inches on center. In addition, insulation shall be held in place with mechanical fasteners. All punctures, breaks, seams, and edges shall be sealed with five- (5-) inch wide strips of sealing tape adhered in such a manner as to provide a continuous vapor barrier seal.
2. For ductwork which will be exposed and externally insulated outside the mechanical rooms and spaces, finish insulation with a layer of fibrous glass cloth and make suitable for painting.
3. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation.

E. Ductwork Liner Insulation (Type C) Application:

1. All portions of duct designed to receive duct liner shall have smooth, coated surfaces of the duct liner facing the air stream. All duct liner shall be cut to assure tight, overlapped corner joints. The top pieces shall be supported by the side pieces.
2. Duct liner shall be adhered to the sheet metal with full coverage of an approved adhesive that meets ASTM C916, and all exposed leading edges and transverse joints shall be neatly butted without gaps and be coated with factory-applied edge coating. Shop or field cuts shall be liberally coated with adhesive.
3. Metal nosings shall be securely installed over transversely-oriented liner edges facing the airstream at forward discharge and at any point where lined duct is preceded by unlined duct.

4. When velocity exceeds 4,000 fpm, use metal nosing on every leading edge. Nosing may be formed on duct or be channel or zee attached by screws, rivets, or welds.
5. Ductwork dimensions indicated are net inside dimensions required for air flow. Increase actual ductwork sizes to allow for duct liner thickness.

F. Interior Ductwork Insulation (Type D) Application:

1. Insulation shall be rated for zero clearance to combustibles.
2. Install insulation, section by section using adhesive on all sections and joints. Apply adhesive in 6-inch wide strips, 12-inches on center.

   a. If fire resistive duct wrap is used, install duct wrap in direct contact with the duct it encloses, with every portion of duct protected by a minimum of two (2) layers of overlapping wrap. Overlap both perimeter and longitudinal joints a minimum of 3-inches per layer of material. Use welded insulation pins and banding to secure duct wrap to the ductwork.

3. Fasten insulation with mechanical fasteners installed 8- to 12-inches on-center.
4. Apply insulation bands 24-inches on-center.

G. Continue all insulation with vapor barrier through penetrations.

3.03 SCHEDULE - DUCTWORK INSULATION

DUCTWORK TYPE	INSULATION TYPE	INSULATION THICKNESS (INCH)
All concealed supply, return and outside air ductwork located outside the mechanical rooms and spaces, except ductwork which is indicated to be lined. All exhaust and relief air ductwork within 10'-0" of connection to building exterior.	A	1-1/2”
All supply, return and outside air intake ductwork located exposed in mechanical rooms or other spaces, except ductwork which is indicated to be lined. All exhaust and relief air ductwork located exposed in mechanical rooms or other spaces within 10'-0" of connection to building exterior.	B	1-1/2"
All lined ductwork, including return air transfer ducts and where indicated on drawings.	C	1-1/2” or as otherwise indicated
Kitchen hood exhaust ductwork, grease ductwork	D	3" or 4" as required to achieve 2-hour fire resistance rating.

END OF SECTION

SECTION 23 51 00

HYDRONIC PIPING

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Pipe and pipe fittings.

B. General valves.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly items.

1.05 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9 and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME SEC 9.

D. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

1.06 SUBMITTALS

A. Submit product data under provisions of Section 23 01 00.

B. Include data on pipe materials, pipe fittings, valves, and accessories.

C. Include welder's certification of compliance with ANSI/ASME SEC 9.

D. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style or series number.

PART 2 - PRODUCTS

2.01 HOT WATER PIPING, ABOVE GROUND AND INTERIOR PIPING

A. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: Cast brass or wrought copper.

a. Joints: Solder, Grade 95TA.
b. Viega ProPress or Nibco “Press System” copper couplings.

B. Steel Pipe: ASTM A53 Grade B or ERW, carbon steel, Schedule 40.

1. Fittings: Malleable iron or forged steel welding type.
2. Joints:

a. Screwed for 2" and smaller.
b. Welded or grooved for piping over 2".

2.02 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: Cast brass of solder wrought copper.

a. Joints: Solder, Grade 95TA.
b. Viega ProPress or Nibco “Press System” copper couplings.

2.03 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2-Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; 150 psig bronze unions for copper pipe, soldered joints.

B. Pipe Size Over 2-Inches: 150 psig forged steel slip-on flanges for ferrous piping; 150 psig bronze flanges for copper piping.

C. Dielectric Connections:

1. Union with galvanized or plated steel threaded end, copper solder and water impervious isolation barrier.
2. Waterway fitting with zinc-electroplated ductile iron or carbon steel body, grooved, threaded or plain end connections, water impervious isolation barrier. Victaulic Style 47.

2.04 ACCEPTABLE MANUFACTURERS - BALL VALVES

A. Apollo, Model 70-100 or 70-200

B. Milwaukee

C. Stockham

D. Watts

E. Viega ProPress

F. Nibco “Press System”

G. Victaulic

2.05 BALL VALVES

A. For Soldered or Threaded Ends up to and including 3 Inches: Bronze body, steel plated ball, Teflon seats and stuffing box ring, and lever handle to suit piping in which valve will be installed.

B. Ball valves installed in piping to be insulated shall have 2-inch stem extensions suitable to allow for insulation of the valve body to the thickness of the adjoining pipe insulation without interfering with valve handle operation.

2.06 ACCEPTABLE MANUFACTURERS - BUTTERFLY VALVES

A. Stockham

B. Grinnell

C. Milwaukee

D. Centerline

E. Victaulic

2.07 BUTTERFLY VALVES

A. 200 psi, iron body, bronze disc, EPDM replaceable seat for service to 250 deg. F, 416 stainless steel stem, lug type, extended neck, 10-position lever handle.

B. Valves shall have stem extensions suitable to allow for insulation of the valve body to the thickness of the adjoining piping insulation without interfering with valve lever operation.

C. Lever operated up to 3-inches, gear operated with handwheel over 3-inches, chain operated handwheel if valve over 6 feet above grade.

D. Valves installed above 8'-0" in mechanical rooms shall be gear-operated with chain wheel and position indicator.

2.08 ACCEPTABLE MANUFACTURERS - GATE VALVES

A. Stockham

B. Grinnell

C. Milwaukee

D. Crane

2.09 GATE VALVES

A. Class 125, iron body, bronze trim, rising stem, handwheel, OS&Y single wedge, flanged ends.

B. Valves shall have stem extensions suitable to allow for insulation of the valve body to the thickness of the adjoining pipe insulation without interfering with valve wheel operations.

2.10 ACCEPTABLE MANUFACTURERS - SWING CHECK VALVES

A. Stockham

B. Grinnell

C. Milwaukee

D. Crane

E. Victaulic

F. Viega ProPress

G. Nibco “Press System”

2.11 SWING CHECK VALVES

A. Up to 2-Inches: Bronze 45-deg. swing disc, solder or threaded ends to suit piping in which valve will be installed.

B. Over 2-Inches: Iron body, bronze trim, 45-deg. swing disc, renewable disc and seat, flanged ends.

2.12 ACCEPTABLE MANUFACTURERS - SOFT SEAT, NON-SLAM CHECK VALVES

A. Stockham

B. Grinnell

C. Milwaukee

D. Crane

E. Victaulic

F. Viega ProPress

G. Nibco “Press System”

2.13 SOFT SEAT, NON-SLAM CHECK VALVES

A. Compact wafer style check valve with two (2) spring loaded disc plates or single spring loaded plug, which close when flow decreases without the necessity of flow reversal. Check valve shall be rated for a minimum 150 psi at 225 deg. F fluid temperature, and provide leak-tight sealing to 250 deg. F. Bearings shall be PTFE and springs shall be 316 stainless steel. Body shall be cast iron, and disc plates or plug shall be aluminum bronze or bronze.

B. Check valve shall be installed between ANSI Class 125 or 150 flanges.

C. Soft-seat, non-slam check valves shall be used on all pump discharge applications.

2.14 ACCEPTABLE MANUFACTURERS - GROOVED PIPING OPTION TO WELDED FOR PIPING 2½" AND ABOVE

A. Victaulic

2.15 GROOVED PIPING

A. Piping shall remain Schedule 40 as specified above. Grooved couplings may be used in lieu of welding, thread or flanging on 2-1/2" and above carbon steel piping, on water, glycol and compressed air services from -30 deg. F to 230 deg. F (250 deg F. if Quick-Vic™ utilized) within the manufacturer's rated working pressures. Pipe grooving shall be cut grooved and/or rolled grooved as per manufacturer's latest specifications. Installation is per manufacturer's latest recommendations. System and components shall comply with ASME power piping B31.1 and ASME building services piping B31.9. System manufacturer shall be ISO 9001 Certified.

2.16 PIPING COMPONENTS

A. Grooved couplings, 2-1/2” to 12”, consisting of two (2) pieces of ductile iron. Coupling gaskets will be a synthetic rubber gasket with a central cavity pressure responsive design. Coupling bolts and nuts shall be heat treated carbon steel, trackhead conforming to physical properties of ASTM A183 and A 449. All grooved couplings shall be as manufactured by Victaulic Co. Style 77, 07 or equal.

1. Rigid Type: Housings shall have offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9. Victaulic Style 07 Zero-Flex or Style 107 Quick-Vic™ (suitable for temperatures up to 250 deg. F.)
2. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration. Victaulic Style 77.

B. AGS grooved couplings, 14” to 24”, consisting of two (2) pieces of ductile iron, cast with a deeper wedge-shaped key profile, lead-in chamfer, and flat bolt pads for metal-to-metal contact. Coupling gaskets will be a wide-width synthetic rubber gasket with a central cavity pressure responsive design. Coupling bolt and nuts shall be heat treated carbon steel, trackhead conforming to physical properties of ASTM A 183 and A449. All AGS grooved couplings shall be as manufactured by Victaulic Co. Style W07 and W77.

1. Rigid Type: Provides a rigid joint that corresponds with support spacings as defined by ASME B31.1 and B31.9. Victaulic Style W07.
2. Flexible Type: Allows for linear and angular movement, vibration attenuation and stress relief. Victaulic Style W77.

2.17 CONNECTIONS

A. For piping 2-1/2" and larger, full-size branch connections shall be made with manufactured grooved end tees. Branch connections for less than full size shall be made with Victaulic hole cut products. Style 920 or Style 920N branch connections with locating collar engaging into hole or Style 72 outlet coupling used to join grooved pipe and to create a branch connection. Gaskets for branch connection shall be Victaulic Grade "E" EPDM compound with working temperature of -30 deg. F to 230 deg. F.

2.18 FLANGES

A. Vic-Flange Style 741 (2" - 12") for connection to ANSI Class 125 and 150 flanged components.

B. Vic-Flange Style 743 (2" - 12") for connection to Class 300 flanged components.

C. Vic-Flange Adapter Nipple Style W45R (14” – 24”) for connection to Class 150 flanged components.

2.19 FITTINGS

A. Fittings shall be full-flow cast fittings, steel fittings or segmentally welded fittings with grooves or shoulders designed to accept Victaulic grooved end couplings.

1. Standard Fittings: Shall be cast of ductile iron conforming to ASTM A 536 (Grade 65-45-12), painted with a rust inhibiting modified vinyl alkyd enamel or hot-dip galvanized to ASTM A 153 or zinc electroplated to ASTM B 633, as required.
2. Standard Steel Elbow Fittings (14" - 24"): Shall be forged steel conforming to ASTM A 234, Grade WPB (0.375" wall), painted with rust inhibiting modified vinyl alkyd enamel or hot-dip galvanized to ASTM A 153.
3. Standard Segmentally Welded Fittings: Shall be factory fabricated, by fitting manufacturer, or carbon steel pipe as follows:

   a. 3/4" to 4": Conforming to ASTM A 53, Type F.
   b. 5" to 6": Schedule 40 conforming to ASTM A 53, Type E or S, Grade B.
   c. 8" to 12": Schedule 30 conforming to ASTM A 53, Type E or S, Grade B.
   d. 14" to 24": 0.375" wall conforming to ASTM A 53, Type E of S, Grade B, painted with rust inhibiting modified vinyl alkyd enamel or hot dip galvanized to ASTM A 153, as required.

4. Fittings 14” – 24” shall be supplied with AGS wedge-shaped grooves designed for installation with Victaulic “W” series couplings.

2.20 VALVES

A. Butterfly Valves:

1. Vic 300 MasterSeal, Sizes 2" through 12": A grooved end butterfly valve for all services up to and including 300 psi. Valve body shall be ductile iron, electroless nickel-plated ductile iron disc, offset to provide full 360 degree seating, with grooved end designed to accept grooved mechanical couplings. Valves shall be bi-directional and provide bubble-tight shut-off and dead-end service at full rated working pressure. Disc seal (EPDM) shall be rated for service up to 230 deg. F.
2. Series W709, Sizes 14" through 24": A single-piece ductile cast body, PPS coated on the inside for corrosion resistance. The ductile iron disc rides on stainless steel stems with stainless steel wetted hardware. The EPDM seal, mounted on the offset disc, seals on the PPS seal for bi-directional working pressure of 175 psi.

B. Ball Valves:

1. Ball valves shall be Vic Ball Style 726 Ball Valves, designed for 800 psi (WOG) bubble-tight working pressure.

C. Check Valves:

1. Check valves 4" through 12", elastomer encapsulated ductile iron disc check valves shall be Vic-Check Series 716 check valves with spring-activated, non-slamming design. Valves shall be suitable for horizontal or vertical installation and rated for working pressures up to 300 psi.
2. Series 716 2½" and 3" Vic-Check valve with a tilting disc design with a stainless shaft and spring. The disc is aluminum bronze. Rated for 300 psi.
3. Swing check valves shall be Vic Swinger Series 712 in sizes 2" through 4" with full port opening and bolted coupling closure access. Valves shall be rated for 300 psi working pressure, "E" EPDM disc seat ASTM D 2000.
4. Check valves 14” through 24” shall be Victaulic Series W715, spring-activated, non-slamming, stainless steel dual disc design. EPDM seat bonded to the valve body. Suitable for horizontal or vertical installation and rated for 230 psi.

D. Strainer:

1. Strainer, Style 730 and W730 is a tee pattern strainer for easy access and cleaning with grooved ends for installation in vertical downflow or horizontal flow position.
2. Strainer, Style 732 is a wye pattern strainer with straight through flow for lower pressure drop, blowdown port and pipe plug with grooved ends.

E. All Victaulic components installed and requirements for handing, supporting, anchoring, expansion, and contraction shall be in accordance with the latest published instructions from Victaulic Company of America.

Pressure and temperature ratings are shown in manufacturer's latest published literature for individual style of coupling and gasket.

F. Grooved End Expansion Joints:

1. 2” through 6”: Packless, gasketed, slip-type expansion joint, with grooved end telescoping carbon steel body for assembly with Victaulic Style 07 rigid type couplings, providing up to 3” axial end movement and pressure rating up to 350 psi. Victaulic Style 150 Mover®.
2. ¾” and Larger: Combination of short nipples and Victaulic Style 75 or 77 flexible type couplings. Joint movement and expansion capabilities determined by number of couplings/nipples used in the joint. Pressure rating determined by style/size of flexible couplings used. Victaulic Style 155.

G. Tri-Service Valve Assembly:

1. In lieu of Triple-Duty/Multi-Purpose devices, combination shut-off, throttling and non-slam check valve. Vic®-300 MasterSeal™ butterfly valve assembled with Style 779 Venturi Check. Working pressures to 300 psi (2065 kPa).

H. Victaulic Hole-Cut Branch Outlets:

1. Bolted Branch Outlet: Branch reductions on 2" through 8" header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183. Victaulic Style 920/920N.
2. Strapless Outlet: 1/2" or 3/4" NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa). Victaulic Style 923 Vic-Let™.
3. Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa). Victaulic Style 924 Vic-O-Well™

I. Victaulic Pipe Hanging (Victaulic Hanging Standard A-130):

1. Style 07 Zero-Flex for rigid piping systems should be supported as per Building Services B31.9 Hanging.
2. Style 77 flexible piping systems are supported as per Victaulic Hanging Standard A-130.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges, grooved joint couplings, or unions.

D. After completion, fill, clean, and treat systems. Refer to Section 23 54 50.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

E. Provide clearance for installation of insulation, and access to valves and fittings.

F. Slope piping and arrange systems to drain at low points. Use eccentric reducers for all reduction in main sizes, and maintain top of pipe level.

G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

H. Prepare pipe, fittings, supports, and accessories for finish painting. This work shall be accomplished in accordance with Division 09.

I. Install valves with stems upright or horizontal, not inverted.

J. Connections shall be made from the top of the main for all upfeed runouts and from the bottom of the main for all downfeed runouts from all water mains.

K. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory trained field representative (direct employee) shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Victaulic factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

   1. Install the Victaulic AGS piping system in accordance with the latest Victaulic installation instructions. Use Victaulic grooving tools with AGS roll sets to groove the pipe. Follow Victaulic guidelines for tool selection and operation. AGS coupling installation shall be complete when visual metal-to-metal contact is reached. AGS products shall not be installed with standard grooved end pipe or components. Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.

L. Viega ProPress or Nibco “Press System” Fitting Installation: Prepare copper tube and install in strict accordance with manufacturer installation instructions. Pipe ends shall be cleaned, free of indentations, projections, burrs and foreign matter. Use a tube preparation tool(s) as supplied by the manufacturer to clean and make installation mark. Lubricate piping as recommended by manufacturer. Push copper tube into fittings to installation depth mark, per installation instructions. Keep fittings free of debris, dirt and oil.

M. Seal through wall and floor penetrations with appropriate fire-stopping and/or water-proofing. Seal foundation wall penetrations and slab-on-grade penetrations water-tight with mechanical conduit-to-wall penetration seals per manufacturer recommendations.

3.03 APPLICATION

A. All piping 3-inches in diameter and smaller shall be either steel or copper, and shall be as specified herein.

B. All piping larger than 3-inches in diameter shall be steel, and shall be as specified herein.

C. Provide companion flanges in piping where connecting to flanged equipment or valves.

D. Malleable iron fittings shall be used on all non-welded steel pipe. Bushings shall not be used in screwed fittings for size reductions.

E. All connections between steel pipe and copper tubing shall be made with dielectric fittings, bronze valves, or bronze couplings. These connections shall be made outside of all pipe chases - no connection between steel pipe and copper tube shall be concealed behind walls.

F. Install unions or grooved joint couplings at all non-flanged equipment including pumps, control valves, coils, air vents and any other equipment where it may be necessary to disconnect piping for maintenance and/or repair.

G. Install valves of the types indicated on the drawings. Unless otherwise indicated, all valves shall be of the same size as the line in which they are installed.

H. Provide 3/4-inch ball drain valves with hose connection at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

END OF SECTION

SECTION 23 51 50

HYDRONIC SPECIALTIES

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Bladder type expansion tanks.

B. Air vents.

C. Air and dirt separators.

D. Strainers.

E. Manual and automatic balancing/flow control valves.

F. Equipment hook-up components.

G. Relief valves.

H. Backflow preventers.

I. Pressure reducing valves.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks.

1.04 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project.

C. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

D. Submit manufacturer's installation instructions under provisions of Section 23 01 00.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

PART 2 - PRODUCTS

2.01 BLADDER TYPE EXPANSION TANKS

A. Acceptable Manufacturers:

1. Taco
2. Bell & Gossett
3. Amtrol
4. Wessels Company
5. Watts

B. Provide bladder type expansion tanks as indicated on the drawings or as appropriate for the application. Tanks shall be horizontal, vertical or horizontal/vertical installation type as indicated or required.

C. Bladder type expansion tank construction: Welded steel, designed, tested and stamped in accordance with ASME (BPV code sec VIII, div 1); supplied with National Board Form U-1, rated for working pressure of 150 psi, with flexible heavy duty butyl rubber bladder. Bladder shall be able to accept the full volume of the expansion tank and shall be removable and replaceable.

D. Accessories: Standard automobile tire style air-charging fitting (Schrader Valve), and tank drain fitting.

E. Pre-charge tanks to 27 psig or as indicated on the Drawing schedules.

2.02 AIR VENTS

A. Acceptable Manufacturers:

1. Taco
2. Bell & Gossett
3. Amtrol
4. Spirotherm, Inc.
5. Watts
6. Armstrong

B. Manual Type: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8-inch brass needle valve at top of chamber.

C. Automatic Type: Brass or semi-steel body, copper float, stainless steel valve and valve seat; suitable for operating temperature and pressure of 240°F and 75 psig, respectively.

D. High-Capacity Type: Cast iron body with stainless steel mechanism and Buna-N rubber valve seat. Float actuated non-modulating air vent to vent air from the system air separator. Vent shall

not open if pressure at vent is negative. Suitable for operating temperature and pressure of 250°F and 150 psig, respectively.

2.03 AIR AND DIRT SEPARATORS

A. Acceptable Manufacturers:

1. Spirotherm

B. Combination air eliminator and dirt separator shall be full flow coalescing type. Separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet/outlet nozzles.

C. Unit shall include internal elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 microns and larger within 100 passes. The elements shall consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.

D. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

E. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill.

2.04 STRAINERS

A. Acceptable Manufacturers:

1. Watts
2. Sarco
3. Mueller
4. Armstrong
5. Victaulic

B. Size 2-inch and Under: Screwed brass or iron body for 125 psig working pressure, "Y" pattern with 1/32-inch stainless steel perforated screen.

C. Size 2-1/2-inch and Larger: Flanged iron body for 125 psig working pressure, "Y" pattern with 3/64-inch (2½-and 3-inch strainer) or 1/8-inch (4-inch and larger strainers) stainless steel perforated screen.

2.05 MANUAL BALANCING VALVES

A. Acceptable Manufacturers:

1. Macon (Basis-of-Design)
2. Nexus
3. Taco
4. Armstrong
5. IMI TA

B. Provide Macon Series STVL, STV, STVA, STVC or equal by other listed manufacturer. Valves are to be of the “Y” pattern globe style design and perform the following functions:

1. Flow balancing

2. Flow measurement

3. Positive shut-off

C. All balancing valves shall have a minimum ten (10) turn, 360° handwheel with digital and vernier scale readout for precise setting. Balancing handwheel shall include a memory stop and locking feature to prevent tampering after pre-setting.

D. All balancing valves shall have self-sealing ports for measurement of differential pressure and fluid temperature using standard pressure and temperature test probes. Test ports shall be located at a 45° offsetting angle and be removable for implementation of optional drain kits where required.

E. All balancing valves in sizes 1/2” through 2” shall be made of dezincification resistant brass and have either sweat or NPT thread connections. Valve body sizes 2-1/2” through 12” shall be made of cast iron and flanged to 125 lb standard.

F. All balancing valves shall be manufactured by the company complying with international quality standard ISO 9001.

2.06 AUTOMATIC BALANCING VALVES

A. Acceptable Manufacturers:

1. Macon (Basis-of-Design)
2. Nexus
3. Taco
4. Armstrong
5. IMI TA

B. Provide Macon Series AB, ABW, ABG, AW or equal by other listed manufacturer.

C. Design

1. The flow rate (GPM) for the automatic balancing valves shall be factory set and shall automatically limit the rate of flow to within ± 5% of the specified GPM over at least 95% of the control range.

2. For sizes 1/2" through 2", the flow cartridge shall be removable from the Y-body housing without the use of special tools to provide access for cartridge change-out, inspection and cleaning without breaking the main piping.

3. The permanent pressure loss added to the pump head shall not exceed seven feet.

4. Each valve shall have two (2) pressure/temperature (P/T) ports.

5. The valve handle shall be fitted with a fine tuning memory stop handle to allow for adjusting the pressure control range.

D. Construction

1. The internal wear surfaces of the valve cartridge shall be Ultrason® Composite or stainless steel.

2. The flow cartridge shall be permanently marked with the GPM and differential pressure range.

3. For 1/2" through 2" pipe sizes: An assembly shall consist of a brass Y-type body, integral brass-body ball valve and O-ring type union. Macon Model AB or equal.

4. For 2-1/2" and larger flanged connections: Ductile-iron body, suitable for mounting wafer style between standard 150# or 300# flanges. The long flange bolts and nuts shall be provided with each control valve. Macon model AW or equal.

E. Minimum Ratings

1. 1/2" through 2" pipe sizes: 600 PSI @ 250°F

2. 2-1/2” through 12” pipe sizes: 600 PSIG @ 250°F

F. Test Kit

1. Provide a pressure and temperature test kit to be turned over to Owner upon completion of project. Test kit shall be provided with the ability to read differential pressure from 0 to 75 PSI and temperature from -10 to 230° F.

2.07 EQUIPMENT HOOK-UP COMPONENTS

A. Acceptable Manufacturers:

1. Macon (Basis-of-Design)
2. Nexus
3. Taco
4. Armstrong
5. IMI TA

B. Unions

1. Provide Macon Series UR, URP, US, UB or equal by other listed manufacturer.

2. For pipe sizes 1/2" through 2": Constructed of brass with EPDM O-ring. Fixed-end with FNPT or SWT. Tailpiece with MNPT, FNPT, or SWT. Provide size reductions as required.

3. Minimum Ratings: 600 PSIG @ 250°F

C. Y-STRAINERS

1. Provide Macon Series SV, SVF or equal by approved manufacturer.

2. For pipe sizes 1/2" through 2": Constructed of forged or cast brass body with plated steel handle and vinyl grip, blow out-proof stem, chrome plated ball with Teflon seats, 20-Mesh stainless steel screen with removable cap. Fixed-end with FNPT or SWT. Tailpiece with MNPT, FNPT, or SWT. Provide size reductions as required.

3. For pipe sizes 2-1/2" – 12": Constructed of cast iron body with fiber gasket and stainless steel strainer screen, ANSI 125# flanges with lug type ductile iron butterfly valve mounted on the inlet.

4. Provide the following options for all strainers:

   a. Hose end blow down valve with cap and chain

   b. Combination pressure and temperature ports at inlet and outlet.

5. Minimum Ratings

   a. 1/2" – 2": 600 PSIG @ 250°F

   b. 2-1/2" – 12": 175 PSIG @ 250°F.

D. MANUAL AIR VENTS

1. Provide Macon Series MAV, PTV or equal by approved manufacturer.

2. Manual Air Vent: Constructed of brass body with knurled slotted handle, blowout-proof stem, side vent, 1/4" NPT.

3. Combination Manual Air Vent and PT Port: Constructed of brass body with EPDM core and O-rings, knurled handle and cap, blowout-proof stem, side vent with 1/8" hose barb, 1/4" and 1/2" NPT.

4. Minimum Ratings

   a. Manual Air Vent: 400 PSIG @ 250°F

   b. Combination Manual Air Vent and PT Port: 250 PSIG @ 250°F

E. AUTOMATIC AIR VENTS

1. Provide Macon Series AAV or equal by approved manufacturer.

2. Constructed of forged brass body, manual shut-off cap, polypropylene float. Body designed to be disassembled for cleaning.

3. Vent Capacity: 1 SCFM @ 60 PSIG.

4. Minimum Ratings: 150 PSIG @ 250°F

F. BALL VALVES

1. Provide Macon Series AB, BB, MB, SB or equal by approved manufacturer.

2. For pipe sizes 1/2" – 2": Constructed of forged or cast brass bodyEPDM O-ring. Plated steel handle with vinyl grip. Blow out-proof stem. Chrome plated ball with Teflon seats. Fixed End available in FNPT, SWT

3. or Press End. Tailpieces available in MNPT FNPT, SWT or Press End. Size reductions available.

4. Minimum Ratings

5. 600 PSIG @ 250°F

G. PRESSURE AND TEMPERATURE PORTS

1. Provide Macon Series PT, PTV or equal by approved manufacturer.

2. Pressure/Temperature Port: Constructed of brass body with dual durometer EPDM core, brass cap with EPDM O-ring and neoprene strap. Shall accept 1/8" diameter gage adapter or thermometer stem. 1/4" and 1/2" NPT.

3. Pressure/Temperature/Vent Port: Constructed of brass body with dual durometer EPDM core, brass cap with EPDM O-ring and neoprene strap. Side air vent with 1/8" hose barb. Shall accept 1/8" diameter gage adapter or thermometer stem. 1/4" and 1/2" NPT.

4. Minimum Ratings

   a. PT 500 PSIG @ 250°F

   b. PTV 250 PSIG @ 250 °F

2.08 RELIEF VALVES

A. Acceptable Manufacturers:

1. Watts
2. Sarco
3. Mueller

B. ANSI Z21.22, bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled sized to match system protected.

2.09 BACKFLOW PREVENTERS

A. Domestic Water Reduced Pressure Backflow Preventers: ANSI/ASSE 1013 and AWWA C511-92; bronze body with bronze and plastic internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two ball valves, strainer, and four test cocks; Model 009, as manufactured by Watts or approved equal.

B. Accessories: Provide air gap fitting.

2.10 PRESSURE REDUCING VALVES

A. Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded ends. Pressure adjustment setting shall match fill pressure indicate on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Support tanks inside building from building structures.

C. Provide manual air vent at the high points of all cabinet unit heaters, propeller unit heaters, fin tube radiators, unit-mounted heating coils, and as indicated.

D. Provide automatic air vents at all high points of hot water piping mains and branches and at other points as indicated or required for complete air venting of the system.

E. Provide a high-capacity air vent to vent air from the heating hot water system air and dirt separators.

F. Provide balancing valves in the return line from all cabinet unit heaters, finned tube radiators, unit-mounted coils, and in each branch return line, as well as at the discharge of each pump and at all other points as indicated or required to properly balance the hot water heating system.

G. Install balancing valves with a minimum of three unrestricted pipe diameters upstream and downstream of each valve.

H. Provide air separator on suction side of system circulation pumps.

I. Provide valved drain and hose connection on strainer blow down connections.

J. Provide relief valves on pressure tanks, low pressure side of reducing valves, and expansion tanks.

K. Select system relief valve capacity so that it is greater than makeup pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

L. Install flexible pipe connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

M. Provide all components of the hot water heating systems as shown on the drawings and as required to install complete working systems.

N. Install full size drain from air gap fitting on backflow preventer to nearest floor drain.

END OF SECTION

SECTION 23 53 50

REFRIGERATION PIPING AND SPECIALTIES

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Check valves.

G. Pressure relief valves.

H. Filter-driers.

I. Solenoid valves.

J. Expansion valves.

K. Flexible connectors.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit shop drawings indicating schematic layout of system, including equipment, critical dimensions, and sizes.

C. Submit product data indicating general assembly of specialties, including manufacturer's catalogue information.

D. Submit manufacturer's installation instructions.

E. Submit test reports under provisions of Division 01.

F. Submit Test reports indicating results of leak test, acid test.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9.

B. Refrigeration equipment manufacturer shall review application of their equipment specifically to this project, as well as piping routing and sizing indicated on the plans. Mechanical Contractor shall advise Architect of any suggested changes to the piping routing and sizing, based on the equipment manufacturer's review. Refrigeration equipment manufacturer shall advise Mechanical Contractor as to all required system specialties to ensure proper system operation.

PART 2 – PRODUCTS

2.01 PIPING

A. Copper Tubing: Type L refrigerant grade copper tubing.

1. Fittings: ANSI/ASME B16.22 wrought copper or B16.26 cast copper.
2. Joints: Brazing compound shall be "SIL-FOS 15" or equal with a flowing temperature of 135 deg. F or greater.

2.02 REFRIGERANT

A. Refrigerant: ANSI/ASHRAE 34; R-410A, or other refrigerant as approved by the Architect and Owner.

2.03 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single-port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure of 500 psi, and maximum temperature of 200 deg. F.

2.04 VALVES

A. Diaphragm Packless Valves: UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 deg. F.

B. Packed Angle Valves: Forged brass, forged brass seal caps with copper gasket, rising stem and seat, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 deg. F.

C. Packed Ball Valves: Two-piece forged brass Body with Teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 deg. F.

2.05 STRAINERS

A. Straight Line or Angle Line Type: Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.06 CHECK VALVES

A. Straight Through Type: Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 250 deg. F.

2.07 PRESSURE RELIEF VALVES

A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; selected to ANSI/ASHRAE 15.

2.08 FILTER-DRIERS

A. Replaceable Cartridge Angle Type: ANSI/ARI 710, UL listed, brass shell and bronze cap, perforated brass shell and molded desiccant filter core; for maximum working pressure of 350 psi.

2.09 SOLENOID VALVES

A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psi. Stem shall permit manual operation in case of coil failure.

B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box.

2.10 EXPANSION VALVES

A. Angle or Straight Through Type: Design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and bulb well.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 deg. F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.11 FLEXIBLE CONNECTORS

A. Corrugated stainless steel or bronze hose with single layer of stainless steel exterior braiding, minimum 9-inches long with copper tube ends; for maximum working pressure 500 psi.

2.12 ACCEPTABLE MANUFACTURERS - HOT GAS MUFFLERS

A. Dumont Refrigeration Corp.

B. Edwards Engineering Corp.

C. Hussman Corp.

D. Parker Co.

E. Sporlan Co.

2.13 HOT GAS MUFFLERS

A. Hot gas muffler installed in refrigeration compressor discharge piping to reduce compressor noise, pulsations, and vibration. Hot gas muffler shall be selected and sized for minimal pressure drop and optimum performance by the refrigeration equipment manufacturer for the specific application.

B. Hot gas muffler shall be of copper, copper plated steel, and/or stainless steel construction, with minimum working pressure of 450 psi. Hot gas muffler shall consist of steel outer shell, perforated refrigerant dispersion tube, multiple resonance chambers, oil aspirator tube, and appropriate type inlet and outlet piping connections.

C. Hot gas muffler shall be U.L. listed, and comply with applicable ARI Standards. Muffler shall be designed for use with R-22 refrigerant, and screw or scroll type compressors.

PART 3 – EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Provide non-conducting dielectric connections when joining dissimilar metals.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide clearance for installation of insulation and access to valves and fittings.

H. Provide access to concealed valves and fittings.

I. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

J. Insulate piping; refer to Section 23 26 00.

K. Locate expansion valve sensing bulb immediately downstream or evaporator on suction line.

L. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

M. Install flexible connectors at right angles to axial movement of compressor.

N. Fully charge completed system with refrigerant after testing.

O. Provide electrical connection to solenoid valves in accordance with Division 26 specifications.

3.03 APPLICATION

A. Provide line size liquid indicators in main liquid line leaving condenser.

B. Provide line size strainer upstream of each automatic valve. Where multiple expansion valves with integral strainers are used install single main liquid line strainer.

C. Provide shut-off valve on each side of strainer.

D. Provide filter-driers for each solenoid valve.

E. Provide solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

F. Provide refrigerant charging (packed angle) valve connections in liquid line between receiver shut-off valve and expansion valve.

G. Utilize flexible connectors at or near compressor connections.

3.04 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ANSI/ASME B31.5.

B. Pressure and vacuum test in accordance with the manufacturer's written instructions.

END OF SECTION

SECTION 23 53 60

MINI-SPLIT AIR CONDITIONING SYSTEMS

(Mechanical Trade Bid Requirements)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Mini-split air conditioning equipment.

B. Refrigerant piping and appurtenances.

C. Refrigerant.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9, and ANSI/ASHRAE Standard 15-1994, "Safety Code for Mechanical Refrigeration."

B. Refrigeration equipment manufacturer shall review application of their equipment specifically to this project, as well as pipe routing and sizing indicated on the plans. Mechanical Contractor shall advise Architect of any suggested changes to the pipe routing and sizing, based on the equipment manufacturer's review. Refrigeration equipment manufacturer shall advise Mechanical Contractor as to all required system specialties to ensure proper system operation.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit shop drawings indicating schematic layout of system, including equipment, critical dimensions, and sizes.

C. Submit product data indicating general assembly of specialties, including manufacturer's catalogue information.

D. Submit manufacturer's installation instructions.

E. Submit test reports under provisions of Division 01.

F. Submit test reports indicating results of leak test, acid test.

PART 2 - PRODUCTS

2.01 MINI-SPLIT AIR CONDITIONING EQUIPMENT

A. Equipment shall consist of a ductless indoor evaporator unit, and an outdoor air-cooled compressor-condenser unit. Equipment capacities and features shall be as scheduled on the Drawings. Equipment manufacturer shall be Trane, Mitsubishi, or Daikin.

2.02 PIPING

A. Copper Tubing: Type L refrigerant grade copper tubing.

1. Fittings: ANSI/ASME B16.22 wrought copper or B16.26 cast copper.
2. Joints: ANSI/ASTM B32, solder Grade 95TA or flared.
3. Appurtenances: Install equipment and piping in accordance with manufacturer’s instructions. Provide all required system appurtenances for a complete and operable installation.

2.03 REFRIGERANT

A. R410A (Refrigerant blend of R32/125, 50%/50%).

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Provide factory fabricated equipment supports for installation of compressor-condensing units on roof.

B. Provide and install refrigeration specialties in accordance with manufacturer's instructions, and recommendations.

C. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

F. Provide non-conducting dielectric connections when joining dissimilar metals.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access to concealed valves and fittings.

J. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

K. Insulate piping; refer to Section 23 26 00.

L. Fully charge completed system with refrigerant after testing, and prepare for placement into service.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ANSI/ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psig using halide torch electronic leak detector. Test to no leakage.

END OF SECTION

SECTION 23 54 00

HVAC PUMPS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. HVAC in-line pumps.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Indicate dimensions, connection sizes, and installation instructions.

C. Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Taco

B. Grundfos

C. Bell & Gossett

2.02 GENERAL CONSTRUCTION REQUIREMENTS

A. Balance: Rotating parts, statically and dynamically.

B. Construction: To permit servicing without breaking piping or motor connections.

C. Pump Motors: Operate at 1,750 rpm unless scheduled otherwise. In compliance with Section 23 17 00 - Motors.

D. Pump Connections: Flanged.

2.03 IN-LINE CIRCULATORS

A. Pump shall be in-line type, close-coupled, single-stage design, for installation in vertical or horizontal position, and capable of being serviced without disturbing piping connections.

B. Pump casing shall be of Class 30 cast iron. The impeller shall be of cast bronze, closed type, dynamically balanced, keyed to the shaft and secured by locking capscrew.

C. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A bronze shaft sleeve shall completely cover the wetted area under the seal.

D. Pumps shall be rated for minimum of 175 psi working pressure (125 psi will be allowable for air handling unit heating coil booster pumps). The pump case shall have gauge tappings at the suction and discharge nozzles and shall include vent and drain ports.

E. Motor shall meet NEMA specifications and shall be the size and voltage called for on the plans. It shall have heavy-duty, grease-lubricated ball bearings, completely adequate for the maximum load for which the pump is designed. Refer to Section 23 17 00 for additional requirements.

F. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

2.04 CARTRIDGE WET-ROTOR CIRCULATORS

A. Cartridge wet-rotor circulators shall be maintenance-free, in-line, all bronze for domestic water service and iron bodied with ceramic shaft and polypropylene impeller suitable for 240 deg. F and 150 psi for heating system service.

B. Motors shall meet NEMA specifications and shall be the size and voltage called for on the plans.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install pumps in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

C. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

E. Provide air cock and drain connection on horizontal pump casings.

F. Lubricate pumps before start-up.

END OF SECTION

SECTION 23 54 50

HYDROSTATIC TESTING AND CHEMICAL WATER TREATMENT

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Hydrostatic testing of piping systems.

B. Cleaning of piping systems.

C. Treatment for closed systems.

D. Chemical feeder equipment.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience. Company shall have local representatives with water analysis laboratories and full-time service personnel.

B. Water Treatment Supplier: Company specializing in the products specified in this Section with minimum three years documented experience. Company shall have local representatives with water analysis laboratories and full-time service personnel.

C. Acceptable Water Treatment Supplier: Aquafax, Inc., Lee, NH or Owner approved vendor.

1.05 REGULATORY REQUIREMENTS

A. Conform with applicable code for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.

B. Comply with applicable environmental rules and regulations of the Maine Department of Environmental Services, the U.S. Environmental Protection Agency (USEPA), and local environmental agencies or departments having jurisdiction.

1. Provide material data and documentation as required to demonstrate and/or certify compliance with applicable environmental regulations pertaining to the release of water treatment chemicals to the atmosphere and/or waters-of-the-state.

1.06 MAINTENANCE SERVICE

A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion.

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

C. Provide laboratory testing and technical assistance services for warranty period.

D. Include eight-hour (minimum) training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at startup of systems.

E. Provide on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

PART 2 – PRODUCTS

2.01 MATERIALS

A. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
2. Algaecide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

B. Closed System Treatment:

1. Sequestering agent to reduce deposits and impart a pH of 7.5 to 9.0.
2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.

2.02 EQUIPMENT

A. Bypass Chemical Feeder: As indicated on the drawings for hot water systems.

1. Vertical Style, dish bottom out tank. Neptune DBF Series (10-gallon capacity DBF-10HP, unless noted otherwise). Tank shall include a quick-opening, wide-mouth high pressure cap with 2½ turn course thread design and square section "O" ring seal, which will close and seal easily by hand without the need for a wrench or other specialty tool. The underside of the fill cap which comes in contact with system fluids shall be epoxy coated. Tank shall include removable leg extensions and a full bottom drain. Tank shall be constructed of 10-gauge steel and have a maximum pressure rating of 300 psi.

B. Full-view flow sight glass with 360-degree viewing area to observe flow movement, color, and clarity from any angle. Sight shall include nylon ball float and restrictor orifice to slow flow for examination. Brass or bronze body, boro-silicate sight, Buna-N seals, 130 psi, 225°F.

1. Sight glasses used for high temperature and/or high pressure applications shall be selected by the Water Treatment Supplier as appropriate for the application(s). Sight glasses used in such situations shall have pressure ratings and/or temperature ratings of at least 25% higher than the normal operating pressure or temperature of the system in which they are installed.

C. Factory Fabricated Coupon Rack: including coupon(s), coupon holder(s), isolation ball valves, flow control orifice (as appropriate), flow indicator, sample tee, back-flow prevention check valve, Y-type strainer, and corrosion resistant back-board for mounting. Constructed to ASME specifications, of materials suitable for the application; with pressure and temperature ratings suitable for the application. As manufactured by Pulsafeeder, or Engineer approved equal.

1. Heating hot water systems as indicated on the drawings shall have coupon racks fabricated from 3/4" black iron pipe, similar to Pulsafeeder Model CCR2D.
2. The Water Treatment Supplier shall select coupons (iron, steel, and copper) suitable for the application(s).

PART 3 – EXECUTION

3.01 TESTING

A. Test piping to be concealed and/or covered before concealment or covering. Test all hot water piping at 125 psig hydrostatically and all other lines at working pressure and repair all leaks as required.

B. All instruments and equipment that are not rated to withstand the test pressure shall be isolated from the system before tests are conducted.

C. 48-hour notice shall be given to the Engineer and Owner's representative before tests are made so that a representative can witness the tests, if desired.

3.02 PREPARATION

A. Systems shall be operational, filled, tested, started, and vented prior to cleaning.

B. Place terminal control valves in open position during cleaning.

3.03 CLEANING SEQUENCE

A. Add cleaner to closed systems at concentration as recommended by the cleaner manufacturer.

B. Hot Water Heating Systems: Apply heat while circulating, slowly raising temperature to 160°F and maintain for 8 hours minimum. Remove heat and circulate to 100°F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.

D. Remove, clean, and replace strainer screens.

E. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.04 CLOSED SYSTEM TREATMENT

A. Introduce closed system treatment through bypass feeders and/or other treatment equipment as required for water treatment.

B. Test water of each system and submit written report indicating test results, water composition, chemical concentrations, and quantities of treatment chemicals introduced into systems. Report shall include recommendations for system maintenance.

END OF SECTION

SECTION 23 55 80

CONDENSING BOILERS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDES

A. Medium mass condensing type high efficiency boilers, controls and accessories.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit product data under provisions of this section.

B. Submit product data indicating general layout, dimensions, and size and location of connections.

C. Submit manufacturer's installation instructions under provisions of this section.

D. Submit flow diagram of gas valve trains.

E. Submit schematic wiring diagram of boiler control system.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of this section.

B. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain shop drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.

1.05 REGULATORY REQUIREMENTS

A. Conform to applicable and NFPA 70 code for internal wiring of factory-wired equipment.

B. Conform to applicable NFPA 54, UL, and A.G.A. requirements.

C. Conform to State of Maine code requirements.

1.06 CERTIFICATIONS

A. Manufacturer's Certification: The boiler manufacturer shall certify the following:

1. The products and systems furnished are in strict compliance with the specifications.

2. The boiler, burner, and other associated mechanical and electrical equipment have been properly coordinated and integrated to provide a complete and operable boiler package.
3. ASME Certification in the form of ASME Stamp on the product and completed and signed data sheet.
4. ASME CSD-1 Certification, in the form of completed data sheet.
5. CSA or UL Certification in the form of an affixed label to the equipment.
6. The specified factory tests have been satisfactorily performed.
7. The specified field tests have been satisfactorily performed.

B. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.

B. Responsibility of making freight claims to be performed by owner personnel.

1.08 WARRANTY

A. The pressure vessel shall be guaranteed against thermal shock for 20 years when utilized in a closed loop hydronic heating system with a temperature differential of 120 °F or less. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.

B. The pressure vessel, tubes and tube sheets (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years. The condensate collection box shall be guaranteed for 20 years. The burner cylinder shall be warranted for a period of 5 years.

C. All parts not covered by the above warranties shall carry a 1 year warranty from startup, or 18 months from shipment, whichever occurs first. This shall include all electrical components and burner components.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - CONDENSING HIGH EFFICIENCY BOILERS

A. Cleaver Brooks, ClearFire Model CFC-3300

Cleaver Brooks as indicated above is the basis-of-design. The following manufacturers are acceptable provided the boilers meet or exceed the basis-of-design standards of quality, design criteria, ratings, performance and physical space requirements:

B. Viessmann, Vitocrossal 300 Model CT3-89

C. Bosch, Buderus Model SB745WS-1050

2.02 GENERAL DESCRIPTION

A. Boiler shall be a down-fired fire-tube type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be factory package. Boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in

accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 PSIG. The boiler shall be CSA or UL certified as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.

2.03 PERFORMANCE

A. The capacity of each unit shall be as indicated on the drawing schedule.

B. Performance Criteria:

Max. Input	3,300,000 MBTUH
Output @ 176/140F and 100% Firing	2,871,000 MBTUH
Max. Allowable Working Pressure Rating	125 PSIG
Fireside Heating Surface	1258 Square Feet
Burner Turndown Ratio	4:1 @ 20 PPM NOx, 5:1 @ 30 PPM NOx
Overall Efficiency @ 120F Return Water Temperature	95% Eff. @ 20% Firing Rate 93% Eff. @ 50% Firing Rate 92% Eff. @ 75% Firing Rate 91% Eff. @ 100% Firing Rate
Max. NOx Emissions	20 PPM (corrected to 3% O2)
Max. CO Emissions	10 PPM (corrected to 3% O2)
Max. Noise Level	70 dBA measured 3 feet in front boiler per ABMA test

C. Performance Guarantee: The equipment must comply with the following performance guarantee at the scheduled conditions.

1. At 20% firing rate with no higher than 7-8% O2 levels, the flue gas temperature shall not be more than 5 deg. F above the return water temperature.
2. At 100% firing rate with no higher than 6-7% O2 levels, the flue gas temperature shall not be more than 50 deg. F above the return water temperature.

2.04 BOILER DESIGN

A. Boiler shall be a compact, single-pass, vertical down-fired fire-tube type, with duplex stainless steel tubes, tube sheets, and combustion chamber. The boiler pressure vessel shall be completely insulated with a minimum of 2” of insulation and shall be encased in an 18-gauge metal cabinet with powder coated finish. To prevent installation damage, the casing shall be packaged separately and shall ship loose for field installation by the manufacturer’s service representative.

B. The tubes shall be duplex stainless steel and shall be fitted with aluminum alloy internal heat transfer fins creating no less than 10 square feet of fireside heating surface per boiler horsepower.

C. The vessel shall be mounted on a structural steel stand with exhaust gasses collected in a polymer drain collection box complete with drain fitting for draining condensation from the products of combustion.

D. Provide two (2) condensate neutralizing tanks complete with limestone chips for field installation. Provide condensate drain piping from boilers and base of chimney stack to tanks in accordance with manufacturer's instructions. Condensate from three (3) boilers shall be piped to the first tank and condensate from the other two (2) boilers shall be piped to the second tank.

E. The top tube-sheet shall be fully accessible without burner disassembly or removal from the boiler. The burner assembly shall be complete with lifting hinges and pneumatic lifters. The boiler shall have a built in hinged platform allowing the operator to access the tube-sheet, burner, ignition assembly and flame rod without the use of a ladder.

F. The vessel shall be fully insulated with a minimum of 2" of insulation, guaranteeing external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input.

G. The condensing capability shall allow the boiler to be operated without the use of a 3-way valve for the boiler supply water temperature reset. No minimum boiler return water temperature or secondary pump or minimum flow rate shall be required to protect the boiler against thermal shock or for minimum temperature water.

H. Boiler shall be built to withstand seismic forces (refer to Section 23 14 00). Manufacturer shall provide seismic calculations showing tie-down requirements for bolt diameters. Bolts and tie-down shall be by contractor.

I. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp and shall be manufactured within an ISO 9001 Certified facility to ensure high quality standards.

J. The boiler shall be designed for top rear water outlet and bottom rear water inlet; the water inlet shall be equipped with internal baffling. Inlet connection size shall be 5-inch flanged. Outlet connection size shall be 5-inch flanged. The maximum pressure drop through the boiler shall not exceed 0.45 psi with a 20-degree differential and less than 0.05 psi with a 60-degree differential.

K. The boiler shall be equipped with a second water return connection that will permit low temperature returns to be utilized for condensing, regardless of the primary return temperature water above condensing conditions.

L. A threaded air vent connection shall be furnished at the top rear of the boiler for field piping to an expansion tank or for the addition of an auto-vent valve when a bladder type expansion tank is utilized.

M. To drain the boiler, a bottom-threaded connection shall be provided at the front of the boiler and field piped by the installing contractor with a manual full size shutoff valve to drain.

N. Boiler design shall permit operation with a water condition of 8.0 - 9.5 pH range.

2.05 BURNER DESIGN

A. General: Forced draft burner mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tube-sheet, and tubes are exposed. The burner door shall utilize easy removable threaded handles, and the burner shall swing upward on hydraulic piston arms, one on each side to provide open support of the burner assembly.

B. A drop down hinged service platform shall be furnished to provide service personnel an easy means of accessing the burner and controls for service and maintenance. When out of use, this platform shall fold up beneath the front service boiler panel.

C. The burner shall be of the Unitized Venturi, Gas Valve, Blower, and burner head design. This pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate fuel and air for a minimum a 5:1 turndown ratio. The venturi design shall also act as a method for compensating for changes in barometric pressure, temperature and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions. External linkages, damper motor drives and single speed fans shall not be acceptable.

D. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven fecralloy material creating a 360 degree low temperature radiant flame.

E. Emissions: The equipment shall be guaranteed to limit NOx emissions to 20 PPM or less, as certified by an independent testing lab. NOx emission levels shall not be exceeded at full operating conditions and at designed turndown of the burner. Proof of such emissions certification shall be made available to the engineer and purchaser and demonstrated at the time of start-up. External flue gas recirculation shall not be accepted for emission control.

F. Gas Train – As a minimum, the gas train shall meet the requirements of CSA/UL and ASME CSD-1 and shall include:

1. Low Gas Pressure Interlock, manual reset.
2. High Gas Pressure Interlock, manual reset.
3. Upstream and downstream manual test cocks.
4. Ball Type manual shutoff valve upstream of the main gas valve.
5. Unibody double safety gas valve assembly.
6. Gas Pressure Regulator
7. Union connection to permit burner servicing.

G. Combustion Air Proving Switch shall be furnished to ensure sufficient combustion airflow is present for burner ignition firing.

H. To ensure that proper draft is not blocked in the stack, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack back draft.

2.06 BOILER TRIM

A. Safety valves shall be ASME Section IV approved side outlet type mounted on the boiler air vent outlet. Size shall be in accordance with code requirements and set to open at 125 psig.

B. Temperature and pressure gauge shall be mounted on the water outlet.

C. Solid State Low water cut-off probe with manual reset and test switch.

D. Manual Reset High Limit Temperature sensor; range not to exceed 210F and shall be an integral device of the Boiler Burner Control and UL recognized as a limit control.

E. Outlet water supply sensing probe for operating water limit setpoint.

F. Return water-sensing probe for operating water limit setpoint.

2.07 BOILER CONTROLS

A. The Boiler shall include a Falcon Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point. It shall be mounted at the front of the boiler panel for easy access and viewing.

B. Controller shall provide for both flame safeguard and boiler control through separate power supplied CPU's (to meet NFPA) and shall perform the following functions:

1. Burner sequencing with safe start check, pre-purge, pilot ignition (CFC-3300) and post purge. UV scanner (CFC 3300) to prove combustion.
2. Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent six faults. The control shall be connected to a keyboard display module that will retrieve this information.
3. Safety Shutdown with display of error.
4. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
5. Gas pressure supervision, high and low.
6. Combustion Air Proving Supervision.
7. High Air Pressure [back draft too high] Supervision.
8. The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.
9. Controller shall be equipped with a touch screen display for set up, trouble shooting, and operational display, and shall include ModBus communication capability of this information.
10. Include the programming of system circulating pump and provide the programming of 2 heating loops.

C. All parameter input control set-points shall be factory downloaded with jobsite conditions programmed at the time of initial jobsite operation.

D. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements.

E. Electrical power supply shall be 208-volt, three phase (CFC 3300) for the fan and 120-volt for control circuit.

F. When multiple boilers are to be installed together, a system integration control shall be provided to stage up to 8 boilers. The control shall include automatic selection of needed boilers based on energy demand, an adjustable outdoor reset schedule, domestic hot water priority, and a system digital display. The control shall force each boiler to a lower fire, before allowing any boiler to operate at high fire. This allows for inverse efficiency (lower fire rate, higher efficiency). The control shall monitor supply water temperature, return water temperature and shall communicate between boilers via RS-485 wiring.

G. Provide a BACnet communication interface for interconnection to the Building Automation System.

2.08 BOILER FLUE VENTING

A. The Boiler shall be UL certified as an indirect or direct vent boiler. Venting shall be accomplished with stainless steel, double-wall, vent piping installed in accordance with applicable national and local codes.

B. For separated combustion, the boiler shall have the combustion air intake supply ducted with PVC pipe from the outside.

2.09 BURNER CONTROLS

A. Boiler Burner controls shall be an integrated, digital modulating controller.

B. Controller shall provide the following functions:

1. 2 Heating loops.
2. Burner sequencing with safe start check, pre-purge, direct spark ignition and post purge.
3. Electronic ignition.
4. Flame supervision.
5. Safety shutdown with display of error.
6. Modulating combustion fan.
7. Circulating pump operation.
8. Low gas pressure, air proving, high limit, and frost protection.

C. Controller shall have an option for multiple boiler sequencing.

D. Controller shall have an option for communication device to computer interface.

2.10 BURNER DESIGN

A. Burner shall be a unitized Venturi, gas valve, blower, and burner head design.

B. Burner shall incorporate a variable speed DC combustion air fan capable of modulating the burner at a 5:1 ratio from high fire to low fire.

C. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame.

D. Burner shall produce less than 70-dBA sound reading at full firing rate.

E. Burner design shall have provision for induction of outside combustion air for sealed combustion.

PART 3 – EXECUTION

3.01 GENERAL

A. Install equipment in strict compliance with manufacturer's installation instructions.

B. Install equipment in strict compliance with state and local codes and applicable NFPA standards.

C. Maintain manufacturer's recommended clearances around sides and top of equipment.

D. Install components that were removed from equipment for shipping purposes.

E. Install components that were furnished loose with equipment for field installation.

F. Provide all control wiring and coordinate power wiring requirements with Electrical Contractor.

G. Provide all fuel gas venting, combustion air intakes and service piping.

H. Provide all piping for boiler pipe connections.

I. Pipe relief valves to nearest floor drains.

J. Pipe neutralization tanks drains to nearest floor drains and coordinate cold water piping requirements with Plumbing Contractor.

3.02 CONCRETE BASES

A. Coordinate concrete work with Division 03.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic code requirements at project site.

C. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

D. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

E. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

F. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

G. Install anchor bolts to elevations required for proper attachment to supported equipment.

H. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03.

3.03 MANUFACTURER'S FIELD SERVICES AND START-UP

A. The manufacturer's representative shall be responsible for performance of inspections, start up and testing of the package boiler, and accessory equipment and materials furnished under this Section. A detailed written record of the start-up performance, including burner setting data over the entire load range shall be furnished to the engineer before final acceptance. All labor, equipment, and test apparatus shall be furnished by the authorized service organization. All equipment defects discovered by the tests shall be rectified either by the service organization or boiler manufacturer.

B. The manufacturer's representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced. All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's representative.

C. The manufacturer's representative to provide eight (8) hours of jobsite assistance to inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied and potential damages. All shipped loose components, such as casing, to be mounted on boiler by boiler provider after contractor has set boiler in building.

D. Pre-startup walk-through: Boiler representative shall spend eight (8) hours at jobsite reviewing installation with mechanical contractor to be conducted approximately 1 week prior to startup.

E. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization, and shall include:

1. Demonstrate that boiler, burner, controls, and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
2. Readings at different firing rates (20, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall

include readings for each firing rate tested and include stack temperatures, O2, CO, NOx, and overall boiler efficiency.

3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non-compliance with referenced standards or overloading as applicable.
4. Commissioning Requirements:

    a. Fireside inspection.
    b. Set up fuel train and combustion air system.
    c. Set up operating set points.
    d. Check all safeties, including Flame safeguard, LWCO, Airflow, Fuel pressures, High limits.
    e. Set up and verify efficiencies at 20%, 50%, 75%, and 100%.
    f. Set up and verify burner turndown.

F. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single eight (8) hour continuous session to accommodate operator's availability on site.

3.04 OPERATING MANUALS

A. Instructions for installation, operation, and maintenance of the boilers shall be contained in a manual provided with each boiler unit.

B. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

END OF SECTION

SECTION 23 57 60

BOILER BREECHING AND ACCESSORIES

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Double-wall chimney stack systems.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit product data and shop drawings under provisions of Section 23 01 00.

B. Submit product data indicating factory-built chimneys, including dimensional details of components and flue caps, dimensions and weights.

C. Submit manufacturer's installation instructions under provisions of Section 23 01 00.

D. Submit layout drawings of chimney system of this project. Indicate plan view, elevations, and support details of the complete system.

E. The inner diameter for breeching and stack shall be verified by the manufacturer's computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the inner pipe. The Contractor shall furnish the exact boiler model and operating characteristics to the factory representative. Operating characteristics shall include the flue gas flow rate, BTU input, outlet temperature, local altitude, stack layout, and available external pressure at boiler outlet, etc., necessary to determine system operation at maximum and minimum levels of burner turndown range.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI Category I, II, III and IV gas burning appliances.

B. Conform to UL-103, NFPA 211 for installation of 1,400 deg. F chimneys.

PART 2 – PRODUCTS

2.01 MANUFACTURERS - DOUBLE-WALL CHIMNEY STACK SYSTEM

A. Cleaver Brooks, AL 29-4C stainless steel

B. Heatfab Saf-T Vent CI Plus

C. Metal-Fab Corr/Guard

2.02 DOUBLE-WALL CHIMNEY STACK SYSTEM

A. Provide for all chimneys shown on the Drawings a pre-fabricated chimney system suitable for Category I, II, III and IV gas burning appliance. System shall be UL 1738/ULC S636 Listed and Tested.

B. The double-wall chimneys shall have an outer shell of 430 stainless steel, a one-inch thick air space and an inner shell of AL 29-4C stainless steel. The chimney system shall be complete with all tee sections, elbows, straight sections, wall guide assemblies, wall support assemblies, roof thimble suitable for construction type, exit cone, stack cap, wall and floor sleeve assemblies, flashing, V-bands, caulking, channel bands and all other appurtenances required for a completed installation.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install breeching with minimum of joints. Align accurately at connections, with internal surfaces smooth.

C. Support breeching from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breeching, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.

D. Pitch breeching with positive slope up from fuel-fired equipment to chimney.

E. Clean breeching during installation, removing dust and debris.

F. Provide minimum length of breeching to connect appliance to chimney.

G. At equipment, provide slip joints permitting removal of appliances without removal or dismantling of chimney system.

END OF SECTION

SECTION 23 73 00

VARIABLE REFRIGERANT FLOW SYSTEMS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SUMMARY

A. The HVAC basis of design shall be Trane 4TVH Variable Refrigerant Flow (VRF) System as scheduled.

B. Bidders shall provide the minimum system as indicated on drawing, including Heat Pump systems as defined by model and family numbers. All systems shall be capable of providing the scheduled capacity at the location of the indoor unit regardless of pipe length. Nominal or catalog capacities will not be accepted.

C. The Heat Pump system shall consist of Trane 4TVH Air Source units, multiple Trane indoor units, and Trane VRF System Controls.

D. Building Automation System (BAS) controls, installation, and integration shall be provided by the manufacturer of the VRF system. This is to ensure sole source responsibility for the BAS control system.

1.02 QUALITY ASSURANCE

A. System efficiencies (SEER and HSPF) for units less than 65,000 BTUH shall be certified by AHRI standard 210-240, and shall be published for public review at www.ahrinet.org. Equipment that is "rated" in accordance with AHRI Standard 210-240, but not published for public review by AHRI shall not be accepted.

B. System efficiencies (IEER and SCHE) for units greater than 65,000 BTUH shall be certified by AHRI standard 1230, and shall be published for public review at www.ahrinet.org. Equipment that is "rated" in accordance with AHRI Standard 1230, but not published for public review by AHRI shall not be accepted.

C. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

D. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

E. Project shall comply with the applicable version of ASHRAE standard 15.

F. Project shall comply with the applicable version of ASHRAE 90.1

G. The VRF manufacturing facility shall be registered to ISO 9001 and ISO14001.

H. All components shall be provided by one manufacturer including but not limited to:

1. Outdoor Units
2. Indoor Units
3. Mode Control Units
4. All necessary and applicable controls for the VRF System
5. Factory refrigerant charge for outdoor unit(s) only

6. Y and or T-Branch(s) (field fabrication of Y or T branches is not acceptable)
7. Condensate Lift Pump(s) as shown on the contract documents
8. Refrigerant Ball Valves as shown on the contract documents
9. Service Software

1.03 DELIVERY, STORAGE AND HANDLING

A. Installing contractor will take all reasonable and appropriate care to store and handle equipment per the manufacturer's recommendation.

1.04 SUBMITTALS

A. Installing contractor shall provide the following:

1. Trane VRF Guide Specification
2. Trane VRF Dimensional Data for all products submitted
3. Trane VRF Product Data for all products submitted.
4. Trane VRF Select report showing design conditions, total load profile, and actual capacity at actual Indoor Unit location,
5. Trane VRF Select Piping and Wiring layout showing estimated piping, wiring sizes, equipment quantities, piping length estimate, and additional refrigerant charge.
6. Trane VRF Select Schedule showing the performance for all pieces of equipment.

1.05 INSTALLATION AND OPERATION MANUALS

A. Owner shall be provided with a complete and comprehensive electronic set of Installation and Operation Manuals.

1.06 QUALIFICATIONS

A. Manufacturer shall have a minimum of twenty-five (25) years of HVAC experience in the North America market.

B. Manufacturer to have Local Factory Service within seventy-five (75) miles of jobsite.

C. The VRF system shall be installed by a manufacturer certified installer with extensive VRF installation and service training. The mandatory contractor service and install training shall be performed by the manufacturer.

1.07 WARRANTY

A. The units shall be covered by the manufacturer's standard limited warranty for a period of 12 months from date of installation. If during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

B. The units shall carry an extended manufacturer's functional parts warranty for a period of 10 years from date of installation.

C. The following steps shall be taken by the contractor to ensure systems are eligible for extended warranty.

1. System is designed and submitted using the approved application tool.
2. System installed by a contractor who has successfully completed the manufacturer factory training class.

3. Upon completion of installation and prior to final commissioning, contractor shall provide revised piping layout reflecting actual installation conditions to manufacturer VRF technician for submittal to Factory Service Department.
4. Provide a verified and submitted commissioning report to Factory Service Department.

D. The contractor shall provide labor warranty as specified in the general conditions for this project.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Basis of design shall be: Trane VRF

B. The following manufacturers shall be allowed to bid as a deductive alternate provided they meet the scheduled performance indicated on the drawings:

1. Mitsubishi
2. Daikin

2.02 HEAT PUMP AIR SOURCE UNITS

A. The Trane 4TVH VRF Heat Pump Air Source unit shall be specifically used with Trane VRF Heat Pump components. The unit electrical power shall be 208/230 volts or 460 volts, 3 phase, 60 hertz as specified. Units shall have weather tight construction for outdoor installation, (outdoor unit).

B. The Trane Heat Pump outdoor unit shall be equipped with multiple circuit boards. These boards shall perform all functions necessary for operation. The outdoor unit shall be completely factory assembled, internally piped and wired. Each unit shall be run tested.

3. The combination ratio of the nominal indoor cooling capacity versus the nominal outdoor rated cooling capacity shall range from 50% to 130%.
4. Outdoor unit shall have a sound rating no higher than 62/83(Pressure/Power) dB(A).
5. Unit shall have a night quiet setting to reduce nighttime sound levels.
6. All refrigerant lines from the outdoor unit to IDUs (Indoor Units) shall be field insulated with a minimum insulation as referenced in the Trane VRF IOM (VRF-SVN034A-EN) Table 27, “Pipe insulation selector.”
7. The outdoor unit shall have an accumulator.
8. The outdoor unit shall have a high pressure safety switch, fuse, over-current protection and crank case heater.
9. If the outdoor unit is above the indoor unit, the outdoor unit shall have the ability to operate with a maximum height difference of 164ft. If the indoor unit requirement is greater than 164 ft, contact your local Trane Sales Office.
10. If the outdoor unit is below the indoor unit, the outdoor unit shall have the ability to operate with a maximum height difference of 131 ft.
11. The system shall have a maximum total refrigerant tubing length of 3281ft.
12. The maximum length between outdoor unit and the furthest indoor units is not to exceed 656 ft (722 equivalent feet).
13. The maximum height difference between indoor units shall be 164 ft.
14. The outdoor unit shall be capable of operating in cooling mode from 23°F to 120°F.
15. The outdoor unit shall be capable of operating in heating mode from 75°F to -13°F ambient temperatures without additional low ambient controls, additional modules, or low ambient accessories.
16. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

17. The outdoor units shall provide continuous heating during oil return and the defrost cycle through the use of rotational defrost. (multiple module systems)
18. Units shall have a snow blower feature to ensure the dispersion of accumulated snow

D. The unit casing(s) shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

E. The outdoor unit condenser fans shall be furnished with direct drive, variable speed motor(s). All fan motors shall have inherent motor protection, have permanently lubricated bearings. All fan motors shall be mounted for quiet operation. All fans shall be provided with a raised guard to prevent contact with moving parts. The outdoor unit shall have vertical discharge airflow.

F. R410A refrigerant shall be required for Trane VRF outdoor unit systems. Manufacturer shall only provide the refrigerant as required for unit charge. Contractor shall be required to provide additional refrigerant as specified in Trane VRF Select reports.

G. System shall use Polyvinylether (PVE) oil. Due to the increased risk of hydrolysis and formation of acids, Polyolester (POE) oil shall not be acceptable.

H. The outdoor condenser coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing. The condenser coil shall have Blue Fin anti-corrosion protection as a standard feature. The coil shall be protected with an integral metal guard. The coil fins shall be coated with hydrophilic paints.

I. The Trane VRF Heat Pump outdoor units shall be equipped with inverter driven vapor injection asymmetric scroll compressor(s). The asymmetric design will allow for only one point of contact for the scroll compressor blades resulting in reduced friction, and increased efficiency. Conventional scroll compressors with 2-points of contact will not be allowed due to their inherent inefficiency.

1. The outdoor unit compressor shall utilize inverter driven technology to modulate capacity. The compressors shall also utilize advanced technology adaptive sine wave control for reduced harmonics and faster frequency acceleration.
2. The compressor shall be capable of 1/60th second advanced micro-control.
3. The outdoor unit compressor shall utilize vapor injection technology which shall increase the mass flow rate of refrigerant, resulting in improved performance for low temperature conditions.
4. The compressor will be equipped with an internal thermal overload protection.
5. The compressor shall be mounted to avoid the transmission of vibrations.

J. Use 18 AWG, 25pF/ft nom., 60.7 Ω impedance, braid or foil shielded, twisted pair wire for communications wiring. Splicing of communication wiring shall not be permitted.

2.03 SINGLE PHASE HEAT PUMP OUTDOOR UNITS

A. The Trane 4TVH Single Phase Air Source unit shall be specifically used with Trane VRF Heat Pump components. The outdoor unit electrical power shall be 208/230 volts as specified. Units shall have weather tight construction for outdoor installation, (outdoor units).

B. The Trane Single Phase Heat Pump outdoor units shall be equipped with multiple circuit boards. These boards shall perform all functions necessary for operation. The outdoor unit shall be completely factory assembled, internally piped and wired. Each unit shall be run tested.

1. The combination ratio of the nominal indoor cooling capacity versus the nominal outdoor rated cooling capacity shall range from 50% to 130%.

2. Outdoor unit shall have a sound rating no higher than 53/74 (Pressure/Power) dB(A).
3. Unit shall have a night quiet setting to reduce nighttime sound levels.
4. All refrigerant lines from the outdoor unit to IDUs (Indoor Units) shall be field insulated with a minimum insulation as referenced in the Trane VRF IOM (VRF-SVN033A-EN) Table 14, "Pipe insulation selector."
5. The outdoor unit shall have an accumulator.
6. The outdoor unit shall have a high pressure safety switch, fuse, over-current protection and crank case heater.
7. If the outdoor unit is above the indoor unit, the outdoor unit shall have the ability to operate with a maximum height difference of 164ft.
8. If the outdoor unit is below the indoor unit, the outdoor unit shall have the ability to operate with a maximum height difference of 131 ft.
9. The system shall have a maximum total refrigerant tubing length of 984 ft.
10. The maximum length between outdoor unit and the furthest indoor units is not to exceed 492 ft (574 equivalent feet).
11. The maximum height difference between indoor units shall be 49 ft.
12. The outdoor unit shall be capable of operating in cooling mode from 118°F to 23°F
13. The outdoor unit shall be capable of operating in heating mode from 66 F° to -4°F ambient temperatures without additional low ambient controls.
14. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
15. Units shall have a horizontal snow blower feature to ensure the dispersion of accumulated snow.

C. The unit casing(s) shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

D. The outdoor unit condenser fans shall be furnished with direct drive, variable speed motor(s). All fan motors shall have inherent motor protection, have permanently lubricated bearings. All fan motors shall be mounted for quiet operation. All fans shall be provided with a raised guard to prevent contact with moving parts. The outdoor unit shall have horizontal discharge airflow.

E. R410A refrigerant shall be required for Trane VRF outdoor unit systems. Manufacturer shall only provide the refrigerant as required for unit charge. Contractor shall be required to provide additional refrigerant as specified in Trane VRF Select reports.

F. System shall use Polyvinylether (PVE) oil. Due to the increased risk of hydrolysis and formation of acids, Polyolester (POE) oil shall not be acceptable.

G. The outdoor condenser coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing. The condenser coil shall have Blue Fin anti-corrosion protection as a standard feature. The coil shall be protected with an integral metal guard. The coil fins shall be coated with hydrophilic paints.

H. The Trane Single Phase Heat Pump outdoor units shall be equipped with modulating rotary compressor(s).

1. The outdoor unit compressor shall utilize inverter driven technology to modulate capacity.
2. Units shall have crankcase heaters.
3. The compressor will be equipped with an internal thermal overload protection.
4. The compressor shall be mounted to avoid the transmission of vibrations.

I. Use 18 AWG, 25pF/ft nom., 60.7 Ω impedance, braid or foil shielded, twisted pair wire for communications wiring. Splicing of communication wiring shall not be permitted.

2.04 4-WAY MINI/ 4-WAY CEILING CASSETTE INDOOR UNITS

A. The Trane 4TVB/4TVC are four-way cassette style indoor units that recess into the ceiling grid with an exposed ceiling grille and an integral 2000 step modulating expansion device. The unit electrical power shall be 208-230 volts, 1-phase, 60 hertz.

B. The indoor unit shall be a factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, the electronic modulating linear expansion device, control circuit board, and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function.

C. The unit cabinet shall be a space-saving ceiling-recessed cassette. The cabinet panel shall have provisions for a field installed filtered outside air intake. Branch ducting shall be allowed from cabinet.

D. The indoor fan shall consist of a turbo fan with a single direct drive motor. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. The indoor fan shall have high, medium, and low fan speeds. The fan speed shall be adjustable by an optional remote controller. The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution. If require the cassette shall be capable of closing off one or more vanes to prevent “stray airflow”.

E. Return air shall be filtered by means of a long-life washable permanent filter.

F. The indoor coil shall be constructed as follows:

1. The indoor coil shall be of nonferrous construction with slit fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The coil fins shall be coated with hydrophilic paints.
7. The factory installed condensate lift mechanism shall be able to raise drain water 29.5 inches water column above the condensate pan.
8. Both refrigerant lines to the indoor units shall be insulated.

G. Use 18 AWG, 25pF/ft nom., 60.7 Ω impedance, braid or foil shielded, twisted pair wire for communications wiring. Splicing of communication wiring shall not be permitted.

H. This unit shall use controls provided by Trane to perform functions necessary to operate the system. Please refer to Part 3 of this guide specification for details on controllers and other control options.

2.05 REQUIRED ACCESSORIES

A. Y-Joint Kits- are a required component for Trane VRF-Systems with multiple evaporators and MCU’s on the same system. Y-joints shall be provided for liquid, suction, and hot gas fittings as required. Y-joints shall be provided with polystyrene insulation. Y-branches shall facilitate different pipe sizes without having to braze additional fittings. Field fabrication or substitution of non-Trane Y-Joints shall void warranty. Kits shall be installed per manufacturer guidelines. Requires field installation.

B. T-Joint Kits – are a required component for Trane VRF systems with multiple outdoor modules on a single system. The T-Joint shall be provided for liquid, suction, and hot gas fittings as required. T-Joints shall be provided with polystyrene insulation. T-Branches shall facilitate different pipe

sizes without having to braze additional fittings. Field fabrication or substitution of non-Trane T-joints shall void warranty. Kits shall be installed per manufacturer guidelines. Requires field installation.

C. EEV KITs- the EEV (Electronic Expansion Valve) provides refrigerant management of indoor units. The EEV shall be required for field installation on ceiling suspended (floor) indoor units. Heat Recovery systems shall require the single room EEV. Heat Pump systems (only) may also utilize the two or three room EEV kits. Kits shall be installed per manufacturer guidelines. Requires field installation.

D. Condensate Drain Pumps shall be provided for field installation as required for efficient condensate management. Condensate pumps shall be capable of 29.5" of lift to allow condensate to reach the closest gravity drain line. Condensate pumps shall include a check valve to prevent water form flowing back into the indoor unit. Pump shall be mounted in the chassis of the indoor unit. Pump shall draw on required power from the associated indoor unit. Requires field installation (Standard factory installed for all ceiling cassettes).

E. Refrigerant Isolation Ball Valves - shall be provided for field installation as specified by the contract documents. Valves shall utilize a uni-body full port design to minimize leaks and internal pressure drops. Valves shall be rated for 700PSIG, and are offered with an optional factory insulation package. Valves shall be factory tested under pressure. Valves shall require polytetrafluroethylene (PTFE) seals and gaskets. No synthetic O-rings are allowed. Design shall permit valve operation without removal of seal cap. Valves shall have a temperature operation range of -40°F to 300°F. Requires field installation.

F. Simple wired remote controller can be used with all Trane VRF Indoor Units. Remote shall utilize a Multi-function LCD display and shall possesses the following functionality:

1. ON/OFF Control
2. Mode Selection
3. Temperature Set-point
4. Fan Speed Setting
5. ON/OFF Timer
6. Controls up to 16 Indoor Units
7. Up to 2 can be averaged as single controller
8. Child Lock
9. Dirty Filter Alert

G. Standard Cassette Panels shall be required with as indicated for all 1-way, Mini 4-way, and 4-way ceiling cassettes.

H. Wind/Snow Prevention Duct Kit are for vertical air source units. The kits are used in windy or snowy regions to prevent cold gusts of air from interfering with stable operation of the units. They are also for use in snowy regions to prevent snow from accumulating on the units. The kit is recommended when low ambient heating is required. The Wind/Snow prevention kit may require the additional use of the Duct Discharge Kit. Requires field installation.

PART 3 – CONTROLS

3.01 BAS MANUFACTURER

A. The Trane VRF System Network Controls shall be capable of supporting remote controllers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet®.

3.02 ELECTRICAL CHARACTERISTICS

A. The Trane VRF System Network Controls shall operate at 12VDC. Controller power and communications shall be via a common non-polar communications bus.

B. Control wiring shall be installed in a system daisy chain configuration from the wired remote controller to the indoor unit, to the and to outdoor unit. Control wiring to wired remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

C. Control wiring for system controllers, and centralized controllers shall be installed in a daisy chain configuration from interface module to interface module, to system controllers, to the power supply.

D. For communication wiring between ODUs, IDUs, MCU, system controller, and remote controllers use 18 AWG, 25pF/ft nom., 60.7 Ω impedance, braid or foil shielded, twisted pair wire. Splicing of communication wiring shall not be permitted.

E. The Trane VRF SC Web UI shall be capable of being networked with the VRF System Controller TVCTRLTIMD00A0, system controllers for web based control.

F. Network wiring shall be CAT-5e with RJ-45 connection.

3.03 VRF-SYSTEM CONTROLLER+BACnet®

A. The VRF System Controller+BACnet is an intelligent field panel that communicates with VRF Outdoor Unit(s), Indoor Unit(s) and other Trane VRF controllers. Additionally, it shall include a BACnet® IP (Internet Protocol) port to function as a communications gateway to other BACnet IP devices, such as Trane's Tracer SC. The VRF System Controller+BACnet shall connect to associated indoor and outdoor units utilizing a dedicated control network. The controller utilizes the local area network (LAN) to provide a web page-based user interface available wherever the building's network access is available. The VRF System Controller+BACnet is housed in a protective enclosure suitable for wall-mounting in a mechanical or electrical equipment room. The Trane VRF BACnet® Gateway shall be capable of controlling up to 256 indoor units/EEVs support.

B. The VRF System Controller shall allow a building operator to view the system using a PC with a standard web browser, such as Windows® Internet Explorer or Mozilla Firefox.

C. The VRF System Controller shall include a user interface that includes control and monitoring of each Indoor unit through a standard graphical display with convenient pop-up controller screen to adjust comfort settings for each zone.

D. The VRF SC shall be capable of controlling a maximum of 256 indoor units via a PC. A field supplied PC shall be required. The VRF SC shall support operation superseding that of the remote controllers, system configuration, 1-day/daily/weekly scheduling, monitoring of operation status, error email notification, online maintenance tool and malfunction monitoring.

E. The VRF SC shall have a basic set of operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 256 indoor units), or all indoor units (collective batch operation).

F. The basic set of operation controls for the VRF SC shall include on/off, operation mode selection (auto, cool, heat, dry, and fan), temperature setting, fan speed setting, airflow direction setting, error email notification, and online maintenance.

G. Since the VRF SC provides centralized control, it shall be able to enable or disable operation of local remote controllers via the PC. In terms of scheduling, the VRF SC shall allow the user to define 1-day, daily, and annual schedules with operations consisting of ON/OFF, mode selection, temperature setting, permit/prohibit of wireless/wired remote controllers.

H. The system shall detect and store alarms in the Alarm Log. The Alarm Log shall display critical data about the alarm, including the location of the device, and the time of occurrence. Alarms shall be routed by e-mail to stationary or mobile devices. Capacity to store up to 1024 alarm events on time specific basis shall be required.

I. Database changes made by other users shall automatically be reflected in the VRF System Controller without the need for a central server. The system database be capable of archiving or backing up data for local or offsite storage. This is desirable in the event the date is ever needed for restoring the system. A built-in SD card slot provides for on-board but removable data backup storage.

J. A password shall protect the VRF control system from unauthorized access. Each operator is assigned a role. Roles are defined by access rights. Pre-defined roles shall be selected from the VRF System Controller interface. Operators shall have access only to those features which define their roles. Roles may also be customized. An operator with administrative-level security shall access all information on the system, and shall have the ability to alter passwords and create new security roles.

Trane VRF System Controller+BACnet®

Item	Description	Operation	Display
ON/OFF	Start stop operation for a single group	Each Group	Each Group
Operation Mode	Changes mode between Auto/Cool/Dry/Fan/Heat	Each Group	Each Group
Temperature Setting	Sets the temperature for a single group. Range of temperature settings: Auto/Cool/Dry: 64°F-86°F (18°C-30°C), Heat: 61°F-86°F (16°C-30°C)	Each Group	Each Group
Fan Speed Setting	Models with 3 air flow settings: High/Mid/Low	Each Group	Each Group
Air Flow Direction Setting	Air flow 2-step direction (Swing/Stop). Direct settings at a specific angle. Air flow operation varies depending on the model.	Each Group	Each Group
Web Server Function	Remote control with the public IP address. No management software required – PC-independent management	Each Group	Each Group
Accessible level/ Dynamic user security Management	Wireless/wired remote controller restriction setting Specifies the scope of control and monitoring unit on a per-user 3 accessible levels -Admin/Manager/User	Each Group	Each Group
Error	When an error is occurs on an outdoor unit, the affected unit and error code are displayed	Each Group	Each Group
Schedule Operation	Up to 256 schedule settings including weekly and daily schedule setting	Each Group	Each Group
External Contact Interface	Full indoor unit control with simple contact input (Emergency/Lock) State output (Operation/Error) for synchronous control. 6 digital outputs / 8 digital inputs	Each Channel	Each Channel

Trane VRF System Controller+BACnet®

Item	Description	Operation	Display
Smart Central Management	Control & monitoring zone edition. Wireless/wired remote control restriction. Temperature limit setting Operation mode restriction. Silent control setting	Each Group	Each Group
User editable control logic	User can edit control logic with arithmetic/conditional operators and parameters. Efficient energy saving realization based on various operation conditions.	Each Group	Each Group
Data backup/ Useful history management	Important data is safely stored in SD memory card Record the operation history and error history	Each Group	Each Group
Multi language	English, Korean, Chinese, Spanish, Italian, Portuguese, Dutch, Hungarian, Polish, Russian		

Indoor Unit BACnet® Point List

Instance Number	Object	Object Type	Object Name	Unit Inactive Text-1	Text-2	Text-3	Text-4	Text-5
1	Indoor Temperature	AI	AC Room Temp	°C				
2	Set Temperature	AV	AC Temp Set	°C				
3	Setting lower temperature limit	AV	AC Cool Limit Temp	°C				
4	Setting upper temperature limit	AV	AC Heat Limit Temp	°C				
5	IDU power usage after the basic date	AI	AC Baseline kWh	kWh				
6	IDU hour usage after the basic date	AI	AC Baseline Minute	Minute				
7	Power value within period	AI	AC Period KWh	kWh				
8	IDU hour usage within period	AI	AC Period Minute	Minute				
9	Power On/Off	BV	AC Power	Off	On			
10	Applying lower temperature limit setting	BV	AC Cool Limit set	False	True			
11	Applying upper limit temperature setting	BV	AC Heat Limit set	False	True			

Indoor Unit BACnet® Point List								
12	Filter sign status	BI	AC Filter Sign	False	True			
13	Filter sign reset	BO	AC Filter Sign Reset	False	True			
14	Operation mode status	MV	AC Operation Mode	Auto	Cool	Heat	Fan	Dry
15	Fan speed status	MV	AC Fan Speed	Auto	Low	Mid	High	
16	Airflow direction status	MV	AC Fan Flow	None	Vertic al	Horizon	All	
17	Operatiom mode limit status	MV	AC Mode Limit	No Limit	Cool Only	Heat Only		
18	Remote controller limit status	MV	AC Remocon	Enable RC	Disabl e RC	Conditio nal RC		
19	Integrated error code of both indoor unit and outdoor unit	AI	AC Error Code	Refer to List of Error Codes				
20	SPI setting	BV	AC SPI	False	True			
21	Human Sensor setting	BV	AC MDS	False	True			
22	AC Indoor Notify	NC	AC Notify	When the error occurred, send event to list of destination in the recipient list. (Max:8)				

Outdoor Unit BACnet® Point List								
Instance Number	**Object**	**Object Type**	**Object Name**	**Unit Inactive Text-1**	**Text-2**	**Text-3**	**Text-4**	**Text-5**
1	Outside Temperature	AI	ODU Outside Temp	°C				
2	Cool capacity compensation	AV	ODU Cool Compen	0:5~7°C/1:7~9°C/2:9~11°C/3:10~12°C/ 3:11~13°C/5:12~14°C/6:13~15°C/ 14:Auto control (from ODU)				
3	Heat capacity compensation	AV	ODU Heat Compen	0:25kg/cm^2/1:26kg/cm^2/ 2:27kg/cm^2/3:28kg/cm^2/ 4:29kg/cm^2/5:30kg/cm^2/ 6:31kg/cm^2/7:32kg/cm^2/ 8:33kg/cm^2/14:Auto control (from ODU)				
4	Setting upper temperature limit	BI	AC Heat Limit Temp	False	True			

Outdoor Unit BACnet® Point List								
Instance Number	**Object**	**Object Type**	**Object Name**	**Unit Inactive Text-1**	**Text-2**	**Text-3**	**Text-4**	**Text-5**
5	Compressor Status	AI	ODU Comp Status	Refer to the list of the integrated error codes				
6	Interface module notify	NC	IM Notify	When the error occurred, send event to list of destination in the recipient list. (Max:8)				

3.04 VRF-SYSTEM TOUCHSCREEN CONTROLLER

A. The VRF System Touchscreen shall provide an intuitive, fast and convenient method of centrally operating a Trane VRF system. The VRF System Touchscreen shall communicate with associated VRF components through a dedicated control network. It can control many comfort and energy-saving settings, including temperature, fan speeds, and operating schedules for up to 128 indoor units, and up to 16 outdoor units. The unit shall be housed in an attractive enclosure suitable for wall-mounting in an office, corridor or utility room.

B. The System Touchscreen shall feature a 7” Color Capacitive Touch Screen. The User interface shall display operating equipment icons indicating mode status at a glance. All units within a zone shall be managed with one-button control. Unique zone description icons shall make it easy to recognize a zone.

C. Control shall include but not be limited to the following; On/Off control, temperature set-point, mode settings Auto/Heat/Cool/Auto/Dry/Fan, air-direction adjustment, and local temperature set-point restrictions.

D. The System Touchscreen shall be capable of setting up to up to 10 unique schedules including exception day setting for holidays, and Daylight Saving Time adjustment.

E. The System Touchscreen shall be capable of grouping indoor unit in common zones. There may be up to 12 zones. Zones may be individually named.

F. The System Touchscreen shall provide management of multiple indoor units as 1 unit (Group control). Additionally, the controller shall provide monitoring and control points for Interlocking of external equipment via 2 Binary Inputs and 1 Binary Output.

G. The System Touchscreen shall provide an alarm/error display, and alarm history.

H. Security shall be provided by a secure password.

I. The System Touchscreen shall connect via R1/R2 VRF communications link for monitoring and control of up to 128-total Indoor Units and MCUs, associated with up to 16-outdoor units. Alternately, the system shall connect via F1/F2 VRF communications link for monitoring and control of up to 64-indoor units plus up to 16-MCUs, associated with 1-Outdoor Unit.

PART 4 – EXECUTION

4.01 INSTALLATION

A. System shall be installed in accordance with manufacturer’s guidelines.

B. Installing contractor shall attend and successfully complete the Trane VRF Installation factory training class. Contractor shall submit certificate of completion as part of project closeout documents.

C. Installing contractor shall install units to comply with building codes.

D. Trane VRF systems shall be installed in such a way as to permit access for routine maintenance.

4.02 COMMISSIONING

A. Upon completion of installation and prior to final commissioning, contractor shall provide revised piping layout reflecting actual installation conditions to Trane VRF technician.

B. The system shall then be reviewed and commissioned by a Trane Factory VRF Technician. Contractor shall provide a verified and submitted commissioning report to Trane Factory Service Department, and to the owner's agent verifying the system has met the requirements for proper installation, and function.

C. Engage a Trane Factory Certified VRF Technician to train owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 78 00

PACKAGED ROOFTOP AIR CONDITIONING UNITS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Packaged rooftop unit.

B. Refrigeration components.

C. Unit operating controls.

D. Spring isolated acoustical roof curb.

E. Electrical power connections.

F. Operation and maintenance service.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01.

B. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.

C. Submit product data indicating rated capacities, weights, accessories, service clearances and electrical requirements.

D. Submit manufacturer's installation instructions.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Division 01.

B. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions and maintenance procedures.

1.05 WARRANTY

A. Provide five-year extended warranty for compressors and two-year parts and labor warranty for remainder of unit.

1.06 MAINTENANCE SERVICE

A. Furnish complete service and maintenance of packaged rooftop units for one year from Date of Substantial Completion by Contractor.

B. Provide maintenance service with a two-month maximum time interval between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data.

D. Submit copy of service call work order or report to the Owner, and include description of work performed.

1.07 ACOUSTICS

A. Manufacturer of packaged rooftop equipment shall provide indoor and outdoor sound power level data across all major octave band center frequencies for cataloged operating range of unit at gross cooling capacity range. Data shall be obtained in conformance with ANSI S1.32-1980, American National Standard Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow Band Noise Sources in Reverberation Rooms and per AMCA Standard 300-85 test code "Sound Rating Air Moving Devices."

1.08 EXTRA MATERIALS

A. Provide one set of filters for each unit.

B. Provide one set of belts for each belt driven motor for each unit.

1.09 SUMMARY

A. The contractor shall furnish and install packaged rooftop air conditioning unit(s) as shown and as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the conditions specified, scheduled or as shown on the contract drawings.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide basis-of-design product or comparable substitute product as listed below.

1. Basis-of-Design Product

   a. Trane, Intellipak Series

2. Substitute Product

   a. Johnson Controls, 40/100 Series or Custom
   b. Daikin, RPS Series or Custom
   c. AAON, RN Series or Custom

B. Substitute Product: Substitute product acceptable only if in compliance with requirements. Bidding contractor shall be responsible for electrical, mechanical and structural modifications

required when using substitute product. It shall be the responsibility of the bidding contractor to make the Engineer aware of any required modifications.

2.02 GENERAL UNIT DESCRIPTION

A. Unit furnished and installed shall be heating and cooling packaged rooftop as specified on the contract documents and within these specifications. Cooling capacity ratings shall be based upon ARI Standard 360. Unit shall consist of insulated weather-tight casing with compressors, air cooled condenser coil, condenser fans, evaporator coil, filters, supply and return/exhaust fan motors, variable frequency drives, and unit controls.

B. Unit shall be single-piece construction as manufactured at the factory. Site assembled sub-assemblies will not be allowed. Package units shall be constructed for installation on a roof curb and vibration isolation base rail to be provided by rooftop unit manufacturer providing full perimeter support under air handler section and pedestal support and vibration base rail under condenser section.

C. Unit shall be factory run tested to include the operation of all fans, compressors, heat exchangers, and control sequences.

D. Unit shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.

2.03 UNIT CASING

A. Cabinet: Galvanized steel, phosphatized, and finished with an air-dry paint coating durable enough to withstand 1000 consecutive-hour salt spray application in accordance with standard ASTM B 117. Structural members shall be 14-gauge with access doors and removable panels of minimum 18-gauge steel. Roof panels shall be sloped to provide positive drainage of rain water/melting snow away from the cabinet.

B. Provide custom exterior paint color to be selected by Architect.

C. Access Doors: Fully gasketed hinged doors of double-wall construction with fluted knob fasteners and chained "tie-backs" to provide access to filters, heating section, return/exhaust air fan section, supply air fan section and evaporator coil section.

D. Control Panel: The unit control panel section shall be compartmented to separate high and low voltage components. The control panels shall also be fully gasketed, hinged and provided with quick release latches for easy access.

   1. The high voltage control panel shall be provided with a door handle disconnect switch to facilitate convenient, safe disconnection of main three phase power.

E. Insulation: Provide 1/2-inch thick coated fiberglass internal liner on all exterior panels in contact with the conditioned air stream.

2.04 AIR FILTERS

A. Air Filters: Filters shall mount integral within unit casing and be accessible via hinged access panels. Filters shall be two-inch thick high efficiency throw-away type.

2.05 FANS - SUPPLY AND RETURN/EXHAUST

A. Provide forward curved supply and return/exhaust fans with fixed-pitch sheave drive assemblies. Dynamically balance all fans and the unit's running fan assembly (fan mounted on actual shaft, bearings and in scroll housing) to assure smooth operation of the fan and its associated assembly. Balancing of the fan only shall not be acceptable.

B. Mount fan motors and fans on a common base assembly. Provide thrust restraint isolation on the fan housing/fan board to assure smooth fan startup transition and operation.

C. Fan shafts shall be mounted on grease lubricated ball bearings.

D. Motors shall be open drip-proof. Motor shall have a standard T-frame and a minimum service factor of 1.15. Motors shall be "premium efficiency" type. All drive components shall be accessible without the use of scaffolds or ladders, to facilitate periodic maintenance checks and for operator safety.

1. Motors shall be tested and designed in accordance with IEEE Standard 112.
2. Motors shall have a minimum service factor of 1.15.

2.06 HOT WATER HEATING SECTION

A. Provide factory assembled and installed non-freeze coil, ARI certified. Pitch coils to ensure complete drainage.

2.07 EVAPORATOR COIL SECTION

A. Provide heavy duty aluminum fins mechanically bonded to seamless copper tubes. Evaporator coil shall be inter-circuited to maintain active coil face area at part load conditions. Coil shall also utilize internally enhanced tubing for maximum efficiency.

B. Provide a thermostatic expansion valve (TXV) for each refrigerant circuit. Factory pressure and leak test coil at 300 psi.

C. Provide pitched stainless steel drain pan to assure positive drainage of condensate from the unit casing.

2.08 CONDENSER SECTION

A. Provide heavy duty aluminum fins mechanically bonded to seamless copper tubes. Factory leak test coil under 450 psig pressure.

B. Provide subcooling circuit(s) integral with condenser coils to maximize efficiency and prevent premature flashing of liquid refrigerant, to a gaseous state, ahead of the expansion valve.

C. Provide vertical discharge, direct drive fans with steel blades, and three phase motors. Fans shall be statically and dynamically balanced. Motors shall be permanently lubricated, with built-in current and thermal overload protection in weather-tight slingers over motor bearings. All motors shall comply with Section 23 17 00 - Motors, in addition to the requirements of this section.

D. Provide factory-installed louvered steel coil guards around perimeter of condensing section to protect the condenser coils, refrigerant piping and control components. Louvered panels shall be fabricated from minimum 20-gauge galvanized steel and be rigid enough to provide permanent protection for shipping and pre-/post- installation. Course wire mesh is not an acceptable material for coil guards.

E. Condenser coils shall be V-banked for cleaning ease. The coils shall not exceed 14 fins per inch density in order to permit routine cleaning, and prevent excessive air pressure drop across the condenser coil.

2.09 REFRIGERATION SYSTEM

A. Compressor shall be industrial grade, energy efficient direct drive 3600 RPM maximum speed reciprocating or scroll type. The motor shall of a suction gas cooled hermetic design. Compressor shall have centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve.

1. If semi-hermetic reciprocating industrial grade compressors are utilized provide single piece crankshafts, connecting rods aluminum pistons, rings to prevent gas leakage, high strength non-flexing ring type suction and discharge valves, spring loaded heads, replaceable cylinder liners, and sealing service immersed in oil. Provide removable discharge heads and hand hole covers, and discharge service valves.
2. Provide compressor with automatic capacity reduction equipment consisting of suction valve unloaders. Use electric solenoid actuated lifting mechanism operated by oil pressure. Provide for unloaded compressor start.

B. Provide with thermostatic motor winding temperature control to protect against excessive motor temperatures resulting from over-/under-voltage or loss of charge. Provide high and low pressure cutouts, and reset relay.

C. Provide factory-installed compressor lockout thermostat to prevent compressor operation at low ambient conditions.

D. Provide coil frost protection compressor unloading based on refrigerant circuit suction temperature to prevent coil frosting with minimum energy usage. As an alternate, factory-installed hot gas bypass shall be required on all VAV units to prevent coil frosting.

2.10 EXHAUST/RETURN SECTION

A. Provide 100% modulating exhaust air capabilities integral to unit. Unit shall control building pressurization by the operation of exhaust fans and exhaust fan motor variable frequency drive. Controller shall compare actual building interior pressure with outside ambient air pressure and supply duct pressure. Pressurization set point shall be field adjustable at the human interface to positive, neutral or negative values.

2.11 OUTDOOR AIR SECTION

A. Provide 100% modulating enthalpy-based economizer system fully integrated with unit return and exhaust air dampers. Unit operation shall be through primary temperature controls that automatically modulate dampers to maintain desired space temperature conditions.

B. Provide automatic outdoor enthalpy lockout sensor.

C. Provide adjustable minimum position control through the standard rooftop Human Interface.

D. Provide air flow measuring station similar to Trane Traq Damper to enable constant minimum outside air flow control during modulation of total air flow.

E. Provide spring-return motor for outside air damper closure during unit shutdown or power interruption.

2.12 DAMPERS

A. Provide ultra low leak dampers with a leakage rate not to exceed 1.0% of nominal airflow at one inch W.C. static pressure.

B. Leakage rate shall be determined in accordance with AMCA Standard 575.

2.13 DDC MICROPROCESSOR CONTROLS

A. General - Each unit shall be provided with a factory-installed, programmed and run-tested, stand-alone, microprocessor control system suitable for VAV control as required. This system shall consist of temperature and pressure (thermistor and transducer) sensors, printed circuit boards, and a unit-mounted Human Interface Panel. The microprocessor shall be equipped with on-board diagnostics to indicate that all hardware, software, and all interconnected wiring and sensors are in proper operating condition. The microprocessor's memory shall be non-volatile EEPROM type, thus requiring no battery or capacitive backup to maintain all data during a power loss.

B. The Human Interface Panel shall be readily accessible for service diagnosis and programming without having to open the main control panel on the rooftop unit. Alphanumeric coded displays shall not be acceptable.

1. Human Interface (HI) Panel - shall be a 16-key touch-sensitive membrane key switch panel, password protected to prevent use by unauthorized personnel. The Human Interface Panel display shall consist of a 2-line by 40 characters per line clear English display. The display shall be Supertwist Liquid Crystal Display (LCD) with blue characters, 5 × 7 dot matrix with cursor, on a gray-green background for high visibility and reading ease.

C. Ventilation Override Module (VOM) - shall be provided which will allow the user to field reconfigure and establish up to five different purge, exhaust and building pressurization sequences. These sequences, factory prioritized, shall be reconfigurable through the Human Interface Panel at the rooftop unit, the Remote Human Interface.

D. Anti-recycle Protection - shall be provided to prevent excessive cycling, and premature wear, of the compressors, contactors and related components.

E. Supply and exhaust fan airflow modulation shall be provided by independent variable frequency drive units. Variable frequency drives shall be factory-mounted integral to the unit. Adjustable frequency inverter drives shall safely vary the speed of the fan motors allowing the motor to meet the dynamic requirements at the shaft of the motors and meet the system static. Properly sized motor protection shall be provided by a motor overload relay and fuses. Inverter controller shall have a display that provides readout functions that include: output frequency, output voltage, output current, output power, DC bus voltage, interface terminal status, and fault status.

F. The unit manufacturer shall be responsible for establishing sequences of operation specified in Section 23 97 50 - Building Automation System.

G. Provide a control panel similar to a Trane Summit BACnet Control Unit (BCU). The BCU shall be fully installed and programmed by the unit manufacturer specifically for this project. The BCU shall be interconnected to the rooftop units and shall be capable of complete interface with the Building Automation System. As a minimum, BCU/BAS system interface for the following points lists are required:

1. Analog inputs:

a. Supply air temperature
b. Return air temperature
c. Mixed air temperature

d. Economizer position
e. OA cfm
f. Duct static pressure
g. Building pressure
h. Supply fan variable frequency drive output
i. Exhaust fan variable frequency drive output

2. Analog outputs:

a. Supply air temperature set point
b. Minimum OA position set point
c. Duct static pressure set point
d. Building pressure set point

3. Binary outputs:

a. Unit start/stop

4. Binary inputs:

a. Compressor status (each compressor)
b. Dirty filter
c. Supply fan status
d. Exhaust fan status
e. External stop
f. Heating status
g. Automatic reset diagnostic exists
h. Manual reset diagnostic exists

2.14 MISCELLANEOUS FEATURES

A. Horizontal Discharge: Provide field removable access panels to allow for horizontal discharge applications without the use of a special roof curb.

B. Provide unit mounted 115 volt convenience outlet

C. Non-fused Disconnect Switch with External Handle: External handle shall enable an operator to disconnect power to the unit with the control box door closed.

D. Extended Grease Lines: Extended lines shall allow greasing of supply and exhaust fan bearings through the filter access door.

2.15 SPRING ISOLATED ACOUSTICAL ROOF CURB

A. Provide factory-supplied acoustical roof curb to form a complete and matched rooftop system with the rooftop air conditioning unit.

B. Roof curb shall be prefabricated, non-combustible construction with sealing gasket around perimeter members to ensure air/watertight integrity. The curb shall be constructed of minimum 14-gauge galvanized steel structural members with minimum 20-gauge galvanized steel flashing with overlapping continuous rubber counter-flashing. Curb shall be furnished with a 2" × 2" nailed strip for attaching roofing felts. The base of the curb shall contain acoustically non-conductive floor pans with the supply and return air openings framed for duct attachment (duct must be supported independent of curb and flex connected).

C. Curb shall incorporate integral spring-vibration isolation rail with adjustable 1" deflection isolators, properly sized and selected for unit point loading. Spring isolators shall have a minimum of 90% isolation efficiency.

D. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines for rooftop equipment support.

E. The curb shall be designed to provide pedestal support for an open (no base pan constructed) condensing section. Full perimeter supported condensing sections shall not be permitted.

F. Curb shall be a minimum of 24" high.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork. Install roof mounting curb level.

3.03 MANUFACTURER'S FIELD SERVICES

A. Manufacturer shall furnish a factory trained service engineer without additional charge to start the unit(s). Package rooftop unitary manufacturers shall maintain service capabilities no more than 100 miles from the job site.

END OF SECTION

SECTION 23 78 10

PACKAGED ROOFTOP DEHUMIDIFICATION UNITS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Factory packaged rooftop units capable of supplying 100 percent outdoor air and providing cooling and dehumidification.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, recommended clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:

   a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

   b. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For design of vibration isolation and wind restraints, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Informational Submittals:

1. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   a. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.

b. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

2. Startup service reports.
3. Sample warranty.

F. Closeout Submittals:

1. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.04 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One complete set for each belt-driven fan.
2. Filters: One complete set for each unit.

1.05 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Five (5) years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Ten (10) years from date of Substantial Completion.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide basis-of-design product or comparable substitute product as listed below.

1. Basis-of-Design Product

a. Trane, Horizon™ Model OAU

2. Substitute Product

a. Johnson Controls, JDHA/JDMA Series or Custom
b. Daikin, DPS/MPS Series or Custom
c. AAON, RN Series or Custom

B. Substitute Product: Substitute product acceptable only if in compliance with requirements. Bidding contractor shall be responsible for electrical, mechanical and structural modifications required when using substitute product. It shall be the responsibility of the bidding contractor to make the Engineer aware of any required modifications.

2.02 GENERAL UNIT DESCRIPTION

A. Units shall be factory packaged rooftop units capable of supplying 100 percent outdoor air and providing cooling and dehumidification. Units shall be as scheduled on Drawings and described in these specifications. For dehumidification and cooling modes the evaporator temperature shall

be monitored and reported at the unit controller. Compressor controls shall modulate capacity to maintain evaporator leaving set point. Hot gas bypass shall not be used to control compressor capacity. Compressor hot gas reheat (HGRH) shall be factory installed. To prevent rehydration of evaporator condensate the reheat coil face shall be located a minimum of 6” downstream from the leaving face of the evaporator coil. Heating system shall include modulating controls. Compressor on-off only or heating on-off only controls shall not be acceptable control strategies.

B. Units shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.

C. Unit discharge airflow configuration shall be as indicated on Drawings.

D. Wiring internal to the unit shall be colored and numbered for identification.

2.02 ACOUSTICS

A. Refer to Drawings for maximum sound power levels.

B. Manufacturer of packaged rooftop equipment shall provide indoor and outdoor sound power level data across all major octave band center frequencies for cataloged operating range of unit at gross cooling capacity range. Data shall be obtained in conformance with ANSI S1.32-1980, American National Standard Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow Band Noise Sources in Reverberation Rooms and per AMCA Standard 300-85 test code "Sound Rating Air Moving Devices".

2.03 CABINET

A. Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Top of cabinet base pan shall be insulated with 2” thick polyisocyanurate foam. Foam insulation shall be fully enclosed with galvanized steel insulation cover. Insulation shall not be applied to underside of unit base.

B. Cabinet Base Rails: Side and end base rails shall include openings for forklift and tie-down access. To protect unit base from fork damage side rails shall include removable heavy gauge fork pockets.

C. Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping.

D. Cabinet material interior and base rails shall be G-90 zinc-coated galvanized steel. Material gauge shall be a minimum of 14-gauge for base rails, 16-gauge for structural members and 20-gauge for access doors and cabinet panels.

E. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-60 galvanized steel with both exterior and interior surfaces cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Unit’s surface shall be in compliance with ASTM B45 salt spray testing at a minimum of 672 hour duration.

F. Cabinet Panels: 2” double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed.

G. Insulation: 2” polyisocyanurate foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness.

H. Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service.

I. Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.

J. Hinged Access Panels: Water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, optional ERV and power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Door hardware shall be constructed to allow the door swing to be reversed in the field.

1. Hold-open devices shall be factory installed on all hinged access doors. Chains shall not be used as hold-open devices.

2. Latches with locking hasp or tool operated closure devices shall be factory installed on all hinged access panels.

K. Drain pan material shall be Type 304 Stainless steel drain and constructed to sloped in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2". Base of pan shall be insulated with 1" thick foam insulation.

L. Provide openings on side of unit or thru the base as indicated on Drawings for pipes, power, and control connections.

M. Air inlet hood shall be factory installed and shall not require field assembly. Hood shall include 2" thick removable aluminum mesh mist eliminators sized for a velocity not to exceed 500 FPM at maximum unit rated airflow. Service access shall be hinged and held in place with thumb latches that shall not require tools for service access.

N. Unit shall be equipped with a 6" filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.

2.04 AIR FILTERS

A. Unit inlet hood shall include 2" thick aluminum mesh removable mist eliminators with hinged access cover. Inlet velocity shall not exceed 500 FPM.

B. Evaporator coil upstream filter shall be:

1. 4" deep MERV 14

C. Energy recovery wheel return air filter shall be:

1. 2" deep MERV 8

D. Energy recovery wheel outside air filter shall be:

1. 2" deep MERV 8

2.05 DAMPERS

A. Unit shall include a motor operated outdoor air damper constructed of galvanized steel.

B. Damper blades shall be airfoil design with rubber edge seals designed not to exceed a 4 CFM/Sq.Ft. leakage rate exceeding ASHRAE 90.1 damper leakage requirements.

C. Damper linkage shall be located out of the airstream, and concealed within the damper frame to reduce air pressure and air noise.

D. Damper actuator shall be factory mounted and wired with sealed spring return. Damper actuator shall be two-position or fully modulating as required by sequence of operation.

E. Dampers air velocity shall not exceed 2000 FPM.

F. Return air damper shall be of same material, construction and leakage rate as outdoor air damper. Damper actuator shall be factory mounted and wired with sealed spring return. Damper actuator shall be two-position or fully modulating as required by sequence of operation.

2.06 COOLING AND DEHUMIDIFICATION

A. Compressors

1. All units shall have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps.
2. Provide digital scroll compressor for lead circuit.
3. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage.

    a. Internal overloads shall be provided with the scroll compressors.
    b. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
    c. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.
    d. Provide each unit with multiple hermetically sealed refrigerant circuits factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve. Refer to Drawings for required number of circuits.
    e. Provide each circuit with automatic reset high and low pressure switches for safety control.

B. Coils

1. Evaporator, condenser and hot gas reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins.
2. Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG.
3. The condenser coil shall have a fin designed for ease of cleaning.
4. Evaporator coil shall include six or four rows of cooling interlaced for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning. Refer to Drawings for required number of rows.
5. Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature.
6. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated BY a minimum of six inches.

C. Condenser Section

1. Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets.
2. Fans shall be statically and dynamically balanced.

D. Compressor Capacity Control

1. Electronic Control: Compressor output capacity shall be controlled by a 0-10V output signal from the units Main Control Module to the compressor.

2.07 POWER EXHAUST ASSEMBLY

A. Provide a factory installed power exhaust assembly.

B. Power exhaust shall be plenum direct drive airfoil design. Exhaust wheel material shall be heavy gauge aluminum, welded construction and rated for up to Class III speed/pressure performance. Factory install and wire fan motor to on-board Variable Frequency Drive.

C. Exhaust air damper shall be of same material, construction and leakage rate as outdoor air damper. Damper actuator shall be factory mounted and wired with sealed spring return. Damper actuator shall be two-position.

D. Exhaust to discharge through louvers located on each side of unit cabinet.

2.08 TOTAL ENERGY RECOVERY WHEEL

A. Composite Wheel

1. The rotating wheel heat exchanger shall be composed of a rotating cylinder in an insulated cassette frame complete with seals, drive motor, and drive belt. The total-energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be a lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity. The wheel shall rotate between the ventilation and exhaust air stream to pick up sensible and latent heat energy and release it into the colder air stream. The driving force behind the exchange shall be the difference in temperatures between the opposing air streams. Bypass dampers shall be provided on both the outside and exhaust air paths.

B. Aluminum Wheel

1. The rotor media shall be lightweight and made of aluminum. The rotor media shall be coated to prohibit corrosion; etched or oxidized surfaces are not acceptable. All surfaces shall be coated with a non-migrating adsorbent layer of desiccant prior to being formed into the honeycomb media structure to insure that all surfaces are coated and that adequate latent capacity is provided. The desiccant shall be designed for the adsorption of water vapor. The media shall be cleanable with low temperature steam, hot water or light detergent without degrading the latent recovery. Bypass dampers shall be provided on both the outside and exhaust air paths.

C. Sensible and latent recovery efficiencies shall be clearly documented through a testing program conducted in accordance with ASHRAE Standard 84 and AHRI 1060. The testing shall have been conducted by a qualified independent organization. The performance test reports shall be provided for engineering review as part of the submittals for this project.

D. The rotor design shall ensure laminar airflow to minimize parasitic pressure loss and to optimize the operating efficiency of the system fans. The pressure loss across the media shall be no greater than the scheduled pressure loss values. The energy wheel shall operate effectively up to 180 degrees F.

E. The wheel manufacturer must have been producing energy recovery wheels for a minimum of ten years.

F. The rotor shall be supplied with perimeter brush seals and face contact seals to minimize air leakage and wheel bypass.

G. The rotor media shall be supported by a structural aluminum hub and aluminum reinforcing spoke system. The rotor bearings must be greaseable and provide L10 life in excess of 20 years.

H. The cassette framework shall be made of galvanized steel to prevent corrosion.

I. The rotor must be driven by long-life polyurethane/polyester composite link belt system. The rotor/cassette shall be designed so that belt can be removed or serviced without the removal of the bearing. A 3-phase A/C gear motor shall be utilized to accommodate variable speed applications.

J. Variable speed control for frost prevention shall be accomplished by the use of a factory installed and wired A/C inverter. The variable speed drive system shall allow for a minimum 60:1 turndown ratio. Systems using electric preheat are acceptable provided the cost to increase unit overcurrent protection devices and branch circuit conductor sizes is borne by the Division 23 Contractor and carried in the base bid price.

K. Factory installed and wired sensors shall monitor energy recovery wheel leaving air temperatures on exhaust and supply sides.

2.09 ELECTRICAL

A. All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be a listed as touch-safe design.

B. Field wiring access to be provided thru unit base into isolated enclosure with removable cover.

C. Power wiring to be single point connection.

D. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.

E. Factory wired main disconnect switch and overcurrent device shall be rated for total unit connected power.

F. Factory wired phase monitor shall be included as standard.

G. Factory to mount and wire optional 120 volt convenience outlet. Field wiring of convenience outlet not acceptable.

H. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

2.10 CONTROLS

A. General: The rooftop unit shall be equipped with a packaged control system provided by the rooftop equipment manufacturer. The packaged control system shall include the following features:

1. Standalone microprocessor controller with BACnet interface for BAS connection.
2. All control devices mounted and wired except for remote mounted devices which are to be factory furnished and field installed.
3. BACnet communication protocol to end devices.
4. Clock and scheduling function for occupancy. Separate occupied and unoccupied setpoints.
5. Non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
6. Anti-cycle timing and minimum equipment run/off times.

B. Main unit controller shall be a microprocessor based controller with resident control logic. Controller program logic shall include:

1. Single program with field selectable

   a. Discharge air control with unit conditioning modes enabled based on outdoor air conditions and controlled to maintain discharge air setpoints.
   b. Space control with unit conditioning modes enabled and controlled to maintain space setpoints.

2. Single Zone Variable Air Volume (SZVAV) with unit conditioning modes enabled based on space temperature cooling setpoint and modulate supply fan to maintain setpoint. Cooling will be staged to maintain discharge air cooling setpoint. Heat will modulate to maintain space temperature with indoor fan held at maximum design airflow.

C. Main unit controller shall:

1. Prevent simultaneous operation of any conditioning modes.
2. Accept separate setpoints for occupied and unoccupied states.
3. Include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
4. Enable HGRH dehumidification and cooling modes and control modulation to maintain (discharge air temperature / space temperature).
5. Prevent low-ambient compressor operation via a user defined compressor lockout outdoor air temperature setpoint.
6. Include separate occupied and unoccupied setpoints.

D. Main unit controller shall include touch screen with full color display and shall be factory installed in unit control compartment and provide a full list of points included in the main unit controller. The display shall provide a list and history of all unit alarms.

E. Smoke detectors to sense return and discharge airstreams shall be factory installed and wired.

F. Refer to Control Diagrams on Drawings and Section 239750 for additional requirements.

2.11 SOUND AND VIBRATION ISOLATION ROOF CURB

A. Provide custom made acoustical roof curb to form a complete and matched rooftop system with the rooftop air conditioning unit.

B. Acceptable Manufacturers

1. Kinetics noise Control
2. Cambridgeport
3. Thybar Corp.
4. Novia Associates
5. Approved equal.

C. All rooftop air-handling units shall be supported by vibration isolation curbs as manufactured by Kinetics Noise Control. The vibration isolation curbs shall be complete assemblies designed to resiliently support the equipment at the specified elevation and shall constitute a fully enclosed air- and weather-tight system. The isolation curb shall consist of an upper structural steel support rail with supply and return flexible connector supports on which the equipment and duct openings rest and a lower support curb which is attached to the roof structure, separated by freestanding, unhoused, laterally stable steel springs and lateral seismic and/or wind load restraints. The upper support rail shall provide continuous structural steel support for the rooftop equipment and shall be designed to provide isolation against casing-radiated vibration in the rooftop equipment housing and structure borne vibration from rotating and mechanical equipment in the rooftop package.

D. The upper support rail shall consist of structural steel channel with a minimum height of 4" (121 mm) above the spring to preclude interference with the rooftop equipment and permit access to inspect, level, or change the springs after placement of the rooftop equipment.

E. The lower support curb shall be a formed channel fabricated of heavy gauge galvanized steel with a continuous 3-1/2" x 1-1/2" (89 mm x 38 mm) nominal wood nailer. The base plate of the curb shall be 1-1/2" (38 mm) wide and shall be welded, bolted or screwed to the building support steel. The lower support curb shall have a minimum elevation of 14" (356 mm). Spring components shall be (1"/25 mm) (2"/51 mm) deflection, freestanding, unhoused, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed for a typical 50% overload to solid. All springs shall have an epoxy-based, powder-coated finish and be color coded to indicate load capacity.

F. The vibration isolation curb shall be air and weather tight using an elastomeric seal, which is attached to the upper support frame with a galvanized steel clip. The seal shall extend down past the wood nailer of the lower support assembly and flash over the roof material at the wood nailer on the lower support curb. The seal shall be Class A, as tested in accordance with approved Underwriter's Laboratories, Inc., provisions. Metal or combination metal and elastomer seals are not permitted. Spring must be accessible without the need to penetrate or damage installed roof membrane or flashing.

G. Supply and return flexible connector support hardware shall be supplied for installation by the contractor in the field. The supports will be clearly marked and dimensioned on the submittal and installation drawings. The support hardware shall be cut-to-length; galvanized steel channels supported and connected with stamped and punched galvanized steel duct support hangers. The support hangers shall allow the duct support elevation to be equal to or lower than the equipment rail elevation. Supply and return air duct shall be flexibly attached by the contractor to prevent transmission of vibration to the building structure. The flex connectors shall be furnished by others.

H. The isolation curb assemblies shall be shipped to the job site fully assembled with the upper support rail, lower support curb, springs, stabilizers and duct supports completely assembled. Units exceeding freight limitations will be split and assembled in the field by others.

I. Vibration isolators shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.

J. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines for rooftop equipment support.

K. The curb shall be designed to provide an island pedestal support for an open (no base pan constructed) condensing section. Full perimeter supported condensing sections shall not be permitted. The condenser island support shall include a fixed element, spring isolated rail section and interfacing isolators.

L. The roof curb shall be constructed to include two (2) separate supply and return air plenums within the curb.

M. Noise blocking panels shall be fitted to the floor, top, and all four (4) sides of the curb's air plenums. (Kinetics Noiseblock™ Air Plenum).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and concrete pad and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support: Install roof curb on steel roof structure or concrete pad as indicated on Structural Drawings.

1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
2. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof installer.

C. Install sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

D. Install separate devices furnished by manufacturer and not factory installed.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

F. Install drain pipes from unit drain pans to discharge at roof. Provide condensate traps in drain pipes in accordance with manufacturer's recommendations.

1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L (ASTM B 88M, Type B), with soldered joints.
2. Pipe Size: Same size as condensate drain pan connection.

3.03 CONNECTIONS

A. Duct Connections:

1. Drawings indicate the general arrangement of ducts.
2. Connect ducts to units with hard connections.

B. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.04 STARTUP SERVICE

A. A factory-authorized service representative shall perform startup service and assistance with commissioning.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
3. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:

    a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
    b. Cooling coil entering-air, dry- and wet-bulb temperatures.
    c. Condenser coil entering-air dry-bulb temperature.
    d. Condenser coil leaving-air dry-bulb temperature.

4. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.

5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Clean coils and inspect for construction debris.
9. Inspect and adjust vibration isolators.
10. Verify bearing lubrication.
11. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Adjust fan belts to proper alignment and tension.
13. Start unit.
14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
15. Operate unit for run-in period.
16. Calibrate controls.
17. Inspect outdoor air dampers for proper stroke and interlock with return air dampers as applicable.
18. Verify operational sequence of controls.
19. Measure and record the following airflows. Plot fan volumes on fan curve.

a. Supply air volume.
b. Return air flow.
c. Outdoor air flow.
d. Exhaust air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION

SECTION 23 83 50

TERMINAL HEAT TRANSFER UNITS

(Mechanical Trade Bid)

PART 1 – GENERAL

1.01 WORK INCLUDES

A. Fin tube radiation.

B. Cabinet unit heaters.

C. Propeller unit heaters.

D. Radiant ceiling heating panels.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit shop drawings indicating cross section of cabinets, grille, bracing and reinforcing, and typical elevation.

C. Submit product data indicating typical catalog of information including arrangements.

D. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified heat required to actual heat output provided.

E. Submit schedules for radiant heat panels indicating lengths, number of pieces, corner pieces, panel stiffeners, splice pieces, and comparison of specified heat required to actual heat output provided.

F. Submit manufacturer's installation instructions.

G. Submit color charts of standard finishes to Architect. Architect will select finish color.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.05 REGULATORY REQUIREMENTS

A. Conform to NFPA 70 code for internal wiring of factory wired equipment.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - FIN TUBE RADIATION, CABINET UNIT HEATERS, PROPELLER UNIT HEATERS

A. Vulcan

B. Sterling

C. Trane

2.02 FINTUBE RADIATION

A. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins, one tube end belled, designed for 100 psi at 220 deg. F

B. Enclosure: Minimum 16-gauge steel, pencil-proof louvered openings, of the types as scheduled on the Drawings and complete with all accessories, including but not limited to corner pieces, end caps, and joint strips.

C. Access Doors: For otherwise inaccessible valves, provide factory made permanently hinged access doors, 6 × 7 inch minimum size, integral with cabinet.

D. Finish: Factory applied baked enamel finish of color as selected by the Architect.

E. Element Brackets: Minimum 16-gauge galvanized steel to support from panel and noise-free element cradle.

F. Capacity: As scheduled on drawings.

2.03 CABINET UNIT HEATERS

A. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 220 deg. F.

B. Cabinets: Cabinets shall be formed from 14-gauge cold-rolled steel and shall be suitably braced and reinforced where necessary to provide stiffness, and accurately fitted to prevent air leakage. Adequate work area for installation of control valves or electrical equipment shall be provided on both sides of the cabinet. The motor/fan support shall be provided with a mid-length support gusset to ensure quite operation. All cabinets shall be supplied with adjustable rear mounting brackets which shall provide adjustment to correct alignment of the unit at installation to non-square or out-of-true walls, joists, studs or surfaces. All cabinets shall be supplied with a continuous hinged front panel. The continuous hinge shall provide full swing through 90 degrees. A safety chain shall be provided as standard to prevent the face panel from swinging full open accidentally. This chain must be easily detached to allow full access for servicing.

C. Finish: Factory-applied baked enamel finish of color as selected by the Architect.

D. Filters: All filters supplied for cabinet unit heaters shall be 1-inch thick glass fiber throw-away type.

E. Fans: Fan wheels shall be centrifugal, forward curved, double-width of electro-galvaneal steel. Fan housings shall be of formed galvanized sheet metal.

F. Motors: All motors shall have integral thermal overload protection. All electric motors shall comply with Section 23 17 00.

G. Control: Multiple speed switch with disconnect, factory-wired, located in cabinet. Automatic controls under Section 23 97 50.

H. Mounting: Units shall be of the mounting configurations as scheduled on the drawings.

I. Capacity: As scheduled on the drawings.

2.04 PROPELLER UNIT HEATERS

A. Coils: Seamless copper tubing, 0.025-inch minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing, designed for 100 psi at 220 deg. F.

B. Cabinets: 18-gauge steel with threaded pipe connections for hanger rods.

C. Finish: Factory applied baked primer coat. Factory baked enamel finish of color selected by the Architect for finished areas.

D. Fans: Direct-drive propeller-type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

E. Air Outlet: Adjustable pattern diffuser on projection models and four-way louvers on horizontal throw models.

F. Motors: All motors shall have integral thermal overload protection. All electric motors shall comply with Section 23 17 00.

G. Control: Factory wire disconnect switch.

H. Mounting: Units shall be of the mounting configurations as scheduled on the drawings.

I. Capacity: As scheduled on the drawings.

2.05 RADIANT CEILING HEATING PANELS

A. Provide radiant heat panel systems constructed of linear extruded aluminum ceiling panels of dimensions and heating capacity as indicated on Drawings.

B. Extruded aluminum panels shall have an overall thickness of 0.1 inches with 1/2-inch copper tubes inserted into "U" shaped channels at the back of the extrusions.

C. Provide required piping configuration, trim pieces, and splice hardware for completely operational systems and finished appearance.

D. Provide insulation for installation on top of panels.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that required utilities are available, in proper location, and ready for use.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Locate fin tube radiation as indicated on the drawings and run cover continuously wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install end caps where units butt against walls.

C. Installation of access doors in fin tube radiation must allow for full operation and maintenance of all recessed valves.

D. Install cabinet unit heaters as indicated. Coordinate to assure correct recess size for recessed units.

E. Install propeller unit heaters as indicated and suspend with threaded rods from building structure. Do not hang from piping. Mount as high as possible to maintain greatest head room unless otherwise indicated.

F. Protect units with protective covers during balance of construction.

3.03 INSTALLATION - RADIANT CEILING HEATING PANELS

A. Panels shall be provided of length required for wall-to-wall installation. Follow manufacturer's instructions for required field cuts and panel alterations.

B. Make accommodations to allow for panel expansion. Coordinate with ceiling system installer. Connect panels to fixed piping system with 18" long flexible connectors with screwed connections.

C. Use soft cotton gloves when handling panels or follow manufacturer's recommendations to prevent damage to finish.

D. Provide 12-gauge suspension wires to support panels directly to structure.

E. Join series connected panels with Type "L" tubing formed into a horseshoe configuration per manufacturer.

F. Provide minimum 1-1/2 inch thick fiberglass insulation on top of all radiant panels per manufacturer's recommendation.

3.04 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. After construction is completed, install new throw-away filters in all cabinet unit heaters.

END OF SECTION

SECTION 23 86 00

IN-LINE EXHAUST FANS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Inline centrifugal fans.

B. Ceiling cabinet fans.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Provide product data on centrifugal fans and accessories as required for the work.

C. Provide fan curves with specified operating point clearly plotted.

D. Submit sound power levels for both fan inlet and outlet at rated capacity.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Greenheck

B. Loren Cook

C. Penn

2.02 IN-LINE SQUARE CENTRIFUGAL FANS

A. Square centrifugal in-line blowers shall be of the belt-driven type, as indicated on the Drawings. The blower housing shall be of the square design and constructed of heavy-gauge steel. All steel components shall be painted with enamel primer and a coat of gray enamel.

B. Access doors shall be provided and shall be located on any side with the exception of the motor side, allowing wheel, bearings, shaft, and drive components to be serviced or removed without disturbing the ductwork connections.

C. Square centrifugal in-line blowers shall have all aluminum centrifugal blower type wheels, featuring non-overloading backward inclined blades and a tapered inlet shroud. Wheels shall be statically and dynamically balanced.

D. The motor and drives shall be isolated from the airstream.

E. Motors shall be heavy-duty, permanently lubricated, sealed ball bearing type. Motors shall comply with Section 23 17 00.

F. Bearings shall be permanently sealed pillow block type. Bearings shall be selected for a minimum of 200,000 hours life at maximum cataloged operating speed.

G. Fan shafts shall be ground the polished steel.

H. For belt-driven fans, motor drives shall be variable pitch through 5 horsepower. Oil-resistant non-static belts shall be provided. Drives shall be sized for 165% of motor horsepower.

I. Centrifugal in-line blowers shall be licensed to bear the AMCA seal for both air and sound.

J. Units shall be supplied with unit-mounted disconnect switches.

2.03 CEILING CABINET FANS

A. Ceiling ventilators shall be direct-drive, forward-curved, centrifugal blower type. Fan wheels shall be constructed of galvanized steel and shall be dynamically balanced. Housings shall be constructed of galvanized steel and acoustically insulated for quiet operation. Integral aluminum backdraft dampers shall be standard.

B. Blower and motor assemblies shall be easily removable from housings without disturbing the ductwork.

C. Motors shall be permanently lubricated with built-in thermal overload protection and shall be factory tested prior to shipment. Motors shall comply with Section 23 17 00.

D. Units shall be supplied with an internal wiring box, disconnect receptacle, and solid-state speed controller.

E. Discharge positions shall be adjustable by moving interchangeable panels supplied with removable fasteners.

F. Ceiling ventilators shall be furnished standard with a powder-painted white steel grille.

G. Ceiling ventilators shall be certified and licensed to bear the AMCA seal for air and sound performance.

2.04 SPARE PARTS

A. Belts: Provide one new set of belts for each fan furnished under this Contract.

B. Mark each assembly with associated fan number.

C. Hang the spare belts on a Contractor-furnished device where indicated by Owner.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Install all fans in accordance with manufacturer's instructions.

C. Install all in-line fans with vibration isolators and flexible electrical leads.

D. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

END OF SECTION

SECTION 23 86 10

LAB EXHAUST FANS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Power ventilators for lab exhaust systems.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Provide product data on centrifugal fans and accessories as required for the work.

C. Provide fan curves with specified operating point clearly plotted and submit sound power levels for both fan inlet and outlet at rated capacity.

D. Provide nozzle velocity of exhaust fan, total exhaust flow, and discharge plume height at specified wind velocity.

E. Submit sound data.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with AMCA 211 and 311 in an AMCA accredited laboratory and licensed to bear the AMCA Certified Ratings Seal for sound and air performance.

B. Classification for Spark Resistant Construction Conform to AMCA 99.

C. Each fan shall be vibration tested at the factory before shipping.

1.06 EXTRA STOCK

A. Belts: Provide one new set of belts for each fan furnished under this Contract.

B. Hang spare belts on Contractor provided device at location as directed by Owner and mark assembly to identify associated fan number.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Greenheck, Model Vektor-H.

2.02 GENERAL DESCRIPTION

A. Base fan performance at standard conditions.

B. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.

C. Fans shall be belt driven.

D. Fans to be equipped with lifting lugs.

E. Fans to be coated steel with a minimum of 4 mils of Hi-Pro Polyester Resin.

F. Fasteners to be stainless steel.

G. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guide wires.

2.03 FAN HOUSING AND OUTLET

A. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.

B. Fan housing shall be welded steel with a minimum of 4 mils of Hi-Pro Polyester Resin. No uncoated metal fan parts shall be acceptable.

C. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.

D. Provide housing drain for removal of rain and condensation.

E. A bolted and gasketed access door shall be supplied in the fan housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.

F. Standard finish color to be gray.

2.04 FAN IMPELLER

A. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.

B. Fan impeller shall be manufactured of aluminum (AMCA class B spark resistant), fully welded and coated with a minimum of 4 mils of Hi-Pro Polyester resin.

2.05 FAN MOTORS AND DRIVE

A. Motors to be premium efficiency, standard NEMA frame, TEFC with a 1.15 service factor. A factory mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.

B. Drive belts and sheaves shall be sized for 150% of the motor horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.

C. Shaft to be polished and ground steel.

D. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.

E. Bearings shall have extended lube lines with Zerk fittings.

2.06 ROOF CURBS

A. Furnish exhaust fans with factory furnished roof curbs for flat or sloped roofs as appropriate. Curbs shall have continuously welded seams, 1-inch insulation, and curb bottom. See drawing schedules for curb height requirements.

B. Furnish 5/8" thick foam rubber gasket for installation between fan and roof curb.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Do not operate fans for any purpose until ductwork is clean, bearings lubricated, and fan has been test run under observation.

B. Install fans in accordance with manufacturer's instructions. Install with flexible electrical leads.

C. Pipe housing drain to nearest drain.

D. Secure fans to curbs with lag screws.

END OF SECTION

SECTION 23 87 00

ROOF-MOUNTED EXHAUST FANS

(Mechanical Trade Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Centrifugal roof exhaust fans.

B. Roof curbs.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Provide product data on roof exhaust fans and accessories.

C. Provide fan curves with specified operating point clearly plotted.

D. Submit sound power levels for both fan inlet and outlet at rated capacity.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - CENTRIFUGAL ROOF EXHAUST FANS

A. Greenheck

B. Loren Cook

C. Penn Ventilation/Barry Blower

2.02 CENTRIFUGAL ROOF EXHAUST FANS

A. Centrifugal roof exhaust fans shall be belt-driven type, downblast or upblast as indicated on the Drawings.

B. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

C. Fan housing shall be constructed of heavy-gauge aluminum with a rigid internal support structure. The fan shroud shall have a rolled bead for added strength.

D. Motors shall be heavy-duty ball bearing type. All electric motors shall comply with Section 23 17 00.

E. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy-gauge steel and mounted on vibration isolators.

F. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.

G. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A fan conduit chase shall be provided through the curb cap to the motor compartment for ease of installation.

H. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.

I. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

J. Backdraft dampers shall be gravity activated aluminum multiple-blade construction, felt edged with nylon bearings.

2.03 ROOF CURBS

A. Furnish exhaust fans with factory furnished 18-inch high roof curbs for flat or sloped roofs as appropriate. Curbs shall have continuously welded seams, 1-inch insulation, and curb bottom.

B. Furnish 5/8" thick foam rubber gasket for installation between fan and roof curb.

2.04 SPARE PARTS

A. Belts: Provide one new set of belts for each fan furnished under this Contract.

B. Mark each assembly with associated fan number.

C. Hang spare belts on a Contractor-furnished device where indicated by Owner.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with lag screws to roof curb.

END OF SECTION

SECTION 23 89 00

DUCTWORK

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. HVAC ductwork.

B. Roof exposed exterior ductwork.

C. Grease ductwork.

D. Duct cleaning.

E. Double-wall ductwork.

F. Duct leakage testing.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REFERENCES

A. Material, construction, and installation shall meet requirements of most recent editions of the following standards and references, except where more stringent requirements are specified or indicated on the Drawings.

1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
2. SMACNA - HVAC Duct Construction Standards.
3. SMACNA - HVAC Duct Leakage Test Manual.
4. SMACNA - Guidelines for Welding Sheetmetal
5. SMACNA - Duct Cleanliness for New Construction Guidelines (Latest Edition).
6. SMACNA - Guidelines on Through-Penetration Fire-Stopping (Latest Edition).
7. SMACNA - Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems (Latest Editions).

1.04 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Indicate duct fittings, types, and particulars such as gauges, sizes, welds, and configuration prior to start of work.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.

B. Steel Ducts: Fabricate with a minimum ASTM A653 Coating Designation "G60" zinc-coated (galvanized) steel sheet, of lock-forming quality. Steel sheet zinc coating shall be a minimum of 0.60 oz. per sq. ft. total both sides, per Triple-Spot Test. Steel sheet shall be in accordance with ASTM A568 and/or ASTM A924. Testing shall be per ASTM A90.

C. Aluminum Ducts: AWSI/ASTM B208; aluminum sheet, alloy 3003-H14. Aluminum connectors and bar stock; alloy 6016-T6 or equivalent strength.

D. Flexible Ducts: Triple interlocking spiral of galvanized steel or aluminum construction; rated to 2 inches WG positive and 1.5 inches WG negative for low pressure ducts.

1. Buckely Associates, Inc. "Flexmaster" Triple Lock "Buck Duct" flexible ducting.

E. Insulated Flexible Ducts:

1. Flexible duct as indicated above wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 deg. F (0.034 KSI at 24 deg. C). Buckley Model BDA, acoustic flexible duct or equivalent.

F. Fasteners: Rivets, bolts, or sheet metal screws.

G. Sealant: As appropriate for the application, UL 21S3 listed, water-based duct adhesive and/or sealant, which is non-flammable and fire retardant; solvent free so as to release no harmful vapors or fumes (e.g. "low V.O.C.); antimicrobial and antibacterial agents which remain effective after curing. Suitable for operating temperatures from -25 deg. F to +200 deg. F; and tested to meet SMACNA leakage requirements with tests from -40" w.c. to +40" w.c.

1. Flanged transverse joints: McGill AirSeal Corp. "United Duct Sealer" or "Uni-Flex" water based sealant, or approved equal.
2. Non-flanged transverse joints: McGill AirSeal Corp. "United Duct Sealer" or "Uni-Flex" water based sealant, or approved equal.
3. Engineer approved equal water-based sealers as manufactured by Hardcast, DuctMate, GE. Silicones, 3-M Worldwide and GeoCel may be provided.
4. ALL duct sealants and adhesives MUST comply with USGBC LEED indoor air quality requirements, and must specifically state such in the manufacturer's literature.

   a. In order to comply with USGBC LEED indoor air quality requirements, sealants must be consistent with the requirements of south Coast Air Quality Management District.

H. Hanger Rods: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

I. Hanger Cable:

1. Load rated cable suspension system similar to the Gripple Hang-Fast system, as manufactured by Gripple Incorporated. Suspension system shall have a specified manufacturer’s Safe Working Load (SWL) and supplementary safety factor of at least five times the SWL.
2. Suspension system shall be verified by SMACNA Testing and Research Institute to be in compliance with SMACNA Duct Construction Standards guidelines.

3. Suspension system shall consist of Grade AISI 316 zinc galvanized BS 302 cable; slip-on locking fasteners, with cast zinc housing and spring-loaded locking wedges; insertion type anchors; saddles; clips; decorative fastener covers; and other manufacturer supplied miscellaneous hardware.

2.02 HVAC DUCTWORK

A. Fabricate, install, and support in accordance with SMACNA HVAC Duct Construction Standards and other referenced standards, except if more stringent requirements are specified or indicated on the Drawings.

1. The Duct Cleanliness Level appropriate for this project shall be the “Advanced Level” as defined and described in the SMACNA - Duct Cleanliness for New Construction Guidelines.
2. All ductwork for this project shall be fabricated, transported, stored, handled, installed, and protected in accordance with the recommendations and requirements set forth in the SMACNA Duct Cleanliness for New Construction Guidelines.
3. During construction (including transportation and storage) provide temporary metal, taped polyethylene or “shrink-wrapped” closures on ALL open ductwork to prevent or minimize construction dust from entering ductwork system. Remove and provide new temporary closures as duct installation progresses. At the completion of construction and prior to system start-up, verify all temporary closures have been removed.
4. The Mechanical and Sheet-metal Contractors shall be responsible to ensure that every effort is made to maintain cleanliness throughout each air handling system.

    a. Do not allow ductwork and duct system components to be exposed to water, dirt, sprays, or other detrimental environmental conditions.

B. **Fabricate ductwork for the maximum external static pressures indicated on the Drawing schedules associated with the system.** For each ductwork system, provide duct materials, sheet-metal gauges, cross-breaking and reinforcing, etc., as appropriate to withstand the positive and/or negative static pressures the system fan(s) could generate.

1. As a minimum, all supply air ductwork upstream of supply VAV and CAV boxes (i.e., ductwork between the main air handling unit supply fan outlet and the air terminal unit inlets) shall have a minimum basis of compliance of +3" W.G. (positive) pressure class.
2. As a minimum, all return air ductwork associated with the main air handling unit shall have a minimum basis of compliance of -3" W.G. (negative) pressure class.
3. All other supply air ductwork (i.e., downstream of the air terminal outlet) shall have a minimum basis of compliance of +2" W.G. (positive) pressure class.
4. All outside air ductwork shall have a minimum basis of compliance of 2" W.G. pressure class (positive or negative depending on relationship to system fans).
5. All relief or general exhaust air ductwork shall have a minimum basis of compliance of 2" W.G. pressure class (positive or negative depending on relationship to system fans).
6. Unless specified otherwise, or as more stringent standards dictate, all kitchen and dishwasher exhaust ductwork shall have a minimum basis of compliance of -3" W.G. (negative) pressure class.

C. As a minimum, **SEAL ALL TRANSVERSE JOINTS AND LONGITUDINAL SEAMS** (except continuously welded joints and gasketed jointing systems) in all ductwork in accordance with Seal Class B as defined in the SMACNA HVAC Duct Construction Standards, and seal additional joints and seams based on pressure classification as recommended by SMACNA HVAC Duct Construction Standards.

1. Completely seal all joints, seams, fittings, connections, flanges, take-offs, etc. If the use of variable angle (adjustable) gore elbows is allowed, seal all joints and seams in these fittings.

2. Do not allow ductwork to be insulated until duct sealing is complete and ductwork has been inspected and/or leakage tested.
3. Duct systems shall be fabricated, installed and sealed to limit leakage in medium-pressure systems (e.g., ductwork between the supply fan and air terminal box inlet) to less than 1%. Low-pressure duct systems (e.g., ductwork downstream of air terminal boxes) shall be fabricated, installed and sealed to limit leakage to less than 5%.

D. Size round ducts installed in place of rectangular ducts in accordance with SMACNA table of equivalent rectangular and round ducts. No variation of duct configuration or sizes is permitted except by written permission from the Architect.

E. Fittings:

1. Construct all elbows, offsets, "tees", bends, turns, etc., with full radius inside (throat) and full radius outside (heel) duct wall. Inside and outside radii shall correspond to a fitting centerline radius of 1-1/2 times the width of the duct.
2. For instances where a fitting centerline radius of 1-1/2 times the width of the duct cannot be installed, a fitting centerline radius equal to the width of the duct (1 times duct width), <u>may</u> be permitted. Fittings with a centerline radius less than the width of the duct (<1 times duct width) shall not be permitted.
3. For duct systems with velocities greater than 1,200 feet per minute (e.g., medium and high pressure systems), radius fittings with a centerline radius less than 1-1/2 times the width of the duct shall be provided with full length splitter vanes. The number and spacing of splitter vanes shall be according to SMACNA design standards and ASHRAE recommended practices. Splitter vanes shall be fully welded in place. The Engineer's approval of the splitter vane design is required prior to fabrication.
4. For instances where short radius fittings cannot be installed, rectangular mitered fittings <u>may</u> be permitted, provided single thickness turning vanes are installed. Turning vanes shall be continuously welded into supporting tracks. Turning vanes shall be of extra heavy gauge and include peened edges for stiffness and to prevent vibration and “flutter”. Turning vane supporting tracks shall be secured in fittings with sheet-metal screws or rivets for ducts with pressure classifications less than 2" W.G. For ducts with pressure classifications of 2" W.G. or greater, turning vane supporting tracks shall be welded into the fittings. Turning vanes shall be installed such that the leading and trailing edges of the vanes are plumb and parallel to the air-stream for all fittings.
5. **Fittings with radius outside (heel) and square inside (throat) duct wall shall not be accepted. Mitered fittings without turning vanes shall not be accepted.**
6. The use of variable (adjustable) angle, gored elbows is not acceptable on systems with duct velocities greater than 1,200 feet per minute (e.g., medium and high pressure systems). Elbows and fittings shall be fabricated for the job specific application and installation requirements (installed conditions).
7. The use of variable (adjustable) angle, gored elbows is not desired on systems with duct velocities less than or equal to 1,200 feet per minute (e.g., low pressure systems). However, if certain or particular job conditions require the use of variable (adjustable) angle, gored elbows in such systems, **they must be properly secured and sealed** (sealing each gore), and they shall not be adjusted or configured in such a manner as to exceed the offset and divergence limits described elsewhere in this section.

F. Branch takeoffs shall be flange-mounted 45-degree lateral wye, conical tee, or bell-mouth, “mini” bell-mouth, or square-to-round dovetail type. Other takeoff types shall not be used except by written permission from the Architect.

1. Spin-in take-offs are not acceptable.
2. “Cut-and-tabbed over” connections are not acceptable.
3. “Straight-taps” are not acceptable.

4. All branch take-offs shall be sealed with appropriate gasket and/or sealant for an air-tight connection.

G. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. For duct pressure classification less than 2" W.G., divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees. For duct pressure classifications over 2" W.G., divergence upstream of equipment shall not exceed 15 degrees; convergence downstream shall not exceed 45 degrees.

H. Do not use ductwork easements without written permission from the Architect.

I. All round ductwork shall be of spiral lock-seam or continuous longitudinally welded construction with slip joint connections. **Round longitudinal snap-lock ductwork is not acceptable** (except as noted below). Refer to paragraph 2.3 for additional requirements.

1. For low pressure systems with pressure ratings between -1” w.c. and +2” w.c., Ductmate “Green Seam Plus” self-sealing snap-lock ductwork (or equal) may be used. Otherwise, snap-lock ductwork shall not be used.

J. Welded seams and joints shall be ground smooth and clean. After grinding and cleaning, weld joints shall be painted with corrosion inhibiting paint (e.g., zinc primer, or similar).

K. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws and/or draw-bands. Flexible ductwork shall not be used in exposed areas.

L. Use crimp joints with or without bead for joining round duct sizes 8-inch and smaller with crimp in direction of air flow.

M. Rectangular longitudinal lock seams shall be Pittsburgh style and/or double-locked and flattened, with flanged connections, for tight joints. Rectangular longitudinal snap-lock ductwork is not acceptable. All longitudinal seams shall be fully sealed.

N. Make transverse joints, field connections, collar attachments, and flexible connection to ducts and equipment with sheet-metal screws or bolts and nuts. Do not use rivets and staples.

O. Transverse joints shall be slip joint construction, except as described elsewhere in this section, and/or required by SMACNA according to the pressure and leakage classes.

P. Except for duct 16-gauge and heavier, and duct 23-gauge or lighter, transverse joints in galvanized sheet-metal ductwork may be made with prefabricated galvanized gasketed frame and angle duct joint system by Ductmate, TDF, or TDC. Angles shall be at least 20-gauge. Secure angles to duct with screws or spot welds spaced as recommended by the joint manufacturer for the particular duct pressure class.

Q. Use double nuts and lock washers on threaded rod supports.

R. Fabricate sheet-metal plenums with standing seams not exceeding 21" centers. Provide reinforced plenums with threaded rod, angle and/or channel as required by SMACNA, and as necessary to resist "oil-canning" and vibration.

S. Reinforce rectangular ductwork with cross-breaks and/or standing seams as per SMACNA recommendations. Provide corrugations in round ductwork as required to reinforce ductwork according to SMACNA recommendations. Additional reinforcement shall be via internal threaded rod in conduit as per SMACNA recommendations.

T. Ductwork exposed to view shall have a clean, bright finish, and shall be free of labels, markings, oil, residues, and other surface treatment resulting from the manufacturing process. Materials and material handling processes shall not diminish the finished appearance of the bare sheet-metal. Rolling and cutting oils shall be thoroughly cleaned from the surface of the metal.

U. Ductwork exposed to view shall NOT be sealed with externally applied duct sealant. Ductwork exposed to view shall be internally sealed, and/or fabricated and installed in such a manner (e.g., gasketed joints) as not to need externally applied duct sealant.

1. If external duct sealant must be applied to exposed ductwork it must be clear HVAC-grade silicone applied after exposed ductwork has been painted.

2.03 ROUND DUCTWORK

A. All round supply, return and exhaust ductwork shall be SPIRO-SAFE® as manufactured by Lindab, Inc., or equivalent by EHG Duct (Div. of E.H. Gustafson & Co.), or McGill Air Flow Inc., or “The Edge” System as manufactured by NorthEastern Sheet Metal Inc.

B. The duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer.

1. Ductwork intended to convey potentially corrosive exhaust MUST BE fabricated and assembled in a suitable manner for the service; this includes, but is not limited to, materials, gaskets, fasteners, sealants, etc. The ductwork manufacturer must provide documentation and demonstration that the system components provided are specifically suitable for corrosive exhaust applications. Manufacturers, who cannot provide this certification and demonstrate to the Owner and Engineer the appropriateness of their system for corrosive air streams, shall not be acceptable for use on corrosive exhaust systems.
2. Ductwork intended to convey potentially corrosive exhaust shall be longitudinally welded; spiral duct is not acceptable for corrosive exhaust systems.

C. Unless otherwise noted, all duct and fittings shall be constructed per SMACNA's Duct Construction Standards (+10 in W.G.) shown in the following table.

Diameter (inches)	Spiral Duct	Fittings
3 - 14	26 GA.	24 GA.
16 - 26	24 GA.	22 GA.
28 - 36	22 GA.	20 GA.
38 - 50	20 GA.	20 GA.

D. Fittings:

1. All fitting ends shall come factory equipped with a double-lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
2. All fitting ends shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.

3. All fitting ends from 3" to 24" diameter shall have rolled over edges for added strength and rigidity.
4. All elbows from 3" to 12" diameter shall be two-piece, die-stamped, and continuously stitch welded. All elbows 14" diameter and larger shall be standing seam gorelock construction and internally sealed.
5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0 times the elbow diameter. The radius of all 15°, 30°, and 60° elbows shall be 1.0 times the elbow diameter.
6. All fittings that are of either spot-welded or button-punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.
7. All volume dampers shall be SPIRO-SAFE Type DRU, DSU or DTU or approved equal. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:

    a. Locking quadrant with blade position indicator.
    b. 2" sheet-metal insulation stand-off.
    c. Integral shaft/blade assembly.
    d. Shaft-mounted, load bearing bushings.
    e. Gasketed shaft penetrations to minimize leakage.

8. All branch take-offs shall be sealed with appropriate gasket and/or sealant for an air-tight connection.

E. Spiral Duct:

1. Spiral duct shall be calibrated to manufacturer's published dimensional tolerance standard.
2. All spiral duct 14" diameter and larger shall be corrugated for added strength and rigidity.
3. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.
4. It is intended that ALL round ductwork shall be of spiral lock-seam, or continuous longitudinally welded seam, construction with slip joint connections. **Round longitudinal snap-lock ductwork is not acceptable** (except as noted below).

    a. For low pressure systems with pressure ratings between -1” w.c. and +2” w.c., Ductmate “Green Seam Plus” self-sealing snap-lock ductwork (or equal) may be used. Otherwise, snap-lock ductwork shall not be used.

F. Performance:

1. Duct system performance shall meet SMACNA's Leakage Class 3 requirements at the system design static pressure as indicated on the contract documents not to exceed -20 in W.G. or +12 in W.G.

G. Ductwork exposed to view shall have a clean, bright finish, and shall be free of labels, markings, oil, residues, and other surface treatment resulting from the manufacturing process. Materials and material handling processes shall not diminish the finished appearance of the bare sheet-metal. Rolling and cutting oils shall be thoroughly cleaned from the surface of the metal.

1. As required by the Architect’s specifications, ductwork exposed to view shall be fabricated, installed and cleaned, ready for finish painting. As necessary, ductwork shall be cleaned and treated (e.g., etched, “pickled”, or otherwise prepared) as necessary to ensure proper paint adhesion.

H. Ductwork exposed to view shall NOT be sealed with externally applied duct sealant. Ductwork exposed to view shall be internally sealed, and/or fabricated and installed in such a manner (e.g., gasketed joints) as not to need externally applied duct sealant.

1. If external duct sealant must be applied to exposed ductwork it must be clear HVAC-grade silicone applied after exposed ductwork has been painted.

2.04 ACCEPTABLE MANUFACTURERS - EXPOSED EXTERIOR DUCTWORK

A. United McGill (Longitudinal Seam K-27)

B. The Edge

C. Northeastern Sheetmetal

D. EGH Duct

2.05 EXPOSED EXTERIOR DUCTWORK

A. Double-wall, flat, oval duct and fittings with 20-gauge galvanized steel outer shell, 3" thick fiberglass insulation with mylar face, galvanized steel, perforated inner liner and butt welded longitudinal seam.

B. Transverse connections shall be with galvanized angle rings. Provide a galvanized vertical flashing at the brick wall penetration to provide a watertight seal.

2.06 ACCEPTABLE MANUFACTURERS - DOUBLE-WALL DUCTWORK

A. Northeastern Sheetmetal

B. United McGill (Rectangular K-27, Acousti K-27)

C. Lindab

2.07 DOUBLE-WALL DUCTWORK

A. Double-wall ductwork and fittings basis of design shall be factory manufactured by Northeastern Sheetmetal (Goffstown, NH). All Alternate substitutions must provide sample product based on double wall ductwork detail in construction documents for approval.

1. Rectangular, double-wall ductwork and fittings shall be galvanized steel outer shell with 1-1/2” thick fiberglass acoustic insulation (anti-microbial; k = 0.24) and galvanized steel perforated rectangular duct liner. Duct and fittings shall be fabricated with galvanized gasketed frame and angle duct joint system.

   a. Where noted on the Drawings, and as appropriate for the application, provide solid inner lining, in lieu of specified perforated liner.

2. Round double-wall ductwork and fittings shall be galvanized steel outer shell with 1-1/2” thick fiberglass acoustic insulation (anti-microbial; k = 0.24) and galvanized steel perforated round duct liner. Duct shall be fabricated of spiral round sheet metal with lock seam construction.

   a. Where noted on the Drawings, and as appropriate for the application, provide solid inner lining, in lieu of specified perforated liner.

3. Fabricate ductwork and fittings in accordance with SMACNA, HVAC Duct Construction Standards, except as indicated otherwise. Fabricate for 3-inch WG pressure class (minimum).
4. Connections to and/or penetrations through the double wall construction and sandwiched insulation shall be such that insulation is enclosed or contained, with no rough or exposed edges, and the perforated sheet-metal liner has no sharp edges. Fold perforated metal liner to enclose insulation on all sides and/or provide metal nosing to contain cut edges of insulation. No edges of internal duct insulation shall be exposed to the air stream. All edges of perforated metal liner shall be folded and/or radiused.

2.08 GREASE DUCTWORK

A. Fabricate in accordance with SMACNA, HVAC Construction Standards and NFPA 96.

B. Construct of 16-gauge carbon steel or 18-guage stainless steel, using continuous external welded joints.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All ductwork for this project shall be fabricated, transported, stored, handled, installed, and protected in accordance with the recommendations and requirements set forth in the SMACNA Duct Cleanliness for New Construction Guidelines.

1. The Duct Cleanliness Level appropriate for this project shall be the “Advanced Level” as defined and described in the referenced SMACNA guidelines.
2. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent or minimize construction dust from entering ductwork system. Remove and provide new temporary closures as duct installation progresses. At the completion of construction and prior to system start-up, verify all temporary closures have been removed.

B. Provide openings in ductwork where required to accommodate thermometers and controllers. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

C. Ductwork shall be sealed in accordance with Seal Class A as defined in the SMACNA HVAC Duct Construction Standards.

D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

E. Connections to the inlet and outlet of VAV and CAV boxes shall <u>not</u> be by flexible duct.

F. Connect ductwork to supply diffusers as indicated on the Drawings.

G. Connect ductwork to return and exhaust registers and grilles with five (5) feet maximum flexible duct. Flexible duct runs shall be taut and shall have no changes in direction greater than 15 degrees. If necessary to prevent changes in direction greater than 15-degree hard duct elbows must be used to connect ductwork return and exhaust registers.

H. For double-wall ductwork, install in accordance with manufacturer’s instructions.

I. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent or minimize construction dust from entering ductwork system.

J. Fabricate duct plenums with standing seams not exceeding 21" centers. Reinforce plenums with steel angle or channel and/or tie rods as required to prevent “oil canning”. Fabricate in accordance with SMACNA recommendations, except the minimum sheet metal gauge for plenums shall be 20-gauge. Seal plenums air- and water-tight. Pitch plenum bottoms to louvers for drainage or cross-break plenum bottoms and pitch to drain pipe fitting.

K. Ductwork Application Schedule:

AIR SYSTEM	MATERIAL
Supply and Return	Galvanized Steel

AIR SYSTEM	MATERIAL
Roof Exposed Supply & Return	Galvanized Steel, Double-Wall (perforated inner wall)
General Exhaust and Relief	Galvanized Steel
Fume Hood Exhaust	18-gauge Stainless Steel with Welded Joints
Locker and Shower Room Exhaust	Aluminum
Grease Ductwork	16-gauge Carbon Steel or 18-gauge Stainless Steel with Welded Joints
Dishwasher Exhaust	18-gauge Stainless Steel with Welded Joints
Dryer Exhaust	Stainless Steel

3.02 ADJUSTING AND CLEANING

A. Protect ductwork in accordance with paragraph 3.01.A from dust, dirt, water, moisture, over-sprays, construction traffic, damage, and other actions or materials that may adversely affect the quality of the installation and the building's air quality after occupancy. Ductwork which becomes soiled or wet will be considered unacceptable, and will be required to be cleaned, or replaced.

B. Where necessary, clean duct system and force air at high velocity through duct to remove any accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

C. Where necessary, clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

D. The Architect reserves the right to require full cleaning of all interior ductwork surfaces as part of this contract. It is imperative that construction dust entering the ductwork system be prevented or minimized at all times.

3.03 DUCT LEAKAGE TESTING

A. Provide selective duct leakage testing of new ductwork provided as part of this contract.

1. Per Energy Code (and/or ASHRAE Standard 90.1) requirements, duct systems (comfort air conditioning systems) designed to operate at static pressures equal to or greater than 3" w.g. are required to be leakage tested.
2. Per the requirements of the Code, a minimum of 25% of the duct area of each supply return air system is to be tested.
3. As required, by the Code, testing shall be performed in accordance with applicable SMACNA standards, and leakage shall be less than or equal to the maximum allowable leakage described in those standards.

B. All ductwork associated with smoke evacuation systems shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test manual to 1.5 times the maximum design pressure with a leakage rate not to exceed 5% of design flow.

C. It is imperative that all effort is made to fabricate and install ductwork in such a manner as to minimize duct leakage. If any new HVAC System demonstrates inadequate performance, and this performance is potentially attributed to excessive duct leakage, the Architect will require additional duct leakage testing.

D. Duct leakage testing shall be provided at no additional cost to the Owner.

E. Duct leakage testing shall be performed by an independent testing agency, In accordance with recognized procedures and standards published by SMACNA, ASHRAE, AABC, NEBB, etc.

F. The Mechanical Contractor, in conjunction with the Leakage Testing Agency, shall provide all materials, labor, equipment, tools, etc., necessary to perform the required tests. This includes isolating equipment, providing temporary caps, making duct connections, wiring fans, etc., as required by the test procedures.

G. In accordance with the recognized procedures and standards, leakage test reports shall be submitted to the Architect for review. Test reports shall include acceptable performance according to the standards and actual test results.

H. If duct leakage is found to exceed acceptable limits, the Contractor shall make all necessary repairs, and re-test the failed ductwork, until the ductwork achieves the required performance. Repairs to, and retesting of, failed ductwork shall be made in a timely manner, and at no additional cost to the Owner.

END OF SECTION

SECTION 23 91 00

DUCTWORK ACCESSORIES

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Volume control dampers.

B. Fire dampers.

C. Smoke dampers.

D. Ceiling diffuser fire dampers.

E. Sidewall diffusers/registers fire dampers.

F. Backdraft dampers.

G. Flexible duct connections.

H. Duct access doors.

I. Duct test holes.

J. Belt guards.

K. Sound attenuators.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REFERENCES

A. Material, construction, and installation shall meet requirements of most recent editions of the following standards and references, except where more stringent requirements are specified or indicated on the Drawings.

1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
2. SMACNA - HVAC Duct Construction Standards.

1.04 REGULATORY REQUIREMENTS

A. Comply with NFPA 90A and SMACNA standards.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit manufacturer's installation instructions for fire dampers.

PART 2 - PRODUCTS

2.01 VOLUME CONTROL DAMPERS.

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Fabricate single blade dampers for duct sizes to 12-inches high and 48-inches wide.

C. For duct sizes over 12-inches high or 48-inches wide, fabricate multi-blade dampers of opposed blade pattern. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. Except in round ductwork 12-inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

E. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30-inches provide regulator at both ends.

F. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.02 ACCEPTABLE MANUFACTURERS - FIRE DAMPERS

A. Greenheck

B. Arrow

C. Ruskin

D. Air Balance/American Warming.

2.03 FIRE DAMPERS

A. Provide vertical UL labeled fire dampers where indicated on the drawings. Assembly shall consist of formed steel blades with 100 percent interlocking joints to form a continuous steel curtain when closed. Damper shall meet NFPA 90A requirements.

B. Provide 16-gauge galvanized steel duct sleeves for dampers in ducts with maximum height dimension of 24-inches and maximum width dimension of 36-inches, and 14-gauge galvanized duct sleeve for larger duct sizes. Depth of sleeve shall be sufficient to install perimeter angles attached to the sleeve on both sides of the wall as required by UL-555.

C. Fire dampers shall be designed and constructed so that the blade stack in the open damper position is completely outside the air stream.

2.04 DAMPERS FOR FIRE BARRIER AND SMOKE APPLICATIONS

A. General:

1. This category covers fire dampers, smoke dampers, combination fire and smoke dampers, and corridor dampers.

B. Air Flow and Pressure Ratings:

1. Fire dampers for use in dynamic systems, smoke dampers, combination fire and smoke dampers, and corridor dampers shall be marked with the maximum air flow and static pressure HVAC system conditions for which the damper has been evaluated.
2. The air flow (velocity) ratings are established in increments of 1000 CFM/ft2 of damper area (FPM), with the minimum being 2000 CFM/ft2.
3. The air flow ratings are established based on test conditions with the damper in the full open position. The static pressure ratings are established in increments of 2 in.WG, with the minimum being 4 in.WG. The static pressure ratings are established based on test conditions with the damper in the full closed position.

C. Sizes: The maximum sizes expressed in inches representing the maximum width and maximum heights are shown in the individual Classifications for each fire damper model, for both single sections and multiple section assemblies.

1. Fire dampers shall be sized and selected by the manufacturer and/or contractor such that the clear inside free area of the ductwork is maintained, and so that no components of the fire damper (e.g., internal bracing, springs, latches, support angles, etc.) interfere with air flow or reduce the net free area of the duct in which the damper is installed.
2. As required to maintain 100% duct cross-section free area, provide fire dampers with Type C (for square and rectangular ducts), Type CR (for round ducts), and/or Type CO (for oval ducts) transitions where the blade stack and frame are completely out of the air stream. If necessary to maintain the inside cross-sectional area of the ductwork, the fire damper size shall be increased from the nominal duct dimensions.

D. Abbreviations: The following abbreviations are used in the individual Classifications:

1. Fire Resistance Rating:

   a. HR Class - Hourly Classification

2. Damper Mounting Position:

   a. V - Vertical
   b. H - Horizontal
   c. V, H - Vertical & Horizontal

3. Maximum Damper Size:

   a. W - Width
   b. H - Height

E. Fire Dampers:

1. Fire dampers are intended for installation where air ducts penetrate or terminate at openings in walls or partitions; in air transfer openings in partitions; and where air ducts extend through

floors as specified in NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

2. Fire dampers are prescribed for use by codes such as the BOCA National Building and Mechanical Codes, SBCCI Standard Building and Mechanical Codes, ICBO Uniform Building and Mechanical Codes, and the International Building and Mechanical Codes.
3. Fire dampers have been evaluated for fire resistance ratings of 1-1/2 or 3 has indicated in the individual Classifications.
4. Fire Dampers for Use in Dynamic Systems: Fire dampers for use in dynamic systems are intended for use in dynamic HVAC systems that remain operational during a fire, and may also be employed in static systems.
5. Fire Dampers for Use in Static Systems: Fire dampers for use in static systems are intended for use only in static HVAC systems that are automatically shut down in the event of a fire.

F. Smoke Dampers:

1. Smoke dampers are intended for the protection of openings in smoke barriers, or in engineered smoke control systems as specified in NFPA 90A. Smoke dampers are prescribed for use by codes such as the BOCA National Building and Mechanical Codes, SBCCI Standard Building and Mechanical Codes, ICBO Uniform Building and Mechanical Codes, and the International Building and Mechanical Codes.
2. Leakage ratings for smoke dampers shall be Class Designation II as shown in the following table. Leakage ratings of the dampers are established at a minimum differential pressure of 4 in. water gauge (WG), across the closed damper. Leakage rates may also be established at higher differential pressures, in increments of 2 in. water gauge.

Maximum Leakage

(CFM/ft2)

Class	4 In WG	6 In. WG	8 In. WG	10 In WG	12 in WG
II	20.0	24.0	28.0	31.5	35.0

3. Leakage ratings of smoke dampers are determined at elevated temperatures. The elevated temperatures are in increments of 100 deg. F with the minimum temperature being 250 deg. F. Leakage ratings of smoke dampers are established based on test conditions using heated air.
4. Classified dampers are marked with respect to the Leakage Class at elevated test temperature.

G. Combination Fire and Smoke Dampers:

1. Combination fire and smoke dampers are intended for use in locations that are designated as both fire barriers and smoke barriers. These products can also be described as combination fire/smoke dampers as defined by the International Building Code (IBC) 2000. Combination fire and smoke dampers have been evaluated for both a fire resistance rating of 1-1/2 or 3 h, and a leakage rating as defined under "SMOKE DAMPERS." Leakage ratings of combination fire and smoke dampers are determined at an elevated temperature 250 deg. F or 350 deg. F. Leakage ratings of combination fire and smoke dampers are established based on test conditions using heated air.

H. Requirements:

1. The basic standard used to investigate fire dampers for use in dynamic systems and fire dampers for use in static systems is UL 555, "Fire Dampers."

2. The basic standard used to investigate smoke dampers is UL 555S, "Smoke Dampers."
3. Combination fire and smoke dampers, and corridor dampers, are evaluated in accordance with the applicable requirements of both UL 555 and UL 555S.

I. Classification Mark:

1. All dampers for fire barrier and smoke applications shall have the Classification Mark of Underwriters Laboratories, Inc., on the product. The Classification Mark for these products includes the UL symbol, the word "CLASSIFIED" above the UL symbol, a control number, and one of the following product names as appropriate: "FIRE DAMPER FOR USE IN DYNAMIC SYSTEMS (+) HR,""FIRE DAMPER FOR USE IN STATIC SYSTEMS + HR,""SMOKE DAMPER - LEAKAGE RESISTANCE CLASS (++) - (+++),""COMBINATION FIRE AND SMOKE DAMPER + HR - LEAKAGE RESISTANCE CLASS (++) - (+++)" or "CORRIDOR DAMPER + HR - LEAKAGE RESISTANCE CLASS (++) - (+++)."

J. Smoke and Combination Fire/Smoke Damper Actuator Requirements:

1. All actuators shall be factory installed (mounted out of the air stream) and factory tested. All actuators shall be specifically listed and tested for the application.
2. All actuators shall be 120-volt A.C., 60-hz., 0.24-A. (max.), 23-watts (max.), SPST controller.
3. All actuators shall be fail closed spring return type (non-power position shall be closed).
4. All actuators shall have factory installed and wired damper momentary test switches to allow the damper to be cycled without the need for power interruption or fire alarm activation.
5. All actuators shall have an external position indicator (indexed to the damper blade position).
6. All actuators shall have auxiliary switches (end switches) for use by the BAS Contractor and/or Fire Alarm System in order to provide remote position indication. Switches shall indicate both full open and full closed positions.

2.05 ACCEPTABLE MANUFACTURERS - CEILING DIFFUSER FIRE DAMPERS

A. Greenheck.

B. Arrow.

C. Ruskin.

D. Air Balance/American Warming.

2.06 CEILING DIFFUSER FIRE DAMPERS

A. Provide ceiling diffuser UL labeled fire dampers and thermal insulating blankets where indicated on the Drawings. Assembly shall consist of 20-gauge galvanized steel blade and frame, UL classified, mineral wool insulation blanket, and 165 deg. F fusible link.

2.07 ACCEPTABLE MANUFACTURERS - SIDEWALL DIFFUSERS/REGISTERS FIRE DAMPERS

A. Greenheck.

B. Arrow.

C. Ruskin.

D. Air Balance/American Warming.

2.08 ACCEPTABLE MANUFACTURERS - SIDEWALL DIFFUSER/REGISTER THINLINE SERIES FIRE DAMPERS

A. Provide vertical UL labeled fire dampers where indicated on the drawings. Assembly shall consist of formed steel blades with 100% interlocking joints to form a continuous steel curtain when closed. Damper shall meet NFPA 90A requirements.

2.09 ACCEPTABLE MANUFACTURERS - BACKDRAFT DAMPERS

A. Greenheck.

B. Arrow.

C. Ruskin.

D. Air Balance/American Warming.

2.10 BACKDRAFT DAMPERS

A. Gravity backdraft dampers, furnished with air moving equipment, may be air moving equipment manufacturer's standard construction.

B. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16-gauge galvanized steel, with center pivoted blades of maximum 6-inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure; Ruskin Model BD2 or approved equal.

2.11 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum-density 20 oz per sq yd, approximately 3-inches wide, crimped into metal edging strip.

C. Leaded vinyl sheet, minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.12 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Review locations prior to fabrication.

C. Fabricate rigid and close-fitting doors of 24-gauge galvanized steel with sealing gaskets and quick fastening locking devices. For insulated or lined ductwork, install minimum one inch thick insulation with sheet metal cover.

D. Access doors smaller than 12-inches square may be secured with sash locks.

E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 × 48 inches. Provide an additional hinge for larger sizes.

F. Access doors with sheet metal screw fasteners are not acceptable.

G. Use Model ADH 1-2 by Ruskin or approved equal.

2.13 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.14 ACCEPTABLE MANUFACTURERS - PREFABRICATED SOUND ATTENUATORS

A. Vibro-Acoustics.

B. Industrial Acoustics Company.

C. United McGill.

D. Commercial Acoustics.

E. Price.

2.15 PRE-FABRICATED SOUND ATTENUATORS

A. Sound attenuators shall be of the size, configuration, capacity and acoustic performance as scheduled on the Drawings. Insertion losses listed in the schedule are minimums; pressure drops are maximum allowable. Silencer performance, including silencers with fiberglass cloth and Mylar encapsulated media, must be substantiated by laboratory testing according to ASTM E477 and so certified when submitted for approval.

B. All sound attenuators shall be factory fabricated and supplied by the same manufacturer. Silencer inlet and outlet dimensions must be equal to duct sizes shown on the Drawings. Duct transitions at silencers are not permitted unless shown on the Drawings. A sheet metal elbow in combination with a rectangular silencer is not acceptable as an elbow silencer.

C. All rectangular sound attenuators shall be constructed with a 20-gauge galvanized steel outer casing and 22-gauge galvanized perforated steel. All elbow sound attenuators shall be constructed with 18-gauge galvanized outer casing and 22-gauge galvanized perforated steel. All perforated steel shall be adequately stiffened to ensure flatness and form. All seams and joints should be mastic sealed to ensure airtight construction.

D. Media shall be incombustible acoustic quality, shot-free fiberglass insulation with long, resilient fibers bonded with a thermosetting resin. Density shall be required to ensure conformance with laboratory test data. Fiberglass shall be packed with a minimum of 10% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break, and conforming to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for fiberglass.

E. Where indicated on the silencer schedule, sound attenuators shall have H.T.L. (High Transmission Loss) walls externally applied and sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The construction of the H.T.L. walls shall be as required to obtain the specified room N.C. (noise criteria) level.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions.

B. Provide volume control dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.

C. Provide fire dampers where indicated on the Drawings.

D. Provide backdraft dampers on all exhaust fans or exhaust ducts nearest to outside.

E. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment (unless manufacturer design specifically provides for the elimination of flexible connectors).

F. Provide duct access doors for inspection and cleaning in the following locations and of the indicated sizes:

1. Fire dampers: 12" x 12", or larger.
2. Automatic control dampers: 6" x 6", minimum.
3. Manual volume dampers 2 sq. ft. and larger: 6" x 6", minimum.
4. Inlet side to coils: 12" x 12", or larger.
5. Suction and discharge sides of inline fans: 24" x 24", minimum, or maximum possible size based on duct size.
6. Provide duct access doors (12" x 12" minimum) at duct-mounted smoke detectors, as required for inspection and cleaning of the detector sampling tube.
7. At additional locations indicated on Drawings, or specified elsewhere: 12" x 12", minimum.

Note: Generally access doors are not shown on the Drawings, but shall be provided in accordance with the above.

G. General Contractor shall install access doors in walls, ceilings, soffits, chases, etc. where required to access mechanical equipment. Coordinate access door sizes and locations with General Contractor.

H. Provide duct test holes where required for testing and balancing purposes.

I. Provide sound attenuators where indicated on the Drawings.

END OF SECTION

SECTION 23 92 50

INDUSTRIAL COLLECTION SYSTEMS

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Industrial dust collectors.

B. Air filter fan units.

C. Extraction arms.

D. Vehicle exhaust systems.

E. Spark detection and extinguishing systems.

F. Industrial duct systems and accessories.

G. Industrial fume//heat hoods.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REFERENCES

A. Material, construction, and installation shall meet requirements of most recent editions of the following standards and references, except where more stringent requirements are specified or indicated on the Drawings.

1. ACGIH - Industrial Ventilation, A Manual of Recommended Practice.
2. SMACNA - HVAC Duct Construction Standards.
3. SMACNA - Round Industrial Duct Construction Standard.
4. SMACNA - Rectangular Industrial Duct Construction Standard.
5. NFPA 68 and 664.

1.04 DEFINITIONS

A. Duct Sizes: Inside clear dimensions.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit scaled detailed fabrication drawings for the duct-to-equipment connection and/or exhaust hood for the equipment serviced by the industrial collection systems (i.e., planner, radial arm saw, jointer, table saw, band saw, and disc/belt sander). Duct-to-equipment and exhaust hood construction shall be as recommended in the *ACGIH - Industrial, Ventilation, a Manual of Recommended Practice*, modified as appropriate to suit project specific equipment requirements.

C. Submit scaled detailed fabrication drawings for entire industrial collection systems indicating all duct sizes, fittings, turning radii, access doors, dampers, collection equipment, and all other appurtenances which will be an integral part of the system. The detailed layout of the collection systems shall be according to recommended practices contained in *ACGIH Industrial Ventilation, A Manual of Recommended Practice*, as well as specified herein and as indicated on the Drawings.

D. Provide manufacturers literature and data indicating rated capacities, dimensions, weights and point loadings, accessories, electrical requirements and wiring diagrams, and location and sizes of field connections.

E. Provide fan curves with specified operating point clearly plotted.

F. Submit sound power levels for both fan inlet and outlet at rated capacity.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 01 00.

B. Operation Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - INDUSTRIAL DUST COLLECTORS

A. Airex Industries

B. Airflow Systems

C. Sternvent Company

D. Donaldson Torit

E. United Air Specialists

2.02 DUST COLLECTORS

A. General:

1. Furnish and install where shown on the plans, high efficiency filter type dust collectors with integral blowers sized for design air flow as shown on the mechanical equipment schedules.

B. Dust Collector DC-C117 - (CTE Exploration)

1. 1- Airex dust collection model SCST-64-660

a. Model SCST dust collectors are mechanical bag units with an electrical shaker. This industrial quality unit utilizes polyester needlefelt bags for filtration and comes in a short hopper model with drum kit standard.
b. Blower Model SXBD-06 includes housing, AMCA C rating, BI wheel, matching paint, <U> base support, and DIRECT DRIVE TEFC motor. 4 500 CFM @ 12-14" H2O.
c. 20HP- 460V/3/60

2. Control panels

a. Electric Shaker full controls includes:

1) 1HP Shaker motor
2) 20 HP magnetic motor starter 460V/3/60
3) Fuses
4) Fused disconnect with fuses
5) Star/Stop button
6) On/Off lamps
7) Relay's
8) Transformer 460-3-60
9) Programmable timer
10) Up to 6 auxiliary contacts
11) Drawings
12) CSA Approved

3. An electronic industrial control panel includes a programmable timer for the (1) HP, 460v, 3ph electric shaker motor, a 20hp magnetic motor starter (260v, 3ph), fuses, a fused disconnect, industrial on/off switches with indicator lamps, relays, transformer at 460v, 3ph, 60hz and up to (6) auxiliary contacts. A full set of electrical drawings are provided. CSA approved.
4. Additional factory installed safety features include: (2) explosion relief doors, rated for the kst value of wood dust, a blow back damper on the collector inlet, a Hansentek AN104 spark detection and suppression system, high speed abort damper and silencer assembly for motor/blower discharge. A fire kit temperature probe and sprinkler pipe only are provided as an additional safety feature.

C. Dust Collector DC-C127 (Building Trades)

1. One (1) Airex dust collector model 100W10

a. Selection Of Dust Collector :

Bag removal service:	inside
Gas inlet:	side connection
Service:	continuous
Operation:	pull-through
Location:	outside or inside

2. Construction Details:

a. Casing :

Material:	black steel
Thickness:	reinforced 12 gauges
Design static pressure:	16 inches water gauge
Filter bag access:	inside removal by service door
Gas inlet:	16''Ø side connection with Baffles

b. Tube Sheet :

Type:	flat
Material:	black steel
Thickness:	12 gauges, reinforced
Quantity:	one (1)
Bag spacings:	center to center 7'' x 7''

c. Filter Media:

Style:	Airex
Material:	reinforced felt

Composition:	100 % polyester
Weight:	15.0 – 17.0 oz/sq.ft.
Finish:	heatset
Maximum operating temperature:	200°F – 275°F

d. Venturis:

Type:	Spun
Material:	Steel Spinning

e. Filter Bags Cleaning System :

Type :	Pulse-Jet
C.F.M. required per module:	5-10 c.f.m. based for cleaning cycle 1-2 minutes
Compressed air pressure:	100 p.s.i.g.
Air properties:	clean, dry, without oil

f. Compressed Air Tank:

Quantity:	One (1) per unit
Size:	5'' x 5'', full length of casing
Location:	side-mounted

g. Diaphragm Valves :

Size:	¾''
Manufacturer:	Goyen

h. Solenoid:

Location:	Mounted inside of one casing NEMA 4 beside compressed air tank

i. Filter Bags Controller:

System:	Pulse-Jet
Operation:	Sequence
Control adjustment:	one (1) for pulse timing (adjustable) One (1) for interval between pulse (adjustable)
Wiring:	printed circuit with terminal block
Enclosure:	NEMA 4
Location:	remote

j. Filter Bag Gauge:

Quantity per unit:	one (1) complete with tubing and connections
Type:	Magnehelic
Range:	0-10 water gauge

k. Support:

Type:	Structural
Clearance:	To suit application

l. Painting:

Standard finish:	one (1) primer and two (2) paints
Surface preparation:	brush clean
Type:	Polyurethane – semi lustre
Thickness:	Average 2.3 mils

3. Blower Model SQB-22.25 includes housing, AMCA C rating, BI wheel, OSHA guard, all belts, matching paint, <U> base support, and TEFC motor. Top mounted. 40HP, 460V/3/60; 10 000CFM @ 16'' H2O.
4. Explosion door as per NFPA68
5. Blowback Ø20''
6. Platform, ladder & cage
7. Complete control panel including Nema 12 enclosure, magnetic motor starter, fuses, thermal overload, step down transformer, illuminated on/off buttons, three position selector switch, integrated pulse sequencer controller board, and rotary disconnect. CSA approved. 40HP, 460V/3/60 with Soft Start.
8. Additional safety and convenience features include, a photohelic gauge (saves significant amounts of compressed air), rotary airlock for the collector discharge, fire kit including temperature probe and sprinkler pipe only, connects to existing fire suppression system, a Hansentek AN104 fire detection and suppression system, and high speed abort damper.

D. Dust Collector DC-C138 (Welding)

1. One (1) Airex cartridge collector model DCCH-24

a. Cartridge dust collector model DCCH-24 complete with 36" paper cartridges, front access doors, venturi assisted reverse automatic pulse cleaning system, adjustable control board for RP in a NEMA 12 enclosure, quick cam cartridge clamping system, hopper, inlet target plate, magnehelic gauge, stand, 55 gallon drum kit, and surge air tank.

2. Construction Details:

a. Casing:

Material:	black steel
Thickness:	reinforced 12 gauges
Design static pressure:	16 inches water gauge
Cartridge access:	outside, re: access door
Gas inlet:	baffles

b. Tube Sheet:

Quantity:	1
Type:	flat
Material:	black steel
Thickness:	12 gauges, reinforced

c. Filter Media:

Material:	paper
Composition:	P-315-361275
Maximum operating temperature:	200°F

d. Cartridges:

Dimensions:	12 ¾'' dia. X 36'' (L)
Access:	Front horizontal hinged door

e. Venturis:

Type:	Spun
Material:	Steel spinning

f. Cartridges Cleaning System:

Type:	Pulse-jet Cycle 1-2 minute(s)
Compressed air pressure:	100 p.s.i.g.
Air properties:	clean, dry without oil

g. Compressed Air Tank:

Quantity:	1 per module
Size:	5'' x 5'', full length of casing
Location:	side-mounted

h. Diaphragm Valves:

Size:	1 ½''
Manufacturer:	Goyen

i. Solenoid Valves:

Location:	Mounted inside of an NEMA 4 casing beside the compressed air tank

j. Pulse Controller:

System:	Pulse-jet
Operation:	sequence
Control adjustment:	one (1) for pulse timing (adjustable) one (1) for interval between pulse (adjustable)Wiring : printed circuit with terminal block
Enclosure:	NEMA 5/12
Location:	beside service platform

k. Cartridge Gauge:

Quantity:	1 complete with tubing and connections
Type:	Magnehelic
Range:	0-10 water gauge

l. Support Structure:

Type:	Structural
Clearance:	4'-0'' below hopper

m. Painting:

Standard finish:	1 primer and 2 finishes
Surface preparation:	cleaned and brushed

n. Discharge Equipement:

Quantity:	1
Location:	under collector
Type:	55 gal. Drum kit

3. Blower Model SQB-24.5 includes housing, AMCA C rating, BI wheel, OSHA guard, all belts, matching paint, <U> base support, and TEFC motor. 50HP- 460V/3/60, 14 000 CFM @ 16'' H2O.
4. Drum kit & steel band clamp.
5. The collector is also specified with a photohelic gauge which cleans the cartridges on demand saving significant volumes of compressed air, while extending the life of all involved components.
6. A fire kit, including a fire temperature probe and sprinkler pipe only are provided to connect to a fire suppressant source.
7. Additional safety features include explosion relief doors on the body of collector, per NFPA 68, and a blow back damper (gravity operated) for the inlet of the collector.
8. A 30" abort damper assembly, in conjunction with a Hansentek AN104 fire detection and suppression system provides complete fire protection and prevents the propagation of fires within the collector.

E. Dust Collector DC-134a & DC-134b (Precision Manufacturing)

1. One (1) Airflow Systems model DC-8-7.5BI-S-BI-Hopper20-Rain cap-7.5-PG-10-Mtr-Str-Mnt Cartridge dust collector with (8) Clean II filters (150 sq. ft. media each), Auto-clean Vibra-pulse filter cleaning system, 7 ½ Hp TEFC motor, 208-230/460/575/3/60Hz (17.2/8.6 amps), with backward incline blower with exhaust silencer, rain cap and motor starter mounted to unit, 16" dia. inlet collar on top, Hopper/stand for 20 gallon pail option; hopper with short legs, connecting hose, lid, and 20 gallon pail. 0-10" Magnahelic dial pressure gauge, surface mounted.
2. Construction: 12 ga. steel cabinet with powder-coat finish; includes (4) removable end caps for easy filter removal, AMCA type B, non-sparking, aluminum, radial blower wheel, ½" NPT regulator, and motor wired to electrical control box.

   a. Unit: 144"H x 54"W x 36"D
   b. Weight: 1,480 lbs

F. Dust Collector DC-134b (Precision Manufacturing)

1. 1- Airflow Systems model 1200VOM-PG-5:

   a. 1000 CFM source capture industrial air cleaner with (1) 2" impingement pre-filter, (1) 2" aluminum mesh filter, (1) 95% main filter (25 sq ft of media), 1 HP TEFC motor, 115/230/1/60 hz, and a 8" dia. Inlet in front only (no side or back inlet). 0-5" Magnahelic dial pressure gauge, surface mounted.
   b. Construction: 16 ga welded steel cabinet with powder-coat finish. Includes Ultra-sealTM filter mounting system, side access door to filters and motor blower compartment, wall mount/rod hanging brackets for installation, 3" deep welded oil sump with 1.5" FPT drain, direct drive blower, on-off switch and 6' power cord for 115v units; 230/1 phase and 3 phase units are wired to side junction box (motor starter not included)

      1) Unit: 16"W x 44"H x 24"D
      2) Weight: 183 lbs

G. Dust collection systems include the following:

1. Building Trades - Provide dust collection system for woodworking equipment: (1) 13,000 CFM cartridge dust collector located outside, (12) extraction arms, (14) equipment connections.
2. Robotics - Provide dust collection system for the woodworking equipment: (1) 800 CFM portable cartridge dust collector.
3. Precision Manufacturing - Provide dust collection system for the welding/ferrous metals: (1) 10,000 CFM cartridge dust collector located outside, (5) extraction arms, (15) equipment connections.
4. CTE Exploration Studio - Provide dust collection system for the woodworking equipment: (1) 6,000 CFM cartridge dust collector located outside, (4) extraction arms, (6) equipment connections. Provide dust collection equipment for welding/ferrous metals: (1) 2,000 CFM cartridge dust collector located outside, (1) extraction arm, (3) equipment connections.
5. Welding Fabrication - Provide dust collection system for the welding/ferrous metals: (1) 13,000 CFM cartridge dust collector located outside, (1) plasma downdraft table, (22) extraction arms, (4) equipment connections. Provide dust collection system for aluminum: (1) 3000 CFM cartridge dust collector located exterior to building, (1) plasma downdraft table.

F. Dust collector shall be self-cleaning fabric type complete with cotton filters, backward inclined blower, motorized shaker, factory wired controller and external discharge silencer. Manufacturer's literature shall state that dust collector and selected filter spacing is designed for the collection of wood dust.

G. Dust collector shall be airtight, all steel construction with sealed seams and gasketed quick opening doors with 1/4 turn knobs. Housing shall be a minimum of 14-ga. mild steel. Unit shall consist of a filter section, with sloped roof to shed rain and a funnel bottom section without slide gates or doors to allow downflow of dust directly into two (2) 55-gallon drum assemblies furnished by manufacturer. Inlet, with baffle, shall be centered on rear of unit for even distribution of dust to the drums. Designs with inlet on narrow side shall not be accepted. Include an explosion relief vent, in the dirty section of the filter housing, per NFPA #664.

H. Unit to include a multi-pocket filter modules, which is sewn from 8-ounce cotton sateen fabric designed to deliver in excess of 99.5% efficiency by weight on industrial dusts. The filter module shall have rigid insert separators to prevent collapse of filters and loss of the effective filter area. Flat shaker fingers located at the bottom of the filter module shall prevent adjoining pockets from touching one another and blanking off. The filter pocket spacing shall be of the wide spacing type (1-1/2") to permit the collected dust to be shaken off the exterior of the filters and recommended by the manufacturer for the collection of wood dust. Fabric media with narrow spacing, open bottom pockets with dust collected inside the pockets or pleated cartridges will not be accepted. Total airflow to filter fabric area (air to cloth ratio) shall not exceed 10 CFM per square foot.

I. Each filter module shall be secured in place by two lever, operated over-center, locking mechanisms to assure a positive seal and allow for easy removal of filters from outside of unit, without tools. Designs which require entry into unit (confined space), for filter maintenance, are not acceptable.

J. Filters will be cleaned automatically after a fifteen second delay following the shutdown of the blower, by the oscillating action delivered by the motorized eccentric driven shaker assembly, which imparts a vibratory force throughout the entire surface of each individual filter pocket to dislodge the dust.

K. Operation of the automatic shaker shall be controlled by a solid state, dual mode timer with adjustable shaker cycle range from 1.8 - 180 seconds. VFD for blower motor, magnetic starter with overload relay for shaker motor and transformer shall be factory wired in a NEMA12 control panel for indoor mounting & wiring by contractor. Outdoor NEMA 3R safety disconnect switches shipped loose for field mounting & wiring by contractor. Also included shall be a push button station for remote mounting.

L. The control panel wiring shall be either UL or ETL labeled for compliance with 508A. Control panels not labeled by dust collector manufacturer shall be labeled, in field, by a certified UL or ETL representative, prior to placing equipment in operation.

M. The integral non-sparking AMCA Type C direct drive blower shall be located on the clean air side of the filters, top mounted at the factory and be of the backward inclined design with a dynamically balanced impeller. It shall be driven by a 3450 RPM, TEFC motor. The blower shall be tested in accordance with AMCA Standard 210. A factory-supplied cover shall protect the motor cooling fan from ice.

N. Discharge noise from the blower shall be attenuated by an external field supported duct silencer fabricated with 4.75 lb. density inorganic mineral or glass fiber. This media shall be protected from erosion by the air flow through the use of galvanized perforated metal with aerodynamic leading and trailing edges to insure maximum acoustical insertion loss at minimum static pressure drop. Lining of the fan scroll, instead of an external silencer, shall not be accepted.

O. Interior and exterior carbon steel surfaces shall be coated with two part epoxy primer and exterior painted with two-part urethane enamel.

2.03 AIR FILTER FAN UNITS (PRECISION MANUFACTURING & CTE EXPLORATION)

A. Airflow Systems Model F70R:

1. 2500 CFM air cleaner with (1) 10 sq. ft. reduced maintenance pre-filter, (1) 65% bag filter (66 sq. ft.), and a ¾ hp TEAO 2-speed motor, 115/1/60 hz
2. Construction: 18 gauge steel cabinet with powder-coat brown finish; includes direct drive, 10x10 blower, 4-way adjustable airfoil blade exhaust grille, 6’ power cord with plug, and mounting eye bolts (factory installed).

2.04 EXTRACTION ARMS (PRECISION MANUFACTURING)

A. Airflow Systems model 6P035:

1. Special 5' long, 6" dia. Positioner with vertical (DOWN) wall bracket. (5.5 ft. hose required).

2.05 EXTRACTION ARMS (WELDING)

A. Airflow Systems model 4E05-WB-4:

1. 4” dia. EZ Arm II, 5’ long, high performance fume extractor with black aluminum tubes, black hose, external support joint and wall bracket painted black. Specify if up-flange (overhead) or down-flange (table top).

2.06 ACCEPTABLE MANUFACTURERS – VEHICLE EXHAUST SYSTEMS

A. Airflow Systems, Inc

B. Approved equal

2.07 VEHICLE EXHAUST SYSTEMS

A. Furnish and install, where shown on the plans, vehicle exhaust systems for Automotive Technology and Firefighting Science.

B. Hose Reel Assembly: Constructed of high gloss powder coated 12-, 14- and 16-gauge steel, mounted on an adjustable base of 1.25-inch diameter steel pipe. Drum: 18-inch diameter, 16-gauge steel, secured between two 16-gauge spinnings.

1. Reel Assembly: 4-inch Hose.

C. Hose: Rubber flexible hose shall have temperature rating appropriate for the application with minimum rating of 275 degrees F.

1. 4-inch inside diameter, 25 feet long.

D. Tailpipe Nozzle:

1. 4-inch with toggle clamp.
2. 6-inch rubber adapter for vertical truck exhaust

2.08 ACCEPTABLE MANUFACTURERS - SPARK DETECTION AND EXTINGUISHMENT SYSTEM

A. Hansenteck

B. Acceptable substitute

2.09 SPARK DETECTION AND EXTINGUISHMENT SYSTEM

A. Provide spark detection and extinguishment system to National Fire Protection Association standards (NFPA), 69, 664, and 72 guidelines. The system shall be a single zone control system, as manufactured by Hansentek or approved equal. All components shall be Factory Mutual (FM) approved.

1. Installation requires coordination with sheet metal, plumbing, fire alarm and electrical contractors.

B. The programmable microprocessor panel shall include programmable shutdown, built-in automatic and manual detector sensitivity checking. The system shall provide supervision on all input and output circuits. Fan shutdown relay shall be included, as well as alarm and trouble relays. The system shall have a battery backup power supply and VDC alarm horn.

C. Two (2) 24 addressable infrared direct optic spark detectors with built-in test light for calibrated through the lens sensitivity checking and quick release brackets.

D. Spray assembly with spring-loaded, chrome plated nozzle, 24VDC solenoid, water strainer, mounting flange and gasket.

E. 1” NPT supervised water shut off valve

F. Electrically operated abort gate damper to be located in the return duct and supported by contractor made stand or wall bracket. Abort gate damper shall be activated by the spark detection system.

G. The spark detection and extinguishing system shall be installed indoors and located on and penetrating into a straight horizontal section of the main duct, in the area between the first branch and the dust collector. Based on an air & dust velocity of 4000 fpm in the main duct, the sensor (spark detector) to solenoid valve (spray nozzle) distance (SVD) must be a minimum of 20’. Allow for additional straight duct 1-1/2 duct diameter before and after the detectors and spray nozzle. Flow rate shall be a minimum of 19 GPM at 50 PSI.

H. System shall be installed in accordance with the manufacturer’s installation requirements, per the installation manual and tested, commissioned and end-user trained by a factory trained technician before placing the system in operation.

2.10 INDUSTRIAL DUCT SYSTEMS

A. Product Description:

1. The system is a full line of duct and components. All parts are of standard sheet metal construction with a rolled lip applied to the each end of the component. An all stainless over-center locking clamp is used to encompass the rolled lips, pull them together and then securely join them. Adapters enable connection to virtually any machine or existing duct.

B. Clamp:

1. The lifetime guaranteed clamp is fitted with a 'winged- O-ring' gasket made or N-butyl rubber. The gasket is designed to fully encompass the entirety of the rolled lips including the area formed by the 'v' between the rolled lips. Other gasket material is available.

C. Duct and Adjustability:

1. The duct is a nominal 5' length. Adjustable sleeves and adjustable components enable the installer to quickly make odd lengths and to adjust for a proper fit. To utilize this feature, a cut piece of pipe is slid into the sleeve or fitting and secured with an O-ring and standard clamp.

D. Standard Product

1. Materials:

   a. Material Duct and Components are available in galvanized, stainless (304-316) as a standard.

2. Gauges:

   a. Duct Standard Gauges for the duct are 26 ga for 3", 24 ga for 4-6", 22 ga for 7-12" and 20 ga for sizes 13-22".
   b. Elbows are typically one gauge heavier than standard duct gauge.
   c. All components (branches, reducers etc) are of 18 ga material.

E. Product Options

1. Material:

   a. Carbon steel and galvaneel are available as an option.

2. Gasket Material:

   a. Viton, Gore-tex, Red Silicone Rubber, Asbestos gaskets and O-ring material are also available.

3. Gauges:

   a. All duct can be provided in standard configuration in one ga heavier. (24 in 22 , 22 in 20 and 20 in 18).
   b. Rolled lips can be applied to gauges upto 10 ga by applying a rolled lip collar to fully welded duct and components.
   c. Heavy tubed elbows are available.

F. Pressure Rating

1. The rolled lip on the duct and fittings act as a stiffing ring and therefore allow the product to withstand much higher pressures than normally associated with spiral or other rolled duct.

The duct is typically installed with confidence in pressure applications up to 40" negative water column pressure. Higher pressures guarantees are available. To obtain this simply call K&B.

G. Galvanized Steel Ductwork:

1. Unless otherwise specified, all duct, fittings, and hoods shall be a minimum G-90 galvanized sheet metal in accordance with ASTM A525 and A527 specifications.
2. All ductwork shall be as manufactured by United McGill or acceptable substitute.

H. Exhaust Duct:

1. All duct subject to negative pressure shall be of round spiral lockseam construction, suitable for 0 inches wg to -10 inches wg operation.
2. Duct shall be provided in continuous, un-joined lengths wherever possible. Except when interrupted by fittings, round spiral duct sections shall not be less than 12 feet long.
3. Ductwork gauge table:

Diameter Of Duct or Max. Single Side of Hood/Duct	**Minimum Nominal Thickness**			
	Non-Abrasive		**Medium Abrasive**	**Abrasive**
	Class A	**Class B**	**Class C**	**Class D**
0-8	26g	24g	22g	20g
9-15	24g	22g	20g	18g
15-21	22g	22g	18g	16g
22-30	20g	20g	18g	16g
Over 30	18g	18g	16g	14g

4. System classification and materials:

   a. Industrial collection system:

      1) Class C - Galvanized Steel.

5. Exhaust fittings:

   a. All exhaust system fittings shall be round and shall have a wall thickness two gauge numbers (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected.
   b. Elbows shall be 90-degree die stamped for Class A systems and seven-gore, 90-degree elbows for Class B and C systems.
   c. Converging-flow fittings shall be constructed with no excess material projecting from the body into the branch entrance.

      1) Lateral fittings shall be constructed so that airstreams converge at angles of 45 degrees or less.
      2) All branch entrances shall be by means of factory-fabricated fittings or factory-fabricated duct/tap assemblies.

   d. Balancing dampers shall be provided where indicated on the Drawings. The dampers shall be equivalent to United McGill Model CF, full frame cut-off blast gates.
   e. Vertical stack heads shall be equivalent to United McGill Model WV stack heads.

f. Duct connectors for Class A and B shall be standard duct couplings equivalent to United McGill SRNCF. Duct connectors for Type C shall be suitable for material handling applications equivalent to United McGill SRSCI.
g. Fasteners: Rivets, bolts, and sheetmetal screws the same materials as the ductwork (lengths shall be as short as practical to fasten properly).

6. Duct joint and fitting sealants:

   a. Interior ductwork:

      Transverse joints and duct wall penetrations shall be sealed with Uni-Cast7 two-part tape sealing system, which is a combination of an adhesive activator and woven-fiber tape impregnated with a gypsum mineral compound. Sealing system shall be formulated to withstand temperatures from !40 deg. F to +200 deg. F. Sealing system shall have a UL Classification with a flame spread and smoke developed of zero (0) when tested on both 18-gauge galvanized steel and inorganic reinforced cement board, at a coverage of at least 31 square feet per gallon.

   b. Exterior ductwork:

      All transverse construction joints shall be factory-sealed with United McGill Uni-Weather duct sealant, or equivalent. Sealant shall be formulated to withstand temperatures from -20 to +300 deg. F. Sealant shall be formulated such that surface preparation or solvent cleaning is not necessary. Sealant shall exceed 500 hours without becoming brittle under ASTM D572 test conditions (oxygen bomb).

7. Hangers and supports:

   Duct supports and hangers shall be of the same materials as the ductwork and shall comply with SMACNA standards and per drawing details.

8. Access doors:

   Ductwork conveying materials shall have hinged type access doors suitable for system conveying materials. Access doors shall be equivalent to United McGill Model ASHXFSDC.

9. Hood construction:

   Hood construction shall be to the dimensions as detailed on the Drawings, or as required for the application. Hood construction shall be externally welded stainless steel as indicated. All surfaces and joints shall be smooth without sharp edges or protrusions.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

C. Install fans with resilient mountings and flexible electrical leads.

D. Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Refer to Sections 23 89 00 and 23 91 00 for additional duct construction information and requirements.

END OF SECTION

SECTION 23 93 00

AIR TERMINAL UNITS

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Variable volume and constant volume terminal units.

B. Integral heating coils.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 01 00.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.

D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4-inch wg.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 01 00.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - AIR TERMINAL UNITS

A. Enviro-Tec

B. Trane

C. Tuttle & Bailey

D. Nailor

2.02 VARIABLE VOLUME AND CONSTANT VOLUME AIR TERMINAL UNITS

A. Pressure independent, ceiling mounted variable air volume and constant air volume supply air control terminals for connection to medium pressure duct, central air systems, with direct digital controls (DDC), variable volume controls, integral hot water heating coils, and where indicated, integral sound attenuators.

B. Identify each airflow unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory set air flow, minimum factory set air flow, and coil type.

2.03 FABRICATION

A. Casings: Minimum 22-gauge galvanized steel.

B. Lining: Minimum 1/2-inch thick neoprene or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.

C. Assembly: Air volume damper and controls in single cabinet.

D. Plenum Air Inlets: Round/oval stub connections for duct attachment.

E. Plenum Air Outlets: Slip and drive connections for duct attachment.

2.04 SENSOR

A. The unit shall be equipped with a center tapped averaging sensor that samples duct pressures as twelve (12) points strategically located to represent equal duct areas, and shall provide a differential pressure signal amplified to equal three (3) times the duct velocity pressure that represents actual air flow with an accuracy of ±5% throughout the cataloged operating range of the unit. Straight inlet duct conditions shall not be a requirement.

2.05 DAMPER ASSEMBLY

A. The damper assembly shall be constructed of two 24-gauge blades sandwiched with an integral seal to provide minimum leakage. Damper leakage shall not exceed 2% of units maximum rated capacity or ten (10) cfm, whichever is greater, with inlet duct pressures up to 5-inch water gauge. Damper blade will have a maximum angular travel of 60 degrees to provide improved linearity and flow characteristics. Damper bearings shall be nylon type for noise-free operation requiring no lubrication.

2.06 WIRING

A. Factory-mount and wire controls. Mount electrical components in control box with removable cover.

2.07 CONTROLS

A. Terminal units shall have pressure independent single or dual reset controllers capable of maintaining airflow set points ±5%. The pressure independent controllers shall be capable of resetting between factory maximum setting and minimum set point to satisfy the room thermostat demand. Devices using CFM limiters will not be acceptable. Maximum and minimum CFM settings shall be field adjustable.

B. Damper actuators shall be electric.

C. Terminal unit controls shall be DDC factory installed. Coordinate with BAS Controls vendor selected for this project.

2.08 SOUND

A. Sound tests shall have been conducted in accordance with ARI Standard 880. Discharge and radiated sound power data shall be submitted for all octave bands 125 through 8,000 HZ. NC data only will not be acceptable.

2.09 HEATING COILS

A. Hot Water Heating Coil: ½-inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 PSIG pressure, factory installed.

B. Provide with access plate upstream of coil for inspection and cleaning.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide ceiling access doors or locate units above easily removable ceiling components.

C. Support units individually from structure. Do not support from adjacent ductwork.

3.02 ADJUSTING

A. Set volume damper operator to allow flow range modulation from maximum design flow to minimum design flow.

END OF SECTION

SECTION 23 93 60

AIR OUTLETS AND INLETS

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Diffusers.

B. Registers.

C. Grilles.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 23 01 00.

B. Provide product data for items required for this project.

C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.

D. Where Architect is to make color selection, submit color charts indicating available colors.

E. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - DIFFUSERS, REGISTERS, AND GRILLES

A. Tuttle & Bailey

B. Titus

C. Metalaire

D. Kreuger

2.02 DIFFUSERS, REGISTERS, AND GRILLES

A. Provide diffusers, registers, and grilles of the types and sizes as indicated on the drawings and as specified herein. Selections have been based on Tuttle & Bailey. Titus, Metalaire and Kreuger are acceptable manufacturers provided that they can provide diffusers of the same types, materials, sizes, and performance (including noise levels) which the design has been based on.

B. All square and rectangular supply air diffusers shall have diffusing vanes and shall be of the overall and neck size as indicated.

C. Provide plenum transitions where round duct ductwork is to be connected to square or rectangular necks, and where square or rectangular ductwork is to be connected to square or rectangular necks of different sizes.

D. Provide diffusers, registers, and grilles specifically intended for the type of ceiling, wall or floor in which they are to be installed.

E. All ceiling-mounted diffusers, registers, and grilles shall be of the overall size indicated on the Drawings.

F. All diffusers, registers, and grilles shall have baked enamel finish of color to be selected by the Architect except as noted otherwise.

G. All diffusers, registers, and grilles to be installed on exposed ductwork shall be finished with a factory primer suitable for field painting.

H. Refer to the drawing schedules for diffuser, register, and grille types, sizes, and capacities.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 23 97 50

BUILDING AUTOMATION SYSTEM

(Mechanical Trade Bid Required)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Building Automation System (BAS).

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

C. Refer to Section 012300 – ALTERNATES.

1.03 DESCRIPTION

A. The BAS shall be as indicated on the drawings and described in these specifications. The BAS shall be a complete system of direct digital control (DDC) electric/electronic temperature and motor controls to provide the specified sequences. The control systems in general shall consist of all DDC controllers, network controllers, thermostats and temperature sensors, automatic operators, control valves, duct mounted automatic dampers, switches, relays, specified control panels, indicators, transformers, time clocks, communication wiring and interlocking wiring between control components and equipment.

B. BAS must be fully integrated and coordinated with mechanical equipment DDC controllers furnished and installed by equipment manufacturers as specified in respective sections. The intent of the BAS is to integrate all mechanical equipment into one system for global monitoring, control, and alarming associated with the building. It is the BAS manufacturer's responsibility to provide all design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BAS operators have the capability of managing the building mechanical system to ensure occupant comfort while maintaining energy efficiency.

C. The BAS Contractor shall provide an operator workstation server as part of this project.

D. The Sanford School District presently has a Trane District-Wide BAS with central operator workstation located in the existing "Maintenance Building". The intent of this specification is to provide a new central operator workstation located in the new "Sanford High School and Technical Center" that will extend and interoperate with the existing central operator workstation. The existing Trane District-Wide BAS presently serves the following buildings:

1. Sanford High School
2. Sanford Regional Technical Center
3. Memorial Gym
4. Willard School
5. Lafayette School
6. Carl J. Lamb School
7. BRIDGE Program

8. Margaret Chase Smith School
9. Maintenance Building

E. Contractor shall configure graphic displays, trending and alarming to meet Owner's requirements.

F. The BAS shall meet both BACnet and LonTalk communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects.

G. The BAS shall accommodate simultaneous multiple user operation. Access to the control system data shall be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.

H. The mechanical systems and terminal devices shall be provided with DDC controls that will permit each system to operate in a stand-alone fashion. As such, in the event of a BAS network communication failure, or the loss of an individual controller, the other DDC controllers shall continue to independently operate and communicate to the BAS.

I. Communication between DDC controllers and operator workstation shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the controller identifier or location to view or control a point (object). Application Specific Controllers shall be constantly scanned by the Building Controllers to update point information and alarm information globally.

J. The BAS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

K. Magnetic motor starters shall be supplied with 120 volt control transformer and a normally open and normally closed auxiliary contact.

L. All mechanical, electrical, and plumbing equipment installed under this project shall be equipped with and served by new building automation and automatic temperature control system components.

M. The installation of the BAS shall be performed under the direct supervision of the BAS manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number, sequence of operations, and graphic display layout screens all bearing the name of the manufacturer.

1.04 ACCEPTABLE MANUFACTURERS

A. Base Bid: The following manufacturers/installers are acceptable subject to meeting requirements of the specification:

1. Trane Controls installed by Trane, Inc. (Basis-of-Design)
2. Johnson Controls installed by Johnson Controls, Inc.
3. Siemens Controls installed by Siemens Building Technologies
4. Honeywell Controls installed by Honeywell, Inc.

B. Alternate No.12: The following manufacturers/installers are acceptable subject to meeting requirements of the specification:

1. Trane Controls installed by Trane, Inc. (Basis-of-Design)
2. No substitutes.

1.05 QUALITY ASSURANCE

A. BAS Manufacturer Qualifications

1. The BAS manufacturer shall have an established business office within 50 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.
2. The BAS Manufacturer shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BAS manufacturer shall be able to provide training certifications for all local office personnel upon request.
3. The BAS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers.
4. Independent representatives of BAS manufacturers are not acceptable. BAS vendor must be corporate owned entity of BAS manufacturer.

B. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
2. National Electrical Code -- NFPA 70.
3. Federal Communications Commission -- Part J.
4. ASHRAE/ANSI 135-1995 (BACnet) - (System Level Devices) - Building Controllers and PC Operator Workstations communicating on an Ethernet/IP protocol shall permit interoperability with other various building system manufacturers that are BACnet approved systems.
5. EIA-709.1 LonTalk Standard and EIA 901.2 (LonMark Certification) - (Unit Level Devices) - Custom Application Controllers and Application Specific Controllers shall use FTT-10A transceivers and support the LonTalk communication protocol utilizing Standard Network Variable Types (SNVT) as defined by Echelon Corporation. This standard communication protocol provides interoperability with hundreds of other various building system manufacturers' control systems and devices.

C. All products used in this installation shall be currently manufactured, and shall have been applied to a minimum of three previous projects. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.

1.06 SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the operator's request.
2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 60 seconds.

5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.
9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

B. Reporting Accuracy

Measured Variable	Reported Accuracy
Space temperature	±1°F
Ducted air	±2°F
Outside air	±2°F
Water temperature	±1°F
Delta-T	±0.25°F
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of 10% to 100% scale
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±0.1" W.G.
Air pressure (space)	±0.01" W.G.
Water pressure	±2% of full scale
Electrical Power	5% of reading
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

1.07 SUBMITTALS

A. BAS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications. All shop drawings shall be provided to the Owner electronically as .dwg or .dxf file formats once they have been approved and as-built drawings have been completed.

B. Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the BAS manufacturer of furnishing quantities required based upon contract documents.

C. Provide the Engineer and Owner, any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.

D. Submit the following:

1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.
2. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.

3. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.
4. Provide all manufacturers' technical cut sheets for major system components. When technical cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.
5. Each submitted product literature and drawings shall clearly reference the specification page and section number and/or drawing number associated with the product. This is to include:

    a. Building Controllers
    b. Custom Application Controllers
    c. Application Specific Controllers
    d. Operator Workstations
    e. Portable Operator Terminals
    f. Auxiliary Control Devices
    g. Proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements.
    h. Detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.
    i. Points list showing all system objects and the proposed English language object names.
    j. Sequence of operation for each controlled mechanical system and terminal end devices.
    k. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the point list for proper coordination of interoperability with other building systems if applicable for this project.
    l. Provide LonMark Certification and functional profile SNVT's for unitary-level controllers (i.e. chillers, RTU's, AHU's, Terminal VAV boxes, FCU's, UV's, etc.) for interoperability with other building systems if applicable for this project.
    m. Color printouts of proposed operator graphics including a list of points for workstation display.

E. Project Record Documents: Upon completion of installation, submit record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .dwg or .dxf drawing files shall also be provided.
2. Testing and Commissioning Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BAS) commissioning personnel.
3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:

    a. Names, address and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.
    b. Procedures for operating the BAS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements.
    c. Description of the programming language including syntax, statement descriptions, algorithms, calculations, point database creation and modification, program creation and modification, and operator use of the editor.
    d. Explanation of how to design and install new points, new DDC controllers, and other BAS hardware.
    e. Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.

f. Documentation of all software program logic created for Custom Programmable Controllers including the overall point database. Provide one set of magnetic media containing files of the software and point database.
g. One set of electronic media containing files of all operator color graphic screens for the project.
h. A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.
i. Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.
j. Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
k. Licenses, Guarantee, and Warranty documents for all equipment and systems.
l. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) and task descriptions.

F. Training Manuals: The BAS manufacturer shall provide a course outline and copies of training manuals at least two weeks prior to the start of any corporate training class to be attended by the Owner.

1.08 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project developed hardware and software shall become the property of the Owner. This includes but is not limited to:

1. Operator Graphic files
2. As-built hardware design drawings
3. Operating & Maintenance Manuals
4. BAS System software database
5. Controller application programming databases
6. Application Specific Controller configuration files
7. Required Licensed software

1.09 BAS ARCHITECTURE

A. All building level BAS devices, controllers, etc., shall be connected together using twisted shielded wiring between each device in a daisy chain manner. This communications system shall operate completely independently of the building communications wiring and independent of the building level communications network.

B. The BAS database and interface software shall reside on a server based computer. This server shall connect to the building level network. The server shall have a complete database of the BAS.

C. The BAS shall be able to be fully accessed by an authorized user from any BAS workstation computer. The BAS shall allow the following data exchange to/from the BAS system, for up to five concurrent users (based on user authorization level):

1. Analog temperature values.
2. Temperature set point adjustments.
3. Valve position indicators.
4. Equipment status indications.
5. Graphic representation of all equipment controlled.
6. Alarm reporting (all temperature set point values and equipment status indicators shall be configured as alarms; temperature alarms shall be high and low).

7. Programming of controllers
8. Creation of programs and new points
9. Save and reload of controllers
10. Real time program editor
11. The BAS will have the ability to import/export data automatically into Microsoft Excel, Word and Access for custom reporting.

1.10 INTEROPERABILITY WITH EQUIPMENT CONTROLLERS

A. General:

1. The BAS shall be included with BACnet I/P communication protocol for interoperating with multiple building systems supplied by different manufacturers. The BAS shall be able to receive, react to, and in some cases, return information from multiple building systems.
2. Point inputs and outputs from the third party controllers shall have real time interoperability with BAS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Dial up and Local Area Network Communications.

B. Networking/Communications:

1. The BAS shall support any combination of third party controllers (if more than one third party manufacturer is being integrated) on a single network.
2. A minimum of 100 third party controllers shall be supported on a single network.
3. Integration shall be by RS 485 technologies.
4. Diagnostics/Verification:
5. The installer/operator shall have the ability to verify, and diagnose communication messages and point information between third party controllers and the BAS.

C. Point Inputs and Outputs:

1. The BAS shall be able to monitor and control third-party controller point inputs and outputs provided by equipment supplied with packaged controls that use standard communication protocols.

1.11 WORK RESPONSIBILITY

A. The BAS Contractor shall provide all temperature sensors and transmitters, thermostats, controllers, automatic valves and dampers, valve and damper operators, control panels, electronic, and electric equipment, computer hardware, software, programming, and appurtenances, and other accessory equipment along with a complete system of electrical wiring to fulfill the intent of the specification and provide for a complete and operable system:

B. All control equipment shall be fully proportioning, except as noted otherwise. All damper and valve actuators shall be electric.

C. The initial system programming shall include the set up of all building occupancy schedules and trend logs. Coordinate with the Owner's operating personnel to receive scheduling and trend log requirements.

D. Products, systems, and equipment which the BAS contractor shall integrate into, but which are not furnished or installed by the BAS Contractor, include (but are not necessarily limited to):

1. Variable frequency drives.
2. Packaged rooftop dehumidification units.

3. Packaged rooftop air conditioning units.
4. Variable refrigerant flow systems.
5. Electrical meter.
6. Refer to other Division 22, 23 and 26 specification sections for additional products, systems, and equipment integration and monitoring requirements.

E. The following incidental work shall be furnished by the Designated Contractor under the supervision of the BAS Contractor:

1. The Division 23 Mechanical Contractor shall:

   a. Install automatic valves, flow stations, valved pressure taps, wells, and piping accessories and equipment that are specified to be supplied by the BAS Contractor.
   b. Furnish and install all necessary service valves, and water, drain and overflow connections and piping.
   c. Provide, on magnetic starters and/or motor controls furnished, all necessary auxiliary contacts, with buttons and switches in the required configurations.

2. The Division 23 Sheet Metal Contractor shall:

   a. Install dampers, flow stations, taps, and other duct accessories and equipment that are specified to be supplied by the BAS Contractor.
   b. Furnish and install all necessary balancing dampers, duct accessories, and ductwork.
   c. Provide access doors or other approved means of access through ducts for service of control equipment.

3. The General Contractor shall:

   a. Provide access doors or other approved means of access through ceilings and walls for service of control equipment.

1.12 ELECTRIC WIRING

A. Except for power and control wiring specifically shown on the electrical drawings or called for in the electrical specifications, electric wiring, interlock wiring and wiring connections required for the installation of the BAS, shall be provided by the BAS Contractor. This requirement includes any required mounting and field wiring of control devices furnished with mechanical equipment.

B. All wiring shall comply with the requirements of the electrical section of the specification (Division 26). In addition, the following shall apply:

1. All exposed wiring shall be in EMT. Exposed wiring allowed only in mechanical rooms and at underside of floor/roof in areas without ceilings.
2. All wiring down through floors shall be in EMT and concealed in shafts and walls.
3. All wiring to wall mounted sensors shall be in EMT and concealed in walls.
4. All wiring within accessible ceilings shall be allowed to be plenum rated cable supported from UL Listed J-hook supports.
5. All control cabinets shall be UL listed in accordance with NEC 508a and labeled as an assembly.
6. All control wiring shall be plenum rated.

1.13 ACCEPTANCE PROCEDURE

A. Upon completion of system(s) calibration, the BAS Contractor shall startup the system and perform all necessary trouble shooting and run diagnostic tests to ensure proper operation. The

BAS Contractor shall be responsible for generating all software and entering all database information necessary to perform the sequence of operations and specified software routines. An acceptance test in the presence of the Owner's representative or Engineer shall be performed.

B. The BAS Contractor and the Balancing Contractor shall check the BAS for conformance to Drawings and Specifications including location of components and correct sequence of operations. The Balancing Contractor shall report the results in writing to the Engineer. The Engineer and BAS Contractor shall do a performance test of the system including checking the sequence of operations.

C. The Mechanical Contractor and BAS Contractor shall instruct the Owner in the proper operation of the mechanical systems as specified.

1.14 PRE-INSTALLATION CONFERENCE

A. Under provisions of Division 01, convene a conference one week prior to commencing work of this section.

B. Require attendance of parties directly affecting the work of this Section.

C. Review locations of field equipment (control panels), work schedules and required coordination with other trades.

1.15 COORDINATION

A. Coordinate work under provisions of Division 01 and applicable sections of Division 23 and Division 26.

B. Ensure that installation of components is complementary to installation of similar components of other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

D. Ensure that systems are complete and commissioned.

1.16 WARRANTY

A. The BAS indicated on the drawings and herein specified, shall be warranted to be free from original defects in both material and workmanship for a period of two (2) year of normal use and service, excepting damages from other causes. This warranty shall become effective starting the date of Substantial Completion.

1. Provide all repair and maintenance services (scheduled and unscheduled), materials, and equipment necessary for the successful operation of the entire BAS system for a period of two (2) years after date of Substantial Completion. This shall include all adjustment, required testing, and repair of all systems, all computer equipment, transmission equipment, sensors, control devices, and appurtenances.
2. On line support services shall be provided by the BAS Contractor to remotely monitor and control the BAS. This remote service shall be provided within two (2) hours of the time that a problem is reported. This coverage shall include normal business hours, after business hours, weekends, and holidays.
3. If the reported problem cannot be resolved on line by the local office, the national office of the BAS manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that a problem is reported.

4. Prior to completion of the warranty period, the BAS Contractor shall submit to the Owner a proposal for continuation of scheduled maintenance on an annual basis.

PART 2 – PRODUCTS

2.01 COMMUNICATION ARCHITECTURE

A. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall utilize BACnet MSTP (RS485) communications.

1. The Owner will provide all communication media, connectors, repeaters, network switches, and routers necessary for the high speed Ethernet network. An active Ethernet port will be provided adjacent to each System Controller and operator interface (PC) for connection to this high speed Ethernet network.
2. Active Ethernet data drops will be limited to six (6) for System Controllers and one (1) for operator workstation (PC). No additional Ethernet data drops will be provided for BAS Communication.
3. All values within the system (i.e. schedules, datalogs, points, software variables, custom program variables) shall be readable and controllable (where appropriate) by any System Controller or BACnet Workstation on the communications network via BACnet.

B. Peer-to-Peer Building Level Network:

1. All operator devices shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.
2. The network shall support a minimum of 100 DDC controllers and PC workstations.
3. Each PC workstation shall support a minimum of 4 peer to peer networks hardwired or dial up.
4. The system shall support integration of third party systems via panel mounted open protocol processor. This processor shall exchange data between the two systems for inter-process control. All exchange points shall have full system functionality as specified herein for hardwired points.
5. The system shall allow for alarms to be sent via e-mail to any workstation on the network and to an alpha-numeric pager.

C. DDC Controller Floor Level Network:

1. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.
2. Auto-dial/auto-answer communications shall be provided to allow DDC Controllers to communicate with remote operator stations and/or remote terminals via telephone lines.
3. Auto-dial DDC Controllers shall automatically place calls to workstations to report alarms or other significant events. The auto-dial program shall include provisions for handling busy signals, "no answers" and incomplete data transfers.
4. Operators at dial-up workstations shall be able to perform all control functions, all report functions and all database generation and modification functions as described for workstations connected via the network. Routines shall be provided to automatically answer calls from remote DDC Controllers. The fact that communications are taking place with remote DDC Controllers over telephone lines shall be completely transparent to an operator.

D. The BAS including the peer-to-peer building level network and the DDC controller floor-level network shall be able to be fully accessed by an authorized user from any intranet or Internet connected computer.

2.02 DDC CONTROLLERS

A. DDC Controllers shall be 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and/or the sequences of operation. Each controller shall support a minimum of three (3) Floor Level LAN Device Networks.

B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including, but not necessarily limited to:

1. Control processes.
2. Energy management applications.
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified.
5. Maintenance support applications.
6. Custom processes.
7. Operator I/O.
8. Dial-up communications.

C. Each DDC Controller shall support flash firmware upgrades without the need to replace hardware.

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. DDC Controllers shall provide a minimum two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

F. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

G. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

H. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in, or from a network workstation PC.

2.03 HVAC MECHANICAL EQUIPMENT CONTROLLERS

A. HVAC Mechanical Equipment Controllers shall be 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.

B. Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases, including, but not necessarily limited to:

1. Control processes.
2. Energy management applications.
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified.
5. Maintenance support applications.
6. Custom processes.
7. Operator I/O.
8. Dial-up communications.

C. Each HVAC Mechanical Equipment Controller shall support firmware upgrades without the need to replace hardware.

D. HVAC Mechanical Equipment Controllers shall provide an RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.

E. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

F. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

G. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

1. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V.
2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power.
4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
5. Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:

    a. IEEE Standard 587-1980.
    b. UL 864 Supply Line Transients.
    c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11).

H. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.
2. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in, or from a network workstation PC.
3. Provide a separate HVAC Mechanical Equipment Controller for each AHU or other HVAC system as indicated in this section and/or as appropriate to the sequences of operation. It is intended that each unique system be provided with its own point resident DDC Controller.

2.04 DDC CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:

1. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:

   a. Two-position control.
   b. Proportional control.
   c. Proportional plus integral control.
   d. Proportional, integral, plus derivative control.
   e. Automatic tuning of control loops.

C. DDC Controllers shall have the ability to perform any or all the following energy management routines:

1. Time-of-day scheduling.
2. Calendar-based scheduling.
3. Holiday scheduling.
4. Temporary schedule overrides.
5. Start-Stop Time Optimization.
6. Automatic Daylight Savings Time Switch-over.
7. Night setback control.
8. Dry bulb economizer switch-over.

D. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.
2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
3. DDC Controller shall provide a HELP function key.
4. DDC Controller shall be capable of comment lines for sequence of operation explanation.

E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent

alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device, or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hour's destinations) or based on priority.
4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.
6. Alarm messages will be sent via e-mail to any workstation on the network and to designated alpha-numeric pagers.

F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary and/or sequences of operation.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controller's point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of one (1) minute to seven (7) days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data. All trend data shall be available for use in third party personal computer applications (i.e., Microsoft Excel, Lotus 1-2-3).
2. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary and/or sequences of operation.

    a. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation, or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

G. DDC Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule and/or sequences of operation.

H. The peer to peer network shall allow the DDC Controllers to access any data from, or send control commands and alarm reports directly to any other DDC controller, or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.

I. The peer to peer network shall allow the DDC controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g., all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

2.05 APPLICATION SPECIFIC CONTROLLERS (ASC)

A. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through Floor Level LAN Device Networks.

B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of ASCs as a minimum:

1. Central System Controllers.
2. Terminal Equipment Controllers.

C. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.

D. Central System Controllers:

1. Provide for control of central HVAC systems and equipment including, but not limited to, the following:

   a. Air handling systems.
   b. Hot water systems.

2. Controllers shall include all points, inputs, and outputs necessary to perform the specified control sequences. For motors not equipped with hand/off/automatic switches as part of the electrical control equipment (i.e., as part of motor starters or variable frequency drives), provide a hand/off/automatic switch for each digital output for manual override capability.
3. Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication with its DDC Controller is lost and to insure protection during power outages.
4. All programs shall be field-customized to meet the user's exact control strategy requirements. Central System controllers utilizing pre-packaged or canned programs shall not be acceptable. As an alternative, provide DDC Controllers for all central equipment in order to meet custom control strategy requirements.
5. Programming of central system controllers shall utilize the same language and code as used by DDC Controllers to maximize system flexibility and ease of use. Should the system controller utilize a different control language, provide a DDC Controller to meet the specified functionality.
6. Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

   a. The terminal shall provide the user with the following functionality as a minimum:

      1) View and set date and time.
      2) Modify and override time-of-day schedules.

3) View points and alarms.
4) Monitor points.
5) Command and modify set points.

b. Should the system controller be unable to interface to a door-mounted terminal, provide a laptop or similar terminal at the controller, or provide a DDC Controller with a door-mounted or local terminal in lieu of the system controller in order to meet the specified minimum functionality.

E. Terminal Equipment Controllers:

1. Provide for control of each piece of equipment , including, but not limited to, the following:

a. As required by the sequences of operation.

2. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators. Terminal controllers utilizing proprietary control signals and actuators shall not be acceptable. As an alternative, provide DDC Controllers or other ASCs with industry standard outputs for control of all terminal equipment including pneumatic actuation.

2.06 SYSTEM SERVER

A. All computer hardware specified herein, and as required to make the BAS complete and operable, shall be provided by the BAS Contractor. All required computer software, programming, and labor for computer hardware and overall system set-up shall also be provided by the BAS Contractor.

B. The following technical data for the main computer hardware is considered "up to date" for the purpose of the BAS, and shall represent the minimum level of hardware to be provided.

1. System shall utilize a server class PC tower located in Custodial Room B055
2. Two Xeon 2.8GHz, 1MB L3 cache processors
3. 2GB, DDR266 SDRAM memory
4. DVD+R/W or CD ROM
5. Microsoft Windows Server 2003 (IIS 6.0) Or Server 2008, IIS V7 +
6. Microsoft SQL Server 2005
7. .NET Framework 1.1 BJE: .NET 3.5
8. Furnish all required serial, parallel, and network communication ports, and all cables for proper system operation. The server shall include a minimum 17", color monitor with 1024 x 768 screen resolution.

2.07 GRAPHICAL USER INTERFACE SYSTEM

A. Basic Interface Description:

1. Operator workstation interface software shall minimize operator training through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:

a. Real-time graphical viewing and control of environment.
b. Scheduling and override of building operations.
c. Collection and analysis of historical data.
d. Point database editing, storage and downloading of controller databases.

e. Alarm reporting, routing, messaging and acknowledgment.

2. Provide a graphical user interface which shall minimize the use of the keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection. There shall be a minimum of 8 pre-defined function keys to allow quick access to frequently used applications.
3. The software shall provide a multi-tasking type environment which allows the user to run several applications simultaneously. BAS software shall run within a 32 bit operating system such as Windows XP. These Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information.

   a. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows:

      1) Dynamic color graphics and graphic control.
      2) Alarm management, routing to designated locations, and customized messages.
      3) Week-at-a-Glance Time-of-day scheduling.
      4) Trend data definition and presentation.
      5) Graphic definition and construction.
      6) Program and point database editing on-line.

   b. If the software is unable to display several different types of displays at the same time, the BAS contractor shall provide at least two operator workstations at no additional cost to the Owner.
   c. Report and alarm printing shall be accomplished via Windows program manager, allowing use of network printers.

4. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. A minimum of six levels of access and 50 passwords shall be supported.
5. Operator Activity Tracking: An audit trail report to track system changes, accounting for operator initiated actions, changes made by a particular person or changes made to a specific piece of equipment, designated time frame, shall be printable and archived for future use. The operator activity tracking shall be in a tamper -proof buffer file.
6. Reports shall be generated on demand or via pre-defined schedule and directed to either CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:

   a. A general listing of all or selected points in the network.
   b. List of all points currently in alarm.
   c. List of all points currently in override status.
   d. List of all disabled points.
   e. List of all points currently locked out.
   f. List of user accounts and access levels.
   g. List all weekly schedules.
   h. List of holiday programming.
   i. List of limits and dead bands.
   j. Excel reports.
   k. System diagnostic reports including, list of DDC panels on line and communicating; status of all DDC terminal unit device points.
   l. List of programs.
   m. Custom configurable lists of any user-defined object in the system.

7. Scheduling and Override: Provide a calendar based graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. It should allow scheduling at least one year in advance. Schedules reside in both the Primary and Secondary Servers and DDC Controllers to ensure time equipment scheduling when PC is off-line; PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:

    a. Weekly schedules.
    b. Zone schedules, minimum of 500 unique zones.
    c. Monthly calendars.

8. Collection and Analysis of Historical Data:

    a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
    b. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

B. Dynamic Color Graphic Displays:

1. Complete color graphic floor plan displays and system schematics for each piece of mechanical equipment, including, but not limited to, air handling units and exhaust fans, hot water systems and chilled water systems, shall be provided by the BAS Contractor for the systems included in the sequences of operation of this specification to optimize system performance analysis and speed alarm recognition.
2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands. Graphics software shall permit the importing of AutoCAD or Bitmap drawings for use in the system.
3. For system schematics at individual pieces of equipment, occupancy schedules, set points, status, alarm status, and written sequence of operations, shall be displayed or shall be available by direct link.
4. Dynamic temperature values, humidity values, flow values, valve and damper positions, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates. All flow valves shall be in units generally accepted as standard in the industry (i.e., air flow in "CFM"; water flow in "GPM"; temperature in "°F"; pressure in "psig"; etc.). Valve and damper position shall be indicated as an actual percentage value, not voltage value.

    a. Analog bars in 3 sizes shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the set point.
    b. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.

c. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or set point.

5. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
6. Off the shelf graphic software, Microgafx Designer or Coral Draw software shall be provided to allow the user to add, modify or delete system graphic displays.
7. A clip-art library of HVAC and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork and piping diagrams and symbols. The user shall have the ability to add custom symbols to the clip-art library.
8. System Configuration & Definition:

   a. Network-wide control strategies shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
   b. Provide automatic backup and restore of all DDC controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
   c. System configuration, programming, editing, graphics generation shall be performed on-line.

C. Alarm Management:

1. Alarm Routing shall allow the user to send alarm notification to selected printers, alphanumeric pagers or PC location via e-mail based on time of day, alarm severity, or point type.
2. Alarm Notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons shall be displayed when user is working in other Windows programs. The BAS alarm display screen shall be displayed when the user clicks on the alarm icon.
3. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message.
4. Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

D. Workstation Communications:

1. Provide automatic dial-up communications for buildings as specified. Automatic dial-up communications shall include the following features as a minimum:

   a. Dial-Out:

      1) Manual dial-out from the workstation to remote networks shall be accomplishable using only a mouse to select and request the desired remote connection.

   b. Dial-In:

      1) Alarms shall automatically dial into the workstation for display at the terminal and for hard copy printout at the associated event printer.

2. Alarms shall, at the operator's option, dial into a stand-alone modem-printer to provide for real-time alarm printouts even when the workstation is off-line (such as when it is being used to run operator-selected third-party software).
3. Trend data shall be scheduled for automatic updating to the workstation at operator-selected times. The operator shall also have the option of manually collecting trend data at any time.

E. Web Browser Clients:

1. The graphical user interface system shall be capable of supporting an unlimited number of clients using a standard Web Browser such as Internet Explorer™. Systems requiring additional software resident on the client machine or manufacture-specific browsers shall not be acceptable.
2. The Web Browser client shall support at a minimum, the following functions:

   a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication techniques to prevent unauthorized access shall be implemented.
   b. Graphical screens developed for the graphical user interface shall be the same screens used for the Web Browser client. Storage of the graphical screens shall be in the system, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
   c. Depending on user access privileges, the user shall be able to view data, modify and command objects such as start/stop, and adjust set points. In addition, users can be provided with the ability to view logs and view and acknowledge alarms.

3. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. The capability to limit the user to just their home page shall be provided. From the home page, links to other views, or pages in the system shall be possible.
4. Graphic screens on the Web Browser client shall support hypertext links to other Web pages on other Internet or intranet sites.

F. Object Library:

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
4. The library shall include applications or objects for the following functions:

   a. Scheduling Object. Provide a BACnet compliant, 7-day plus holiday and temporary scheduling object to allow for a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
   b. Calendar Object. Provide a BACnet compliant 12-month calendar object to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling-objects for effective event control.
   c. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

d. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
e. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start/stop time object properties based on the previous day's performance.
f. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

5. At a minimum, the library shall include services to support LonWorks or BACnet networks.
6. The library shall include control objects for the following functions at a minimum:

a. Analog Input Object - Minimum requirement is to meet the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
b. Analog Output Object - Minimum requirement is to meet the BACnet standard for data sharing.
c. Binary Input Object - Minimum requirement is to meet the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
d. Binary Output Object - Minimum requirement is to meet the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme must also be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing this contention resolution shall not be acceptable.
e. PID Control Loop Object - Minimum requirement is to meet the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
f. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

g. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
h. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
i. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
j. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
k. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

7. The object library shall include objects to support common LonMark devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering.

2.08 SAFETY DEVICES

A. Low Limit: Electric type, with 20 foot long serpentine element, with manual reset and set for 35°F for "freeze" protection and 48°F or 55°F for fan discharge application. Double pole, double throw.

B. High Limit: Electric high temperature thermostats shall have bimetal type sensing element with insertion length appropriate for the application. These shall be two position manual reset type.

C. Smoke Detectors: The Electrical Contractor shall provide duct smoke detectors and all associated wiring to signal the building fire alarm system. The BAS Contractor shall provide wired and hardwired interlock to the respective fan motor controller(s) and/or control panel to shutdown the equipment and signal an alarm at the operator's workstation.

D. Smoke dampers: Smoke dampers are furnished and mounted by the sheet metal contractor. The Electrical Contractor shall wire, 120 VAC, and control all smoke dampers via supervised fire alarm control modules. The BAS shall monitor smoke damper end switch and shutdown the equipment and signal an alarm at the operator's workstation.

E. Condensate Pan Overflow Switch: Model ACS-3 as manufactured by Little Giant, or acceptable substitute. Switch rated for 120/250 volts with maximum current of 11 amps.

2.09 AIR FLOW MEASUREMENT STATIONS

A. Where air flow measurement stations are required by the sequence of operations, and where such measurement stations are not specified to be furnished integral to equipment, the required measurement stations shall be furnished by the BAS Contractor. Where such measurement stations are furnished integral to equipment, provide all required transducers, wiring, etc., required for interface to the BAS.

B. Air measurement devices shall be of the temperature compensated velocity type, Ebtron Gold series.

C. Air flow monitoring is required for the following equipment (refer to other specification sections and coordinate with equipment manufacturers as required):

1. All air handling units.

2.10 FLOW METERS

A. Flow meter stations are required at primary heating water service. Meters shall be provided by the Mechanical Contractor and wired by the BAS Contractor.

2.11 FIELD DEVICES

A. All devices should conform to those already in use at this facility unless otherwise specified herein.

B. Temperature Sensors:

1. Room sensors serving offices, classrooms and conference rooms shall have LCD display night override button, and set point slide adjustment override options. The set point slide adjustment shall be able to be software limited to limit the amount of room adjustment. Room sensors serving toilet rooms, common areas, and other public spaces shall not have set point adjustment. Room sensors serving the gymnasium shall be provided with high impact guards.
2. Room sensors shall have sensing accuracy of 0.5°F, display accuracy and resolution shall be a minimum of 1°F.
3. Some specialty sensors and sensor accessories (different from those indicated above) are required for this project. Specific requirements for this are indicated on the drawings.

C. Duct Temperature Sensors:

1. Duct temperature sensors shall be averaging nickel wound resistance type. Sensors shall be 10,000 ohms at 77°F and have an accuracy of 0.25%. AHU's shall have duct temperature sensors installed to allow monitoring of the discharge air temperature, return air temperature, outside air temperature, and mixed air temperature at the operator's workstation. If supply or return duct size exceeds 48" x 48" then the use of an averaging temperature sensor mounted in the duct is required. Access to be provided to duct via an access door supplied and installed by the sheet metal contractor. (Outside air temperature may be sensed globally for the entire facility).

D. Humidity Sensors:

1. Humidity sensor elements shall be of the all polymer capacitive type with an active range of 0% to 100%. Accuracy of space humidity sensors shall be 5% at 77°F in the 20% to 95% range. Duct humidity sensors shall have an accuracy of 3% over the same range.
2. Outdoor humidity sensors shall be of the aspirated type, located in a sealed enclosure, protected from the sun. Outdoor air humidity sensors shall have a 0% to 100% range. Where the specifications require outdoor air humidity monitoring for enthalpy and other control sequences, a single outdoor air humidity sensor may be installed provided the control system is capable of true peer-to-peer data sharing between local control processors. If local control processors are not capable of sharing data without relying on the network control processors, a separate humidity sensor must be installed at each controller where such data is required.

E. Dampers, sized for specific application:

1. Automatic dampers shall be furnished by the BAS Contractor except where specified as part of packaged equipment. Dampers shall be single or multiple blades as required. Dampers are to be installed by the sheet metal contractor under the supervision of the temperature control contractor. All blank off plates and conversions necessary to install smaller than duct size dampers shall be the responsibility of the sheet metal contractor.
2. Provide automatic control dampers as indicated, with damper frames not less than formed 13 gauge galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-gauge galvanized steel, with maximum blade width of 8".
3. All blades are to be of airfoil or corrugated type construction. Airfoil blades shall be of extruded or cast metal. Corrugated blades shall be fabricated from two (2) sheets of No. 22 galvanized sheet steel, spot welded together. Blades are to be suitable for high velocity performance.
4. Secure blades to 2" diameter zinc plated axles using zinc plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. All damper bearings are to be made of oil impregnated plastic, or permanently lubricated ball bearings. Construct blade linkage hardware of zinc plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.
5. Operating Temperature Range: From -20 to 200°F (-29 to 93°C).
6. For standard applications as indicated, provide parallel or opposed blade design (as selected by the manufacturer's sizing techniques) with optional closed cell neoprene edging.
7. For low leakage applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable steel blade edging, or replaceable rubber seals, rated for leakage less than 10 cfm/sq.ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch pounds.

    a. For dampers in outside air intake or exhaust systems, replaceable butyl rubber seals are to be provided. Seals are to be installed along the top and bottom of each blade edge. Blade end seals shall be made of stainless steel. Seals shall provide a tight closing, low leakage damper.

F. Damper Operators, sized for specific application:

1. Automatic damper operators shall be furnished by the BAS Contractor except where specified as part of packaged equipment. They shall be quiet in operation and shall have ample power to overcome friction of damper linkage and air pressure acting on louvers to position dampers accurately and smoothly. The damper operator mounting arrangement shall be outside the airstream whenever possible.

2. Provide spring returns where required by the sequences of operation and/or as appropriate for the application.
3. Damper operators shall close tight against the differential pressure involved.

G. Automatic Control Valves, sized for specific application:

1. Electric Automatic Control Valves:

a. Automatic control valves for fin tube radiation and radiant panels shall be 2-position. All other automatic control valves (including, but not limited to, variable air volume box and constant air volume box heating coil valves) shall be fully proportional.
b. Valve bodies to be three-way mixing or two-way normally open or normally closed to suit application. Bodies 2" and less to be 250 psig bronze, screwed connection, bronze seats, equal percentage plugs, stainless steel stems with Teflon7 packing. Bodies over 2" to be 125 psig iron, flanged connection with modified equal percent plug. Valve selection to be based on maximum 3 psig drop across fully open valve.
c. All control valves shall be sized by the control manufacturer and shall be guaranteed to meet the performance required or specified. Water control valves shall be suitable for 125 PSIG working pressure and sized for 3 psi maximum allowable pressure drop.

H. Valve Operators, Sized for Specific Application:

1. Automatic valve operators shall be quiet in operation and fail safe in either normally open or normally closed position. All valve operators shall be capable of operating in sequence when required by the sequence of operation.
2. Valve operators shall have electric actuator.
3. Valve operators shall close tight against the differential pressure involved.

I. Aquastats:

1. Furnish immersion type electric; two position electric thermostats for all required applications, except strap on two position electric thermostats will be acceptable for cabinet and propeller unit heaters.

J. Differential Pressure Flow Switches (Water):

1. Flow status by differential pressure switches measuring the differential pressure between the supply and return lines. The set point shall be adjustable between 5 and 50 PSIG, or between 20 and 100 PSIG, as appropriate to the application, with an operating differential pressure of 2 PSI. The set point for heating system booster pumps shall be adjustable down to 2 PSIG. Maximum pressure difference between bellows shall be 120 PSI. The switches shall signal the operator workstation of loss of flow and, where applicable, allow for the activation of a stand by pump. Pump status shall be monitored by differential pressure switches (or by motor current switches).

K. Differential Pressure Flow Switches (Air):

1. Air flow switches shall be provided to monitor filter differential pressure. The switches shall have an adjustable set point range of 0.05" to 5.00" W.C. (field selectable). Air flow switches shall be provided to signal the operator's workstation (where applicable) of supply, return, and/or exhaust fan status for every AHU (supply, return, and exhaust fans independent). Fan status shall be monitored by differential pressure switches (or by motor current switches).

L. Pressure Transmitters:

1. Pressure transmitters shall have stainless steel diaphragms and shall be accurate to 1.0% of full scale and repeatability shall be less than 0.3% of full scale. The ranges for all pressure transmitters shall be as necessary to ensure proper control of the systems without exceeding the sensing range of the transmitter. Static pressure sensors shall be selected as appropriate for the application. Static pressure readings shall be reported to the operator's workstation.

M. Current Switches:

1. Fan and pump motor status shall be monitored by adjustable reading current switches (or by differential pressure switches). Sensors shall provide ON/OFF indication at the operator's work station.

2.12 DDC CONTROL RELAYS

A. Relay modules shall contain two or four SPDT line voltage relays (Form C) and Hand-Off-Auto override switches. Each relay shall have a LED to indicate an energized state.

2.13 MISCELLANEOUS CONTROL DEVICES

A. Furnish all other required control devices as required to fulfill the specified sequences of operation.

PART 3 – EXECUTION

3.01 PROJECT MANAGEMENT

A. Provide a designated project manager who will be responsible for the following:

1. Construct and maintain project schedule.
2. On site coordination with all applicable trades and subcontractors.
3. Authorized to accept and execute orders or instructions from Architect/Engineer.
4. Attend project meetings as necessary to avoid conflicts and delays.
5. Make necessary field decisions relating to this scope of work.
6. Coordination/Single point of contact.

3.02 START-UP AND TESTING

A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that all systems are operable from local controls in the specified failure mode, upon panel failure or loss of power.

1. Test all controlled mechanical equipment in concert with the mechanical contractor.
2. Test fire alarm monitoring in concert with the electrical contractor and speciality electrical subcontractors. Refer to Specification Division 26.

B. Provide any recommendation for system modification in writing to the Architect/Engineer. Do not make any system modification, including operating parameters and control settings, without prior approval of Architect/Engineer.

3.03 ADJUSTING AND CLEANING

A. Start Up: Start up, test, and adjust control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Schedules: The initial system programming shall include the set up of all building occupancy schedules and trend logs. Coordinate with the Owner's operating personnel to receive scheduling and trend log requirements.

C. Cleaning: Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch up paint.

D. Final Adjustment: After completion of installation, adjust thermostats, sensors, control valves, motors and similar equipment provided as work of this section.

1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

3.04 TRAINING AND CLOSEOUT PROCEDURES

A. The Contractor shall provide a factory trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The BAS Contractor shall provide all "students" with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.

B. Owner's Instructions: Provide services of manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of control systems.

1. Provide a minimum of 16 on site hours of training for Owner's designated operating and maintenance personnel, in multiple sessions (up to 4 sessions total) at intervals convenient to the Owner. Training shall include, but is not limited to:

   a. Explanation of drawings, operations and maintenance manuals.
   b. Walk through of the job to locate control components.
   c. Operator workstation and peripherals.
   d. DDC controller and ASC operation/function.
   e. Operator control functions including graphic generation and field panel programming.
   f. Explanation of adjustment, calibration and replacement procedures.
   g. Student binder with training modules.
   h. Schedule instruction with Owner; provide at least seven (7) day notice to Contractor and Engineer of training dates.

C. All training shall be coordinated with the Mechanical Contractor. Refer to Specification Section 23 01 00.

D. Since the Owner may require personnel to have more comprehensive understanding of the BAS, additional training must be available from the BAS Contractor. If such training is required by the Owner, it will be contracted at a later date

PART 4 – SEQUENCE OF OPERATIONS

NOTE: All set points indicated in the Sequences of Operation shall be adjustable, unless otherwise noted.

4.01 GENERAL

A. Low voltage power for air terminals, control valves, etc. shall be from control power transformers located in mechanical and/or electrical rooms at BAS panel locations (transformers located in ceiling spaces are not allowed). Installation of controls and all wiring to be provided by the BAS Contractor.

B. All control functions shall be direct digital controls (DDC) unless otherwise noted.

C. All modulating output points shall use PID control loops.

D. All on/off control points shall have adjustable minimum on and off time delays to prevent short cycling of equipment.

E. All DDC setpoints shall be adjustable. Setpoints listed within the sequences are suggested starting points. The BAS Contractor to adjust setpoints to suit actual working conditions and to meet Owner requirements.

F. BAS Contractor to perform calibrations each season during the first year of operation as part of commissioning and system warranty period.

G. Setpoints and time delays shall be adjustable by the BAS operator without hardware or software revisions.

H. Hand-Off-Auto switches for equipment controlled through the BAS shall be located in the associated DDC control panels and monitored through the BAS.

I. Motors with variable frequency drives shall have the following control points connected to the BAS through hard-wired terminations:

1. Start/Stop (Binary Output)
2. Speed Control (Analog Output)
3. Alarm/Fault (Binary Input)
4. Safeties (Local Interlocks)

J. Motors with variable frequency drives shall have the following control points connected to the BAS through a communications interface port:

1. Start/Stop (Binary Output)
2. Speed Control (Analog Output)
3. Status (Binary Input)
4. Alarm/Fault (Binary Input)
5. Safeties (Local Interlocks)

K. Motors without variable frequency drives shall have the following control points connected to the BAS through hard-wired terminations:

1. Start/Stop (Binary Output)
2. Speed Control for ECM Motors (Analog Output)
3. Amperage Sensor for Motors > 0.5 HP (Analog Input)

4. Amperage Status for Motors < 0.5 HP (Binary Input)

L. The BAS contractor shall provide airflow stations to measure outside air, supply air, return air and exhaust air flow for all air handling units. The air flow stations shall be used to measure the air entering and leaving the system during operation. The BAS contractor shall coordinate with the balancing contractor in order to calibrate air flow stations, establish damper positions, and to establish the proper tracking of fans.

M. Fail-Safe positions are positions that devices will go to when de-energized: NO = Normally Open, NC = Normally Closed. Device fail safe positions shall be spring driven.

N. Whenever a unit is off per the control system or the main power is disconnected, the control devices for the unit shall go to their fail-safe positions.

O. Occupied/Unoccupied mode shall be scheduled through the BAS. Provide override pushbutton switch on space temperature sensors in private areas for timed override of unoccupied mode.

P. Optimized start/stop for morning warm-up & cool-down cycles shall be determined by the BAS.

4.02 ALARMS

A. High and low limits shall be programmed into all sensors. When limits are exceeded, alarm shall be generated and logged by the BAS at the operator workstations.

B. Fan and pump status shall be monitored by the BAS through adjustable current switches, current sensors or VFD output as indicated above. If commanded status differs from measured status, an alarm shall be generated and logged by the BAS at the operator workstations.

C. All alarm messages generated at the operator workstations shall consist of descriptive English language text indicating time, date and exact nature of the alarm condition.

D. All alarms deemed “critical” or “dispatch alarms” shall also transmit alarm signal via security system, text message and/or email (coordinate with Owner).

4.03 DUCT SMOKE DETECTORS

A. Duct smoke detectors shall be furnished under Division 26 and installed by the Division 23 Contractor in the main supply and return air ducts associated with air handling units. Wiring to fire alarm system shall be part of work of Division 26 and wiring to shutdown associated supply and return air fans shall be by BAS Contractor.

4.04 SMOKE DAMPERS

A. Smoke dampers shall be furnished and installed by the Mechanical Contractor and wired by the Division 26 Contractor.

4.05 HOT WATER HEATING SYSTEM (B-1 AND BP-1)

A. General

1. A packaged control system shall be provided by the boiler manufacturer. This shall include a computerized boiler burner control system which shall be an integrated, solid state, digital micro-processing, modulating device, complete with sequence indication, fault reset, mode selection, and parameter setpoints. The boiler controller shall provide for both flame safeguard and boiler control and shall perform the following functions:

a. Burner sequencing control with safe start check, pre-purge, pilot ignition, post purge, and UV scanner to prove combustion.
b. Flame supervision control with pre-purge and post-purge and trending to maintain a running history of operating hours, number of cycles, and most recent faults. The control shall be connected to a keyboard display module.
c. Safety shutdown with display of error.
d. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
e. Gas pressure supervision, high and low.
f. Combustion air proving supervision.
g. High air pressure supervision, back draft too high.
h. The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.
i. Controller shall be equipped with a touch screen display for set up, troubleshooting, and operational display, and shall include ModBus communication capability of this information.
j. Include the programming of system circulating pump.

2. The BAS shall communicate with the packaged control system using a BACnet interface. In general, the BAS Contractor scope of work shall be:

a. Control wiring for BAS communication and field installed devices.
b. Programming and set-up of the BAS to send/receive and trend points available through the packaged control system.
c. Overall commissioning of unit controls including coordination with sub-contractors and unit manufacturer's start-up technician.

B. Hot Water Supply Temperature Reset

1. The controller shall measure the supply water temperature and modulate the burner to maintain supply water temperature setpoint as determined by the BAS.
2. Supply Water Temperature Reset: The supply water temperature setpoint shall reset as follows:

a. The supply water temperature setpoint shall be 160°F when outside air temperature is below 20°F.
b. As outside air temperature rises from 20°F to 60°F, the supply water temperature setpoint shall reset downwards from 160°F to 120°F.
c. The supply water temperature setpoint shall be 120°F when outside air temperature is above 60°F.

C. Pump Run Conditions

1. The pump shall be enabled to run whenever outside air temperature is less than 60°F (adj.) or there is a heating demand in a definable number of zones.
2. To prevent short cycling, the pump shall run and be off for minimum adjustable times (both user definable).

D. Differential Pressure Control

1. The controller shall measure hot water differential pressure and modulate the pump variable frequency drive (VFD) to maintain differential pressure setpoint of 10 psig (adj.). The differential pressure sensor shall be located 2/3 downstream in the system. The differential pressure setpoint shall be field adjusted during system testing and balancing to meet requirements of actual field conditions. The VFD minimum speed shall not drop below 20% (adj.).
2. The differential bypass valve shall normally be closed, but shall modulate to maintain differential pressure setpoint if pump is at minimum speed and pressure setpoint is exceeded.

E. Temperature Monitoring: The following temperatures shall be monitored.

1. Hot water supply
2. Hot water return
3. Outside air temperature

F. Boiler Interface Monitor

1. Status and operating conditions of the boilers shall be monitored through a BACnet communication interface. The interface will monitor and trend the points as shown on the points list.

G. VFD Interface Monitor

1. Status and operating conditions for each pump VFD shall be monitored through a BACnet communication interface. The interface shall monitor and trend points as shown on the points list.

H. Alarms: Alarms shall be provided as follows.

1. Boiler Flame Failure.
2. Pump Failure: Commanded on, but the status is off.
3. Pump in Hand: Commanded off, but the status is on.
4. Pump Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
5. Pump VFD Alarm/Fault.
6. High Hot Water Supply Temp: If greater than 200°F (adj.)
7. Low Hot Water Supply Temp: If less than 100°F (adj.)
8. High Hot Water Differential Pressure: If 25% (adj.) greater than setpoint
9. Low Hot Water Differential Pressure: If 25% (adj.) less than setpoint

I. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Differential Pressure	x								x	x	x
Hot Water Supply Temp	x								x	x	x
Hot Water Return Temp	x								x		x
Outside Air Temp	x								x	x	x
Differential Bypass Valve		x							x		x
Pump Speed		x							x		x
Pump Status			x						x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Pump VFD Alarm/Fault			x							x	x
Pump Start/Stop				x					x		x
Supply Water Temperature Setpoint						x			x		x
Boiler Burner Cycles					x				x		x
Boiler Operating Hours					x				x		x
Boiler Operating Temperature					x				x		x
Boiler Supply Water Temperature					x				x		x
Boiler Return Water Temperature					x				x		x
Boiler Firing Status							x		x		x
Boiler Flame Failure							x			x	x

4.06 PACKAGED ROOFTOP DEHUMIDIFICATION UNITS (DHU-1A, 1B, 2, 3, 4, 5, 6B, 7, 8, 9, 10, 11, 12)

A. General

1. A packaged control system shall be provided by the rooftop unit manufacturer. The packaged control system shall include the following features:

   a. Standalone microprocessor controls with local display and BACnet connection for BAS interface.
   b. All control devices mounted and wired except for devices required to be remotely mounted. These devices to be factory furnished and field installed by BAS Contractor.
   c. BACnet communication protocol to end devices.
   d. Clock and scheduling function for occupancy with separate occupied and unoccupied setpoints. Scheduling shall be through the BAS with backup provided by integral time clock upon loss of communication with BAS.

e. Non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
f. Supply and exhaust fans with motor protection devices and variable frequency drives.
g. Energy recovery wheel with motor protection device and variable frequency drive.
h. Dampers and damper actuators.
i. Refrigeration system components.
j. Anti-cycle timing and minimum equipment run/off times.

2. The BAS shall communicate with the packaged control system using a BACnet interface. In general, the BAS Contractor scope of work shall be:

   a. Overall coordination with rooftop unit manufacturer.
   b. Control wiring for BAS communication and field installed devices.
   c. Programming and set-up of the BAS to send/receive and trend points available through the packaged control system.
   d. Overall commissioning of unit controls including coordination with sub-contractors and unit manufacturer's start-up technician.

3. The rooftop unit shall perform the following functions:

   a. Operate with 100% outside air during occupied periods and 100% return air in unoccupied mode.
   b. Dehumidify and cool supply air prior to delivery to spaces.
   c. Provide airflow to duct mounted heating coils for space heating.
   d. Recover energy in exhaust air using energy recovery wheel.

4. Whenever the unit is shut down by command of the control system or power disconnect, all control devices associated with the system shall revert to the normal state or position. Outside air, return air and exhaust air dampers shall be equipped with end switches to prove positions.
5. After a power interruption, the rooftop unit shall automatically restart in the mode appropriate to the operating schedule.
6. The BAS shall include logic to stagger rooftop unit startups to limit electrical surges.
7. Control device state or position shall be as follows for the various modes of operation:

Mode	Supply Fan	Exhaust Fan	Energy Recovery Wheel	Cooling System	OA Damper	EA Damper	RA Damper
Power Loss	OFF	OFF	OFF	OFF	CLOSED	CLOSED	OPEN
Unoccupied	OFF	OFF	OFF	OFF	CLOSED	CLOSED	OPEN
Unoccupied Dehum.	ON	OFF	OFF	ON & MOD	CLOSED	CLOSED	OPEN
Unoccupied Night Purge	ON	ON	JOG	OFF	OPEN	OPEN	CLOSED

Mode	Supply Fan	Exhaust Fan	Energy Recovery Wheel	Cooling System	OA Damper	EA Damper	RA Damper
Unoccupied Heating	ON	OFF	OFF	OFF	CLOSED	CLOSED	OPEN
Occupied Dehum.	ON	ON	ON	ON & MOD	OPEN	OPEN	CLOSED
Occupied Cooling	ON	ON	ON	ON & MOD	OPEN	OPEN	CLOSED
Occupied Heating	ON	ON	ON	OFF	OPEN	OPEN	CLOSED
Energy Recovery - Economizer	ON	ON	JOG	TBD	OPEN	OPEN	CLOSED
Energy Recovery - Frost Protection	ON	ON	ON & MOD	OFF	OPEN	OPEN	CLOSED

B. Unit Start Initiation

1. The start sequence shall be initiated through one of the following methods:

   a. Enable switch is placed in the “Hand” position at controller.
   b. Enable switch is placed in the “Auto” position at controller and remote BAS enable contacts are closed.

2. The unit shall be commanded to run through the BAS based upon an operator adjustable schedule or when a definable number of unoccupied zones require heating or there is a dehumidification demand. Upon loss of BAS communications, unit shall run based upon time clock provided with packaged controls.
3. In addition, the following control method shall be available for operator selection:

   a. Local Override: The unit shall run for 2 hours (adj.) upon activation of override at any zone.

C. Optimal Start

1. The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints as determined by the BAS. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.

D. Night Purge Cycle

1. The unit shall start and run in economizer mode during unoccupied periods when conditions are appropriate for night purge cycle. Night purge cycle shall be initiated when

a. Outside air temperature falls 10ºF (adj.) below average space temperature
b. AND average space temperature is greater than 70ºF (adj.)
c. AND outdoor air enthalpy is below 24 btu/lb (adj.)
d. AND outdoor air temperature is above 50ºF (adj.)

2. Night purge cycle shall stop when

a. Average space temperature falls to within 5°F (adj.) of outside air temperature
b. OR average space temperature falls below 70ºF (adj.)
c. OR outdoor air enthalpy rises above 24 btu/lb (adj.)
d. OR outdoor air temperature drops below 50ºF (adj.)

3. During night purge cycle associated terminal heating and cooling units shall remain off.

E. Occupied Periods

1. Unit Start and Fan Control: Upon start sequence initiation, outside air and exhaust air dampers shall open and prove open. The energy recovery wheel shall start and run at full speed. The exhaust fan shall start and run at minimum speed. After a 15-second (adj.) delay, the supply fan shall start and run at minimum speed. After a 30-second (adj.) delay, the supply fan and exhaust fan airflow controls shall be enabled. The following two fan control methods shall be available for operator selection:

a. Method #1 Predetermined Speeds (Default for Classroom Units): The supply and exhaust fans shall slowly ramp up in unison to predetermined speeds necessary to achieve design airflows. The BAS contractor shall coordinate with the balancing contractor in order to establish variable frequency drive setpoints necessary to obtain the required airflows.
b. Method #2 Exhaust Airflow Tracking (Default for Shop Units): The supply and exhaust fans shall slowly ramp up in unison. Supply fan shall ramp up to predetermined speed necessary to achieve design airflow. Exhaust fan shall ramp up to exhaust airflow setpoint equal to a percentage of the supply air flow minus local exhaust airflow. Status of associated exhaust fans shall determine local exhaust airflow. Unit exhaust airflow setpoint shall be 90% (adj.) for Classroom Units and 120% (adj.) for Shop Units. Local exhaust fans associated with each unit are as follows:

1) DHU-4: EF-C134
2) DHU-5: EF-C121 and VE-1, 2, 3, 4

c. Airflow stations shall be factory installed in unit to measure supply airflow and exhaust airflow. The air flow stations shall be used to measure the air entering and leaving the system during operation. The BAS contractor shall coordinate with the balancing contractor in order to calibrate air flow stations.

2. Dehumidification Mode: This mode shall be initiated when outside air dew-point downstream of the energy recovery wheel is above 48ºF (adj.). Compressor #1 shall start and modulate to maintain evaporator leaving air temperature setpoint of 48ºF (adj.). If after a 5 minute delay the evaporator leaving air temp is higher than setpoint by 2ºF (adj.) and compressor #1 is at 100% capacity, compressor #2 shall start and compressor #1 shall modulate to maintain evaporator leaving air temperature setpoint. Additional compressors shall be brought online in similar fashion as required. The reverse shall occur upon a drop in evaporator leaving air temperature below setpoint with a 5-minute delay between stages. During the dehumidification cycle, the controller shall enable hot gas reheat system which shall modulate to maintain discharge air temperature setpoint in accordance with the reset schedule. The hot gas reheat coil shall undergo a purge cycle every 30 minutes for 3

minutes. During the purge cycle the hot gas reheat coil shall be bypassed 100%. Heating mode shall be disabled when dehumidification mode is enabled.

3. Cooling Mode: This mode shall be initiated when outside air temperature downstream of energy recovery wheel is higher than discharge air temperature setpoint by 2ºF (adj.) and outside air dew-point downstream of energy recovery is below 48ºF (adj.). Compressor #1 shall start and modulate to maintain discharge air temperature setpoint in accordance with reset schedule. If after a 5 minute delay the discharge air temperature is higher than the discharge air temperature setpoint by two 2ºF (adj.) and compressor #1 is at 100% capacity, compressor #2 shall start and compressor #1 shall modulate to maintain discharge air temperature setpoint. Additional compressors shall be brought online in similar fashion as required. The reverse shall occur upon a drop in discharge air temperature below setpoint with a 5 minute delay between stages. Heating mode shall be disabled when cooling mode is enabled.
4. Energy Recovery - Economizer Mode: This mode shall be initiated when the outside air dew-point entering the unit is within +/– 2.5ºF of the return air dew-point. Energy recovery wheel shall stop and jog every 5 minutes (adj.) to keep clean.
5. Energy Recovery – Frost Protection Mode: This mode shall be initiated when the exhaust air temperature leaving the energy recovery wheel drops below the frost control temperature setpoint as determined by unit manufacturer. Energy recovery wheel VFD shall modulate speed to maintain frost control temperature setpoint. Systems using electric preheat shall energize heating coil upstream of energy recovery wheel to prevent frost formation. Energy recovery wheel shall jog every 5 minutes (adj.) to keep clean. .

F. Unoccupied Periods

1. Unit Start: Upon start sequence initiation, outside air and exhaust air dampers shall remain closed and return air damper shall remain open and prove open. The supply fan shall start and run at minimum speed. The energy recovery wheel and exhaust fan shall remain off. After a 30-second (adj.) delay, the supply fan shall run at predetermined speed necessary to achieve design airflow. The BAS contractor shall coordinate with the balancing contractor in order to establish speed set point necessary to obtain the required airflow rate.
2. Dehumidification Mode: A relative humidity sensor located in one of the classrooms served by the unit shall monitor space relative humidity levels. Unit shall start and enter mode when space relative humidity rises above 55% (adj.). Cooling system operation shall be the same as for occupied dehumidification mode. Dehumidification mode shall cease when space relative humidity drops 5% below setpoint.
3. Heating Mode: Unit shall start and enter mode when 2 (adj.) or more zones drop 2ºF below unoccupied heating setpoint. Zone heating coil valves shall open to achieve a zone temperature 2ºF above unoccupied heating setpoint. Cooling mode shall be disabled when heating mode is enabled. Heating mode shall cease when zone heating demands are satisfied.

G. Discharge Air Temperature Reset

1. Outside Air Temperature Reset: The discharge air temperature setpoint shall reset between 55ºF and 65ºF as follows:

   a. The discharge air temperature setpoint shall be 65°F when outside air temperature is below 40°F.
   b. As outside air temperature rises from 40°F to 70°F, the discharge air temperature setpoint shall reset downwards from 65°F to 55°F.
   c. The discharge air temperature setpoint shall be 55°F when outside air temperature is above 70°F.

H. Safeties: The following hard-wired safeties shall shutdown unit and generate an alarm.

1. Fire Alarm System: Unit shall shutdown upon activation of building fire alarm system. Electrical Contractor shall provide fire alarm system control module. BAS Contractor shall hardwire through control module to shut down unit. Unit shall resume normal operation automatically upon manual reset through the fire alarm system.
2. Smoke Detectors: Unit shall shutdown upon activation of unit mounted smoke detectors. Rooftop unit manufacturer shall provide smoke detector within unit supply air and unit return air plenums. BAS Contractor shall hardwire through smoke detectors to shutdown unit. Unit shall resume normal operation automatically when smoke condition clears.
3. Freezestat: Unit shall shutdown upon activation of low temperature switch (freezestat). BAS Contractor shall provide double pole, low limit temperature switch with sensing bulb in supply air duct main. Switch shall trip when any one foot section of the sensing element drops below 38°F. One pole shall be hardwired to shut down unit and the other pole shall be used to provide status to BAS. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.
4. Supply Air High Static: Unit shall shutdown upon activation of high static pressure switch. BAS Contractor shall provide a double pole, pressure switch to sense static pressure within the supply air duct main. Switch shall trip when pressure set point is exceeded. One pole shall be hardwired to shut down unit and the other pole shall be used to provide status to BAS. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.
5. Return Air Low Static: Unit shall shutdown upon activation of low static pressure switch. BAS Contractor shall provide a double pole, pressure switch to sense static pressure within the return air duct main. Switch shall trip when pressure set point is exceeded. One pole shall be hardwired to shut down unit and the other pole shall be used to provide status to BAS. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.

I. Alarms: The following shall generate and alarm.

1. Dirty Filter (Each Filter): Alarm shall be generated if filter differential pressure switch trips. Rooftop unit manufacturer shall provide pressure switch for each filter bank. Adjust switch setting per filter manufacturer's recommendations.
2. Supply Fan Runtime Exceeded: Alarm shall be generated if runtime hours exceed a user definable limit (adj.). BAS shall monitor supply fan runtime through BACnet interface. Runtime hours shall be resettable through BAS.
3. Supply Fan Failure: Alarm shall be generated upon fan failure. BAS shall monitor failure status through BACnet interface.
4. Exhaust Fan Runtime Exceeded: Alarm shall be generated if runtime hours exceed a user definable limit (adj.). BAS shall monitor supply fan runtime through BACnet interface. Runtime hours shall be resettable through BAS.
5. Exhaust Fan Failure: Alarm shall be generated upon fan failure. BAS shall monitor failure status through BACnet interface.
6. Energy Recovery Wheel Runtime Exceeded: Alarm shall be generated if runtime hours exceed a user definable limit (adj.). BAS shall monitor supply fan runtime through BACnet interface. Runtime hours shall be resettable through BAS.
7. Energy Recovery Wheel Failure: Alarm shall be generated upon energy recovery wheel failure. BAS shall monitor failure status through BACnet interface.
8. Temperature and Relative Humidity Sensor Failure: Alarm shall be generated upon failure of any sensor. BAS shall monitor sensors through BACnet interface.
9. Low Space Temperature: Alarm shall be indicated if space temperature is less than 55ºF (adj.). BAS shall monitor sensor through BACnet interface.
10. High Space Temperature: Alarm shall be generated if space temperature is greater than 85ºF (adj.). BAS shall monitor sensor through BACnet interface.

11. High Space Relative Humidity: Alarm shall be indicated if space relative humidity is greater than 65% (adj.). BAS shall monitor sensor through BACnet interface.

J. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Outside Air Temp (Global)	x								x		x
Outside Air Relative Humidity (Global)	x								x		x
Freezestat			x							x	x
Supply Air High Static			x							x	x
Return Air Low Static			x							x	x
Rooftop Unit Occupied/Unoccupied			x						x		x
Average Space Temperature					x				x		x
POINTS ACCESSIBLE VIA BACNET INTERFACE											
Outside Air Temp	x								x		x
Outside Air Relative Humidity	x								x		x
Space Temperature	x								x	x	x
Space Relative Humidity	x								x	x	x
Energy Recovery Wheel Leaving Air Temp (Supply Air)	x								x		x
Energy Recovery Wheel Leaving Air Relative Humidity (Supply Air)	x								x		x
Discharge Air Temp	x								x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Evaporator Leaving Air Temp	x								x		x
Hot Gas Reheat Command		x							x		x
Supply Fan VFD Command		x							x		x
Exhaust Fan VFD Command		x							x		x
Comp #1 Command (Digital Scroll)		x							x		x
Supply Fan Status			x							x	x
Exhaust Fan Status			x							x	x
Filter Status (Each Filter)			x							x	x
Emergency Stop			x							x	x
Occupancy Input			x								x
OA Damper End Switch			x								x
Supply Fan Start/Stop Command				x							x
Exhaust Fan Start/Stop Command				x							x
OA Damper Command				x							x
Heating Demand				x							x
Comp #1 Command				x							x
Comp #2 Command				x							x
Comp #3 Command				x							x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Comp #4 Command				x							x
Energy Recovery Wheel Command				x							x
Occupied Space Cooling Setpoint					x						x
Occupied Space Heating Setpoint					x						x
Discharge Air Temperature BAS					x						x
Space Relative Humidity BAS					x						x
Outdoor Air Dewpoint Setpoint					x						x
Evaporator Leaving Air Temperature Setpoint					x						x
Space Temperature BAS					x						x
Unoccupied Space Cooling Setpoint					x						x
Unoccupied Space Heating Setpoint					x						x
Unoccupied Space Dewpoint Setpoint					x						x
Outdoor Air Cooling Setpoint					x						x
Discharge Air Cooling Setpoint					x						x
Discharge Air Heating Setpoint					x						x
Outdoor Air Heating Setpoint					x						x
Space Dewpoint Setpoint					x						x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Supply Fan VFD Setpoint					x						x
Exhaust Fan VFD Setpoint					x						x
Supply Airflow					x						x
Exhaust Airflow					x						x
Outdoor Air Temperature BAS					x						x
Outdoor Air Relative Humidity BAS					x						x
Minimum Discharge Air Cooling Setpoint					x						x
Minimum Discharge Air Heating Setpoint					x						x
Supply Fan Failure							x			x	x
Exhaust Fan Failure							x			x	x
Diagnostic: OA Damper Proving Switch							x				x
Diagnostic: Discharge Air Temperature Source Failure							x			x	x
Economizer Mode							x				x
Diagnostic: Space Temperature Source Failure							x			x	x
Diagnostic: Outdoor Air Temperature Source Failure							x			x	x
Diagnostic: Outdoor Air Relative Humidity Source Failure							x			x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Alarm Reset							x				
System Lockout							x			x	x
Diagnostic: Space Relative Humidity Source Failure							x			x	x
Unoccupied Cooling Mode							x				x
Unoccupied Dehumidification Mode							x				x
Cool Stage 1 Request							x				x
Cool Stage 2 Request							x				x
Cool Stage 3 Request							x				x
Cool Stage 4 Request							x				x
Dehumidification Command							x				x
Program Control							x				
Occupancy Request							x				x

4.07 PACKAGED ROOFTOP DEHUMIDIFICATION UNITS (DHU-6A)

A. General

1. A packaged control system shall be provided by the rooftop unit manufacturer. The packaged control system shall include the following features:

   a. Standalone microprocessor controls with local display and BACnet connection for BAS interface.
   b. All control devices mounted and wired except for devices required to be remotely mounted. These devices to be factory furnished and field installed by BAS Contractor.
   c. BACnet communication protocol to end devices.

d. Clock and scheduling function for occupancy with separate occupied and unoccupied setpoints. Scheduling shall be through the BAS with backup provided by integral time clock upon loss of communication with BAS.
e. Non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
f. Supply fan with motor protection devices and variable frequency drives.
g. Dampers and damper actuators.
h. Refrigeration system components.
i. Anti-cycle timing and minimum equipment run/off times.

2. The BAS shall communicate with the packaged control system using a BACnet interface. In general, the BAS Contractor scope of work shall be:

   a. Overall coordination with rooftop unit manufacturer.
   b. Control wiring for BAS communication and field installed devices.
   c. Programming and set-up of the BAS to send/receive and trend points available through the packaged control system.
   d. Overall commissioning of unit controls including coordination with sub-contractors and unit manufacturer's start-up technician.

3. The rooftop unit shall perform the following functions:

   a. Provide ventilation air and makeup air during occupied mode and operate with 100% return air in unoccupied mode.
   b. Dehumidify, cool and heat supply air prior to delivery to space.

4. Whenever the unit is shut down by command of the control system or power disconnect, all control devices associated with the system shall revert to the normal state or position.
5. After a power interruption, the rooftop unit shall automatically restart in the mode appropriate to the operating schedule.
6. The BAS shall include logic to stagger rooftop unit startups to limit electrical surges.
7. Control device state or position shall be as follows for the various modes of operation:

Mode	Supply Fan	Cooling System	Heating Coil Valve	OA Damper	RA Damper	Exhaust Fan KEF-5
Power Loss	OFF	OFF	OPEN	CLOSED	OPEN	OFF
Unoccupied	OFF	OFF	CLOSED	CLOSED	OPEN	OFF
Unoccupied Dehum.	ON	ON & MOD	CLOSED	CLOSED	OPEN	OFF
Unoccupied Night Purge	ON	OFF	CLOSED	OPEN	CLOSED	ON
Unoccupied Heating	ON	OFF	OPEN	CLOSED	OPEN	OFF

Mode	Supply Fan	Cooling System	Heating Coil Valve	OA Damper	RA Damper	Exhaust Fan KEF-5
Occupied Dehum.	ON	ON & MOD	CLOSED	OPEN	CLOSED	ON
Occupied Cooling	ON	ON & MOD	CLOSED	OPEN	CLOSED	ON
Occupied Heating	ON	OFF	MOD	OPEN	CLOSED	ON

B. Unit Start Initiation

1. The start sequence shall be initiated through one of the following methods:

   a. Enable switch is placed in the “Hand” position at controller.
   b. Enable switch is placed in the “Auto” position at controller and remote BAS enable contacts are closed.

2. The unit shall be commanded to run through the BAS based upon an operator adjustable schedule or when any associated exhaust fans is energized (KEF-4, 5 or 6) or there is a zone heating or dehumidification demand. Upon loss of BAS communications, unit shall run based upon time clock provided with packaged controls.
3. In addition, the following control method shall be available for operator selection:

   a. Local Override: The unit shall run for 2 hours (adj.) upon activation of override at any zone.

C. Optimal Start

1. The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints as determined by the BAS. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.

D. Night Purge Cycle

1. The unit shall start and run in economizer mode during unoccupied periods when conditions are appropriate for night purge cycle. Night purge cycle shall be initiated when

   a. Outside air temperature falls 10ºF (adj.) below average space temperature
   b. AND average space temperature is greater than 70ºF (adj.)
   c. AND outdoor air enthalpy is below 24 btu/lb (adj.)
   d. AND outdoor air temperature is above 50ºF (adj.)

2. Night purge cycle shall stop when

   a. Average space temperature falls to within 5°F (adj.) of outside air temperature
   b. OR average space temperature falls below 70ºF (adj.)

c. OR outdoor air enthalpy rises above 24 btu/lb (adj.)
d. OR outdoor air temperature drops below 50ºF (adj.)

3. Heating and cooling mode shall remain off during night purge cycle.

E. Occupied Periods

1. Unit Start and Fan Control: Upon start sequence initiation, the supply fan shall start and run at minimum speed. After a 30-second (adj.) delay, supply fan shall ramp up to predetermined speed to achieve airflow of 1800 CFM, exhaust fan KEF-5 shall start, outside air and return air dampers shall be positioned for minimum outside air of 860 CFM, and the ventilation airflow controls shall be enabled. The BAS contractor shall coordinate with the balancing contractor in order to establish variable frequency drive setpoint and damper positions necessary to obtain the required airflows. The following two ventilation airflow control methods shall be available for operator selection:

a. Method #1 Predetermined Speed/Positions: The supply fan shall run at predetermined speed and the outside air and return air dampers shall be positioned to achieve design airflows based on the status of associated exhaust fans as follows:

KEF-4 STATUS	KEF-5 STATUS	KEF-6 STATUS	KEF TOTAL CFM	SUPPLY CFM	O/A CFM	R/A CFM	NEG. PRESS. CFM
OFF	ON	OFF	1260	1800	860	940	400
OFF	ON	ON	3250	2850	2850	0	400
ON	ON	OFF	4020	3620	3620	0	400
ON	ON	ON	6010	5610	5610	0	400

b. Method #2 (Static Pressure Control): Control shall be enabled whenever KEF-4 or KEF-5 is energized. Upon activation, the supply fan shall modulate to maintain a space static pressure setpoint of negative 0.05 inches w.g. (adj.). Outside air and return air dampers shall be positioned for 100% outside air.
c. Airflow stations shall be factory installed in unit to measure supply airflow and outside airflow. The air flow stations shall be used to measure the air entering and leaving the system during operation. The BAS contractor shall coordinate with the balancing contractor in order to calibrate air flow stations.

2. Dehumidification Mode: This mode shall be initiated when outside air dew-point is above 48ºF (adj.) and the space relative humidity is above 50% (adj.). Compressor #1 shall start and modulate to maintain evaporator leaving air temperature setpoint of 48ºF (adj.). If after a 5 minute delay the evaporator leaving air temp is higher than setpoint by 2ºF (adj.) and compressor #1 is at 100% capacity, compressor #2 shall start and compressor #1 shall modulate to maintain evaporator leaving air temperature setpoint. Additional compressors shall be brought online in similar fashion as required. The reverse shall occur upon a drop in evaporator leaving air temperature below setpoint with a 5-minute delay between stages. During the dehumidification cycle, the controller shall enable hot gas reheat system which shall modulate to maintain the space air temperature heating setpoint. The hot gas reheat coil shall undergo a purge cycle every 30 minutes for 3 minutes. During the purge cycle the hot gas reheat coil shall be bypassed 100%. Cooling mode shall be disabled when dehumidification mode is enabled.

3. Cooling Mode: This mode shall be initiated when outside air temperature is above 55ºF (adj.), space air temperature is above 75ºF (adj.) and there is no dehumidification demand. Compressor #1 shall start and modulate to maintain discharge air temperature of 57ºF (adj.). If after a 5 minute delay the discharge air temperature is higher than the discharge air temperature setpoint by two 2ºF (adj.) and compressor #1 is at 100% capacity, compressor #2 shall start and compressor #1 shall modulate to maintain discharge air temperature setpoint. Additional compressors shall be brought online in similar fashion as required. The reverse shall occur upon a drop in discharge air temperature below setpoint with a 5 minute delay between stages. Cooling mode shall cease when space air temperature setpoint is 2ºF below setpoint. Heating mode shall be disabled when cooling mode is enabled. Provide minimum 5ºF differential between space heating and cooling temperature setpoints.
4. Heating Mode: This mode shall be initiated when outside air temperature is below 65ºF and space air temperature is below 70ºF (adj.). Heating coil valve shall modulate to maintain discharge air temperature setpoint which shall be reset from 65ºF to 95ºF based on space temperature. Cooling mode shall be disabled when heating mode is enabled. Provide minimum 5ºF differential between space heating and cooling temperature setpoints.

F. Unoccupied Periods

1. Unit Start: Upon start sequence initiation, outside air damper shall remain closed and return air damper shall remain open. The supply fan shall start and run at minimum speed. Exhaust fan KEF-5 shall remain off. After a 30-second (adj.) delay, the supply fan shall run at predetermined speed necessary to achieve airflow of 1800 CFM. The BAS contractor shall coordinate with the balancing contractor in order to establish speed set point necessary to obtain the required airflow rate.
2. Dehumidification Mode: A relative humidity sensor located in space served by the unit shall monitor space relative humidity levels. Unit shall start and enter mode when space relative humidity rises above 55% (adj.). Cooling system operation shall be the same as for occupied dehumidification mode. Dehumidification mode shall cease when space relative humidity drops 5% below setpoint.
3. Heating Mode: Unit shall start and enter mode when space drops 2ºF below unoccupied heating setpoint. Unit heating coil valve shall open to achieve a zone temperature 2ºF above unoccupied heating setpoint. Cooling mode shall be disabled when heating mode is enabled. Heating mode shall cease when space heating demand is satisfied.

G. Safeties: The following hard-wired safeties shall shutdown unit and generate an alarm.

1. Fire Alarm System: Unit shall shutdown upon activation of building fire alarm system. Electrical Contractor shall provide fire alarm system control module. BAS Contractor shall hardwire through control module to shut down unit. Unit shall resume normal operation automatically upon manual reset through the fire alarm system.
2. Smoke Detectors: Unit shall shutdown upon activation of unit mounted smoke detector. Rooftop unit manufacturer shall provide smoke detector within unit supply air plenum. BAS Contractor shall hardwire through smoke detector to shutdown unit. Unit shall resume normal operation automatically when smoke condition clears.
3. Freezestat: Unit shall shutdown upon activation of low temperature switch (freezestat). BAS Contractor shall provide double pole, low limit temperature switch with sensing bulb in supply air duct main. Switch shall trip when any one foot section of the sensing element drops below 38°F. One pole shall be hardwired to shut down unit and the other pole shall be used to provide status to BAS. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.
4. Supply Air High Static: Unit shall shutdown upon activation of high static pressure switch. BAS Contractor shall provide a double pole, pressure switch to sense static pressure within the supply air duct main. Switch shall trip when pressure set point is exceeded. One pole shall be hardwired to shut down unit and the other pole shall be used to provide status to

BAS. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.

5. Return Air Low Static: Unit shall shutdown upon activation of low static pressure switch. BAS Contractor shall provide a double pole, pressure switch to sense static pressure within the return air duct main. Switch shall trip when pressure set point is exceeded. One pole shall be hardwired to shut down unit and the other pole shall be used to provide status to BAS. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.

H. Alarms: The following shall generate and alarm.

1. Dirty Filter: Alarm shall be generated if filter differential pressure switch trips. Rooftop unit manufacturer shall provide pressure switch for filter bank. Adjust switch setting per filter manufacturer's recommendations.
2. Supply Fan Runtime Exceeded: Alarm shall be generated if runtime hours exceed a user definable limit (adj.). BAS shall monitor supply fan runtime through BACnet interface. Runtime hours shall be resettable through BAS.
3. Supply Fan Failure: Alarm shall be generated upon fan failure. BAS shall monitor failure status through BACnet interface.
4. Exhaust Fan KEF-5 Runtime Exceeded: Alarm shall be generated if runtime hours exceed a user definable limit (adj.). BAS shall monitor supply fan runtime. Runtime hours shall be resettable through BAS.
5. Exhaust Fan KEF-5 Failure: Alarm shall be generated when fan is commanded on, but status is off.
6. Temperature and Relative Humidity Sensor Failure: Alarm shall be generated upon failure of any sensor. BAS shall monitor sensors through BACnet interface.
7. Low Space Temperature: Alarm shall be indicated if space temperature is less than 55ºF (adj.). BAS shall monitor sensor through BACnet interface.
8. High Space Temperature: Alarm shall be generated if space temperature is greater than 85ºF (adj.). BAS shall monitor sensor through BACnet interface.
9. High Space Relative Humidity: Alarm shall be indicated if space relative humidity is greater than 65% (adj.). BAS shall monitor sensor through BACnet interface.

I. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Outside Air Temp (Global)	x								x		x
Outside Air Relative Humidity (Global)	x								x		x
Freezestat			x							x	x
Supply Air High Static			x							x	x
Return Air Low Static			x							x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Exhaust Fan KEF-4 Status			x								x
Exhaust Fan KEF-5 Status			x							x	x
Exhaust Fan KEF-6 Status			x								x
Exhaust Fan KEF-5 On/Off				x					x		x
Rooftop Unit Occupied/Unoccupied				x					x		x
POINTS ACCESSIBLE VIA BACNET INTERFACE											
Outside Air Temp	x								x		x
Outside Air Relative Humidity	x								x		x
Space Temperature	x								x	x	x
Space Relative Humidity	x								x	x	x
Discharge Air Temp	x								x		x
Evaporator Leaving Air Temp	x								x		x
Hot Gas Reheat Command		x							x		x
Supply Fan VFD Command		x							x		x
Comp #1 Command (Digital Scroll)		x							x		x
Heating Output Command		x							x		x
Supply Fan Status			x							x	x
Filter Status			x							x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Emergency Stop			x							x	x
Occupancy Input			x								x
OA Damper End Switch			x								x
Supply Fan Start/Stop Command				x							x
OA Damper Command				x							x
Heating Demand				x							x
Comp #1 Command				x							x
Comp #2 Command				x							x
Comp #3 Command				x							x
Comp #4 Command				x							x
Occupied Space Cooling Setpoint					x						x
Occupied Space Heating Setpoint					x						x
Discharge Air Temperature BAS					x						x
Space Relative Humidity BAS					x						x
Outdoor Air Dewpoint Setpoint					x						x
Evaporator Leaving Air Temperature Setpoint					x						x
Space Temperature BAS					x						x
Unoccupied Space Cooling Setpoint					x						x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Unoccupied Space Heating Setpoint					x						x
Unoccupied Space Dewpoint Setpoint					x						x
Outdoor Air Cooling Setpoint					x						x
Discharge Air Cooling Setpoint					x						x
Discharge Air Heating Setpoint					x						x
Outdoor Air Heating Setpoint					x						x
Space Dewpoint Setpoint					x						x
Supply Fan VFD Setpoint					x						x
Supply Airflow					x						x
Outdoor Air Temperature BAS					x						x
Outdoor Air Relative Humidity BAS					x						x
Minimum Discharge Air Cooling Setpoint					x						x
Minimum Discharge Air Heating Setpoint					x						x
Supply Fan Failure							x			x	x
Diagnostic: Discharge Air Temperature Source Failure							x			x	x
Diagnostic: Space Temperature Source Failure							x			x	x
Diagnostic: Outdoor Air							x			x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Temperature Source Failure											
Diagnostic: Outdoor Air Relative Humidity Source Failure							x			x	x
Alarm Reset							x				
System Lockout							x			x	x
Diagnostic: Space Relative Humidity Source Failure							x			x	x
Unoccupied Cooling Mode							x				x
Unoccupied Heating Mode							x				x
Unoccupied Dehumidification Mode							x				x
Cool Stage 1 Request							x				x
Cool Stage 2 Request							x				x
Cool Stage 3 Request							x				x
Cool Stage 4 Request							x				x
Dehumidification Command							x				x
Program Control							x				
Occupancy Request							x				x

4.02 PACKAGED ROOFTOP AIR CONDITIONING UNITS (AHU)

A. General

1. A packaged control system shall be provided by the rooftop air handling unit manufacturer. The packaged control system shall include the following features:

a. Standalone microprocessor controller with BACnet interface for BAS connection.
b. All control devices mounted and wired except for devices required to be remotely mounted. These devices to be factory furnished and field installed by BAS Contractor.
c. BACnet communication protocol to end devices.
d. Clock and scheduling function for occupancy with separate occupied and unoccupied setpoints. Scheduling shall be through the BAS with backup provided by integral time clock upon loss of communication with BAS.
e. Non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
f. Fans, motor protection devices and variable frequency drives.
g. Dampers and damper actuators.
h. Refrigeration system components.
i. Anti-cycle timing and minimum equipment run/off times.

2. The BAS shall communicate with the packaged control system using a BACnet interface. In general, the BAS Contractor scope of work shall be:

   a. Overall coordination with energy recovery unit manufacturer.
   b. Control wiring for BAS communication and field installed devices.
   c. Programming and set-up of the BAS to send/receive and trend points available through the packaged control system.
   d. Overall commissioning of unit controls including coordination with sub-contractors and unit manufacturer's start-up technician.

3. Whenever the unit is shut down by command of the control system or power disconnect, all control devices associated with the system shall revert to the normal state or position. All two-position control dampers and valves shall be equipped with end switches to prove position. All modulating control dampers and valves shall be equipped to provide position indicating feedback.
4. After a power interruption, the air handling system shall automatically restart in the mode appropriate to the operating schedule.
5. The BAS shall include logic to stagger equipment startups to limit electrical surges.
6. Control device state or position shall be as follows for the various modes of operation:

Mode	Supply Fan	Exhaust Fan	Heating Coil Valve	Cooling System	OA Damper	EA Damper	RA Damper
Power Loss	OFF	OFF	FAIL OPEN	OFF	CLOSED	CLOSED	OPEN
Unoccupied	OFF	OFF	CLOSED	OFF	CLOSED	CLOSED	OPEN
Unoccupied Dehum.	ON	OFF	CLOSED	ON & MOD	CLOSED	CLOSED	OPEN
Unoccupied Heating	ON	OFF	OPEN & MOD	OFF	CLOSED	CLOSED	OPEN
Occupied Dehum.	ON	ON	CLOSED	ON & MOD	MOD	OPEN	MOD

Mode	Supply Fan	Exhaust Fan	Heating Coil Valve	Cooling System	OA Damper	EA Damper	RA Damper
Occupied Cooling	ON & MOD	ON & MOD	CLOSED	ON & MOD	MOD	OPEN	MOD
Occupied Heating	ON & MOD	ON & MOD	OPEN & MOD	OFF	MOD	OPEN	MOD
Economizer	ON & MOD	ON & MOD	OFF	TBD	MOD	OPEN	MOD

B. Run Conditions

1. The unit shall be commanded to run through the BAS based upon an operator adjustable schedule or when a definable number of unoccupied zones need heating, cooling, OR dehumidification. Upon loss of BAS communications, unit shall run based upon time clock provided with packaged controls.
2. In addition, the following control method shall be available for operator selection:

   a. Local Override: The unit shall run for 2 hours (adj.) upon activation of override at any zone.

C. Optimal Start

1. The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints as determined by the BAS. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures. Minimum outside air ventilation control shall be disabled during Optimal Start period, but economizer control shall be enabled to allow free cooling when available.

D. Supply Fan Start

1. The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
2. Upon unit start the supply fan shall start and run at minimum speed. After a 30 second delay, the supply fan static pressure controls shall be enabled.

E. Supply Fan Static Pressure Controls

1. The controller shall measure duct static pressure and modulate the supply fan VFD speed to maintain duct static pressure setpoint as determined by the BAS. The supply fan VFD speed shall not drop below 25%.
2. The static pressure sensor shall be located in the supply air duct approximately 2/3 of the distance downstream in the longest medium pressure duct main. The BAS contractor shall coordinate with the balancing contractor in order to establish the static pressure setpoint necessary to obtain the maximum design airflow rate at the lowest possible fan speed. The setpoint established shall be used as the upper limit or SPmax in the static pressure reset range.
3. Static Pressure Reset: The static pressure setpoint shall be reset based on zone cooling demand using trim & respond logic within the range of 0.25 inches to SPmax. When the fan is off, the setpoint shall be reset to 0.5 inches w.g. While the fan is proven on, every two

minutes, trim the setpoint by 0.04 inches w.g. if there are two or fewer zone pressure requests. If there are more than two zone pressure requests, respond by increasing the setpoint by 0.06 inches w.g. A zone pressure request is generated when the air terminal unit damper is greater than 95% open until it drops to 85% open.

F. Supply Air Temperature Reset

1. The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint as determined by the BAS based on outside air temperature.
2. Outside Air Temperature Reset: The supply air temperature setpoint shall reset as follows:

   a. The supply air temperature setpoint shall be 60°F when outside air temperature is below 50°F.
   b. As outside air temperature rises from 50°F to 80°F, the supply air temperature setpoint shall reset downwards from 60°F to 55°F.
   c. The supply air temperature setpoint shall be 55°F when outside air temperature is above 80°F.

3. Temporary Warm-up: If the return air temperature drops below 60°F and the outside air temperature is below 50°F, then the supply air temperature setpoint shall be 70°F until return air temperature rises above 65°F.

G. Heating

1. The controller shall measure the supply air temperature, activate heating and sequentially stage and modulate compressors to maintain its heating setpoint. Heating shall be enabled whenever:

   a. Outside air temperature is less than 60°F.
   b. AND the supply fan status is on.
   c. AND the cooling is not active.

H. Cooling and Dehumidification

1. The controller shall measure the supply air temperature, activate cooling and sequentially stage and modulate compressors to maintain its cooling setpoint. Cooling shall be enabled whenever:

   a. Outside air temperature is greater than 60°F.
   b. AND the economizer is disabled or fully open.
   c. AND the supply fan status is on.
   d. AND the heating is not active.

2. The controller shall measure the return air relative humidity and activate dehumidification if return air relative humidity rises above 55%. Supply air temperature setpoint shall be 55ºF during dehumidification mode.

I. Minimum Outside Air Ventilation

1. Fixed Outside Air Ventilation: When in the occupied mode, the controller shall measure the outside airflow and modulate the outside air, return air and exhaust air dampers to maintain the scheduled minimum outside air ventilation rate.

J. Exhaust Fan Airflow Control: The following two control methods shall be available for operator selection:

1. Method #1 (Airflow Tracking): The controller shall monitor the exhaust airflow and modulate the exhaust fan VFD to maintain exhaust airflow setpoint as determined by the BAS. The

exhaust airflow setpoint shall be 90% of the outside airflow minus local exhaust airflow. The BAS shall monitor status of exhaust fans to determine local exhaust airflow. The exhaust fan VFD speed shall not drop below 25%. If the average building static pressure deviates more than a definable percentage (to be determined in field based on building conditions) from setpoint, Method #2 shall automatically be enabled.

2. Method #2 (Building Static Pressure Control): The BAS shall measure building static pressure in area served and reset exhaust airflow setpoint to maintain a building static pressure of +0.05 inches w.g. The exhaust fan VFD speed shall not drop below 25%. The exhaust fan shall shutdown if building static pressure drops below a definable amount (to be determined in field based on building conditions).
3. To prevent short cycling, the exhaust fan shall have a user definable (adj.) minimum runtime.

K. Economizer

1. The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the supply air temperature setpoint.
2. The economizer shall be enabled whenever:

   a. Outside air temperature is less than 65°F.
   b. AND the outside air enthalpy is less than 22 Btu/lb.
   c. AND the outside air temperature is less than the return air temperature.
   d. AND the outside air enthalpy is less than the return air enthalpy.
   e. AND the supply fan status is on.

3. The economizer shall close whenever:

   a. Mixed air temperature drops below 40°F.
   b. OR the low temperature switch (freezestat) trips.
   c. OR on loss of supply fan status.

4. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

L. Safeties: The unit shall shut down and generate an alarm upon the following conditions.

1. Fire Alarm Shutdown: Upon receiving an emergency shutdown signal from the fire alarm system. Associated duct mounted smoke detectors shall send supervisory signal to fire alarm system. Fire alarm system shall initiate unit shut-down through local control module. Unit shall resume normal operation automatically upon manual reset through the fire alarm system.
2. Freeze Protection: Low temperature switch (freezestat) trips. Provide a double pole, low limit temperature switch with sensing bulb on the discharge side of the heating coil. Switch shall trip when any one foot section of the sensing element drops below 38°F. One pole shall be hardwired to stop the supply and exhaust fans, close the outside air damper, close the exhaust air damper, and open the return air damper. The other pole shall be used to provide status to unit controller. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.
3. High Static: High static pressure switch trips. Provide a double pole, pressure switch to sense static pressure within the main supply air duct. Switch shall trip when pressure set point is exceeded. One pole shall be hardwired to stop the supply and exhaust fans. The other pole shall be used to provide status to unit controller. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.
4. Low Static: Low static pressure switch trips. Provide a double pole, pressure switch to sense static pressure within the main return air duct. Switch shall trip when pressure set point is exceeded. One pole shall be hardwired to stop the supply and exhaust fans. The other pole shall be used to provide status to unit controller. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.

5. Supply Fan Prove: If the differential pressure switch doesn't prove the supply fan is on 60 second (adj.) after commanded to run, the controller shall shutdown unit. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.
6. Exhaust Fan Prove: If the differential pressure switch doesn't prove the exhaust fan is on 60 second (adj.) after commanded to run, the controller shall shutdown unit. Unit shall resume normal operation automatically upon manual reset remotely through the BAS.

M. Alarms: Alarms shall be provided as follows.

1. Supply Fan Failure: Commanded on, but the status is off.
2. Supply Fan in Hand: Commanded off, but the status is on.
3. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
4. Supply Fan VFD Alarm/Fault.
5. Exhaust Fan Failure: Commanded on, but the status is off.
6. Exhaust Fan in Hand: Commanded off, but the status is on.
7. Exhaust Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
8. Exhaust Fan VFD Alarm/Fault.
9. High Supply Air Static Pressure: If the supply air static pressure is 25% greater than setpoint.
10. Low Supply Air Static Pressure: If the supply air static pressure is 25% less than setpoint.
11. High Building Static Pressure: If the building air static pressure is 25% greater than setpoint.
12. Low Building Static Pressure: If the building air static pressure is 25% less than setpoint.
13. High Exhaust Airflow: If the return airflow is an adjustable percentage greater than setpoint.
14. Low Exhaust Airflow: If the return airflow is an adjustable percentage less than setpoint.
15. High Supply Air Temp: If the supply air temperature is 5°F greater than setpoint.
16. Low Supply Air Temp: If the supply air temperature is 5°F less than setpoint.
17. Filter differential pressure exceeds a user definable limit.
18. Low Mixed Air Temp: If the mixed air temperature is less than 45°F.
19. High Return Air Humidity: If the return air humidity is greater than 70%.
20. High Return Air Temp: If the return air temperature is greater than 90°F.
21. Low Return Air Temp: If the return air temperature is less than 50°F.

N. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Outside Air Temp	x								x		x
Outside Air Humidity	x								x		x
Building Static Pressure – Area Served	x								x	x	x
Rooftop Unit Start/Stop				x					x		x
Supply Fan Start/Stop				x					x		x
Exhaust Fan Start/Stop				x					x		x
Outside Air Damper		x							x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Return Air Damper		x							x		x
Exhaust Air Damper		x							x		x
Compressor Start/Stop (Each)				x					x		x
Lead Compressor Speed		x							x		x
Supply Air Temp	x								x	x	x
Supply Airflow	x								x		x
Supply Air Static Pressure	x								x	x	x
Mixed Air Temp	x								x		x
Return Air Temp	x								x	x	x
Return Air Humidity	x								x	x	x
Return Airflow	x								x		x
Outside Airflow	x								x		x
Exhaust Airflow	x								x		x
Outside Air Damper Position	x								x		x
Return Air Damper Position	x								x		x
Exhaust Air Damper Position	x								x		x
Supply Fan Speed		x							x		x
Exhaust Fan Speed		x							x		x
Filter Differential Press	x								x	x	x
Supply Air High Static			x							x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Freezestat			x							x	x
Return Air Low Static			x							x	x
Supply Fan Run Status			x						x		x
Supply Fan Alarm/Fault			x							x	x
Exhaust Fan Run Status			x						x		x
Exhaust Fan Alarm/Fault			x							x	x
Heating Mode Status							x		x		x
Cooling Mode Status							x		x		x
Dehumidification Mode Status							x		x		x
Compressor Status (Each)			x						x		x

4.03 SINGLE DUCT AIR TERMINAL UNIT (VV, CV)

A. General:

1. Air terminal unit shall be controlled independent of system pressure fluctuations by an application specific controller using electric actuation. The controller and damper actuator shall be provided by BAS Contractor and factory installed within an electrical enclosure provided the equipment manufacturer. Damper actuator shall be of the true analog type. Tri-state actuator may be used in lieu of analog type if damper positioning feedback is provided.
2. Air terminal unit shall operate whenever the associated air handling unit is operating. Controller shall modulate damper position, reheat coil valve, and associated perimeter radiation valve (as applicable) in sequence to maintain setpoint.
3. Separate space temperature setpoints shall be provided for occupied and unoccupied periods.
4. Normal control device state or position shall be as follows:

    a. Damper shall be last position
    b. Reheat valve shall be last position

B. Run Conditions

1. The unit shall run based upon an operator adjustable schedule in the following modes:

   a. Occupied Mode: The unit shall maintain a 78°F cooling setpoint and a 68°F heating setpoint.
   b. Unoccupied Mode (night setback): The unit shall maintain an 85°F cooling setpoint and a 55°F heating setpoint.

C. Demand Control Ventilation (where CO2 sensors are shown)

1. When in the occupied mode, the controller shall measure the zone CO2 levels and modulate the zone damper open on rising CO2 concentrations, overriding normal damper operation to maintain a CO2 setpoint of not more than 900 ppm.

D. Zone Optimal Start

1. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

E. Reversing Airflow Control

1. Occupied Mode:

   a. The controller shall measure the zone temperature. When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum and maximum airflow setpoints to maintain the zone temperature cooling setpoint.
   b. When the zone temperature is between the cooling and heating setpoints, the zone damper shall maintain the minimum airflow.
   c. When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature heating setpoint.

2. Unoccupied Mode:

   a. The controller shall measure the zone temperature. When zone temperature is greater than its unoccupied cooling setpoint, the associated air handling unit shall run and the zone damper shall modulate between the minimum and maximum airflow setpoints to achieve a zone temperature 5°F below the unoccupied cooling setpoint. Air handling unit shall continue to run until all zones are satisfied.
   b. When the zone temperature is between the cooling and heating unoccupied setpoints, the zone damper shall maintain the minimum airflow.
   c. When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature unoccupied heating setpoint.

F. Reheat Coil and Perimeter Heating Valves

1. Occupied Mode:

   a. The controller shall measure the zone temperature and modulate the reheat coil valve in unison with the perimeter heating valves to maintain the zone temperature heating setpoint.
   b. The controller shall limit reheat coil valve position to maintain a discharge air temperature less than 15°F above the zone temperature.

2. Unoccupied Mode:

   a. The controller shall measure the zone temperature and modulate the perimeter heating valves to maintain the zone temperature unoccupied heating setpoint. Upon a drop of 2°F below the unoccupied heating setpoint, the associated air handling unit shall run and the reheat coil valve shall modulate in unison with the perimeter heating valves. Air handling unit shall continue to run until all zones are satisfied.
   b. The controller shall limit reheat coil valve position to maintain a discharge air temperature less than 15°F above the zone temperature.

G. Alarms shall be provided as follows:

1. High Space Carbon Dioxide Concentration: If CO2 concentration is greater than 1100 ppm.
2. Low Space Temp: If the space temperature is lower than the heating setpoint by 5°F for more than 15 minutes.
3. High Space Temp: If the space temperature is higher than the cooling setpoint by 5°F for more than 15 minutes.

H. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Space Temperature	x								x	x	x
Space Carbon Dioxide PPM	x								x	x	x
Space Setpoint Adjust	x										x
Supply Airflow	x								x		x
Discharge Air Temp	x								x		x
Damper Position		x									x
Reheat Valve Position		x									x
Override Switch			x						x		x
Perimeter Heating Valve Position				x					x		x

4.04 EXHAUST FANS (EF)

A. Run Conditions

1. Exhaust fan shall run based upon an operator adjustable schedule.

B. Exhaust Fan

1. Exhaust fan shall run anytime commanded to run, unless exhaust air damper is closed. To prevent short cycling, the exhaust fan shall have a user definable (adj.) minimum runtime.

C. Exhaust Air Damper

1. Exhaust air damper shall open anytime the exhaust fan is commanded to run and shall close anytime the exhaust fan stops. Exhaust fan shall be enabled after damper status has proven open. The exhaust air damper shall close after exhaust fan stops.

D. Safeties: The unit shall shut down and generate an alarm upon the following conditions:

1. Damper End Switch: Provide double pole end switch to sense position of exhaust air damper. One pole shall be interlocked to stop exhaust fan unless damper is proven open. The other pole shall be used to provide status to BAS.

E. Alarms: Alarms shall be provided as follows.

1. Exhaust Fan Failure: Commanded on, but the status is off.
2. Exhaust Fan in Hand: Commanded off, but the status is on.
3. Exhaust Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

F. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Exhaust Air Damper Status			x								x
Fan Status			x						x	x	x
Fan Start/Stop				x							x

4.05 KITCHEN EXHAUST FANS (KEF)

A. Run Conditions

1. Exhaust fan shall run as controlled locally at hoods.

B. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Fan Status			x						x		x

4.06 FIN TUBE RADIATION AND RADIANT PANEL (FT, RP)

A. General

1. Separate space temperature setpoints shall be provided for occupied and unoccupied periods.
2. Normal control device state or position shall be as follows:

   a. Heating valve shall be normally open.

B. Heating Valve

1. The controller shall measure the space temperature and open the heating valve to maintain its heating setpoint.
2. Heating shall be enabled whenever:

   a. Outside air temperature is less than 60°F (adj.).

3. Where indicated on plans by a single sensor controlling multiple terminal devices, the devices shall operate in unison.

C. Alarms shall be provided as follows

1. Low Space Temp: If the space temperature is lower than the heating setpoint by 10°F for more than 15 minutes.

D. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Space Temperature	x								x	x	x
Heating Valve				x					x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic

4.07 CABINET UNIT HEATERS (CUH)

A. General

1. Separate space temperature setpoints shall be provided for occupied and unoccupied periods.
2. Normal control device state or position shall be as follows:

   a. Heating valve shall be normally open.

B. Run Conditions

1. The unit shall be enabled to run whenever the outside air temperature drops below 60°F.

C. Fan and Heating Coil

1. The controller shall measure the space temperature and run the fan and open the heating coil valve to maintain its heating setpoint. To prevent short cycling, the fan shall have a user definable minimum runtime.

D. Alarms shall be provided as follows:

1. Low Space Temp: If the space temperature is lower than the heating setpoint by 10°F for more than 15 minutes.
2. Filter Change Required: Filter has been in use for more than 2200 hrs (adj.).

E. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Space Temperature	x								x	x	x
Fan Start/Stop				x					x		x
Heating Coil Valve				x					x		x

4.08 PROPELLER UNIT HEATERS (PUH)

A. General

1. Separate space temperature setpoints shall be provided for occupied and unoccupied periods.
2. Normal control device state or position shall be as follows:

   a. Heating valve shall be normally open.

B. Run Conditions

1. The unit shall be enabled to run whenever the outside air temperature drops below 60°F.

C. Fan and Heating Coil

1. The controller shall measure the space temperature and run the fan and open the heating coil valve to maintain its heating setpoint. To prevent short cycling, the fan shall have a user definable minimum runtime.

D. Alarms shall be provided as follows:

1. Low Space Temp: If the space temperature is lower than the heating setpoint by 10°F for more than 15 minutes.

E. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Space Temperature	x								x	x	x
Fan Start/Stop				x					x		x
Heating Coil Valve				x					x		x

4.09 AIR CONDITIONING UNITS (AC/ACC)

A. General:

1. Packaged control system shall be provided by the air conditioning equipment manufacturer. The air conditioning units shall be equipped with accessory relays for remote enable/disable and alarm indication.
2. The air conditioning units shall be automatically controlled via dedicated, wall-mounted and wired programmable thermostats provided by the air conditioning equipment manufacturer. The BAS Contractor shall install the thermostat and all control wiring in accordance with the manufacturer's instructions.

3. The BAS Contractor shall connect to enable/disable and alarm relays and provide a separate wall sensor to monitor room temperature.

B. Run Conditions

1. Air conditioning units shall be enabled to run based upon an operator adjustable schedule.

C. Alarms shall be provided as follows:

1. Unit Alarm Indication.
2. Low Space Temp: If the space temperature is lower than 55°F for more than 15 minutes.
3. High Space Temp: If the space temperature is higher than 85°F for more than 15 minutes.

4.10 SUMP PUMP (SP-1, 2)

A. Alarms: Alarms shall be provided as follows.

1. Pump Alarm: Alarm indication at packaged controller.

B. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Alarm Status			x							x	x

4.11 PLUMBING PUMP (PP-1, 2)

A. Run Conditions

1. Pump shall run based upon an operator adjustable schedule.

B. Alarms: Alarms shall be provided as follows.

1. Pump Failure: Commanded on, but the status is off.
2. Pump in Hand: Commanded off, but the status is on.

C. BAS Points List

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Pump Status			x						x	x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AVI	AVO	BVI	BVO	Trend	Alarm	Show On Graphic
Pump Start/Stop				x							x

END OF SECTION

SECTION 23 98 00

INSTRUMENTATION

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges and gauge cocks.

B. Thermometers and thermometer wells.

C. Combination temperature and pressure test plugs.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit under provisions of Section 23 01 00.

B. Product Data: Include list which indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

A. ASME/ANSI B40.1, 4-1/2-inch diameter drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, one percent mid-scale accuracy, scale calibrated in psi, Model No. 450 manufactured by Trerice, or approved equal. Pressure gauges shall have ranges of 0-60 psig.

2.02 PRESSURE GAUGE COCKS

A. Gauge cocks shall be tee or lever handle, brass for maximum 150 psig.

2.03 STEM TYPE THERMOMETERS

A. ASTM E1, 9-inch scale, spirit: blue colored, organic lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, 3-1/2-inch brass stem, 2 percent of scale accuracy scale calibrated in degrees F, Model BX91403½ manufactured by Trerice or approved equal. Thermometers shall have ranges of 40-240 deg. F, except chilled water system thermometers shall have range of 0 - 100 deg. F.

2.04 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

B. Flange: 3-inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.05 COMBINATION TEMPERATURE AND TEST PLUGS

A. Provide combination temperature and pressure test plugs by Peterson Equipment Company (Petes Plug) or Sisco, Inc. (P/T Plugs).

B. Plug shall be 1/4" or 1/2" NPT, constructed of solid brass with a Nordel valve core suitable for temperatures up to 350 deg. F. Plug shall be rated zero leakage from vacuum to 1,000 psig.

C. Provide extension fitting for each plug suitable for use with 2-inch maximum pipe insulation.

D. Provide gauge test kit consisting of the following items:

1. Two (2) 3½" dial face gauges 0-100 psi and 0-231 feet.
2. Two (2) gauge adapters with 1/8" O.D. probe.
3. Two (2) 5-inch stem pocket testing thermometers ranges 25-125 deg. F; 0-220 deg. F.
4. One (1) carrying case.
5. Two (2) 4-foot length of flexible hose with adapters.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide pressure gauges at suction and discharge of each pump, installing with taps and petcocks. Provide pressure gauges with taps and petcocks elsewhere in the system as indicated on the Drawings.

C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Install thermometers in piping systems as indicated on the Drawings.

D. Install thermometers in air duct systems on flanges. Install thermometers in ductwork systems as indicated on the Drawings.

E. Locate duct-mounted thermometers minimum ten (10) feet downstream of mixing dampers, coils, or other devices causing air turbulence.

F. Install combination temperature and pressure test plugs adjacent to controls system thermostat, transmitter, or sensor sockets. (Note: Combination temperature and pressure test plugs adjacent to control system sockets are not indicated on the Drawings, coordinate with the ATC Contractor for locations.) Install other combination temperature and pressure test plugs as indicated on the Drawings.

G. Coil and conceal excess capillary on remote element instruments.

H. Provide instruments with scale ranges selected according to service with largest appropriate scale.

I. Install gauges and thermometers in locations where they are easily read from normal operating level.

J. Install combination temperature and pressure test plugs as indicated on the Drawings.

END OF SECTION

SECTION 23 99 00

TESTING, ADJUSTING, AND BALANCING

(Mechanical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic systems.

C. Measurement of final operating condition of HVAC systems.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SPECIAL REQUIREMENTS

A. Employ an independent testing and balancing firm, acceptable to and approved by the Architect, to test, adjust, and balance the air handling systems and hydronic systems.

B. The temperature control system must be completely installed before balancing is started. Calibrate the temperature control system simultaneously with the balancing operation.

C. Prior to beginning any testing, adjusting and balancing, schedule a pre-balancing meeting with the Architect, Owner, General Contractor, Mechanical Contractor, and BAS Contractor to schedule the balancing and testing, adjusting and balancing procedures.

D. Make any necessary changes in fan speeds to obtain design system conditions. Change the size of drives, sheaves, and belts as required.

E. In support of system commissioning:

1. Provide additional changes to the sizes of drives, sheaves, and belts, as directed by the Architect. Also provide additional dampers, splitters and other devices as necessary to obtain the correct air balance, as directed by the Architect. (This work may include discretionary changes to specified design conditions, to enhance system operation.)

F. Furnish qualified workmen as required to cut openings in ducts for air readings, adjust fan speeds as directed and do such other work as required to assist in balancing the systems. Cut neat round holes with no sharp edges in belt guards.

G. Prior to the start of balancing, check the rotation of all fans and pumps. Check to verify that all dampers are free to open and close and that all fire dampers are open and equipped with fusible links.

H. All filters must be checked and replaced if operated during construction, before commencing balancing so as not to create excessive resistance to the system.

I. Test, adjust, and put in service all systems and make all adjustments as required to make them operate as specified. Put mechanical equipment specified herein in operation in the presence of the Architect and Owner (if desired by the Architect and Owner) with forty-eight (48) hours notice given for each start-up. Give instructions to a designated representative(s) of the Owner, in the operation and routine maintenance of all parts of the various systems.

1.04 REFERENCES

A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.

B. ASHRAE - 1995 Applications Handbook: Chapter 34, Testing, Adjusting, and Balancing.

C. NEBB - Procedural Standards for Building Systems Commissioning; Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

1.05 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 01 00.

B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.

C. Prior to commencing work, submit draft reports indicating procedures, sample report forms, testing, adjusting and balancing data required.

D. Submit draft copies of completed balancing report for review prior to final acceptance of project.

E. After Architect review, make requested system adjustments and provide final copies of report for Architect and for inclusion in operating and maintenance manuals.

F. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.06 REPORT FORMS

A. Submit reports on AABC National Standards for Total System Balance forms, or reporting forms in a format approved by NEBB.

B. Forms shall include the following information:

1. Title page:

    a. Company name
    b. Company address
    c. Company telephone number
    d. Project name
    e. Project location
    f. Project Architect
    g. Project Engineer
    h. Project Contractor

i. Project altitude

2. Instrument list:

   a. Instrument
   b. Manufacturer
   c. Model
   d. Serial number
   e. Range
   f. Calibration date

3. Packaged rooftop dehumidification units:

   a. Location
   b. Manufacturer
   c. Model
   d. Supply air flow, design and actual
   e. Exhaust air flow, design and actual
   f. Supply air temperature, entering and leaving heat exchanger, specified and actual
   g. Exhaust air flow, entering and leaving heat exchanger, specified and actual
   h. Air relative humidity, entering heat exchanger on supply and exhaust sides, specified and actual
   i. Total static pressure, design and actual
   j. External static pressure, design and actual
   k. Inlet pressure
   l. Discharge pressure
   m. Fan RPM

4. Packaged rooftop air conditioning units:

   a. Location
   b. Manufacturer
   c. Model
   d. Supply air flow, design and actual
   e. Return air flow, design and actual
   f. Outside air flow, design and actual
   g. Supply air temperature
   h. Return air temperature
   i. Outside air temperature
   j. Mixed air temperature
   k. Total static pressure, design and actual
   l. External static pressure, design and actual
   m. Inlet pressure
   n. Discharge pressure
   o. Fan RPM

5. Fan data:

   a. Location
   b. Manufacturer
   c. Model
   d. Air flow, specified and actual
   e. Total static pressure, design and actual
   f. External static pressure, design and actual
   g. Inlet pressure

h. Discharge pressure
i. Fan RPM

6. Electric motor data:

a. Manufacturer
b. HP/BHP
c. Phase, voltage, amperage; nameplate, actual, no load.
d. RPM
e. Service factor
f. Starter size, rating, heater elements

7. V-belt drive data:

a. Identification/location
b. Required driven RPM
c. Driven sheave, diameter and RPM
d. Belt, size and quantity
e. Motor sheave, diameter and RPM
f. Center-to-center distance, maximum, minimum, and actual

8. Duct traverse data:

a. System zone/branch
b. Duct size
c. Area
d. Design velocity
e. Design air flow
f. Test velocity
g. Test air flow
h. Duct static pressure
i. Air temperature
j. Air correction factor

9. Air distribution test sheet:

a. Air terminal number
b. Room number/location
c. Terminal type
d. Terminal size
e. Area factor
f. Design velocity
g. Design air flow
h. Test (final) velocity
i. Test (final) air flow
j. Percent of design air flow

10. Terminal unit data:

a. Identification/number
b. Manufacturer
c. Size/model
d. Type (constant or variable volume)
e. Location/service
f. Minimum inlet static pressure

g. Actual inlet static pressure design
h. Minimum air flow, design and actual
i. Maximum air flow, design and actual
j. Heating coil flow, design and actual.

11. Pump data:

a. Identification/number
b. Manufacturer
c. Size/model
d. Impeller size
e. Service
f. Design flow rate, pressure drop, BHP
g. Actual flow rate, pressure drop, BHP
h. Total operating head pressure
i. Discharge pressure
j. Suction pressure
k. Shut off, total head pressure
l. Shut off, discharge and suction pressures

12. Heating coil data:

a. Identification/number
b. Location
c. Service
d. Manufacturer
e. Air flow, design and actual
f. Air pressure drop, design and actual
g. Entering air temperature, design and actual
h. Leaving air temperature, design and actual
i. Water flow, design and actual
j. Water pressure drop, design and actual
k. Entering water temperature, design and actual
l. Leaving water temperature, design and actual

13. Cooling coil data:

a. Identification/number
b. Location
c. Service
d. Manufacturer
e. Air flow, design and actual
f. Air pressure drop, design and actual
g. Entering air temperature (DB & WB), design and actual
h. Leaving air temperature (DB & WB), design and actual
i. Water flow, design and actual
j. Water pressure drop, design and actual
k. Entering water temperature, design and actual
l. Leaving water temperature, design and actual

14. Balancing valve data:

a. Identification/number
b. Location
c. Service

d. Manufacturer
e. Model
f. Size
g. Design flow rate
h. Design pressure drop
i. Actual flow rate
j. Actual pressure drop
k. Valve calibrated setting

15. Combustion test:

a. Boiler manufacturer.
b. Model.
c. Fire rate (low-high).
d. Overfire draft.
e. Gas firing:

1) Percent oxygen (O_2).
2) Percent excess air.
3) Fuel gas temperature at outlet.
4) Ambient temperature.
5) Net stack temperature.
6) Percent stack loss.
7) Percent combustion efficiency.

1.07 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 23 01 00.

B. Accurately record actual locations of balancing dampers and balancing valves and rough setting.

1.08 QUALITY ASSURANCE

A. Testing and balancing firm shall be a company specializing in the testing, adjusting, and balancing of systems specified in this section with a minimum three years documented experience certified by AABC and/or NEBB. Perform Work under the supervision of an AABC and/or NEBB Certified Test and Balancing Engineer.

B. Total system balance shall be performed in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance; NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems; NEBB Procedural Standards for Building Systems Commissioning; and ASHRAE - 1995 Applications Handbook.

1.09 SEQUENCING AND SCHEDULING

A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before commencing work, verify that systems are complete and operable. Ensure the following:

1. Equipment is operable and in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Correct fan rotation.
7. Fire and volume dampers are in place and open. Fire dampers have fusible links properly installed.
8. Coil fins have been cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage has been minimized.
12. Hydronic systems have been flushed, filled, tested, and vented.
13. Correct pump rotation.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Report any defects or deficiencies noted during performance of services to Architect.

C. Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.

3.02 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.03 INSTALLATION TOLERANCES

A. Adjust air handling systems to plus or minus five (5) percent for supply systems and plus or minus ten (10) percent for return and exhaust systems from figures indicated.

B. Adjust hydronic systems to plus or minus 10 percent of design conditions indicated.

3.04 ADJUSTING

A. Recorded data shall represent actually measured or observed condition.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

F. Check and adjust all HVAC systems approximately six months after final acceptance and submit revised version of original report.

3.05 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters. Provide any necessary additional dampers, splitters, etc., as required to obtain correct air balance, and as directed by the Architect.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive, sheave, and belt changes as required, and as directed by the Architect. Vary branch air quantities by damper regulation.

G. Furnish qualified workmen as required to cut openings in ducts for air readings. Holes shall be cut as small as possible and resealed airtight upon completion of system balancing.

H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

L. For variable air volume units set volume controller to maximum and minimum air flow settings indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

M. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

N. Some air handling units require two settings of outside and return air quantities. Where indicated, properly balance outside and return air quantities for both settings as scheduled on the Drawings. Coordinate with the ATC contractor as required.

O. Upon completion of system balancing, replace all throwaway filters with new filters and clean all permanent metallic filters and reinstall.

3.06 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indicated to do so.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

END OF SECTION

SECTION 26 01 00

BASIC ELECTRICAL REQUIREMENTS

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Basic electrical requirements specifically applicable to Division 26 sections, in addition to Division 01 - General Requirements.

B. Furnish all labor, materials, services, supplies, tools, equipment, apparatus, transportation, facilities and incidentals required and perform all operations necessary to accomplish and complete installation of the electrical power, lighting, motor control systems, and electrical accessories as shown on the Contract Drawings, specified herein or as reasonably may be implied as being incidental to this work, and as required for complete electrical systems.

C. The performance of the work under Division 26 shall be in accordance with the regulations and rulings of all authorities having jurisdiction over the work.

D. The scope of work involves and includes but is not limited to the following:

1. New service entrances including all utility costs (electric, telephone, cable).
2. Utility raceway systems, manholes and equipment pad(s).
3. Power distribution system.
4. Power and control wiring for equipment by mechanical and other systems.
5. Grounding.
6. Building lighting systems.
7. Site lighting systems.
8. Sports lighting (football field) and control equipment.
9. Standby generator system and load bank.
10. Fire alarm system.
11. Security alarm system.
12. Security Management Information System (Door Access).
13. Closed Circuit Television System (CCTV).
14. Master Clock System or Clocks.
15. Data System.
16. Telephone system.
17. Intercom system.
18. Cable Television System (CATV).
19. Media Management System.
20. Sound reinforcement systems.
21. Door bell systems.
22. Telephone, data, and CATV raceways and outlet boxes.
23. Empty outlet boxes and raceway systems for audio/visual systems.

E. Work indicated below shall be coordinated with others to provide the intended operable systems. The Contractor shall include all costs associated with the coordination and provision of this work in this Contract.

1. Coordinate with Central Maine Power (CMP) and include all costs in this Contract for the following:

   a. Extend and tap off existing overhead power lines.
   b. Transformer primary feed, underground.
   c. Metering.

d. Utility-owned transformer(s).
e. Utility-owned manholes.

2. Coordinate with FairPoint and include all costs in this Contract for the following:

   a. Building telephone system service entrance.

3. Coordinate with the local fire department and include all costs in this Contract for the following:

   a. Master box connection to fire department system.
   b. All review, permits, and approvals.

4. Coordinate with Metrocast Cable Company and include all costs in the Contract for the following:

   a. Building CATV system service entrance.
   b. Building CATV system cabling.

5. Coordinate with Sanford IT Department for the following:

   a. Approval of all telecommunication system components.
   b. Telecommunication system labeling.
   c. Approval of all telecommunication system installations

6. Coordinate with the Telecommunications Contractor for the following:

   a. The electrical contractor shall be responsible for properly preparing the project for telecommunications installation, as specified.
   b. Electrical Subcontractor shall provide and install all for outlet box locations and provide single or double gang plaster rings for all single and double gang outlet locations as indicated on the drawings.
   c. Electrical Subcontractor shall provide and install all outlet boxes, plaster rings, floor boxes, pathways, poke through devices, power, cableways, cable tray, cable protection, surface mounted metal raceway, conduits, bushings, stubs with bushings, backboxes, pull strings, grounding and bonding, core drilling, cutting, patching, fireproofing, of penetrations, environmental seals, smoke and firestopping seals including all conduits, raceways, sleeves, slots etc. where cables pass from one location to another for a completely operational system.
   d. Electrical Contractor shall provide and install cable tray over each rack and cabinet as required to facilitate a neat and orderly installation of cables and secure the rack to structure. Including all radius drops which will allow cable to drop straight into the rack and proper support to secure tray to the structure.
   e. The subcontract between the General Contractor and the Electrical Subcontractor shall contain a provision whereby the Electrical Subcontractor shall be obligated to coordinate its work with the Telecommunications Contractor for this section.
   f. Section 27 74 00: The Electrical Subcontractor shall read 27 74 00 in its entirety and shall provide all requirements for the Electrical Subcontractor as detailed in Section 27 74 00.

7. Telecommunication Contractor responsibilities for this section shall be: The Telecommunication Contractor shall be responsible for providing, installing, troubleshooting, training, and warranty service of all cabling and components required for a complete and operational system.

a. Keep fully informed as to the shape, size, and position of all openings, required for all system components and give information in advance to build openings into work. The Electrical Subcontractor shall furnish and set in place all sleeves, pockets, supports and incidentals.
b. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interferences or to provide adequate clearances for code and maintenance requirements shall be made at no additional costs.
c. Structural elements of the project shall not be relocated, altered, or changed to accommodate the work without written authorization from the Architect.
d. Obtain a full set of Drawings and Specifications for coordination and to determine the full scope of work.
e. Attend project coordination meetings to coordinate work of this section, work of other trades and project phasing requirements.

8. Coordination with the Building Automation System (BAS) Contractor and include all costs in this Contract for the following connections to the Building Automation System:

a. Fire alarm system (dry contacts):

1) Trouble alarm.
2) Fire alarm.

b. Emergency generator system (dry contacts):

1) Low fuel.
2) Generator ready/running.
3) Generator failure.
4) Service power failure (from Life Safety transfer switch).

c. Power monitoring (RS-485 port):

1) Full monitoring of all functions at power meter for Service.

d. Occupancy sensors:

1) Provide a dry contact (no/nc) on all occupancy sensors for tie into the BAS.

e. Lighting control system:

1) Full monitoring of network occupancy sensors.

F. Work of Division 26 shall include the coordination of all arrangements and payment of all required fees for agency permits and associated inspections.

1.02 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations.

B. This Specification is partially of the abbreviated or "streamlined" type and includes incomplete sentences. Omitted words or phrases shall be supplied in inference in the same manner as they are when a "note" occurs on the Drawings. Words "shall be" will be supplied by inference where colon (:) is used within sentences or phrases.

C. Drawings and general provisions of the Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

D. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

E. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

F. All trade subcontractors are to note that the organization of these Specifications into divisions, sections, and paragraphs, and likewise the arrangement of the Drawings, is set up for the convenience of understanding the scope of the Work only. This structuring shall not control the General Contractor in dividing the Work among trade subcontractors or in establishing the extent of the Work to be performed by any trade.

G. All related Specification Sections shall be used in conjunction with this Section.

1.03 DEFINITIONS

A. Definitions pertaining to Division 26:

1. Provide: Furnish, install, and connect.
2. Furnish: Supply materials only.
3. Indicated: On Contract Drawings.
4. Concealed: Hidden from sight at completion of work.
5. Trade: General Contractor, HVAC, plumbing, etc.
6. Contractor: The person, firm, or corporation performing the work called for in this Electrical Specification, whether they be prime or sub.
7. Whenever the word "Engineer" appears, it shall be construed as meaning the Owner's representative.

1.04 SUBMITTALS

A. Refer to Division 01 for submittal requirements. The following paragraphs supplement the requirements of Division 01.

B. Submit shop drawings and product data as requested by other Division 26 sections. All submittals to follow requirements of General Conditions, modifications to General Conditions, and Division 01.

C. The Contractor will be held responsible for checking and verifying all field measurements, and shall submit promptly, as to cause no delay in any work, shop drawings, and schedules required for the work. The Contractor shall check and approve all submittals before forwarding to the Architect. All submittals shall be transmitted to the Architect using the submittal transmittal form contained in Division 01. The Architect will forward submittals to the Engineer. The Engineer will check and review the submittals with reasonable promptness, but only for conformance with design concept of the project and for compliance with information given in Contract Documents. The Contractor shall make any corrections required by the Engineer. The Engineer's review of submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications, unless he has, in writing, called the Engineer's attention to such deviations at the

time of submission and has secured the Engineer's written approval. Additionally, the Engineer's review of submittals shall not relieve the Contractor from responsibility for any errors or omissions contained in the submittals.

D. Submittals shall be clear and concise. The submittals shall clearly indicate the product name, applicable Specification Section, proposed location and all features and ratings. The intended product shall be differentiated from others with a model number or highlighting.

E. When necessary, shop and setting drawings shall be based upon actual measurements taken at the site and upon other job conditions. Show any variations and revisions to Drawings or Specifications that are necessary for proper installation.

F. Submit copies of manufacturer's shop drawings showing illustrated cuts of item to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, installation instructions, wiring diagrams and controls and all pertinent information. Submit the quantity of copies indicated in Division 01.

G. The Contractor shall note that where more than one manufacturer's name is listed for the various major items of equipment and materials specified herein, the plans and specifications have been developed on the basis of equipment as manufactured by the first manufacturer name. Other manufacturers names are included to indicate the equipment manufactured by them may be considered acceptable for this project, provided that the equipment meets all requirements as to quality, size, and adaptability to space requirements, etc. It shall be the Contractor's responsibility to assure that the equipment, as manufactured by other than the first name manufacturer, shall meet all requirements as to equipment ratings, quality, size, capacity, function, adaptability to space requirements, etc. The Engineer’s review of shop drawings for equipment as manufactured by other than the first named manufacturer shall in no way relieve the Contractor of this responsibility.

H. Upon request, samples of electrical items shall be furnished to the Engineer. Samples shall be properly tagged, noting Section and paragraph of Specifications where item is proposed for use and listing project name, Contractor's name, manufacturer's name and identifying number and where applicable.

1.05 OPERATION AND MAINTENANCE DATA

A. Refer to Division 01 for operation and maintenance manual requirements. The following paragraphs supplement the requirements of Division 01.

B. The Contractor shall provide the following information in a bound manual:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, routine and normal operating instructions; regulation, control, and emergency instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and schedules.

C. Two (2) copies of operations and maintenance data shall be submitted to the Architect for review: one (1) copy shall be returned to the Contractor (with any instructions for changes). After implementing any changes, five (5) copies of instructions covering all equipment shall be furnished to the Architect who will forward two (2) copies to the Owner for his information and use.

D. Append to the manual, the name, address and telephone number of the Contractors and Subcontractors and for electrical items, provide the name, address and telephone number of companies servicing installed equipment on a 24-hour basis.

E. After submission and approval of the operating and maintenance data, the Contractor shall furnish competent Operation Engineer(s) at such time or times as directed by the Architect to meet with the Owner or his representative, to fully explain instructions and to demonstrate and fully familiarize the Owner or his representative with all of the equipment and all phases of its operation and maintenance. The amount of time devoted to instructions shall be reasonable and consistent with the size of the installation and the complexity therefore. Instructions shall be adequate to the extent that the Owner's personnel may proceed with normal operations in a safe and efficient manner.

1.06 FINAL SUBMITTALS

A. As a requisite for final acceptance, the following are required:

1. Project Record Documents:

   a. During progress of the Work, maintain an accurate record of the installation of the electrical system, locating each concealed conduit precisely by dimension. This shall include, but not be limited to: conduit below ground level and in or below building slab. All service, sub-service and main riser conduits for both power and communication systems. All spare conduits stubbed in concealed spaces and the locations of all electrical equipment essential for system operation (such as end of line resistors, etc.).
   b. Upon completion of the electrical installation, transfer all record data to prints of the original Drawings. Where required by Division 01, provide project record documents in AutoCAD file format.

2. Manual: Upon completion of the electrical installation, and as a condition of its acceptance, deliver to the Owner and the Engineer operation manuals compiled in accordance with the provisions of Division 01 and Article 1.05 of this specification Section; include one copy of as-built Project Record Drawings in each copy of the manual. Provide quantity of manuals as required in Division 01.
3. Certificates:

   a. Two (2) copies of the City Building Inspector's Certificate of Approval showing acceptability of work done under this Contract. Deliver to the Owner with a copy to the Engineer.
   b. Two (2) copies of any other Certificates of Approval. Deliver to the Owner with a copy to the Engineer.

4. At completion of construction, the Contractor shall furnish the Owner with one (1) unused copy of all reviewed shop drawings, manufacturer's diagrams, installation instructions, literature, etc., that were used in execution of the work.
5. Warranties: Provide all indicated warranties in accordance with Division 01.

1.07 SUBSTITUTIONS

A. Any and all proposed substitutions must be approved by the Architect during the bid phase and must be indicated on the form of proposal. For specific substitution requirements, refer to Division 01.

1.08 COORDINATION

A. Coordination Drawings: For locations where several elements of electrical (of combined mechanical and electrical) work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings (shop drawings) showing the actual physical dimensions (at accurate scale) required for the installation. Prepare and submit coordination drawings prior to purchase-fabrication-installation or any of the elements involved in the coordination.

1. Arrange electrical work in a neat, well-organized manner with conduit and similar services running parallel with primary lines of the building construction, and with a minimum of 7'-0" overhead clearance where possible.
2. Locate operating and control equipment properly to provide easy access, and arrange entire electrical work with adequate access for operation and maintenance, and for proper Code clearances.
3. Advise other trades of openings required in their work adequately in advance for the subsequent move-in of large units of electrical work (equipment).

B. Coordinate scheduling, proposed routing, and critical dimensions with all other trades prior to roughing and equipment installation.

C. Coordinate with each utility company and make all installations for their services in accordance with all utility company requirements.

D. It shall be the responsibility of the Contractor to verify dimensions and elevations shown or scaled on Drawings by actual field measurements after building construction has progressed to the point where such measurements may be taken.

E. Advise Owner in writing regarding those critical dimensions which must be held by other Trades as they perform their work.

F. Assume full responsibility for accuracy of all work under this Division and make corrections as required.

G. It shall be this Division's responsibility to coordinate with all other Trades and separate equipment contracts regarding mechanical equipment layouts, space requirements, mounting details, "roughing-in" dimensions, and for items substituted for those specified herein to avoid conflict.

H. Arrange for disassembling large pieces of equipment for entry into buildings as necessary to pass through available openings.

I. Layouts of feeders and wiring shown on Drawings are diagrammatic, and shall be constructed as such, intended to show scope of work and general arrangement, unless otherwise noted.

J. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members and mechanical or other equipment, furnish and install all required supports and wiring to clear the encroachment.

K. Where job conditions require reasonable changes in indicated locations or arrangements prior to roughing, make such changes without extra cost to the Owner.

L. Any Work installed contrary to or without approval of the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed the Contractor for making these changes.

M. Provide all power wiring to equipment furnished by this and other Trades (heating, ventilation, plumbing, general construction, etc.) unless otherwise indicated or specified.

N. Control wiring by Division 26 shall include, but not be limited to that wiring between starters, controllers, interlocks, and motors not included as a manufacturer packaged unit, wired by factory installers or wired by Temperature Control Trade.

   1. Where only portions of control packages are prewired, Division 26 shall provide balance of power and control wiring, and as indicated on control diagrams.

O. Division 26 shall provide all required circuit breakers in addition to those indicated on panelboard schedule for equipment provided by other divisions.

P. Where locations are dimensioned on the Drawings, they may be changed only with the written approval of the Owner or his representative. If interferences are found between the electrical work and that of other Trades, Owner shall decide which must be relocated.

Q. Contractor shall study and compare all Contract Drawings, Specifications, and other instructions and shall at once report to the Engineer any error, inconsistency or omission which he may discover.

R. Where a conflict occurs between this Specification and other Contract Documents, the more stringent requirements shall govern.

S. Contractor shall have a competent foreman in charge of work with authority to receive verbal and written instructions from Owner. Contractor shall inform Owner of foreman's name and title.

T. The Drawings are diagrammatic and functional only, and are not intended to show exact layouts, number of fittings, or other installation details. The Contractor shall furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed by the Contractor wherever needed to conform to the specific requirements of the equipment.

U. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be verified during construction so that they shall coordinate with all other work and equipment. The Contractor shall obtain in the field all information relevant to the placing of electrical work and, in case of any interference with other work, shall proceed as directed by the Engineer and shall furnish all labor and materials necessary to complete the Work in an approved manner.

V. The ratings of motors and other electrically operated devices, together with the size shown for their branch circuit conductors and conduits, are approximate only, and are indicative of the probable power requirements insofar as they can be determined in advance of the purchase of equipment. Equipment sizes may vary from sizes indicated on the Drawings and must be verified with actual equipment to be furnished and coordinated with all other equipment and material sizes. If equipment or material sizes need to change due to this coordination, such changes shall be made with prior Engineer approval and at no cost to the Owner.

1.09 QUALITY ASSURANCE

A. Qualifications of Installers:

1. For the actual fabrication, installation, and testing of the Work of this Division, use only thoroughly trained and experienced personnel who are completely familiar with the codes and requirements for this Work and with the installation recommendations of the manufacturers of the specified items.

B. Workmanship:

1. Complete electrical installation shall be made in a neat and workmanlike manner and to the full satisfaction and approval of the Owner and Engineer.
2. Work not meeting Owner's standard for adequate workmanship shall be removed and replaced at once, at no additional Contract cost to the Owner.
3. Remove and replace all work rejected by Owner as defective, non-operational or not in conformance with intent of this Contract.

C. Electrical products used shall be UL listed by Underwriters Laboratories. To assure the proper use of electrical equipment, the Electrical Contractor shall verify compliance by reference to the UL Guide Information for Electrical Equipment - The White Book.

1.10 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

1.11 REGULATORY REQUIREMENTS

A. Perform the work and provide material under this Division in strict accordance with applicable provisions of all governing codes, rules, laws and ordinances as amended and in effect on date of issue for bids, specifically including but without being limited to:

1. American National Standards Institute (ANSI).
2. American Society for Testing Materials (ASTM).
3. Americans with Disabilities Act (ADA).
4. Association of Edison Illuminating Companies (AEIC).
5. Canadian Standards Association (CSA)
6. Edison Electric Institute (EEI).
7. Environmental Protection Agency (EPA)
8. Factory Mutual (FM)
9. Federal Communications Commission (FCC)
10. Federal Information Processing Standards Publication 94 (FIPS Pub 94)
11. Institute of Electrical and Electronics Engineers (IEEE).
12. Insulated Cable Engineers Association (ICEA).
13. International Building Code (IBC)
14. International Electrotechnical Commission (IEC)
15. International Energy Conservation Code (IEEC)
16. International Organization for Standardization (ISO 9001)
17. Local ordinances, regulations, and electric codes.
18. Occupational Safety and Health Act (OSHA).

19. National Electrical Code (NEC).
20. National Electrical Safety Code (NESC).
21. National Electrical Manufacturers' Association (NEMA).
22. National Fire Protection Association (NFPA).
23. Maine Department of Environmental Services (MDES).
24. Sheetmetal Air Conditioning Contractors National Association (SMACNA)
25. Requirements for Underwriters' Laboratories, Incorporated for all items installed for which UL standards have been established.
26. Pertinent requirements of the local utility companies.

B. In each case, codes are minimum requirements.

C. It shall be understood that all codes and standards mentioned shall be those in force at the time the Contract is signed. If any code is changed during the construction period, these Specifications may be changed by change order.

D. Each item of equipment and material shall conform to requirements of these applicable publications which make them most suitable for environmental conditions where they shall be installed.

E. Items which are within scope of items tested by Underwriter's Laboratories, Inc., or other suitable nationally recognized independent testing laboratories shall have their conformance with these applicable publications evidenced by attachment of authorized seal, label, or stamp of those testing laboratories.

F. The Contractor shall cooperate with and assist Owner in securing from the authority enforcing the codes any "special permission" or interpretation needed to complete work.

G. The work required by the Drawings and the Specifications shall comply with applicable codes. Conflicting provisions of the Contract Documents to the contrary notwithstanding, it shall be the sole responsibility of the Contractor as part of the base Contract to execute the work so as to obtain the approval of the Local Authority at completion of the work.

H. On preparing his bid, the Contractor shall carefully check the Drawings and Specifications for compliance with applicable codes and other legal requirements. He shall inform the Engineer in writing of any non-conformance before he submits his bid.

1.12 PROJECT/SITE CONDITIONS

A. Install work in locations shown on the Drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect before proceeding.

1.13 PRODUCTS

A. In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays and other items is essential. All similar items shall be of the same manufacturer, type, model, and dimensions or, in the case of special systems which are a composite of a number of manufacturers' products, shall be supplied and/or serviced from an organization with one source of responsibility.

B. Provide products which are compatible within systems and other connected items.

C. For ease of maintenance and parts replacement, to the maximum extent possible, use equipment of a single manufacturer.

D. The Engineer reserves the right to reject any submittal which contains equipment from various manufacturers if suitable materials can be secured from fewer manufacturers and to require that source of materials be unified to the maximum extent possible.

E. All equipment and fixtures shall be of the capacity and type shown on the Drawings and specified herein and shall be as manufactured by one of the manufacturers designated or shall be an equal approved in advance by the Engineer.

F. All other materials, not specifically described but required for a complete and operable electrical installation, shall be new, first quality of their respective kinds, and as selected by the Contractor subject to the approval of the Engineer.

G. Install all equipment and fixtures in complete accordance with the manufacturer's recommendations and all pertinent codes and regulations.

H. Materials and equipment shall be listed by Underwriters Laboratories unless it can be demonstrated that no UL standards exist for a specific items or class of equipment.

1.14 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated electrical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.15 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly packaged and protected to prevent damage during shipment, storage, and handling.

B. Use all means necessary to protect electrical system materials during and after installation and to protect the installed work and materials of all trades until testing and final acceptance.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Product stored equipment and materials from damage.

D. Provide approved protection of all work and property against damage, injury, loss, etc., until testing and final acceptance. Follow manufacturer's recommendations for protection of equipment and materials during storage and construction; protect equipment outlets, pipe and conduit openings with temporary plugs or caps.

E. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

F. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

G. The Contractor shall be responsible for the work of other trades that may be damaged or disturbed in the course of his work and he shall restore the damaged work to the condition existing prior to damage without additional cost to the Owner.

1.16 ELECTRICAL INSTALLATION

A. Coordinate electrical equipment and materials installation with other building components.

B. Routing of all conduit racks, which contain multiple conduits and/or cable trays, through public areas shall be coordinated with the architect and the engineer prior to installation. Public areas shall be areas with open ceilings, including, but not limited to, lobbies, atriums, field houses, gymnasiums, multi-purpose rooms, auditoriums, natatoriums, ice rinks, cafeterias, major corridors (both with or without drop ceilings), etc.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

F. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

G. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

H. Where mounting heights are not detailed or dimensioned, install electrical conduits and services to provide the maximum headroom possible.

I. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

J. Coordinate the installation of electrical materials, light fixtures, and equipment in ceilings with suspension system, mechanical equipment, and other piping installations.

K. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

L. Note that special efforts have been made to layout mechanical and electrical systems exposed to view in order to achieve a certain aesthetic quality. The Contractor is responsible to layout and install all systems, especially those exposed to view, in a neat, orderly, and workmanlike manner in order to provide a high quality installation, and to maintain the desired aesthetic quality, as appropriate.

1.17 CUTTING AND PATCHING

A. Unnecessary cutting and patching shall be avoided through proper planning of work, provision of pipe and duct sleeves and cooperation with other Contractors. Each Contractor shall be responsible for all cutting, patching, and restoration of his own work at no expense to the Owner and to the satisfaction and approval of the Owner.

B. In no case shall structural members be cut or notched without approval of the Engineer.

C. All patching shall be done only by mechanics who are skilled in this line of work to produce a neat finished job acceptable to the Owner in all respects.

D. Repair and/or replace the work of Trades damaged as a result of work performed under this Division, at no additional cost to the Owner.

1.18 SURFACE CONDITIONS

A. Inspection:

1. Prior to all work of this Division, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that the electrical installation may be made in complete accordance with all pertinent codes and regulations and the original design.

B. Discrepancies:

1. In the event of discrepancy, immediately notify the Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

C. Reconditioning for Surfaces:

1. Unpaved surfaces disturbed during the installation of ductbanks shall be restored to their original elevation and condition. Sod or topsoil shall be preserved carefully and replaced by sod or topsoil of quality equal to that removed. Where the surface is disturbed in a newly seeded area, the restored surface shall be reseeded with the same quantity and formula of seed as that used in the original seeding.
2. The Contractor shall patch pavement, sidewalks, curbs, and gutters where existing surfaces are removed for construction. Cut pavement edges shall be sawn. Concrete or brick pavers, or other similar surface finishes, that are removed during the installation of duct, shall be replaced and restored to match surrounding surfaces by qualified personnel experienced in that Trade.

1.19 CLEANING

A. Thoroughly inspect all equipment and any items dented, scratched, or otherwise damaged in any manner shall be replaced or repaired and painted to match original finish.

1. All items so repaired and refinished shall be brought to the attention of the Engineer for inspection and approval.

B. Upon completion of all installation, lamping, and testing, thoroughly inspect all exposed portions of the electrical installation and completely remove all exposed labels, soil, markings and foreign material.

1.20 VISIT TO SITE

A. As there may be various conditions at the site which do not show on the accompanying Drawings, or which are at variance with the conditions indicated on the Drawings, it is important that each Bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

1.21 EXISTING SERVICES

A. Active: When encountered in work, protect, brace, support existing active drains, gas, electric, water, other services where required for proper execution of work. If existing active services are encountered that require relocation, make request in writing for determination. Do not prevent or disturb operation of active services that are to remain. Repair broken service at no cost to the Owner. Record any existing services encountered on Contractor's job site drawing sets.

B. Inactive Services: When encountered in work, remove cap or plug inactive services. Notify Owner; protect or remove these services as directed. Record on "as-built" drawings.

C. Interruption of Services: Where work makes temporary shutdowns of services unavoidable, shutdown at night or at such terms as approved by Owner, which will cause least interference with established operating routine. Arrange to work continuously, including overtime, if required, to assure that services will be shutdown only during time actually required to make necessary connections to existing work.

1.22 MECHANICAL SYSTEMS COORDINATION

A. Furnish and install, as indicated on the electrical drawings all disconnect switches, motor overload protective devices, contactors, magnetic starters, complete with required pushbuttons, selector switches, and pilots.

B. Furnish and connect all duct-mounted smoke detectors (installation by Mechanical Contractor).

C. Provide all power wiring as indicated on the electrical drawings.

1.23 OVERCURRENT PROTECTION COORDINATION

A. The Contractor shall be responsible for an overcurrent protective device coordination study to ensure proper circuit opening sequence and equipment protection. Applicable ANSI and IEEE standards shall be followed.

B. Provide to the Engineer prior to equipment approval, in one bound submittal in accordance with Division 01, the following:

1. Type written description of the coordination study and parameters used.
2. Time current curves for all overcurrent protective devices.
3. One-line diagram indicating overcurrent protective devices location in circuit, type and settings, if needed.
4. Letter by Contractor stating that coordination study has been performed, who performed the study and that equipment is properly coordinated.

C. The Engineer reserves the right to review the submittal for conformance with this contract. Engineer approval is needed prior to equipment purchase. Conform to Division 01 for submittal requirements.

D. See Section 26 01 50 for additional requirements.

1.24 TEMPORARY SERVICES

A. Electric: Temporary electrical service(s) shall be provided:

1. Temporary electrical service shall be coordinated with the utility and be sized for the maximum construction load.
2. All power requirements of individual trades shall be provided.
3. All wiring shall be in accordance with the NEC.

4. All receptacles shall be ground fault protected.
5. Where a temporary power outage due to construction is not acceptable to the Owner, provide a temporary engine generator for the critical loads. Generator shall be suitably sized for the intended loads, have portable fuel supply and critical muffler.

B. Lighting: Provide temporary lighting for construction needs throughout the construction period. Areas to be illuminated shall include but not be limited to:

1. Construction areas: Uniform 20 foot-candles minimum.
2. Security area: Uniform 1 foot-candle minimum.
3. Temporary offices, storage, shop and other construction buildings: Light levels as required.

1.25 WARRANTIES

A. Refer to Division 01 for warranty requirements. The following paragraphs supplement the requirements of Division 01.

B. Compile and assemble all warranties for equipment specified in Division 26 into vinyl-covered three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Include product or equipment, date of beginning of warranty or bond, duration of warranty or bond, and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Provide extended warrantees, at no additional cost to the Owner, for equipment and materials whose basic warranty will expire prior to full beneficial use of the Owner and/or acceptance of the building by the Owner, because of the timing of shipment or installation. (For example, a piece of equipment with a one-year warranty which is installed 18 months prior to completion of the project, due to the enclosing of the building shall be provided with an extended warranty coverage after the building's completion.) The extended warranty may be through the manufacturer or the installing Contractor. However, all benefits of the original manufacturer's warranty shall be conveyed to the Owner for the specified warranty period, commencing with acceptance of the building by the Owner.

1.26 GUARANTEE

A. The Contractor shall guarantee all work to be free from defects for a period of one (1) year after acceptance. Any and all work found defective or not in accordance with the Contract during this period shall be corrected promptly by the Contractor after written notification from the Owner. The Contractor shall repair or correct the work within ten (10) days of the written notification and if the Contractor does not comply, the Owner may have the work corrected and charge all such work to the Contractor.

1.27 PHASING/WORK SEQUENCING

A. Refer to General Conditions and Division 01 sections, and to the General Contractor's and Architect's phasing and/or work sequencing descriptions and/or plan(s), for necessary phasing/sequencing of this project.

B. Coordinate with the General Contractor in order to determine all phasing/sequencing requirements and to schedule work. Electrical work shall be executed in such a manner as to cause minimal or no disruption of other trades' activities in the building. Coordinate all deliveries, installations, etc. as required to avoid disruption and/or inconvenience. Continue to inform the General contractor and the Architect of work anticipated to take place each day and/or week, sufficiently in advance of the work for comment and potential redirection of those activities to avoid conflict and/or disruption

1.28 REVIT FILES

A. Following the receipt of a written request from the Contractor, RFS will furnish REVIT electronic files for electrical drawings. Signing of the Rist-Frost-Shumway Engineering, P.C. Electronic Document File/Digital License Agreement shall be considered prerequisite for the release of the files.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 26 01 50

SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.

1. The study shall be performed using the equipment to be used for the project.
2. The study shall be performed and reviewed prior to the release of the equipment to the site.
3. Any breakers or equipment that does not coordinate properly shall be replaced with equipment that does coordinate, at no cost to the owner.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the latest edition of NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

C. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract.

1.02 RELATED SECTIONS

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition.
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.03 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.04 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

B. For large system studies with more than 200 bus locations, the contractor is required to provide the study project files to the Owner in electronic format. In addition, a copy of the computer analysis software viewer program is required to accompany the electronic project files, to allow the Owner to review all aspects of the project and print arc flash labels, one-line diagrams, etc.

C. The report shall include the following sections:

1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

D. Arc flash labels shall be provided in hard copy and for large system studies with more than 200 bus locations, a copy of the computer analysis software viewer program is required to provide arc flash labels in electronic format.

1.05 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.06 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program.

PART 2 – PRODUCTS

2.01 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.02 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.03 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Tabulations of calculated quantities.
6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point.
2. Incoming switchgear.
3. Unit substation primary and secondary terminals.
4. Low voltage switchgear.

5. Motor control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.
8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.04 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device.
2. Medium voltage equipment overcurrent relays.
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
6. Conductor damage curves.
7. Ground fault protective devices, as applicable.
8. Pertinent motor starting characteristics and motor damage points, where applicable.
9. Pertinent generator short-circuit decrement curve and generator damage point.
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.05 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.06 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

   a. Voltage.
   b. Calculated fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. Equivalent impedance.

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

   a. Voltage.
   b. Calculated symmetrical fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. Calculated asymmetrical fault currents.

      1) Based on fault point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.

   e. Equivalent impedance.

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

   a. Voltage.
   b. Calculated symmetrical fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. No AC Decrement (NACD) Ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:

   a. Current transformer ratio.
   b. Current setting.
   c. Time setting.
   d. Instantaneous setting.

e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

a. Adjustable pickups and time delays (long time, short time, ground).
b. Adjustable time-current characteristic.
c. Adjustable instantaneous pickup.
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard Risk Category.
8. Recommendations for arc flash energy reduction.

PART 3 – EXECUTION

3.01 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.02 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.

2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided.

F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

END OF SECTION

SECTION 26 06 00

GROUNDING AND BONDING

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Power system grounding.

B. Utility system (CMP Co., etc.) equipment grounding.

C. Equipment grounding.

D. Building ground grid (rebar, steel, piping, etc.).

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Product Data: Subject manufacturer's data on grounding systems and accessories.

1. Grounding conductors and connectors.
2. Grounding rods and fittings.

B. Submit building ground resistance test results in accordance with Section 26 08 00.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

A. Manufacturer: Firms regularly engaged in manufacturer of electrical connectors, terminals and fittings of types and ratings required and ancillary grounding materials, including stranded cable, copper braid, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. Installer: Qualified with at least three (3) years of successful installation experience on projects with electrical grounding work similar to that required for project.

C. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment, and wiring.

D. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467, 486A and 869 pertaining to electrical grounding and bonding. Provide grounding products which are UL-listed and labeled.

E. IEEE Compliance: Comply with applicable requirements of IEEE Standard 80 and 142 pertaining to electrical grounding.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle electrical grounding accessories and components carefully to avoid damage; store in original wrappings and protect from dirt and weather.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, providing grounding products of one of the following:

1. Mechanical and compression connectors and fittings:

   a. Anderson
   b. Blackburn
   c. Burndy
   d. Dossert
   e. OZ/Gedney
   f. Thomas & Betts

2. Exothermic connectors:

   a. Erico Products, Inc. (Cadweld)

B. Substitutions: Items of equal quality, function, and performance may be proposed for substitution by following procedures outlined in Section 26 01 00.

2.02 MATERIALS AND COMPONENTS

A. General: Except as otherwise indicated, provide electrical grounding systems indicated, with assembly of materials including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

B. Conductors: Provide bare, stranded, concentric lay, soft drawn annealed copper cable, Class A or B. Where insulated grounding cables are required, they shall be stranded, 600 volt, Class B., with high molecular weight polyethylene (HMWPE) insulation. Provide conductors in sizes as specified on the Drawings. In instances where sizes are not specified or where NEC requirements are more stringent, provide conductors sized according to NEC.

C. Bonding Jumper Braid: Copper braided tape, constructed of 30-gauge, are copper wires and properly sized for indicated applications.

D. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gauge bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cm. Protect braid with copper bolt hole ends with holes sized for 3/8" diameter bolts.

E. Provide miscellaneous grounding materials (nuts, bolts, washers, etc.) fabricated of copper-silicon alloy or stainless steel.

F. Copper clad steel, 3/4" diameter 10' long grounding rods.

G. Ground Bars: Telecom ground bars shall be 4" x 20" (TMGB) for main IT rooms and 1/4" x 4" x 12" (TGB) for Telecom Rooms (see plans for locations). Ground bars shall be pre-drilled with 5/16" and 7/16" hole pattern with insulated stainless steel standoff wall brackets that meet TIA/EIA 607 specifications.

   1. Erico EGBA14420MM (TMGB) and Erico EGBA14412MM (TGB) or equivalent.

PART 3 – EXECUTION

3.01 INSPECTION

A. Installer must examine areas and conditions under which electrical grounding connectors are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 GROUNDING AND BONDING

A. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.

B. Flexible metal conduit and fittings not approved for ground bonding shall have bonding jumper.

C. All equipment enclosures, control panels, motor frames, conduit systems, cable armor, cable tray system, exposed structural steel, and similar items shall be grounded.

D. Conduit runs, metallic wireways and cable trays shall be joined together to form a continuous electrical conductor through standard fittings and connectors.

E. Exposed connections shall be made by means of approved grounding clamps. All buried connections shall be made by Cadweld welding process or equal.

F. The Contractor shall exercise care to ensure good ground continuity, in particular between conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

G. Circuit Grounding: Install grounding bushings, grounding studs, and grounding jumpers at pullboxes, motor control centers, and panelboards.

H. Bonding Jumpers: Provide green insulation, sized correlated with over-current device protecting the wire, attached to grounding bushings on conduit or to lugs on boxes and other enclosures.

I. Bonding Wires: Install bonding wire when using flexible conduit connected at each end to a grounding bushing.

J. Ground rods shall be located as indicated on the Drawings. Rods shall be driven the entire length plus 6 inches. Conductor between rods shall be #4/0 AWG minimum connected with Cadweld Process or equivalent.

K. Ground transformer secondary neutral to building ground in accordance with NEC and as indicated.

L. The concentric neutral wires of each power cable shall be connected to the grounding braid of each cable terminator. The braid shall connect to the neutral point of each surge arrester. The neutral of each phase shall be tied together and a connection shall be made between the surge arrester neutral points, ground, and the overhead neutral conductor.

M. Where a grounding connection requires the removal of, or disturbs a galvanized or other finished surface, the entire connection shall be suitably finished to provide equal protection.

N. All contact surfaces that are bolted connectors shall be thoroughly cleaned to bright metal and coated with "NO-OX-ID," or equal, before connections are made.

3.03 BONDING FOR OTHER TRADES

A. All piping and structural steel shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding jumper shall be sized in accordance with Table 250-122 of the NEC. Connections to pipes shall be made with cast clamps of like material as the pipes to which attached, to ducting terminated in a secure manner by best practical means, bonding across any flexible or insulated connections.

B. All bonding conductors shall be installed in a neat and workmanlike manner, properly shaped for contour of surface involved and properly supported. At locations remote from the switchgear, bond to the largest raceway nearby.

C. The points of attachment of the bonding jumper shall be accessible.

3.04 FOR SYSTEMS TELECOMMUNICATIONS GROUNDING AND BONDING

A. All grounding and bonding connectors shall be listed by a nationally recognized testing laboratory (NRTL) as required by the NEC.

B. All grounding and bonding conductors shall be copper and may be insulated. When conductors are insulated, they shall be listed for the application. The minimum bonding conductor size shall be a No. 6 AWG or as indicated on the Drawings.

C. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 1 m (3 ft.) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.

D. Each telecommunications grounding and bonding conductor shall be labeled. Labels shall be located on conductors as close as practicable to their point of termination in a readable position. Labels shall be non-metallic and include the information depicted below. Refer to ANSI/TIA/EIA 606 for additional labeling requirements.

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER.

3.05 TESTING

A. Test grounding system in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 07 00

SUPPORTING DEVICES

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Hangars, straps, clamps, steel channel, and fastening hardware for supporting and anchoring conduit and electrical equipment.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 26 01 00.

B. Provide manufacturer's catalog data for supporting devices and fastening systems.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 SEISMIC RESTRAINTS

A. Fully conform to 2006 International Building Code, Section 1613 Earthquake Loads ASCE Standard ASCE/SEI 7-Chapter 13 Seismic Design Requirements for Nonstructural Components.

B. The structural drawings indicate the seismic use group and seismic design category as follows:

1. Occupancy Category: III
2. Seismic Design Category: C

C. Refer to structural drawings and specifications for further requirements.

D. The seismic restraint design, consisting of calculations, restraint selection, installation details, and other documentation shall be performed by a professional engineer licensed in the state where the project is located. Submit all documentation with professional seal and signature.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements provide products by the following:

1. Hangars, straps, and beam clamps:

   a. Appleton
   b. Raco, Inc.
   c. Steel City
   d. O.Z./Gedney Co.
   e. Midland Ross
   f. Erico
   g. Minneralac

2. U-channel systems, slotted angle, and fittings (1-5/8" x 1-5/8", 12-gauge):

   a. B-line
   b. Unistrut
   c. Globe Strut

3. Anchors:

   a. B-line
   b. Hilti
   c. Acherman-Johnson Corp.

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures in Section 26 01 00.

2.02 CONDUIT SUPPORTS

A. Single Runs: One-hole malleable conduit strap with backer or ring bolt type hangers with clamp backs.

B. Multiple Runs: Conduit rack with 25% spare capacity. Rack shall be of galvanized steel channel supported by double nuts on 3/8-inch continuous thread, galvanized or cadmium plated steel hanger rods.

C. Vertical Runs: Channel support with conduit fittings.

2.03 MC/AC TYPE CABLE SUPPORTS

A. Only metallic snap-in type support clips approved for armored MC or AC type cable may be used.

2.04 EQUIPMENT SUPPORTS

A. Equipment to be mounted on exterior block or concrete walls or where indicated shall be mounted on 1-5/8" x 1-5/8" minimum galvanized steel channel anchored to the wall.

B. Equipment weights shall not exceed supporting device capacity.

C. Plywood backboards shall be 3/4" thick, void-free, Douglas fir, pressure treated with fire-retardant chemicals, one-side sanded, painted gray on all sides with gray fire-resistant paint prior to installation. Sanded side shall face equipment to be mounted.

2.05 ANCHOR METHODS

A. Hollow Masonry: Toggle bolts shall be all steel spring head type.

B. Concrete and Solid Masonry: Steel expansion anchors or preset inserts. Steel sleeve and expansion anchors utilizing a threaded bolt, lag bolt or threaded stud.

C. Metal Surfaces: Machine screws, bolts, or welded studs. Machine screws, bolted clamps, or power-driven threaded studs.

D. Wood Surfaces: Wood screws. Pan head sheet metal screws or lag bolts.

E. Concrete Surfaces: Self-drilling anchors or power-driven studs.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Layout to maintain headroom, neat mechanical appearance and to support equipment loads required.

B. Conduit and equipment supports shall not impair the building structural integrity. Structural steel joists shall not be drilled or cut. Secure hangers to these materials with mechanical clips.

C. Conduit and equipment supports shall meet or exceed all seismic restraint requirements of the IBC (International Building Code). Seismic restraint shall meet Category C requirements as a minimum.

3.02 SUPPORTS FOR EQUIPMENT

A. Contractor shall provide all necessary supports for equipment installed under this Specification Section. Supports shall consist of steel frames, plates, brackets, racks and other shapes of adequate size and fastened with bolts, screws or by welding, to provide rigid support. Welds shall be continuous and, where exposed, ground smooth. Thoroughly clean metal surfaces and apply one coat of primer as required and two coats of finish paint to match equipment. Any other material to be used for support shall have the Engineer's prior approval.

B. Contractor shall be responsible for fabricating and installing all necessary supplemental supporting structures, including clips, brackets, etc., for conduits, fixtures, and electrical equipment not otherwise provided on pipeways, buildings, vessels, and structures. These shall be adequate for spare or future facilities where applicable.

C. Contractor shall not drill, burn or weld to tanks, vessels, galvanized structures, or finished buildings without specific approval from the Engineer.

D. Contractor shall check for the extent of fireproofing on all structures and install, as approved, the necessary clips or brackets, required for the support on conduits, fixtures, devices, and equipment. Conduits shall not be imbedded in fireproofing.

E. The Contractor shall be fully responsible for the proper sizing and assembling of support systems to adequately and rigidly support raceways and/or equipment mounted thereon with a safety factor of at least three.

END OF SECTION

SECTION 26 07 50

ELECTRICAL IDENTIFICATION

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Nameplates for all panelboards, cabinets, safety switches, contactors, motor-controllers, individual circuit breakers, control devices, motor control centers, unit substations, switchgear and any other equipment used to control, switch or disconnect electrical circuits shall be provided by the Contractor under Division 26 of the specifications.

B. All switchboards and panelboards shall be identified with permanent nameplate on the front identifying **"PANEL XXXXX, FED FROM PANEL XXXXX"** on two lines.

C. Underground warning tape shall be buried above all electrical power and communication underground installations.

D. Provide warning signs for fence, railing, or room enclosing electrical equipment.

E. Provide warning labels regarding potential electric arc flash hazards in all switchboards, panelboards, motor control centers, and industrial control panels per NEC 110-16.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Submit product data and listing of equipment nameplate lettering.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

1. Brady
2. Ideal Industries
3. Thomas & Betts
4. Panduit

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures in Section 26 01 00.

2.02 NAMEPLATES

A. Equipment nameplates shall be 1/16" thick laminated phenolic with engraved block letters, white on a black background, securely fasten nameplates to front covers of enclosure with brass screws.

B. Nameplates for panelboards, switchboards, motor control centers, transformers, unit substations, and switchgear shall have 1/2-inch high letters. Identifying the equipment name indicated on the one-line diagram and the voltage. Include the identification of series rated components within this equipment with nameplates using 1/4-inch letters.

C. Nameplates for individual circuit breakers, disconnect switches, junction boxes, VFDs, and motor starters shall have 1/4-inch letters and shall be as indicated on the one-line diagram and plans, or shall describe the equipment being controlled.

D. Nameplates for transformers shall have 1/2" high letters and indicate the transformer name indicated on the one-line diagram and the primary and secondary voltages.

2.03 WARNING AND CAUTION SIGNS

A. Warning signs shall be provided for the fence, railing, or room enclosing electrical equipment such as substations, transformers, and switchgear having a nominal rating of 400 volts and above; and for the enclosure of metal-enclosed equipment not so guarded or segregated. Unless specified otherwise, the signs shall conform to ANSI Z535.4, shall be minimum 20-gauge steel with a porcelain enamel finish, and shall have the legend "DANGER HIGH VOLTAGE" in two lines of letters of nominal 3-inch height in colors as required by ANSI standards.

B. The signs shall be of such number and position as to be readable from all accessible sides and shall be not more than 300 feet apart.

2.04 UNDERGROUND LINE MARKING TAPE

A. Provide red or yellow, six (6) inches wide by four (4) mils thick, plastic tape with a continuous standard legend buried above underground installations to warn future excavators and prevent damage to the underground installations. If underground conduit is non-metallic, metal tape shall be run along its length to allow detection with metal detectors.

2.05 CONDUIT CONTAINING CIRCUIT WIRING OPERATING AT OVER 600 VOLTS

A. State "DANGER - HIGH VOLTAGE" in black letters two (2) inches high, stenciled at 10-foot intervals over an adhesive type identification tape with a continuous-painted orange background.

2.06 IDENTIFICATION TAGS FOR CABLES IN MANHOLES, PULLBOXES, OR HANDHOLES

A. Brass or aluminum tags with engraved legend or circuit served, punched fastener. Dimensions: 2 inches by 2 inches by 19-gauge.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated on the plans. Install numbers, lettering, and colors as approved by submittals and as required by code.

B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC and ANSI standards.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

D. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches.

E. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance or equipment.

F. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic laminated instruction signs with approved legend where instruction or explanations are needed for system or equipment operation.

END OF SECTION

SECTION 26 08 00

ELECTRICAL TESTING

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work shall include complete testing of all equipment and wiring at the completion of the work, the making of any connection changes or adjustments necessary for the proper functioning of the system and equipment and all testing described in this Section. Power distribution, lighting, control and all miscellaneous systems shall be properly adjusted and in working order, as required, at time of final acceptance.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit test data and results in accordance with Section 26 01 00.

B. Submit certification that all required factory testing has been completed by the manufacturer.

C. Submit name of testing agencies for approval by the Engineer.

D. Prior to commencing work, submit draft reports indicating testing procedures, sample report forms, and testing data required for approval by the Engineer.

E. Submit draft copies of completed test reports for review prior to final acceptance of the project.

F. After Architect and Engineer review, make final requested adjustments and provide final copies of report for inclusion in Operating and Maintenance Manuals by the Architect.

G. Provide test reports in soft cover, letter size, three-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with equipment identified to correspond with data sheets, and indicating thermostat locations.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 REQUIREMENTS

A. Furnish all equipment and personnel and conduct all tests required to secure approval of the installation from all agencies having jurisdiction.

B. Coordinate with other trades in testing equipment furnished by others, including but not limited to:

1. Checking motors for rotation.
2. Running full-load tests on all power consuming equipment.
3. Coordinating and testing control wiring and interlocks.
4. Megohmeter testing of heat trace cables.

C. Contractor shall provide Owner with two (2) working days notice prior to performing all tests to allow Owner to arrange to witness the tests.

D. All testing shall be witnessed by the Owner or Owner's representative. The results of all quantitative tests shall be furnished to the Owner in a typed, approved format as indicated herein.

E. All test results must be accepted by the Owner before the Contractor is relieved of responsibility for the work.

F. Insulation resistance tests shall not be made on any equipment until the manufacturer's instructions have been checked and an inspection made to see if any components such as surge protection devices, semi-conductors, control relay coils, etc., exist which may be damaged by such tests. Such components shall be isolated from the test potentials before the tests are performed.

PART 2 – PRODUCTS

2.01 MATERIALS

A. The Contractor shall be responsible for all equipment and materials required to perform all tests as specified herein. All test equipment shall be in first-class condition, correctly calibrated, and shall be operated by qualified personnel experienced in the use of the equipment.

PART 3 – EXECUTION

3.01 TESTING

A. All systems shall test free from mechanical and electrical defects.

B. Operations tests shall be made of all systems as a condition of acceptance.

C. Balance connected loads across phases at all panels and load centers.

3.02 GROUND SYSTEM RESISTANCE TEST

A. Test the ground system before backfilling to ensure continuity and a maximum of 10 ohms to ground. Make resistance measurements in dry weather, no earlier than 48 hours after rainfall. Test shall be three-point type.

B. Soil type and most recent rainfall shall be noted in test submittal.

3.03 WIRE AND CABLE

A. Testing of conductors shall be done with the conductors disconnected from all equipment.

B. All conductors shall be tested for continuity, shorts, and grounds. All faulty cables shall be replaced at no cost to the Owner.

C. Power conductors rated 600 volts and below shall be given insulation resistance tests with a 1000-volt DC test voltage. The tests shall be between each phase and ground, and between phases. A satisfactory test shall indicate a minimum insulation resistance of 20 megohms.

3.04 TRANSFORMERS

A. Each transformer shall be visually inspected for physical damage.

B. The insulation resistance of each transformer winding shall be checked with a test voltage recommended by the manufacturer. The minimum acceptable one minute reading will be 2 megohms per 1000 volts of nameplate voltage rating, but in no case less than 2 megohms.

C. The windings of each transformer shall be checked for continuity.

D. All transformer mechanical and safety devices such as liquid level gauges, gas pressure alarm devices, fans thermal relays, tap switches and load break switches shall be checked for proper operation.

E. Any additional tests recommended in the manufacturer's instructions shall be completed.

3.05 SWITCHGEAR

A. Switchgear rated 600 volts and below shall be tested as follows:

1. With main and feeder breakers open, test the main secondary bus with a 1000 volt test voltage. The minimum insulation resistance acceptable is 20 megohms.
2. Check manual closing and opening, contact adjustments, drawout operation, etc., for all circuit breakers in accordance with the manufacturer's instructions.
3. Verify setting of overcurrent devices for all circuit breakers and adjust to comply with requirements.

3.06 MOTORS AND GENERATORS

A. An installation resistance test shall be performed with a 500 volt test voltage on all 460 volt motors and generators prior to initial starting. DC High Potential tests shall be given to any motor or generator above 460 volts.

B. All motors shall be tested for proper direction of rotation and necessary reconnections made. No motor coupled to a pump or other driven equipment shall be checked for rotation with the coupling connected. Permission shall be obtained from the owner before starting any motor for test.

C. Generators shall be checked for phase sequence coordination with utility system, voltage regulation, frequency regulation, and fuel consumption. Test shall be for 1 hour minimum. Manufacturer's representative shall be present to verify proper operation.

D. After generator is installed, a four- (4-) hour full load bank installation test shall be performed under the supervision of a factory-trained service engineer, provided by the manufacturer of the generator set. The manufacturer shall provide the necessary lube oil for the crankcase and antifreeze for the cooling system to provide protection to -20°F. Standard readings shall be taken and submitted for approval.

3.07 CONTROLS

A. All control equipment shall be tested, properly adjusted and shall be operating correctly with power applied before final acceptance will be made.

B. All control wiring shall be verified for proper termination.

3.08 HEAT TRACE CABLE

A. The Electrical Contractor shall provide testing of heat trace cable as follows after verifying the following procedure is acceptable to the manufacturer:

1. Measure the heater circuit continuity and the insulation resistance between the braid and the bus wires with a 2500 VDC (megohmeter) megger.
2. Heater cable shall be meggered after installation, but before insulation is applied.
3. Heater cable shall be meggered after insulation has been installed.
4. All field megger readings shall be greater than 20 megohms. Circuits with unacceptable results shall be repaired or replaced.
5. Field megger tests shall be recorded for each heater cable, and reports shall be submitted to the user.

B. All control wiring shall be verified for proper termination.

END OF SECTION

SECTION 26 11 90

UNDERGROUND ELECTRICAL WORK

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. This specification pertains to the requirements for underground electrical work as indicated on Drawings at all voltage levels.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

D. All trade subcontractors are to note that the organization of these Specifications into divisions, sections, and paragraphs, and likewise the arrangement of the Drawings, is set up for the convenience of understanding the scope of the Work only. This structuring shall not control the General Contractor in dividing the Work among trade subcontractors or in establishing the extent of the Work to be performed by any trade.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Product Data: Submit manufacturer's technical product data including size, configuration, and accessories.

C. Shop Drawings: Submit manufacturer's drawings indicating dimensions, weight, mounting details, and operating instructions. Six (6) sets of shop drawings for each rating of equipment shall be submitted and approved before work is started.

1. Conduit (list each size and type).

2. Underground structures.

   a. Composite handholes.

   b. Utility manholes.
   c. Metal frames and covers.
   d. Grounding.
   e. Ground wire.
   f. Ground rods.
   g. Cable racks.
   h. Thermoweld equipment.

D. Certified Laboratory Test Reports: A UL certification or a test report from an approved independent testing laboratory for each rating of equipment shall be submitted and approved before work is started.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

A. Applicable Standards: The standards listed below form a part of this specification to the extent referenced. Contractor shall conform to the latest editions of the following standards, unless otherwise specified herein:

1. American Concrete Institute (ACI) Publication:

ACI 318	Building Code Requirements for Reinforced Concrete

2. American Society of Testing and Materials (ASTM) Publications:

D 1556	Density of Soil in Place by the Sand Cone Method
D 1557	Moisture-Density Relations of Soils Using a 10-lb. Rammer and 18-inch Drop.
C 139	Specifications for Concrete Masonry Units for Construction of Catch Basins and Manholes
C 478	Specifications for Precast Reinforced Concrete Manhole Sections

3. American Association of State Highway and Transportation Officials (AASHTO) Publication:

1977	Standard Specifications for Highway Bridges, Twelfth Edition with Latest Supplements

4. American National Standards Institute (ANSI) Publication:

   C2 National Electric Safety Code

5. National Fire Protection Association (NFPA) Publication:

   70 National Electrical Code (NEC)

6. State of Maine Department of Transportation, "Standard Specifications for Road and Bridge Construction," approved and adopted latest edition.
7. Underwriters laboratories, Inc. (UL) Publications:

   6 Rigid Metal Conduit
   467 Electrical Grounding and Bonding Equipment
   486A Wire Connectors and Soldering Lugs for use with Copper Conductors
   510 Insulating Tape
   514B Standard for Fittings for Conduit and Outlet Boxes
   651 Schedule 40 Rigid PVC Conduit

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.

1. Conduit:

   a. Rigid plastic conduit: UL 651, Schedule 40 PVC. PVC conduit below grade shall be direct buried or concrete encased.
   b. Conduit bends: All bends greater than 10 degrees in conduit ductbanks shall be gradual and made with rigid galvanized steel. All sweeps and elbows shall be long radius, factory fabricated with a minimum bending radius of 4 feet.

2. Fittings and outlet boxes:

   a. Metal fittings and outlet boxes; UL 514A and 514B. Fittings and outlet boxes for use with steel conduit shall be cast-metal with gasketed enclosures.
   b. Tape: UL 510. Plastic insulating tape shall be capable of performing in a continuous temperature environment of 80□deg. C.
   c. PVC fittings: UL 651.

2.02 UNDERGROUND STRUCTURES

A. Composite handholes for power, site lighting, cameras, etc. – As detailed and indicated on the Drawings.

B. Precast concrete manholes, risers and tops shall conform to ASTM C 857. Precast units (ACI 318) shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete manholes and handholes. Manholes shall be the type noted on the Drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking. Ducts at entry points into the manholes shall terminate with bell ends and

be sealed watertight. Covers shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair their strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide all necessary lugs, rabbets, and brackets. Provide permanently mounted fiberglass ladder at the entry of the manhole, extending from floor to ceiling. Set all built-in items in place before depositing concrete. All pulling-in irons shall be stainless steel, installed in the wall opposite each duct line entrance. Covers shall be 42" diameter with the word "ELECTRICAL" cast in the top face of all power manhole covers; the word "TELEPHONE" cast in the top face of all communication manhole covers. Cable racks, including rack arms and insulators, shall be galvanized and adequate to accommodate the cable to be installed using the longest route from cable entrance to exit. Cable rack frames shall be galvanized, as a minimum. All anchors and equipment mounting hardware provided in the manholes shall be stainless steel. Precast concrete shall conform to the requirements shown on the Drawings.

1. Precast manholes:

    a. Manholes shall be precast of reinforced concrete and shall conform to ASTM C 857.
    b. Reinforcing shall be welded wire fabric conforming to ASTM A 615, Grade 60.
    c. Cement shall be Type II Portland Cement conforming to ASTM C 150.
    d. The manhole structure including all component parts shall be capable of withstanding loads of 8 tons (H-20) without failure or leakage.
    e. All precast sections and bases shall have the date of manufacture and the name or trademark of the manufacturer impressed or indelibly marked on the inside wall.
    f. Utility manholes shall be as identified (detailed) on the Drawings.

2. Manhole joints and pipe seals:

    a. Horizontal joints between sections of the precast manholes shall be as shown on the Drawings and, in general, will depend for water tightness upon a mastic-like sealant such as Ram-Nek, Kent Seal No. 2 or an approved equal. All joints shall be mortared both inside and outside after passing the leakage test.
    b. Pipe to manhole joints shall use a manhole boot which shall be approved by the Owner. Watertightness shall not depend on non-shrinking mortar.

3. Asphaltic waterproofing:

    a. All manholes shall be waterproofed, at the factory, with two coats of asphaltic seal coating, applied to the exterior bottom and sides of the manhole in accordance with the manufacturer's recommendations. Asphaltic waterproofing shall be masonry seal MSP-I waterproofing material as made by the Masonry Seal Corporation, 7500 West Ridge Road, Elyria, Ohio, or approved equal.
    b. Exterior of all joints shall be coated with asphaltic waterproofing after setting as per Paragraph 2.a., above.

4. Brick: ASTM C 32, Grade SS.
5. Mortar:

    a. Masonry cement: ASTM C 91.
    b. Aggregate for masonry mortar: ASTM C 144.
    c. Hydrated lime for masonry purposes: ASTM C 207.
    d. Mortar for unit masonry: ASTM C 270, Type S.
    e. Portland cement: ASTM C 150, Type II.
    f. Premixed materials: ASTM C 387.

6. Metal frames and covers: Cast iron frames and covers provided shall be AASHTO Class H20 loading, machine finished with flat bearing surface.
7. Bedding material shall consist of crushed stone as specified in the Drawings.

2.03 GROUNDING

A. Ground and bonding equipment shall conform to UL 467 and details as indicated on the Drawings.

1. Ground rods shall be sectional type copper clad steel, at least 3/4 inch in diameter and 10 feet in length per section. Die-stamp each near the top with the name or trademark of the manufacturer and the length of the rod in feet. The rods shall have a hard, clean, smooth, continuous, surface throughout the length of the rod.
2. Direct buried ground wire: Soft drawn, bare copper ground wire conductors shall be #4/0 AWG.
3. Thermoweld equipment: Provide thermoweld equipment to exothermically weld all underground grounding connections. Equipment shall be properly sized to accommodate the various size and types of connections. Molds which are not designed, through the use of reducers, etc., by the manufacturer to accommodate the equipment being exothermically welded shall not be permitted. Thermoweld equipment shall be as manufactured by Burndy, Cadweld, or Square D - Anderson.
4. Mechanical ground connectors: Provide mechanical ground connectors to connect ground wire to various pieces of equipment. Connectors shall be rated for direct burial, as manufactured by Burndy (Type GB, GBM Series), Gibbons Electric Company (Type VGN, VGM Series), or Square D (Type GC-140 Series).

2.04 CONDUIT SEALS INTO LOWER LEVELS AND BASEMENTS:

A. Any wall penetrations into or out of building lower levels shall be core drilled.

B. Penetrations (below-grade) shall be properly sealed using link-seal type fittings, sized appropriately for the conduit being installed.

C. Fitting shall provide a positive hydrostatic seal that is rated at 20 psig (40 feet of head).

D. Seal shall be manufactured from EPDM compounds that resist temperatures from -40 deg. F to 250 deg. F.

E. Pressure plates shall be glass reinforced nylon and hardware shall be carbon steel with a zinc dichromate plate.

F. Suitable for use in water, direct ground burial and atmospheric conditions.

G. Install as recommended by the manufacturer.

H. Link-Seal shall be as manufactured by Crouse-Hinds or equivalent.

2.05 CONDUITS WITH CABLES ENTERING LOWER LEVELS AND BASEMENTS

A. Any conduits with cables leaving a manhole or handhole and entering into a building at a lower level shall be sealed to prevent the flow of any water or gasses into that building.

B. Hydra-Seal S-60 WTF ("Wide Temp Foam") conduit foam sealant to prevent the intrusion of water and gasses through conduits in manholes, vaults, and handholes.

C. Two-part polyurethane material that expands approximately twenty-five times in volume.

D. Compatible with all common cable jacket materials.

E. Water resistant, capable of holding back greater than 70 feet of water head pressure.

F. Install as recommended by the manufacturer.

G. Hydra-Seal S-60 WTF shall be as manufactured by Arnco Corporation, or equivalent.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Underground cable installation shall conform to NFPA 70 and ANSI C2.

1. Contractor damage: The Contractor shall promptly repair any indicated utility lines or systems damaged by his operations. If the Contractor is advised in writing of the location of a non-indicated line or system, such notice shall provide that portion of the line or system with "indicated" status determining liability for damages. In any event, the Contractor shall immediately notify the Owner of any such damage.

3.02 CONCRETE

A. Concrete for electrical requirements shall be 3000 psi concrete with one-inch maximum aggregate.

1. Concrete: Concrete shall be composed of fine aggregate, coarse aggregate, Portland cement and water so proportioned and mixed as the produce a plastic, workable mixture. Fine aggregate shall be of hard, dense, durable, clean, and uncoated sand. The coarse aggregate shall be reasonably well graded from 3/16 inch to 1 inch. The fine and coarse aggregates shall be free from injurious amounts of dirt, vegetable matter, soft fragments, or other deleterious substances. Water shall be fresh, clean, and free from salts, alkali, organic matter, and other impurities. Concrete shall have a compressive strength of 3000 psi at the age of 28 days. Slump shall not exceed 3 inches. Re-tempering of concrete will not be permitted. Exposed, unformed concrete surfaces shall be given a smooth, wood float finish. Concrete shall be cured for a period of not less than 7 days, and concrete made with high early strength Portland cement shall be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Owner.
2. Design mix: The Contractor shall submit a proposed design mix, in accordance with the latest edition of ACI 318, to the Owner for review and approval before construction. Submit design mix for each strength of concrete called for on the Drawings. Proportion mix to produce concrete with the following properties:

		3000 psi Mix
a.	State of Maine Department of Transportation, "Standard Specifications for Road and Bridge Construction"	Class B
b.	Maximum Water-Cement Ratio (W/C)	0.488
c.	Minimum Cement Content per Cubic Yard of Concrete	564 lbs.
d.	Required Compressive Strength (f'c) at 28 days	3000 psi
e.	Air Entrainment and Water Reducing Agent	3 to 6%
f.	Portland Cement Type	Type II

3. Air-entraining agent: Add an air-entraining agent to the mix of all concrete used in this project.

4. Concrete slump: Without the aid of a superplasticizer, slumps at discharge point into the forms shall be kept within the following limits:

    a. Fill Concrete: 2 to 4 inches

5. Mixing concrete:

    a. Transit-mix concrete in accordance with ASTM C94.
    b. Do not mix or agitate batches of greater volume than maximum capacities on the manufacturer's rating plate.
    c. Mix or agitate at drum speeds within rating plate tolerances, not exceeding the following limits.

        1) Mixing: 4 rpm to a maximum drum speed which will result in a peripheral velocity of the drum of 225 rpm at its largest diameter.
        2) Agitating: 2 rpm to 6 rpm.

    d. Continue mixing until a uniform concrete is produced, with a minimum of 100 revolutions to the drum. The use of concrete which cannot be uniformly mixed in 15 minutes or less is prohibited.
    e. When Type II cement is used, elapsed time between initial contact of the cement with water and the completed discharge of the batch at the Project site shall not exceed 1-1/2 hours or 300 revolutions of the drum, whichever comes first. Reduce the above limits when conditions result in quick stiffening of the concrete, or when directed by Owner.
    f. Re-tempering of concrete is not permitted.

6. Excavation: Excavation shall be to depths indicated. If hard material is excavated, contact the Owner immediately to determine cost adjustment for ledge removal. Hard material shall be defined as solid rock, firmly cemented unstratified masses of conglomerate deposits possessing the characteristics of solid rock not ordinarily removed without systematic drilling and blasting, and any boulder, masonry, or concrete (except pavement), exceeding 1/2 cubic yard in volume. Support existing ductbanks and services when excavating underneath.
7. Excavated materials not required or suitable for backfill shall be wasted as directed by the Owner. Provide sheeting and shoring as necessary for protection of work and safety of personnel. Remove water from excavation by pumping or other approved method.
8. Backfilling around structures shall consist of earth, loam, sand clay, or sand and gravel, free from roots, wood scrap material, organic matter, pieces of pavement, all wet or soft muck, peat, or clay, any cinder or other acid producing mater, all ledge material, rocks over 6 inches in largest dimension, frozen material, or refuse. Backfill materials shall be placed symmetrically on all sides in loose layers not more than twelve inches deep. Each layer shall be moistened, if necessary, and compacted with mechanical or hand tampers to greater than 95 percent compaction. Surfaces disturbed during the installation of manholes shall be replaced as described under paragraph, Reconditioning Surfaces.
9. Backfilling: Provide a plastic warning tape about 12 inches below the top of the trench in the backfill. Backfill shall be placed in layers not more than eight inches thick and each layer shall be compacted. Backfilling shall progress as rapidly as the construction, testing, and acceptance of the work permits. Backfill shall be free from roots, wood scrap material, organic matter, pieces of pavement, all wet or soft muck, peat, or clay, any cinder or other acid producing mater, all ledge material, rocks over 6 inches in largest dimension, frozen material, or refuse. Compaction of backfill shall be 95 percent of maximum density.

3.03 RECONDITIONING OF SURFACES

A. Unpaved surfaces disturbed during the installation of duct shall be restored to their original elevation and condition. Sod or topsoil shall be preserved carefully and replaced by sod or topsoil of quality equal to that removed. Where the surface is disturbed in a newly seeded area, the restored surface shall be reseeded with the same quantity and formula of seed as that used in the original seeding.

B. The Contractor shall patch pavement, sidewalks, curbs, and gutters where existing surfaces are removed for construction. Cut pavement edges shall be sawn. Concrete or brick pavers, or other similar surface finishes, that are removed during the installation of duct, shall be replaced and restored to match surrounding surfaces. Material and installation shall be in accordance with the State of Maine Department of Transportation standard specification for road construction. Paragraphs concerning measurement and basis of payment shall not apply.

3.04 UNDERGROUND DUCT WITH CONCRETE ENCASEMENT

A. Construct underground duct lines of individual conduits encased in concrete. Except where rigid galvanized steel conduit is indicated or specified, the conduit shall be Schedule 40 PVC. Ducts shall not be smaller than 4 inches in diameter unless otherwise indicted. Any concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches, except separate light and power conduits from control, signal, and telephone conduits by a minimum concrete thickness of 6 inches.

1. The top of the concrete envelope shall not be less than 24 inches below grade.
2. Duct lines shall have a continuous slope downward toward manholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, accomplish changes in direction or runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 24 inches for use with conduits of less than 3 inches in diameter and a minimum radius of 48 inches for ducts of 3 inches in diameter and larger.
3. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as concrete, mud, sand, and dirt by means of suitable conduit plugs. As each section of a duct line is completed, draw a brush through having the diameter of the duct, and having stiff bristles until the conduit is clear of all particles of earth, sand, concrete, and gravel; then immediately install conduit plugs.
4. Where raceways transform from Schedule 40 PVC to rigid steel conduit, Contractor shall furnish and install proper coupling(s) to accommodate aforementioned transition.
5. Where offsets are required to clear obstructions and other underground services, a maximum angle of five (5) degrees will be allowed at duct joints.
6. Provide expansion fittings in raceway risers which are attached to fixed equipment or fittings.

B. Pull Rope: Provide all empty conduits with a nylon pull rope having a breaking strength of at least 200 lbs. Leave 24 inches of spare rope at each end of the conduit.

3.05 UNDERGROUND CONDUIT FOR BUILDING SECONDARIES

A. Underground conduit for feeders into buildings shall be four (4") inches, minimum, Schedule 40 PVC from the transformer pad into the building, unless otherwise noted. Sweeps up into the pad(s), and conduits where entering into the building, shall be rigid galvanized steel. Protect the ends of the conduit by caps or bushings. Clean and plug conduit until cable installation. All spare conduits entering into a building shall be sealed with a removable watertight plug.

B. Provide expansion fittings in raceway risers which are attached to buildings, fixed equipment or fittings.

C. Pull Rope: Provide all empty conduits with a nylon pull rope having a breaking strength of at least 200 lbs. Leave 24 inches of spare rope at each end of the conduit.

3.06 MANHOLE INSTALLATION

A. Excavation and Backfilling: Backfilling and compacting shall be performed in accordance with Section A above and the Drawings.

B. Installation of Manhole Bases and Sections:

1. Sections shall not be shipped and manhole accessories shall not be subjected to loading until the concrete has attained a compressive strength of 3000 psi or until 5 days after fabrication and/or repair, whichever is the longer.
2. Precast bases shall be placed on a layer of compacted bedding material as shown on the Drawings. The excavation shall be properly dewatered while placing bedding material and setting the base.
3. Inlet and outlet stubs shall be connected and sealed in accordance with the manufacturer's recommended procedure, and as shown on the Drawings.
4. Barrel sections and cones of the appropriate combination of heights shall then be placed, using manufacturer's recommended procedure for sealing the horizontal joints. Joint sealant shall be bitumastic sealant unless otherwise approved by the Owner.
5. The exterior asphaltic waterproofing shall be touched up after installation and shall be applied to the exterior of all joints in accordance with manufacturer's recommendations.
6. The frame and cover shall be placed on the top of the manhole or some other approved means shall be provide to prevent accidental entry by unauthorized persons, children, animals, etc., until the Contractor is ready to make final adjustment to grade.

C. Setting Frames, Covers and Grates:

1. Frames shall be set with the tops conforming accurately to the grade of the pavement or finished ground surface or as indicated on the Drawings. Frames shall be set concentric with the top of the masonry and in a full bed of mortar so that the space between the top of the manhole masonry and the bottom flange of the frame shall be completely filled and made watertight. If necessary, brick masonry shall be used to build up the manhole entrance throat to meet the finished grade level; the number of brick courses required shall depend on the depth of the vault. (In all cases, a minimum cover of 8 inches shall be provided between the top of the vault and the finished grade.) A thick ring of mortar extending to the outer edge of the masonry shall be placed all around and on the top of the bottom flange. The mortar shall be smoothly finished and have a slight slope to shed water away from the frame.
2. Manhole covers shall be left in place in the frames on completion of other work at the manholes.

D. Mixing Mortar: ASTM C 270.

3.07 MANHOLE EQUIPMENT

A. Provide the following at electrical manholes:

1. Manhole grounding: Each 600 VAC neutral/ground from each circuit entering and exiting the manhole shall be terminated to the cable racks. In addition, cable shielding at each cable joint or splice shall be connected to the ground point on the rack by means of a #4 AWG wire, as a minimum, or the equivalent braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths.

Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground wires shall be neatly and firmly attached to manhole walls, and the amount of exposed bare wire shall be held to a minimum. The #4/0 AWG bare copper ground installed in the ductbanks shall be run continuous and uninterrupted with the electric conduits to the power manholes, and tap off to the communication handholes.

2. Cable racks, including hooks and insulators, shall be sufficient to accommodate the cables and shall be spaced not more than 18 inches horizontally. The wall bracket shall be channel or T-section steel. The hooks shall be of steel or malleable iron and shall be of the removable type. Insulators shall be dry-process glazed porcelain. The metal portion of racks shall be galvanized, as a minimum, after fabrication.
3. Cable duct shields: Shields shall be provided where cables enter and leave manholes, vaults, and other duct entrances and shall be of a suitable type manufactured for the purpose.

3.08 GROUNDING

A. Provide grounding conforming to ANSI C2. Non-current carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid "earth" ground not exceeding the following values:

Pad-mounted Transformers:	5 ohms
(As required per CMP standards)	
Grounds in Manholes, Handholes and Vaults:	25 ohms
Grounds (where required) at Site Lighting Poles:	25 ohms

1. Make grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required, by exothermic type process. Make ground connections by thermite weld for all ground wire, wire to mat or wire to rod connections. Make thermite welds strictly in accordance with the weld manufacturer's recommendations. Welds which have "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. No mechanical connector is required at thermite weldments. Connections which are not acceptable shall be replaced at no cost to the Owner.
2. Make grounding connections which are indicated on the Drawings and above ground (switches, transformers, etc.), by mechanical connection. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding. As part of final acceptance, re-tighten all mechanical connections to the torque as recommended by the manufacturer.

PART 4 – TESTING

4.01 ACCEPTANCE CHECKS, SETTING AND TESTS

A. Perform in accordance with the manufacturer's recommendations and the latest IEEE standards. Perform work in a careful and safe manner so as not to endanger personnel or equipment.

4.02 FIELD TESTS

A. The Owner shall be given 10 working days notice prior to each test.

4.03 FOLLOW-UP VERIFICATION

A. Upon completion of all acceptance checks, setting and tests, the Contractor shall show by demonstration in service that all circuits and devices are in good operating condition and properly performing their intended function. Test shall be such that each item will perform its function not

less than three (3) times. As an exception to requirements that may be stated elsewhere in the contract, the Owner shall be given five (5) working days advance notice of the dates and times for all checks, settings and tests. Certified copies of all test results shall be provided to the Owner.

PART 5 – SITE PROTECTION

5.01 AREAS OF TRENCHING

A. Contractor is responsible for providing secured fencing in all areas of work where trenching and excavation is taking place. The fence shall meet the approval of the Owner or be replaced with a method meeting the approval of the Owner.

B. All holes and trenches shall be backfilled as the work progresses. At no time shall any open ground be exposed where work is not in progress.

END OF SECTION

SECTION 26 12 00

CONDUCTORS AND CABLES

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Extent of electrical wire and cable work is indicated by Drawings and schedules.

B. Types of electrical wire and cable specified in this section include the following:

1. Single conductor copper cables with 600V insulation and jacket.
2. Type MC Cable.
3. Bus Drop Cable (to equipment).
4. Fire Rated Cable.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit manufacturer's data on conductors and cables in accordance with Section 26 01 00.

B. Provide product data on conductors, cables, and connectors.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacturer of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

C. Codes and Standards:

1. NEC Compliance: Comply with NEC requirements as applicable to construction, installation, and color coding of electrical wires and cables.
2. UL Compliance: Provide wiring/cabling and connector products which are UL-listed and labeled.
3. NEMA/ICEA Compliance: Comply with applicable NEMA/ICEA Standards. Follow an approved ICEA color coding method.
4. IEEE Compliance: Comply with applicable requirements of IEEE Standards 82, "Test Procedures for Impulse Voltage Tests on Insulated Conductors," and Standard 141, "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants" pertaining to wiring systems.
5. ASTM Compliance: Comply with applicable requirements of ASTM B1, 12, 3, 8, and D-753. Provide copper conductors with conductivity of not less than 98% at 20°F (68°F).

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

B. The Contractor shall receive all cable shipments, and shall inspect them for damage to reels, lagging or packing material and for integrity of cable and seals. If damage is apparent, lagging or packing shall be removed and cable inspected. All damage or defective cable, reels, packing or end seals shall be promptly reported, in writing, to the Owner. If so directed by the Owner, the Contractor shall check conductor continuity and shall megger test insulation resistance of such cable. Cable with visible water in the interstices shall be reported to the Owner. Contractor has the option of completely replacing damaged reels of cable or trimming away damaged portions. However, trimming shall not be permitted where it would result in need for splices.

C. After receipt and inspection, cable shall be moved promptly to storage. For outdoor storage, all reels shall be blocked to prevent rolling, and non-reel type containers shall be blocked at least 6 inches above ground and shall be so placed as to be protected against snow, or long exposure to sunlight. Store small wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.

D. All ends of cable in storage shall be sealed to exclude moisture, and cut ends shall be immediately resealed. Cable sealing shall be by taping with waterproof tapes. For large cables, heat shrinkable caps of proper size may be used for sealing. The cut ends of cable lengths removed for use shall be protected during installation against dirt and water or other liquids.

E. Partially used cable reels, if stored outdoors, shall be repacked to prevent weathering of the remaining cable.

F. Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

G. Returnable reels, when empty, shall be returned to the cable manufacturer in accordance with established procedures, or shall be stored, subject to Owner's instructions, for later disposal. Nonreturnable reels shall be disposed of by the Contractor.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. All wire and cable shall be sunlight and moisture resistant, rated for use in wet locations and in cable tray. Except as otherwise indicated, provide stranded copper conductors with conductivity of not less than 98% at 20 deg. C (68 deg. F).

B. Wire Conformation: Provide THWN or XHHW. Only wires with "W" in the designation shall be used in wet or damp locations.

1. 600-volt wires and cables for building exterior and underground raceway use: Conductor sizes are indicated by American Wire Gauge (AWG). All wire shall be copper, of the highest commercial conductivity. All cables shall be 600 VAC single conductor, #12 AWG stranded, as a minimum, rated to withstand conductor temperatures of 90°C in dry locations and 75°C in wet locations without deterioration.
2. Wire connectors and terminals for use with copper conductors: UL 486A. Solderless connectors for #8 AWG and larger. Mechanically perfect pressure connectors shall be installed at each termination using an Owner-approved crimping method. Pliers that are not designed to be a crimping tool shall not be permitted.

C. Low Voltage Wiring and Cable:

1. Low voltage power cable shall be single copper conductor with 600V THHN/THWN or XHHW insulation and jacket of flame retardant PVC, CPE, or CSPE.
2. Control cable shall be single copper stranded Class B conductors, 600V, THHN/THWN or XHHW insulation, and jacket of flame retardant PVC, CPE, or CSPE. Conductor insulation shall be color coded or otherwise labeled to delineate phases.
3. Lighting cables shall be single copper conductor Class B, 600V, THWN/THWN insulation.
4. Solid conductor shall be used for wiring to all low voltage electrical devices including switches and receptacles. Stranded conductor shall be used elsewhere, unless otherwise noted.

D. Type MC Cable:

1. 600 volt aluminum, interlocked armor, Class B stranded, copper conductors Type THHN insulation.
2. Filling shall be non-hygroscopic and non-wicking. Core binder shall be polyester tape. Armor shall be interlocked aluminum.
3. Insulated ground wire shall be provided.
4. Where MC cable is used to feed isolated ground receptacle (or equipment) circuits, an isolated grounding conductor shall be supplied in addition to the insulated ground wire.

E. Fire Rated Cable:

1. Description: ANSI/NFPA 70, Type MI, mineral insulated cable.
2. Conductor: Anneal solid electrolytic tough pitch copper.

3. Insulation Voltage Rating: 600 volts.
4. Cable Temperature Rating: 90 degrees C wet or dry.
5. Termination Temperature Rating: 90 degrees C.
6. Insulation Material: Compacted refractory magnesium oxide.
7. Sheath: Seamless phosphorous deoxidized copper.
8. Fire Rating: Cable system and equipment grounding conductor shall have a 2-hour fire rating as listed by Underwriters Laboratories, Inc. Guide FHIT.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable, and connector):

1. Wire and cable:

   a. Cablec Corp.
   b. Alpha Wire
   c. Cerro Wire
   d. General Cable
   e. Southwire Co.
   f. Encore Wire

2. MC cable:

   a. AFC Cable Systems.
   b. Southwire Co.

3. Bus drop cable:

   a. Allied Wire and Cable.
   b. Southwire Co.
   c. Carol Cable.

4. Fire rated cable (Type MI):

   a. Pyrotenax (Pentair Thermal).

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures in Section 26 01 00.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General:

1. Install electrical cables, wires, and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard for Installation," and in accordance with recognized industry practices.
2. Coordinate wire/cable installation with electrical raceway, cable tray, and equipment installation work, as necessary to properly interface installation of wires/cables with other work.

B. Wire and Cable Installation:

1. Install wire in conduit runs after concrete and masonry work is complete and after moisture is swabbed from conduits. Wires shall be pulled into conduit without kinking and without scoring conduit.

2. Pull conductors simultaneously where more than one is being installed in same raceway. Unless otherwise noted, install all three phases of a three-phase system in one conduit to avoid inductive currents on the surface of metallic conduit. Grounding conductor shall be run in the same raceway as the current-carrying conductors.
3. All circuits to kitchen equipment shall be run in conduit from the panelboard to the equipment location. MC cables shall not be allowed. Each kitchen circuit shall contain a dedicated neutral and equipment grounding conductor.
4. Use pulling compound or lubricant (powdered soapstone of Wyrease), where necessary; compound used must not deteriorate conductor or insulation.
5. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.
6. Pulling may be by hand or by power winch. Winches used shall have sufficient capacity to exert a steady, continuous pull. Maximum pulling tension shall be monitored. Values for maximum allowable pulling tension given by the manufacturer shall be observed.
7. Cables which have been pulled in and awaiting termination at some later date shall be sealed in accordance with the cable manufacturer's instructions.
8. Conductors in all panelboards, switchboards, and terminal cabinets shall be neatly fanned in the gutter space and tied.
9. All branch circuit homerun wiring (for both power and lighting) back to the panelboard (not in the same room as the circuit) shall be a minimum of #10 AWG conductor.
10. Wiring for all single phase circuits, 20A or smaller, shall be a minimum of 2#12&1#12G-3/4"C for circuit lengths under 100 feet and 2#10&1#10G-3/4"C for circuit lengths 100 feet and over, unless otherwise noted. Circuits for isolated ground receptacles shall include additional isolated ground conductor. Circuits for double switched light fixtures shall include additional switched conductor(s) as required. The sharing of neutral conductors is not allowed.
11. Do not install any wire or cable with less than the minimum bending radius specified by the manufacturer. During pull-in, maintain minimum bending radius as specified by manufacturer.
12. Do not pull cables over sharp corners of trays and supports.
13. Unless otherwise specified, all conduits, wires, and cable that are required to make the electrical connections to equipment, shall be furnished and installed by the Electrical Contractor. All connections to equipment shall be made as shown, specified, and directed, and in accordance with the approved Shop Drawings.
14. In general, control wiring is not shown on the Plans. Refer to individual equipment specifications and control drawings for information.
15. Wire sizes shown on Drawings and otherwise specified are minimum sizes; if wire of sizes specified is not available, furnish wire of next larger size and if required by NEC, also increase the raceway size to accommodate the larger wire used. Make this substitution at no increase to contract cost.
16. All conductors shall have a single, continuous length without splices, except with the approval of the Engineer. Provide junction box where splices are made. In general, terminate all conductors at terminal blocks.
17. All cable in a raceway shall have the same insulation rating.
18. All low voltage signal cable is to be run in a separate raceway from 120-600 VAC cable.
19. If raceway is installed in a manner that varies from what is indicated on the Contract Documents, or so that the shortest distance is not utilized, contact Engineer to determine if voltage drop will affect the size of cable to be installed in the raceway. Cable size shall be adjusted at no cost to the Owner.

20. Power cables coding shall be as indicated below or existing color coding:

120/208 Volt, 3-Phase	277/480 Volt, 3-Phase
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Neutral - White	Neutral - White with colored (not green) stripe
Ground - Green	Ground - Green

21. Control wiring shall be color-coded with tracers, no solid color. Where wiring extends outside equipment, provide overcurrent protection in accordance with wire size per NEC.
22. Junction boxes for use with six or more control circuits or low voltage signals shall utilize terminal blocks sized for the intended use with 20% spare termination points in addition to those for all wires (including spare wires).
23. Control wiring terminating at the main control panel shall be terminated by the Contractor at terminal blocks as directed by the manufacturer.
24. Shielded cable shall be grounded at one point only. All cable shields shall be connected to a common ground in a control panel unless otherwise required by manufacturer's instructions.
25. Control wiring installed by Electrical, Mechanical, or Controls Contractor shall be installed in J-hooks, or may share space in cable tray, where allowed. J-hooks shall be mounted at distances not exceeding 4-foot centers, and wiring shall not loop more than 6 inches below the bottom of the hooks. Control wiring shall not be installed in free space, or laid on suspended ceilings.
26. Provide permanent plastic nametag indicated load or function for each circuit at all handholes and manholes.

C. MC and AC Cable Installation:

1. MC cable shall be installed in concealed locations only, where allowed. It shall not be run exposed to sight in finished spaces.
2. Cable shall be properly run through the center of wall studs, and upper and lower plates. No cable shall be run around the face of a stud, plate, or structural member.
3. MC cable shall be properly supported in both vertical and horizontal installations. Fastening supports shall be as approved for type MC cable, by Caddy or equivalent. Plastic ties shall not be used as a supporting method for the cable. MC cable shall be run parallel to, and attached to, building structural steel; it shall not be run across open spaces.
4. Stripping of the armor jacket shall be done by an approved tool, or by scoring and breaking the jacket. Stripping and removal of the jacket shall be done without damage to the interior conductors or their insulation.
5. Fittings approved for Type MC cable shall be used to terminate the cable as required.
6. MC cable shall not be installed in, or near, the ribs of steel roof deck.
7. Type MC cable shall not be utilized for circuits to kitchen equipment.

D. Bus Drop Cable Installation:

1. Bus drop cable shall be suspended from the ceiling directly above the equipment that it feeds, mounted as detailed on the Drawings.
2. Cable (with appropriate cord caps) shall be suspended down to a height of approximately 24” above finished floor, unless otherwise noted.

E. Fire Rated MI Cable Installation:

1. The fire rated cable shall be installed according to the manufacturer's recommendations, and the requirements of the UL "Electrical Circuit Protection System" listing. Contractor shall strictly follow the requirements for installation, and use all the proper (sized) equipment for bending, pulling, mounting, and terminating.
2. When installing fire-rated cables, use only steel or copper in the support system; no other materials are acceptable.
3. Field dressing of cables shall be by hammer and block of wood, or a rubber mallet; the use of a steel hammer will damage cables.
4. When single-conductor cables are installed entering into a steel enclosure, a section of the steel enclosure shall be cut out and replaced by a ¼" thick brass plate (to prevent heating by induction). The brass plate is not required when installing multi-conductor cables.
5. Cables bundled in groups containing one conductor from each phase shall be run with the sheaths touching over the entire length, except when entering into an enclosure. When parallel runs are required, cable bundles must be spaced a distance apart, as required per the manufacturer.
6. Cables shall be supported to fire-rated structures using approved materials and fasteners, such as steel strut with pipe/conduit clamps, etc.

F. Splices:

1. Splices and taps shall only be allowed inside approved wireways, junction boxes, and outlet boxes.
2. Proper sized wirenuts shall be allowed for splices and taps on conductors of #10AWG or smaller.
3. Where splices or taps are required for conductors of #8AWG or larger, use solderless splice and tap connectors that are compatible with the conductor material. Insulate (wrap) 600 volt splices and taps with minimum of three (3) lap wound layers of 3M Scotch Super 33+ tape, or equivalent.
4. Multiconductor, pre-insulated, set-screw type connection blocks, of the proper size for the conductors, shall be permitted. Burndy or equivalent.
5. All feeder circuits and single-load branch circuits shall be of continuous, unspliced conductors from source to terminal point.
6. In wet locations, underground, etc., all splices, taps, and connections shall be made waterproof. Conductor insulation shall be well penciled and roughened before applying connector insulation. Apply a minimum of three (3) layers of Scotch 33 tape and coated with Scotch Kote paint. Conductors shall be formed into drip loops so that water will not collect on connections.

G. Schedule of Use:

1. Cable in conduit shall be provided for:

   a. Feeder circuits (three-phase or single-phase) to panelboards.
   b. Three-phase branch circuits.
   c. Underground circuits.
   d. Exposed to sight branch circuits.
   e. All circuits to kitchen equipment and receptacles.
   f. Branch circuit homeruns (from a junction box in the room/space being served or located in the corridor adjacent to the room/space being served to the panelboard)

   Note: Conduits for branch circuit wiring shall be run directly from the panelboard to the room where the load is to be connected. Type MC cable can then be used concealed within that room for extension of branch circuit wiring as allowed.

2. Type MC cable shall be provided for:

   a. Single-phase branch circuit wiring concealed behind architectural finishes (i.e. walls, ceilings, etc.) located within the room/space being served.
   b. Type MC cable shall not be utilized for homeruns to a panelboard or a switchboard. Provide cable in conduit for homeruns.
   c. Lighting fixture whips not exceeding 6'0" in length.

      NOTE: No MC cable shall be allowed where exposed to sight in finished spaces. The electrical contractor may substitute cable in conduit for MC cable where the contractor deems necessary due to constructability concerns.

3. Bus drop cable shall be provided for:

   a. Branch circuit wiring to feed equipment (from overhead) located in the center of a space (out away from a partition).

4. Type MI cable shall be provided as required per the IBC, NFPA and NEC including:

   a. Fire alarm communications wiring between panels.
   b. Fire Alarm Notification Circuits that pass through a zone it does not serve.
   c. Elevator communication System wiring (power and communication).
   d. Fire Fighter Communication System wiring (power and communication).
   e. Power wiring to elevator on emergency or standby power.
   f. Power wiring to elevator accessories (machine room lighting, cab lighting, etc.)
   g. Emergency feeders (NEC Art.700).
   h. Emergency control circuits.
   i. Engine generator start circuits.

3.02 FIELD QUALITY CONTROL

A. Test wire and cable in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 13 00

RACEWAYS

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide all raceways including conduit and couplings. Extent of raceway work is indicated by Drawings and schedules.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Division 01 and Section 26 01 00 of the Specifications.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with electrical raceway work similar to what required for this project.

C. Codes and Standards:

1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.
2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL-listed and labeled.
3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

PART 2 – PRODUCTS

2.01 METAL CONDUIT

A. General: Provide metal conduit, and fittings of types, grades, sizes, and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Owner to fulfill wiring requirements, and comply with applicable portions of NEC for raceways.

B. Rigid Steel Conduit:

1. Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1, UL 6, and in conformity with NEC Article 344.

   Provide zinc coating fused to inside and outside walls by hot dipped galvanizing. Couplings and elbows shall be protected against corrosion in the same manner as the conduit. Threads shall be cut before the zinc coating is applied and the surplus coating removed from the threads after coating.

2. Provide factory-applied, closed-end thread protectors.

C. Rigid Metal Conduit Fittings: Provide cast malleable iron, threaded zinc plated fittings, conforming to FS W-F-408 with steel conduit.

D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight, flexible metal conduit; construct of single strip, flexible, continuous, interlocked and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC).

E. Liquid-tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide zinc plated, malleable iron fittings with compression-type steel ferrule and neoprene gasket sealing rings, with insulated or non-insulated throat.

F. Electrical Metallic Tubing (EMT): Provide EMT that conforms to FS WW-C-563, ANSI C809.3 and UL 797. Only zinc coated ferrous type is acceptable.

G. EMT Fittings: Provide zinc die cast or steel fittings (set screw type) with locknut for thin wall conduit, concrete tight. For EMT 1-1/4" and above, provide a minimum of four set screws per coupling and two for connectors and fittings. Set screws shall be of steel.

H. Snap-in type connectors that do not utilize a locknut are not acceptable.

2.02 NONMETALLIC

A. General: Provide nonmetallic conduit, ducts, and fittings of types, sizes, and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by the Owner to fulfill wiring requirements which comply with provisions of NEC for raceways.

B. Electrical Plastic Conduit:

1. Heavy Wall Conduit: For embedded, concrete encased or direct buried conduits, provide Schedule 40, 90˚C, UL-rated, constructed of polyvinyl chloride and conforming to NEMA TC-2, UL-rated and UL-listed for the intended application and in conformity with NEC Article 352.
2. Cellular core type PVC is not allowed.

C. PVC Conduit Fittings: NEMA TC-3, mate and match to conduit type and material. Provide fittings that are threaded or of the slip-on, solvent welded type.

D. 4" conduit with 4 innerducts: Carlon Multi-gard PVC conduit with 4 PVC innerducts, Part No. MXSS4S. Provide all required accessories including couplings, spacers, and terminators.

2.03 CONDUIT ACCESSORIES AND BODIES

A. Conduit Accessories: Provide conduit accessories of types, sizes, and materials required or indicated, complying with manufacturer's published product information, which mate and match conduit.

B. Conduit Bodies: Provide galvanized cast-iron (for use with steel raceways), conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Provide conduit bodies with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

2.04 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide rigid steel conduit, electrical metallic tubing, and liquid-tight flexible metal conduit manufactured by one of the following:

1. Triangle Conduit & Cable Company, Inc.
2. Republic Steel Corporation.
3. Allied Tube and Conduit Corp.
4. Wheeling Pittsburgh Corp.
5. Wheatland Tube Company.
6. Gould Inc., EFCOR Division.

B. Subject to compliance with requirements, provide plastic conduit and fittings of one of the following:

1. Cantex Inc.
2. Allied Tube and Conduit Corp.
3. Southern Pipe, Inc.

C. Subject to compliance with requirements, provide conduit bodies of one of the following:

1. Appleton Electric; Div. of Emerson Electric Co.
2. Arrow-Hart Div.; Crouse-Hinds Co.
3. Bell Electric Div.; Square D Co.

4. Crouse-Hinds Electrical Construction Materials.
5. Killark Electric Mfg. Co.
6. O-Z/Gedney Div.; General Signal Co.
7. Spring City Electrical Mfg. Co.

D. Substitutions: Items of equal quality, function, and performance may be proposed for substitution by following the procedures outlined in Section 26 01 00.

2.05 J-HOOKS

A. Provide J-hooks as required. J-hooks shall be wide based and sized appropriately to allow correct fill ratio with 20% expansion. J-hooks shall be provided only where allowed by other sections of this specification.

1. Hooks shall be provided as required. Fill ratios are for information only and based on 0.28 diameter cables.

Erico/Caddy

P/N	Max Fill Ratio
CAT 12	10 cables
CAT 21	32 cables
CAT 32	50 cables
CAT 64	185 cables
CAT 425	265 cables

Utilize the appropriate attachment hardware as required (i.e. straps, clamps, brackets, etc.).

2. J-hooks shall be installed at the point of elevation change as well as change of direction.

2.06 CONDUIT SEALING BUSHINGS

A. Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls, consisting of steel sleeve with malleable iron body, neoprene sealing grommets or rings, pressure rings, and cap screws.

2.07 CONDUIT SLEEVES

A. Sleeves fabricated from 2" minimum rigid galvanized conduit with an insulating bushing on each end.

PART 3 – EXECUTION

3.01 GENERAL

A. All wiring shall be in conduits or raceways, unless otherwise indicated. Minimum conduit size shall be as follows:

- 1" for data, telephone, CATV and multiple communication outlets.
- 3/4" for power and security.
- 1/2" for fire alarm, intercom or clock outlets.

B. Install conduit concealed in all areas, except:

1. Motor connections.
2. Exterior of structures.

3. Connections to surface-mounted equipment cabinets.
4. Mechanical and utility areas.

C. Coordinate installation of conduit in masonry work, or wall construction.

D. Where indicated on the Contract Drawings, conduits are shown diagrammatically to outline the general routing of the raceway. Actual routes shall be determined by installer and installed at no extra charge. Where a general routing is not indicated, the conduit and cable routing may be developed by the Contractor. However, all routes must be approved by Engineer before being installed. Avoid interference with pipes, ducts, structural members or other equipment. It is anticipated that the shortest conduit and cable route will be utilized to minimize voltage drop.

E. Complete installation of electrical raceways before starting installation of cables/wires within raceways.

F. All metal conduits entering boxes, panels, etc., shall be terminated with insulating bushings. Where bushings fabricated entirely of insulating material are used, two locknuts shall be installed to ensure proper rigid connection and electrical grounding continuity between box and conduit.

G. Provide standard fittings wherever possible. Avoid field bends wherever possible. Bends and offsets shall be made with factory fittings or with an approved hydraulic bender.

H. Provide standard fittings or field bends with inside radius greater than cable bending radius. Limit the number of bends between pulling points to four 90° bends or the equivalent.

I. Field bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

J. Provide watertight seals for all penetrations through manholes, vaults, tanks, and building walls.

K. Provide 200 lb. test nylon pull cord, or AWG No. 12 wire in empty conduits. For conduits required to be installed, but left empty, test with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.

L. Conduit penetrations through walls, floors, etc., shall not compromise the fire rating. All penetrations shall be sealed with appropriate fire stop material having an equal to or greater than fire rating of the surrounding structure.

M. Provide a listed conduit seal where conduits leave heated area and enter unheated area, cooler or freezer. Seal conduit using a non-drying sealing putty. Duxseal or equal.

N. Provide expansion fittings for all conduits in straight runs of over 100 feet in length.

O. Conduit installation shall meet or exceed all seismic restraint requirements of the IBC International Building Code.

P. Where conduits penetrate non-fire rated walls, seal around conduits with expanding foam insulation.

Q. Where conduit stub is provided to accessible ceilings for low voltage wiring, provide an insulating bushing on the conduit ends.

R. Provide spacing of raceways a minimum of 6 inches from parallel runs of heating system pipes, flues, or other heat radiating piping systems and other heat sources. The minimum spacing shall be increased to ensure that raceways experience no significant temperature rise from external sources. Raceways shall not be embedded in any spray-applied insulation, fireproofing, or other materials that would restrict heat dissipation.

S. Provide deflection/expansion fittings in conduit runs at all expansion and seismic joints to allow for displacement of conduit by expansion, contraction, and misalignment.

T. Conduit shall not be installed in, or near, the ribs of steel roof deck.

U. Provide a 2" conduit sleeve above every interior doorway for the installation of low voltage and communication cables. Coordinate location of sleeve with cable tray, ceiling elevation, and other trades.

3.02 METAL CONDUITS

A. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean. Coat all cut threads with a listed zinc-rich paint, Thomas and Betts, CP8 KOPR-Shield or equal.

B. Fasten conduit terminations in sheet metal enclosures by 2 locknuts, and terminate with grounding type bushing. Install locknuts inside and outside enclosure.

C. Mechanically fasten together metal conduits to form continuous electrical conductor. Connect to cable trays, electrical boxes, fittings, and cabinets to provide electrical continuity and firm mechanical assembly.

D. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contract, coat surfaces with corrosion inhibiting compound before assembling.

E. Install liquid-tight flexible conduit for connections to vibrating equipment such as motors, or to equipment which may move due to expansion or adjustment such as motor operated valves or belt-driven equipment, or to equipment which must be capable of ready removal for maintenance. The maximum length of flexible conduit used shall not exceed 6 feet without the prior approval of the Owner. The fixed end of the rigid conduit shall be terminated with a box or, where necessary, a "condulet" type fitting, and, where linear motion of the connected equipment will occur, shall be located approximately at the midpoint of the expected range of movement. Where practicable, the flexible conduit shall have approximately a 90˚ bend to allow free movement.

3.03 NONMETALLIC CONDUITS

A. Make solvent cemented joints in accordance with recommendations of manufacturer.

B. Install PVC conduits in accordance with NEC and in compliance with local utility practices. Provide PVC conduits UL-rated for direct burial or encasement in concrete as required.

C. Do not install PVC conduits exposed. Where raceway exits soil or concrete, provide rigid steel 90˚ elbow and rigid steel conduit riser.

3.04 EXPOSED CONDUITS

A. Support exposed conduit by use of hangers, clamps, or clips. Support conduit on each side of bends and on spacing not to exceed NEC requirements.

B. Conduit placed against concrete above ground shall be fastened to the concrete with pipe straps or on screw conduit clamps attached to the concrete by means of lead expansion screw anchors and screws or preset inserts. Plastic anchors shall not be used.

C. Install conduits to avoid conflict with passageways or access to, operation or maintenance of, or removal of, electrical or other equipment.

D. Allow minimum of 6 inches clearance at flues, steam pipes, and heat sources.

E. Route all conduits parallel or perpendicular to building lines, structural members, and building walls. Routing shall provide maximum clear space.

F. Provide flashing and pitchpockets making watertight joints where conduits pass through roof or waterproofing membranes.

3.05 UNDERGROUND CONDUIT

A. Coat RGS transition elbows and risers with bitumastic type protective coating in concrete or soil and for four (4) inches above the concrete or soil surface.

B. When making up joints in underground and embedded conduits, draw up coupling and conduit sufficiently tight to ensure watertightness.

C. Underground and embedded conduit installations shall be checked for continuity, and closure integrity, and locations before concrete is placed.

D. Pitch raceways so moisture drains to outlet boxes or manholes. Otherwise, install raceways to avoid trapping moisture. Where dips are unavoidable, install a suitable fitting and drain hole at low point. If this is not practical, seal the conduits with sealing compound after the cables have been installed. Slope conduits to drain a minimum of three (3) inches per one hundred (100) feet.

E. Underground conduit shall maintain maximum available clearance when crossing other underground utilities.

F. Indicated on Drawings, dimensions for the spacing of conduit in the duct bank are minimum. Rigid plastic spacers at intervals of 10'0" or less shall be used for duct banks encased in concrete.

G. A ground conductor shall be run with underground duct banks.

H. Provide expansion fittings in raceway risers which attach to fixed equipment or fittings.

3.06 J-HOOKS

A. J-hooks shall be mounted at distances not exceeding 4-foot centers.

B. J-hooks shall provide clear pulling path for cables, and shall avoid ductwork, piping, and electrical conduits.

3.07 SCHEDULE OF USE

A. Use rigid galvanized conduit for:

1. Up riser pole(s).
2. Exposed exterior conduit.
3. Last 5 feet before underground PVC penetrates grade, slab or building.
4. Buried elbows, bends, offsets and sweeps.
5. Conduit under paved areas and under roads.
6. Where in compliance with NEC.
7. Single runs of conduit in above grade floor slabs. Maximum 1" conduit with a minimum of 2" concrete cover.

B. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:

1. Moist or humid atmosphere where condensate can be expected to accumulate.
2. Subjected to water spray or dripping oil.
3. Connections to vibrating equipment.

C. Use electrical metallic tubing:

1. Where not restricted by the above in interior areas.
2. Where in compliance with NEC.

D. Use PVC conduit:

1. Underground unless indicated otherwise.
2. Under floor slabs.
3. Where encased in concrete.

3.08 INSTALLATION METHODS - TELECOMMUNICATION SYSTEMS

A. Installation methods for telecommunication system conduits shall comply with Installation Methods - General, above, unless superseded by more stringent requirements of this section. Telecommunications conduits shall comply with the requirements of ANSI/EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces and the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual. Note that some of these requirements are more stringent than the requirements of the National Electrical Code.

B. There shall be no more than two 90-degree bends between pull points in telecommunications conduit. Pull boxes added to conduit runs as a result of this requirement shall be in accordance with Section 26 13 70 - Outlet Boxes and Enclosures. If it is not practical to install a pull box in the run due to field conditions the conduit size shall be increased to the next trade size for each additional 90-degree bend. Offsets shall be considered as equivalent to a 90-degree bend.

C. Inside radius of conduit bends shall be at least 6 times the internal diameter of the conduit for sizes up to 2-inch trade size; 10 times the internal diameter of the conduit for sizes larger than 2-inch trade size. Where bending machine shoes are not available with the required bending radius for a one-shot field bend, factory bent, large radius 90-degree elbows shall be provided. Conduits of all sizes for use as optical fiber raceways shall have a minimum inside bend radius of 10 times the internal diameter of the conduit.

D. Conduits shall be properly terminated and supported at all cable trays in accordance with industry standard..

E. Use of flexible conduit for telecommunications shall be kept to a minimum and shall be at the discretion of the Engineer. Obtain prior written approval for the use of flexible conduit. Where required due to physical considerations, flexible metal conduit may be allowed in lengths not exceeding 4 feet. If used, flexible metal conduit shall be increased by one trade size for the application used.

F. Conduits entering the telecommunications closet or equipment room through the floor shall be terminated 4 inches above finished floor. Conduits entering the telecommunications closet or equipment room from above shall be terminated 4 inches below the finished ceiling, but in no case shall the conduits terminate more than 12 inches above the ladder racking or distribution frame.

G. Conduit sleeves connecting vertically "stacked" telecommunications equipment rooms and closets shall be terminated 4 inches above finished floor. Conduits and cutout openings between floors shall be sealed with firestopping material that is removable and reusable, to accommodate ads, moves and changes in the cabling system.

H. Layout of conduits shall give consideration to nearby sources of electromagnetic energy such as electrical power wiring, large electric motors and generators, induction heaters, arc welders, variable frequency drives, etc. Maintain the greatest separation practicable between telecommunication raceways and sources of electromagnetic interference (EMI). A minimum of 5 inches of separation shall be maintained between telecommunication raceways and fluorescent lighting ballasts.

I. Provide 200 lb. test nylon pull cord in all spare and unused conduits.

3.09 ADJUSTING AND CLEANING

A. Clean raceway interior surfaces before and after installation. Interior surfaces shall be free of imperfections (burrs, dirt, construction debris, etc.), likely to damage cable(s). Clean completed conduit runs with an approved tube cleaner equipped with cylindrical mandrel. Mandrel diameter not less than 85% of conduit inside diameter. Cap conduit ends after cleaning to prevent entrance of water or debris.

B. Close upper ends of all vertical conduit during construction.

C. Cap spare conduits using suitable conduit caps/plugs.

3.10 IDENTIFICATION

A. Communication system type shall be clearly identified on the raceway by frequent color coding and labels (10' maximum spacing where raceway is concealed). Coordinate identification with the Engineer. System type shall be clearly identified on each junction box and pull box.

END OF SECTION

SECTION 26 13 10

SURFACE RACEWAYS

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide indicated and necessary surface raceways.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with electrical raceway work similar to what required for this project.

C. Codes and Standards:

1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.
2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL-listed and labeled.
3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Surface Metal Raceway:

1. Wiremold V2400
2. Thomas & Betts

B. Surface Steel Power/Data Raceway:

1. Wiremold 4000
2. Panduit
3. Hubbell

C. Surface Non-Metallic Power/Data Raceway:

1. Wiremold 5400
2. Panduit
3. Hubbell

D. Power/Communication Service Pole:

1. Wiremold ALTP-2S
2. Hubbell

E. Substitutions: Items of equal quality function and performance may be proposed for substitution by following the procedures outlined in Section 26 01 00.

2.02 SURFACE METAL RACEWAY

A. Surface metal raceway shall be two-piece painted steel, totally enclosed, snap cover type. Finish shall be baked-on enamel of a color to match the surrounding conditions.

B. Where indicated on the Drawings, provide surface metal raceway with 125V, 20A receptacles spaced 18" on center.

C. Raceway shall be large enough for the number and size of conductors as determined by the manufacturer and the NEC.

D. Surface metal raceway shall be used where indicated and in areas where conduit is to be concealed but due to building conditions is not possible. Obtain approval of Engineer before installation.

2.03 SURFACE STEEL POWER/DATA RACEWAY

A. Surface raceway shall be two-piece galvanized steel with ivory finish, totally enclosed, snap cover type.

B. Raceway shall be multi-channel type 4.75" high x 1.75" deep, designed to secure and protect power, data, voice and other low voltage wire and cable in medium capacity applications.

C. Provide two compartments with a snap-in divider. Where indicated on the Drawings, provide surface metal raceway with designated receptacles spaced as noted on the drawings. Provide communication outlets where indicated on the Drawings.

D. Raceway shall be large enough for the number and size of conductors as determined by the manufacturer and the NEC.

E. Surface raceway shall be used where indicated. Where specifically approved by the Engineer, surface raceway shall be used in areas where conduit is to be concealed but due to building conditions installation is not possible. Substitution of surface raceway for concealed conduit must be approved by the Engineer for each specific case.

2.04 SURFACE NON-METALLIC POWER/DATA RACEWAY

A. Surface raceway shall be two-piece rigid PVC, totally enclosed, full-width snap cover type. Paintable using latex paint.

B. Raceway shall be multi-channel type, designed to secure and protect power, data, voice and other low voltage wire and cable in medium capacity applications.

C. Provide two compartments with a breakaway divider. Where indicated on the Drawings, provide surface raceway with designated receptacles spaced as noted on center. Provide communication outlets where indicated on the Drawings.

D. Raceway shall be large enough for the number and size of conductors as determined by the manufacturer and the NEC.

E. Surface raceway shall be used where indicated. Where specifically approved by the Engineer, surface raceway shall be used in areas where conduit is to be concealed but due to building conditions installation is not possible. Substitution of surface raceway for concealed conduit must be approved by the Engineer for each specific case.

2.05 POWER/COMMUNICATION SERVICE POLE

A. Provide 2" x 2" clear anodized aluminum service poles with two (2) wiring compartments.

B. Provide service poles in lengths required for the proposed locations.

C. Service pole shall be equipped with removable cover sections to facilitate wiring of the devices installed.

D. Provide fittings necessary to make a workable system, including but not limited to device plates, entrance end fittings for top of each channel, ceiling trim plate, pole mounting bracket, carpet gripper, and adhesive pad.

E. Provide two duplex 20A receptacles, minimum, color to match receptacle color specified in Section 26 14 00.

F. Service pole shall be Wiremold ALTP-2S or equal by Hubbell.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install surface raceways in accordance with the manufacturer's recommendations and Section 26 07 00.

B. All metal raceway shall be electrically continuous and bonded in accordance with the NEC for proper grounding.

END OF SECTION

SECTION 26 13 70

OUTLET BOXES AND ENCLOSURES

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide outlet boxes.

B. Provide wireways, pull, and junction boxes.

C. Provide cast FS box - for use with bus drop cable.

D. Provide all cabinets and enclosures for the installation of electrical equipment, electrical controls, and process equipment as indicated on the Drawings and as described herein.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Submit product data and listing of equipment nameplate lettering.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Steel Boxes:

1. Appleton
2. Raco
3. Steel City

B. Cast Boxes:

1. Cooper Crouse-Hinds
2. Killark
3. Appleton

C. Recessed Floor Boxes:

1. Hubbell
2. Walker

D. Pull Boxes, Enclosures, Wireways and Cabinets:

1. Hoffman
2. Square D

E. Substitutions: Items of equal quality, function, and performance may be proposed for substitution by following the procedures outlined in Section 26 01 00.

2.02 WALL BOX MATERIALS

A. Interior Dry Location Boxes: Pressed sheet steel, blanked for conduit or provided with knockouts and clamps for cable, where applicable. Provide side-mounted bracket for locating on stud.

B. Exterior, Damp Location or Weatherproof Box: Cast aluminum, deep type, with mounting ears.

C. For Flush-Mounting in Walls: Boxes with matching plaster rings for single- or two-gang outlets. For larger boxes, use solid type or special units. In masonry use deep boxes.

D. Wall boxes for power and tel/data devices shall not be less than 2-1/2 inches deep, of physical size as required by NEC for the number and size of conductors involved; shall be securely mounted to the building structure with supporting facilities independent of the raceways entering or leaving. Gang boxes shall be used on multiple outlets.

E. Square conduit boxes shall not be less than 2-1/8 inches deep, of physical size as required by NEC for the number and size of conductors involved; shall be securely mounted to the building structure with supporting facilities independent of the raceways entering or leaving. Provide plaster ring where applicable.

2.03 FLOOR BOXES

A. Type "A" Recessed Floor Boxes:

1. Recessed steel floor box with one hinged section to allow full access to internal cables and connector plates and smaller hinged trap door to create an efficient cable exit.
2. Provide pour pan for ground floor installations.
3. Box shall be fully adjustable.

4. Boxes shall be deep type, rectangular 10" x 12" x 6" deep, with leveling feet.
5. Cover shall be flush, aluminum finish. Coordinate carpet flange dimension with Architect.
6. Unit shall be manufactured by FSR Model FL-500P or equal.

B. Type "B" Surface Activation Concrete Floor Boxes:

1. Floor boxes shall be configured as indicated on the Drawings in one, two, or three-gang versions, and shall be appropriate for floor finish.
2. Provide cast iron construction for ground floor installation areas and stamped steel construction for upper floor installation areas. Box shall be fully adjustable.
3. Boxes shall be deep type, rectangular.
4. Cover shall be flush, brushed aluminum finish. Provide carpet flange or tile flange where applicable.
5. Activations shall be brushed aluminum duplex or GFI flip cover type. Data/telephone activations shall be GFI cover plate type. Coordinate with Telecommunications Contractor.
6. Unit shall be manufactured by Wiremold 880 Omnibox or equivalent.

C. Fire-rated Poke-throughs:

1. Fire-rated poke-through units shall be configured as indicated on the Drawings.
2. Provide fire-rated poke-throughs for upper floor installations.
3. Cover shall be flush-in brass or painted aluminum finish as selected by the Architect.
4. Activations shall be duplex flaps for power and data. Provide carpet flange in brass where applicable.
5. Unit shall be manufactured by Hubbell or equivalent.

2.04 PLASMA/FLAT PANEL DISPLAY WALL BOXES

A. Devices indicated behind flat panel displays shall be mounted in a recessed multi-service wall box with cover. FSR-PWB-100 with white cover or equivalent.

2.05 FLIP-UP POWER AND COMMUNICATIONS GROMMET

A. Provide stain anodized aluminum flip-up power and communications grommets with two receptacles and two data parts.

B. Doug Mockett & Company, Model #PCS36B.

2.06 PULL BOX, WIREWAY, AND ENCLOSURE MATERIALS

A. Pullboxes and Junction Boxes: Metal construction, conforming to National Electrical Code, with screw-on or hinged cover.

B. Flush-Mounted Pullboxes: Provide overlapping covers with flush-head cover retaining screws, prime coated.

C. Wireway shall be constructed of enamel finish. Size shall be in accordance with manufacturer and NEC for intended fill. Minimum cross section shall be 6" × 6".

D. Unless otherwise indicated, enclosure types shall be used as follows:

1. NEMA 1 - Interior locations, dry.
2. NEMA 4 - Wet areas, on outdoor structures, in equipment vaults, where moisture is present.
3. NEMA 12 - Interior locations subject to oil seepage or dust may be used in lieu of NEMA 1.

If location is questionable, consult Engineer.

E. Enclosures shall be fabricated from 16-gauge steel (min.) or equivalent rust-resistant steel with rust-inhibiting primer.

F. Enclosures shall be sized, as a minimum, as indicated on the Drawings.

2.07 BUS DROP CABLE FS BOX

A. Provide cast aluminum, single-gang, double face (deep) FS box with single threaded hub for bus drop installation of standard/GFCI receptacles at work benches, equipment, etc.

B. Cooper, Crouse-Hinds, or equivalent.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Mount outlet boxes flush where conduit is concealed.

B. Adjust position of outlets in finished masonry walls to suit masonry course lines.

C. Do not install boxes back-to-back in same wall. Where located on opposite sides of common walls, device boxes shall not be installed back-to-back in the same stud bay. Where possible, all boxes shall be one complete stud bay apart.

D. Locate boxes in masonry walls so that only a corner needs to be cut from masonry units. Coordinate cutting of masonry walls to achieve neat openings for boxes. Use rotary cutting equipment to cut masonry work for installation of electrical fittings.

E. Do not use sectional or handy boxes unless specifically requested.

F. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.

G. Wall boxes in block or concrete construction shall be masonry boxes with inside ears and shall be concrete tight.

H. Locate pullboxes and junction boxes in electrical rooms, utility rooms, above suspended ceilings or storage areas, where accessible, and allowed by the National Electrical Code.

I. Boxes shall have no openings except through which conduits or cable pass.

J. Install enclosure(s) in accordance with manufacturer's recommendation, Section 26 07 00 and as shown on the Drawings.

K. Provide proper grounding for all enclosures in accordance with the NEC and Section 26 06 00.

L. Verify exact dimensions to ensure that the cabinets specified have space available for the arrangement of equipment provided.

END OF SECTION

SECTION 26 14 00

WIRING DEVICES

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide wall switches.

B. Provide receptacles.

C. Provide cover plates.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - WALL SWITCHES

A. Subject to compliance with requirements, provide products by the following:

1. Wall switches:

   a. Bryant
   b. Hubbell
   c. Pass & Seymour
   d. Cooper Wiring Devices
   e. Leviton

2. Receptacles:

   a. Bryant
   b. Hubbell
   c. Pass & Seymour
   d. Cooper Wiring Devices
   e. Leviton

3. Cover plates:

   a. Bryant
   b. Hubbell
   c. Pass & Seymour
   d. Cooper Wiring Devices
   e. Leviton

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 26 01 00.

2.02 SWITCHES

A. 120-277 Volt Switches: Quiet type, toggle handle, with totally enclosed case, rated 20 ampere or as indicated on the Drawings with silver cadmium oxide contacts. Provide matching two-pole, 3-way, and 4-way switches as indicated. Switches shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

B. Switches shall be horsepower rated when used to control motor loads.

C. Color: To be selected by Architect from the manufacturer's full color range.

D. Handles shall be lighted if indicated.

2.03 INCANDESCENT DIMMING SWITCH

A. Provide general-duty flush, single-pole dimming switches, rated 600 watt minimum of as required with 120 volts slide type intensity control, separate on/off switch and pigtail lead terminals. Color shall match standard switches. Switches shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

2.04 FLUORESCENT DIMMING SWITCH

A. Provide fluorescent dimming switches with configurations and ratings suitable for the intended use and compatible with provided ballast. Unit shall have slide type intensity control and an on/off switch. Color shall match standard switches. Switches shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

2.05 KEY SWITCHES

A. 120-277 Volt Switches: Key-operated, rated 20 ampere or as indicated on Drawings. Specification grade. Provide matching two-pole, three-way, and four-way switches as indicated. Switches shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

B. Color: To be selected by Architect from the manufacturer's full color range.

2.06 LOW VOLTAGE DIMMING SWITCH

A. Provide low voltage dimming switches with configurations and ratings suitable for the intended use and compatible with provided transformers.

B. 0-10 volt stand-alone dimming switches shall be large paddle type with captive linear dimmer slide. Switch shall be compatible with fluorescent ballasts and LED drivers that are compliant to IEC 60929 0-10V current sinking control. Provide with matching power pack for on/off control. Lutron DIVA DVTV-XX or equivalent.

C. Color: To be selected by Architect from the manufacturer's full color range.

D. Provide barrier (partition) in switch outlet boxes where low voltage dimmer switches are ganged with line voltage switches.

E. The Electrical Contractor, in cooperation with lighting control manufacturer and light fixture manufacturers, is responsible for ensuring compatibility between all LED drivers and the lighting control system components. All proposed LED fixtures shall be tested by the lighting control manufacturer at the factory to verify compatibility prior to installation in the field. If any LED fixture is determined to be not compatible with the proposed lighting control system, it is the Electrical Contractor's responsibility to work with the light fixture manufacturer to provide a driver that is compatible with the lighting control system. All 0-10 VDC LED dimming drivers shall meet the requirements of IEC 60929 for current sinking control and shall have an isolate 0-10 VDC control circuit.

2.07 OCCUPANCY SENSOR SWITCH

A. The passive infrared sensor shall be a completely self-contained control system that replaces a standard toggle switch. Switching mechanism shall be a latching air gap relay, compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.

B. Sensor shall be capable of detecting presence in the control area by detecting changes in infrared energy. Small movements shall be detected, such as when a person is writing while seated at a desk.

C. Sensor shall utilize advanced control logic based on RISC (Reduced Instruction-Set Circuit) microcontroller.

D. Detection Signature Processing (DSP) shall be used to avoid false offs and false activations and to provide immunity to RFI and EMI.

E. Continuously adjusting Zero Cross relay control shall be used to guarantee reliable operation with non-linear loads (electronic, PL lamp ballasts) even with temperature changes and product aging.

F. Sensor shall utilize SmartSet™ technology to optimize the sensor behavior to fit occupant usage patterns and adjust sensitivity and time delay to changing conditions. The use of SmartSet shall be selectable by user with a DIP switch.

G. Sensor shall have a time delay that is adjusted automatically (with the SmartSet setting) or shall have a fixed time delay of 5, 10, 15, 20, or 30 minutes, walk-through mode, or test mode, set by DIP switch. In walk-through mode, lights shall turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

H. Sensor shall have the choice of light flash alert and/or audible alert of impending light shut off, selectable with DIP switch.

I. Sensor shall have sensitivity adjustment that is set to either automatic (SmartSet setting) or reduced sensitivity, and is set with DIP switch.

J. Sensor shall have a built-in light level feature selectable with DIP switch. During set up of light level control, sensor shall learn desired hold-off level, requiring only one step.

K. Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.

L. Sensor shall operate at universal voltages of 100, 120, 230, or 277 V AC; 50/60 Hz.

M. Sensor shall have no minimum load requirement and shall be capable of switching 0 to 800 watts fluorescent/incandescent or 1/6 hp at 100/120V AC, 50/60 Hz; 0 to 1200 watts fluorescent or 1/6 hp at 230/277VAC, 50/60 Hz.

N. Sensor shall utilize a temperature compensated, dual element sensor, and a multi-element Fresnel lens.

O. For vandal resistance, Fresnel lens shall be made of hard, 1.0mm Poly IR 2 material that offers greater sensitivity to motion and superior detection performance. Lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

P. To assure detection at desktop level uniformly across the space, sensor shall have a two-level, 28-segment, multi-element Fresnel lens system.

Q. Sensor shall cover up to 300 sq ft for walking motion, with a field of view of 180 degrees.

R. Adjustments and mounting hardware shall be concealed under a removable, tamper resistant cover to prevent tampering of adjustments and hardware.

S. For safety, sensor shall have a 100% off switch with no leakage current to the load.

T. Sensor shall not protrude more than 3/8" from the wall and shall blend in aesthetically.

U. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

V. Sensor shall have standard 5-year warranty and shall be UL and CUL listed.

W. Wattstopper WA-200 or equivalent.

2.08 LOCAL DIGITAL TIMESWITCH

A. The digital time switch shall be programmable to turn lights off after a preset time.

B. Time switch shall be a completely self-contained control system that replaces the standard toggle switch. It shall have a ground wire and ground strap for safety. Switching mechanism shall be a latching air gap relay.

C. Zero Crossing Circuitry shall be used to increase the relay life, protect from the effects of inrush current, and increase the switch's longevity.

D. Time switch shall be compatible with all electronic ballasts, motor loads, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed.

E. Time switch shall operate at universal voltages of 100-300 VAC; 50/60 Hz.

F. Time switch shall have no minimum load requirement and shall be capable of controlling 0 to 800 watt incandescent, fluorescent @ 100/120 VAC, 50/60 Hz; 0 to 1200 watts fluorescent @ 230/277 VAC, 50/60 Hz; 1/6 hp @ 125 VAC.

G. Time scroll feature shall allow manual overriding of the preset time-out period. Selecting time scroll UP shall allow time-out period to scroll up throughout the timer possibilities to the maximum. Time scroll DN (down) shall allow time-out period to scroll down to minimum.

H. Time switch shall have a one second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).

I. Time switch shall have a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.

J. Time switch shall have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.

K. Time switch shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.

L. Time switch shall fit behind a decorator style faceplate. The calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.

M. Time-out period shall be adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.

N. Time switch shall be capable of operating as an ON/OFF switch.

O. For ease of installation and cleaner wiring, the switch shall utilize terminal style wiring.

P. The time switch shall not protrude more than 1/8" from the wall and should blend in aesthetically.

Q. For safety, the time switch shall have a 100% OFF override switch with no leakage current to the load.

R. For safety, in the event there is an open circuit in the AC line such as a ballast or lamp failure, the time switch shall automatically switch to OFF mode.

S. To ensure quality and reliability, time switch shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

T. Time switch shall have 5-year warranty and shall be UL and CUL listed

U. Wattstopper TS-400 or equivalent.

2.09 RECEPTACLES

A. Standard Duplex Receptacles: Full gang size, polarized, duplex, side and back wired, parallel blade, U grounding slot, specification grade, rated at 20 amperes or as indicated on the Drawings, 125 volts, designed for split feed service, NEMA Type 5 20R. Receptacles shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity. Receptacles intended for use in wet locations shall be weather-resistant, Type WR.

B. Color: To be selected by Architect from the manufacturer's full color range.

C. Ground fault interrupter receptacles shall be rated 20 amperes with built in test and reset buttons, and shall comply with NEMA WD 1, NEMA WD 6, UL 498, Federal Specification W-C-596, and UL943, Class A. Feed through feature will protect standard receptacles located downstream. Include indicator light that is lighted when device is tripped. Must have Self-test feature (conducts an automatic test every three seconds, ensuring ground fault protection. If ground fault protection is compromised, power to the receptacle must be discontinued.

D. Special Receptacles: Provide special receptacles of type and located as indicated on the Drawings. Type shall be suitable for intended equipment. Receptacles shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

E. Isolated Ground Receptacles: Provide isolated ground receptacle where indicated. Receptacle shall be orange. Receptacles shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

F. Corrosion-Resistant Receptacles: Polarized, side and back wired, duplex, screw-type terminals, parallel blade, U-grounding slot, specification grade - rated at 20 amperes, 125 volt. Receptacle shall be constructed of grey urea. All metal parts shall be either stainless steel or nickel plated brass, NEMA Type 5-20R. Receptacles shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

G. Clock hanger outlets shall be provided where indicated on the Drawings and be rated 20 amp, 125 volt, three-wire grounding type receptacle recessed in the outlet body, provided with a hook hanger. Receptacles shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

H. TVSS receptacles shall be rated for 20 amperes providing surge protection for hot-to-neutral, hot-to-ground, and neutral-to-ground. Provide 8-hole back and side wired receptacles. Include built-in LED indicators to verify surge protection and ground. Receptacles shall comply with UL 1449 and UL 498 requirements.

I. USB charging duplex receptacles shall be rated for 15 amperes with dual USB charging ports and a minimum charging capacity of 2.1A at 5 VDC.

J. Schedule of Use:

1. Corrosion-resistant receptacles shall be used in areas of high moisture and in all process areas.
2. Standard receptacles shall be used in interior dry locations including electrical room.
3. Isolated ground receptacles shall be used where indicated on the Drawings for power to computers and control terminals.
4. Ground fault interrupter receptacles shall be used where required by NEC and where indicated on the Drawings.

2.10 DROP CORD RECEPTACLE

A. The drop cord receptacle shall be provided using a retractable polymer extension cord unit. The extension cord shall be industrial-duty of heavy-gauge steel with lifetime lubrication, heavy-duty main spring, steel mounting flange, disengagable ratchet lock, 40-foot, three conductor #12 AWG SJTW cord and 4-way tap containing 20A, 125V separately grounded receptacles (and LED status light to indicate power). Mounting brackets shall accommodate either ceiling or wall mounting. Bayco #SL-8904-40, or equivalent.

2.11 COVER PLATES

A. Materials:

1. Stainless Steel: 0.040 inch thick minimum, accurately die cut, protected with release paper.
2. Cast Metal: Die cast profile, ribbed for strength, flash removed, primed with grey enamel, furnished complete with four mounting screws and sealing gaskets.
3. Gaskets: Resilient rubber or closed cell foam urethane.
4. Galvanized Steel: Hot dipped galvanized, heavy-duty stamped steel.
5. Flush-Mount Weatherproof While-in-Use Covers: Polycarbonate self-closing receptacle cover rated NEMA 3R. Weatherproof when attachment plug cap is inserted. Two (2) exit ports for 12/3 cord. Complies with NEC 406-8(b) and UL 514D. Typical to Pass & Seymour WIUFC10. The cover shall be identified as "extra duty."

B. Schedule of Use:

1. Stainless Steel: To be used in all interior dry locations including lab and public area subject to high abuse.
2. Cast Metal: To be used in exterior locations, areas of high moisture or where a weatherproof type device is indicated. All cast type boxes shall have a cast gasketed cover.
3. Galvanized steel to be used in interior dry utility areas including electrical and mechanical areas.
4. Weatherproof while in use: To be used for all exterior receptacles or areas of high moisture, and with devices labeled “WP”.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Switches:

1. Mount switches 44 inches above floor to center of device unless otherwise indicated.
2. Switches shall be located to agree with architectural features and shall not interfere with work by other Trades.
3. The location of all devices shall be subject to the approval of the Engineer. The Drawings show approximate locations only.

4. Where groups of switches are shown, they shall be installed in approved gangable boxes with one piece faceplates that completely cover opening in wall.
5. Low voltage dimmer shall be connected electrically before transformers or as otherwise required by manufacturer.

B. Receptacles:

1. Mount receptacles 18" above finished floor or grade to center of device, unless otherwise noted on the Drawings, with grounding pole at bottom.
2. Outlets shall be located to agree with architectural features and shall not interfere with work by other trades.
3. Do not megger test any circuits when TVSS is connected.

C. Cover plates:

1. Install cover plates on all wiring devices.
2. Metal faceplates shall be grounded.
3. Provide red colored faceplates for all devices wired to emergency or standby power. Provide label indicating the panelboard and circuit # the device is powered from.

D. Identification:

1. Identify each receptacle with panelboard identification and circuit number with durable wire markers or tags inside outlet boxes.

END OF SECTION

SECTION 26 15 00

ELECTRICAL CONNECTIONS

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Extent of electrical connections for equipment is indicated by Drawings and schedules. Contractor shall provide all lugs and termination equipment required to terminate cables and wires installed by him unless furnished with equipment provided by others.

B. Applications of electrical connections specified in these sections include the following:

1. Power cable terminations.
2. Control cable terminations.
3. Instrument and signal cable terminations.

C. Electrical connections for equipment, not furnished as an integral part of equipment, are work of this section.

D. Electrical identification for wire/cable conductors is specified in Division 26 section, "Electrical Identification," and is work of this section.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials in accordance with Division 01.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and auxiliary connection materials, including electrical insulating tape, high voltage cable terminations, and cable ties, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firms with at least 3 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

C. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical connections.

D. IEEE Compliance: Comply with Std. 141, "IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants" pertaining to connections and terminations.

E. ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

F. UL Compliance: Comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL listed and labeled.

PART 2 – PRODUCTS

2.01 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, and other items and accessories as needed to complete terminations of types indicated.

B. Terminations: Provide electrical terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.

1. All terminal lugs shall be of high conductivity copper.
2. For copper control and fire alarm cable, provide ring-tongue type insulating gripping, compression type, and insulated terminals. Do not use any solder, "push-on", or "quick" type connectors. Forked tongue connectors will be used only with the specific approval of the Owner. Acceptable manufacturers are:

    a. Amp-Special Industries.
    b. Burndy Corp.
    c. Thomas and Betts Corp.
    d. Ideal Industries.

3. For power cable, regardless of voltage, provide compression type terminal lugs with NEMA standard bolt hole spacing to match drilling of equipment terminal pads. Lugs for No. 6 AWG and smaller shall be insulated. Lugs for larger conductors shall be uninsulated. Cable terminal lugs shall have the following bolt hole requirements:

    a. Cable sizes smaller than No. 1/O AWG shall use a single hole lug.
    b. Cable sizes equal to, or greater than, No. 1/O AWG shall use a two-hole lug, except where limited by the equipment manufacturer's standard design or otherwise indicated.
    c. Acceptable manufacturers are:

        1) Amp-Special Industries
        2) Burndy Corp.

C. Use wire and cable insulation suitable for temperature encountered in heat producing equipment.

D. Power Distribution Blocks: Provide terminal blocks (one per phase) mounted, as required, in wall-mounted junction box for the tapping of emergency feeders where they enter into the building and distribute to the life safety and standby power systems.

1. Insulated base, terminals manufactured from high strength 6061-T6 aluminum alloy.
2. UL Listed and CSA Certified.
3. Rated for 600V.
4. Type PDB, sized to accommodate number of primary conductors in, and number of secondary conductors out, as a minimum.
5. Dual rated for copper and aluminum conductors. Acceptable manufacturers are:

    a. Ilsco Corporation.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

1. Connectors:

    a. Amp-Special Industries.
    b. Burndy Corp.

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures in Section 26 01 00.

PART 3 – EXECUTION

3.01 INSPECTION

A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Provide rough-in of electrical services to equipment only after reviewing requirements in approved shop drawings.

3.02 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Install electrical connectors as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical conductors to equipment in accordance with equipment manufacturer's written instructions and wiring diagrams and with Owner's Drawings.

D. Removal of cable insulation shall be by skinning tools. Maximum care shall be used to avoid nicking conductor strands. Where penciling is not required, insulation shall be cut square to butt against the barrel of the fitting. After removal of insulation, the conductor shall be cleaned where necessary. Copper conductor shall not be hand wire brushed if it is tinned. Avoid "ringing" conductors while skinning wire.

E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connections and terminals to comply with torquing values contained in UL's 486A.

F. Due to limited space in compact termination cabinets, installation sequencing of multi-conductor cables in the proper physical sequence is necessary. Conductors away from the terminal blocks (back layer of cable) should be connected to the terminal's furthest point of entry. Intermediate conductors should terminate in the middle group of terminals. Finally, conductors nearest to the terminal strip should be connected to the terminals nearest the point of entry.

G. Conductors in all panelboards, motor control centers, and terminal cabinets shall be neatly fanned in the gutter space and tied.

3.03 TERMINATIONS - POWER CABLE

A. Power cable terminations shall be done only under proper environmental conditions. The working areas shall be clean and free from excessive airborne dirt and dust. Outdoor terminations shall be made in clear, dry weather or within temporary weatherproof shelters. Heaters shall be used if necessary to provide proper working temperatures for the cable coverings and terminating and splicing materials. Indoor termination work shall be protected by temporary shelters, if necessary, to protect against falling water, dirt, and welding sparks. All tapes and materials shall be kept dry and clean in original containers until used. Dated materials shall not be used after expiration date.

B. If a medium voltage termination cannot be completed during a single working period, then it must be adequately protected from environmental and physical damage. All steps outlined in the applicable cable manufacturer instructions shall be completed in proper sequence and dimensions shown for the preparation of cable insulation and the location and thickness of tape coverings shall be carefully followed. Particular care shall be used, and termination and grounding of cable shielding where used, and in the fan-out encapsulation of the conductors of non-shielded, three-conductor cable is required. Single conductor shielded cable shall have shield grounded at one end only. The ungrounded end of the cable shield shall be brought out and taped back.

C. All power connections to medium voltage equipment shall be insulated for full voltage in accordance with manufacturer's instructions. Bare copper contact surfaces shall be cleaned and hand wire brushed. Copper contact surfaces which are tinned shall not be wire brushed or otherwise abraded.

D. As soon as possible after completion of cable installation and testing, cable lugs shall be bolted to equipment terminals and final insulation and taping completed.

E. The fittings and the tools and dies used for applying compression terminals shall be of the same manufacture as the terminals and shall be subject to the approval of the Owner. Only dies and fittings of proper matching sizes shall be used. The manufacturer's instructions for the use and maintenance of tools and dies shall be followed. Damaged dies shall not be used, but shall be discarded and replaced. Compression tools shall be of a type giving positive indication of completion of compression and shall be hydraulic or manually operated as required for the cable size involved.

F. Any lugs received with equipment may be used only if checked and found to be of correct make and type. All incorrect lugs shall be discarded.

G. Termination of power cables at or within switchgear shall include fittings to provide support and/or sealing where required.

3.04 TERMINATIONS - CONTROL CABLE

A. Compression tools and dies, manually or power operated, shall be of types which will assure complete compression, and shall be of the same manufacturer as the connectors used. Only matching lugs and dies of proper size for the wire terminated shall be used. The crimping tools shall be subject to a regularly scheduled calibration and inspection.

B. Solid wire, if specified, shall be terminated at terminal blocks or studs by looping the bare conductor around the terminal screw in clockwise direction, to ensure that the loop will tend to close as the screw is tightened.

C. The terminal system used may be either of the overall compression type, or of the type which uses one or more indents for compressing the lug on the conductor. Where an indent system is used, the indents shall be made on the top of the lug barrel, and all single lugs shall be installed on the terminal screw with top visible.

D. Not more than two wires shall be connected to a single terminal, unless approved by Engineer.

E. Control wires at equipment which has terminal boards with studs instead of screw-type terminal blocks, shall be terminated with compression lugs as outlined above. Nuts, washers, and locknuts shall be used as required to make firm and vibration-proof connections to the studs.

F. Where connections are made to small devices, such as limit or pressure switches or pushbuttons, which do not have sufficient internal space for proper termination of control cables, a separate box or fitting shall be provided adjacent to the device, as part of the raceway system. The control cable shall be terminated within this enclosure and connected to single conductor wires run to the device terminals. Where space is severely limited, and if ampacity requirements permit, the extension wires may be smaller than the control cable conductors, but shall not be smaller than No. 18 AWG. For devices which may require disconnection during maintenance or testing (as determined by Owner), use set shells, of fire-resistant plastic. If a solid wire is to be used with a stranded wire, place the solid wire under the stranded wire and tighten down the set screw on the stranded wire.

3.05 TERMINATION - INSTRUMENT AND SIGNAL CABLE

A. Instrument and signal cables are defined as cable carrying low level signals subject to electrical noise interference. They consist of twisted pairs or triples, multiple twisted pairs or triples cabled, with pairs (triples) or multiples shielded, coaxial, thermocouple-pair and multiple-pair extension cables, and other special constructions. Conductors are copper, except for thermocouple extension cables, and conductor sizes are, in general, No. 16 AWG and smaller.

B. Termination arrangements and shielding connections for instrument and signal cables shall be as shown on the wiring diagrams or in special instructions and notes. Where specified instructions are not provided, terminal fittings and methods of termination similar to those outlined for control cables shall be used for the conductors.

C. Care shall be used in the termination and grounding of shields, to comply precisely with specific instructions. Shield grounds shall be applied at one end only, at points indicated on the Drawings. Shield ground connection shall be made by soldered pigtails or with special compression grounding fittings. If soldered connections are used, care shall be exercised to avoid heat damage to the insulation.

D. Shield for instrument and signal cables that are of the foil and drain wire type shall be terminated as follows:

1. Strip shield tape to within 1/2 inch of jacket.
2. Slip a flame-retardant insulating sleeve over the drain wire.
3. Cover the foil tape and end of drain wire with two or three layers of vinyl tape.
4. Terminate the insulated drain wire similar to the other conductors in the cable.

E. Where the Drawings or other instructions do not require special treatment of the shield, such as grounding, the foil and drain wire should be cut to 3 inches in length and taped back over the cable.

F. Instrument and signal cables entering panels and racks for termination shall be neatly trained and formed and cable or wire bundles shall be supported by nonmetallic ties from point of entry to terminating point. A clear space of at least 3 inches shall be maintained, where practicable, between such low level cables and adjacent parallel control cables or wire bundles. Low level wires shall not be bundled with control wires, and shall not be random laid in wiring gutters with control wires.

G. Thermocouple and resistance temperature detector cable terminations shall be so arranged as shown on the wiring diagrams. Where grounded circuits are called for, ground connections shall be made in strict accordance with Drawings and instructions, and only at the points indicated.

3.06 TERMINATION - HVAC AND PLUMBING CONNECTIONS

A. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (VFDs), and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.

B. VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.

C. Unless otherwise specified, all electrical control devices such as aquastats, float and pressure switches, electro-pneumatic switches, solenoid valves and damper motors requiring electrical connections shall be furnished and installed and wired by the Contractor supplying the devices.

D. Each motor terminal box shall be connected with a minimum 12", maximum 36" piece of flexible conduit to a fixed junction box. Use liquid-tight flexible metal conduit for connections in damp or wet locations. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.

3.07 TERMINATION - ELEVATOR CONNECTIONS

A. Provide fused disconnect switch adjacent to elevator equipment room door. Locate on strike side of door. Provide one for each unit.

B. All traveling cables, control stations, control station wiring, and final control connections at the controller shall be furnished and installed under Division 11 - Elevator Work.

C. Coordinate entire installation with Division 11 Contractor prior to rough-in.

3.08 TERMINATION - COOLER AND FREEZER WIRING

A. Provide rigid conduit, IMC or PVC for all surface wiring in coolers and freezers. Whenever possible avoid the use of surface wiring and run conduit in space behind or above insulated panels.

B. Provide non-metallic nipple and sealing fittings whenever conduit pierces wall of cooler or freezer. Provide grounding conductor.

C. All openings cut in walls of cooler or freezer shall be patched and insulation integrity shall be maintained. Patching shall be approved by freezer or cooler installer.

D. Install all wiring for lighting, switches, evaporator, coil fans, compressors, interlocks, defrost heaters, door heaters, drain heaters, alarms, or any other electric devices supplied with unit.

3.09 KITCHEN EQUIPMENT CONNECTIONS

A. Check loose equipment delivered to job by equipment installer against approved shop drawings or other required Drawings. Loose electrical equipment including disconnects, starters, thermostats, controls, local and remote switches shall be furnished by equipment contractor and installed by Electrical Contractor.

B. Electrical Contractor shall rough-in for kitchen equipment only from approved kitchen equipment shop drawings.

C. Rough-in location shall be within 3 inches of equipment. If direct connection is required, use liquid-tight flexible conduit. If receptacle connection is required, verify proper receptacle configuration with equipment installer.

D. Final connections shall include extension of all service to each piece of equipment. All labor and material required to completely connect the equipment ready to operate shall be included in the final connections. All control wiring not integral with equipment hall be included.

E. For kitchen exhaust hoods provide all required power and control wiring. This may include (but is not limited to) the following:

1. Provide switch in hood and branch circuit for integral light fixtures.
2. Provide pushbutton switch or manual starter for exhaust fan.
3. Provide emergency branch circuit for fire suppression system. Wire automatic heat detectors or manual station so, when activated, valve of dry chemical bottle opens, gas solenoid valve

shuts down, all dampers close, exhaust and make-up fans shut down, electrical power contactor opens (integral in equipment), and building fire alarm system is activated. Provide all required wiring conduit and final connections. Refer to wiring diagrams supplied with equipment.

3.10 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, Owner or his representative will test connections to demonstrate continuity and correct installation in accordance with the interconnection diagrams and other drawings, as appropriate. Contractor shall correct any miswiring and replace any faulty wires or cables.

END OF SECTION

SECTION 26 23 00
STANDBY GENERATOR SYSTEM
(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide standby generator system, transfer switch, and accessories for a complete and operable system.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

D. All trade subcontractors are to note that the organization of these Specifications into divisions, sections, and paragraphs, and likewise the arrangement of the Drawings, is set up for the convenience of understanding the scope of the Work only. This structuring shall not control the General Contractor in dividing the Work among trade subcontractors or in establishing the extent of the Work to be performed by any trade.

1.03 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 26 01 00.

B. Submit data, plans, and wiring diagrams, including power and voltage ratings, maximum symmetric short circuit current, annunciation methods, and all control functions. Submittal shall include overall dimension, weight, fuel consumption, and fuel tanks, rated KW, KVA, voltage, starting KVA, circuit breaker rating and alarm. Also automatic transfer switch short circuit voltage and current ratings, dimensions, weight and all control functions.

C. Generator shall operate the intended load with 10% voltage dip and 0.25% frequency dip maximum. Manufacturer's written verification of generator suitability shall be sent to the Engineer. Contact Engineer for intended load information.

D. Submit certification that the following factory testing has been successfully completed by the manufacturer:

1. Prototype factory tests: The system manufacturer shall certify that the engine, generator, controls, and switchgear of an in-house engineered model with similar characteristics has been completed including the following:

a. Fuel consumption at 1/4, 1/2, 3/4, and full load.
b. Exhaust emissions.
c. Mechanical and exhaust noise.
d. Governor speed regulation 1/4, 1/2, 3/4, and full load; and during transients.
e. Motor starting kVA.
f. Generator temperature rise in accordance with NEMA MG1-22.40.
g. Voltage regulation at 1/4, 1/2, 3/4, and full load; and during transients.
h. Harmonic analysis, voltage wave form deviation, and telephone influence factor.
i. Generator short circuit capability.
j. Cooling system performance.
k. Torsional analysis.
l. Linear vibration analysis.
m. Generator revolving field assembly for 2 hours at 2700 rpm (150% overspeed) and 70°C, and each production unit tested at 2250 rpm (125% overspeed) at room temperature.

2. Production factory tests: The system manufacturer shall perform production tests on the complete generator set supplied by the manufacturer's facility. A certified report of these tests shall be available when requested at the time of the generator set order. These tests and controls shall include but not be limited to:

a. Operation at rated kW.
b. Operation at rated kW (optional).
c. Transient and steady state governing.
d. Transient and steady state voltage regulation.
e. Operation of all alarm and shutdown devices.
f. Single step load pickup of rated kW.
g. Operation at 2250 rpm (125% overspeed) at room temperature.

E. Submit operation and maintenance manuals for complete system in accordance with Section 26 01 00, to include but not limited to the following:

1. Operating instructions - with description and illustration of all switchgear controls and indicators; and engine and generator controls and indicators.
2. Parts CD - that illustrates and lists all assemblies, subassemblies, and components, except standard fastening hardware (nuts, bolts, washers, etc.).
3. Preventative maintenance instructions - on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
4. Routine test procedures - for all electronic and electrical circuits and for the main AC generator.
5. Troubleshooting chart - covering the complete generator set showing description of trouble, probable cause, and suggested remedy.
6. Recommended spare parts list - showing all consumables anticipated to the required during routine maintenance and test.
7. Wiring diagrams and schematics - showing function of all electrical components.

F. Submit test results in accordance with Section 26 08 00.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents.

The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 WARRANTY

A. Provide full two-year warranty for standby generator system at the completion of the project. The warranty shall cover all parts, labor and travel expenses necessary for a dependable system for the indicated period. Warranty shall not cover routine maintenance items such as oil, filters, and belts.

B. Provide warranty in accordance with Section 26 01 00.

C. The generator set supplier shall have factory-trained service representatives and tooling necessary to install, test, maintain, and repair all provided equipment and shall maintain a dispatch center 24 hours per day, 365 days per year to minimize service response time.

D. The generator set supplier shall have sufficient parts inventory to maintain over the counter availability of at least 90% of any required parts and shall guarantee 100% parts availability within 48 hours from the time an order is entered with the dealer.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

1. Standby Generator:
   a. Kohler
   b. Caterpillar
   c. Onan
   d. Generac
2. Automatic Transfer Switch:
   a. Asco
   b. Russelectric
3. Manual Transfer Switch:
   a. Westinghouse
   b. General Electric

B. Substitutions: Items of equal quality, function, and performance may be proposed for substitution by following the procedures outlined in Section 26 01 00.

2.02 STANDBY GENERATOR SYSTEM

A. Emergency standby generator system shall be suitable for intended use. Ratings of system shall be adequate for proposed full loading. Work shall be coordinated with Division 23 to ensure proper operation of the system.

B. Upon failure of normal power source switch of emergency load to generator shall be within 10 seconds maximum.

2.03 ENGINE-GENERATOR UNIT

A. Provide an alternating current standby #2 diesel fuel engine-driven generator unit as indicated rated for 800KW, 1000 KVA at 0.8 power factor for standby operation, 480/277 volt, three-phase, four-wire, 60 Hz, 1800 rpm, water-cooled, with unit-mounted radiator, heavy-duty engine connected directly to a 4-pole revolving field type single-bearing generator. Equip unit with low oil pressure, low coolant level, high water temperature, overspeed and overcrank automatic safety shutdown.

B. Unit shall be equipped with a Level 1 type control panel including, but not limited to, water jacket temperature indicator with low temperature (below 70 deg. F) warning light, high engine temperature warning light, oil pressure gauge with low pressure warning light, engine shutdown light indicating overcrank, overspeed, low oil pressure, low coolant level, or high engine temperature as the reason for shutdown, voltmeter and ammeter with phase selector switch, frequency meter, voltage adjust rheostat, auto-off-manual start switch, battery voltage meter, total running time indicator, red indicator light for low-battery voltage, red indicator light for low fuel and contacts for remote alarms. A means shall be provided to shut off the audible signal in the event of an above condition but the indicator lights would remain on until the condition was rectified. Additional alarms, if specified in this section, shall have indication at this panel.

C. Unit shall automatically start upon indication from the automatic transfer switch. Upon transfer of full load, the voltage dip shall not exceed value specified in paragraph 1.03.C, at the rated power factor. Voltage shall be regulated to within 2% of rated value during constant load conditions. Stable operating conditions shall be reestablished within two (2) seconds following any sudden change in load. Generator shall have a manufacturer sized, UL listed, thermal magnetic circuit breaker (with shunt trip device connected to safety shutdowns) on its output. The circuit breaker shall be mounted to be accessible per the NEC.

D. Engine-generator unit shall be installed as indicated on Drawings. Unit shall be mounted on heavy steel base with vibration isolators (Korfund Series L or equal) to reduce the possibility of torsional vibration, and shall conform to seismic requirements. A sufficient number of control wires shall be provided to and from the automatic transfer switch and remote annunciator panel (if specified) for indicated system operation. Critical exhaust silencer shall be provided to minimize the noise emission from the unit. Silencer shall have mounting brackets with isolators to isolate the silencer vibration from the weather housing.

E. Engine shall have electric starting system including rack-mounted 24-volt storage batteries, starting motor alternator, and automatic battery charger. Batteries shall be maintenance-free type with 60-second cranking capability minimum. Battery charger shall be fed from normal power source under normal conditions. Battery shall be charged by alternator when engine/generator unit is in operation. A dual-rate 10 ampere battery charger shall be provided which shall accept 120 volt AC, single-phase input to provide 24 volt DC output. It shall be fused on the AC input and DC output, incorporate current limiting circuitry, and include a DC ammeter and voltmeter. The charger shall be housed in a NEMA 1 enclosure and vibration mounted on the generator set. An automatic disconnect device shall be provided to remove electrical power upon engine start. Wiring for the charger and all controls shall be provided complete and shall be terminated in the Control and Auxiliary Power Enclosure. The charger shall include LED annunciation for low battery voltage, high battery voltage, battery charger malfunction, and AC failure; and dry contacts for battery charger malfunction and low battery voltage; as required by NFPA-110.

F. The exciter shall be a three-phase, brushless, permanent magnet type with full-wave rectified output.

G. Unit shall have 120V electric water jacket heater with thermostat to ease starting in cold weather. Operating temperature shall be as recommended by the manufacturer.

H. Unit shall also have a heated type fuel filter, and generator strip heater.

I. Provide electric solenoid valves equipped with manual operation feature or manual bypass valves.

2.04 AUTOMATIC TRANSFER SWITCH

A. Automatic transfer switch shall be rated for 480Y/277 volts, 400 amperes minimum, (for life-safety), 1000 amperes minimum, (for standby), and 208Y/120 volts, 260 amperes minimum, (for theater equipment), 4 pole, and interrupting capacity of 50,000 amperes rated with any circuit breaker. Unit shall start standby generator unit when line voltage drops to 75% of normal value, transfer load to generator and retransfer load to normal source when voltage is 90% of normal value. Switch shall be electrically operated and mechanically held with overlapping neutral transfer. Units shall be equipped with test switch for manual simulation of normal power outage including standby unit operation and load transfer and time-clock exerciser for automatic periodic exercise of engine-generator unit.

B. The automatic transfer switch shall be equipped with time delay features to override momentary normal source outages (up to 5 seconds), on retransfer to normal source (from 0 to 30 minutes) and for unloaded running time cool down (0 to 5 minutes). Adjustable dwell period between sources shall be provided for voltage decay.

C. Indicator lights shall be provided for connection to normal source and for connection to emergency source. As a minimum a normally closed and a normally open contact shall be provided for both, connection to normal source and connection to emergency source.

D. An in-phase monitor shall be provided. The monitor shall control transfer/retransfer operation between live source so that closure on the alternate source will occur only when the two sources are approaching synchronism and are within 60 electrical degrees maximum so that inrush currents do not exceed normal starting currents. The monitor shall function over a frequency difference range of up to ±2.0 Hz with a maximum operating transfer time of one-sixth of a second. If the voltage of the load carrying source drops below 70%, the in-phase function shall be automatically bypassed. The monitor shall not require interwiring with the generator controls, or active control of the governor.

2.05 MANUAL TRANSFER SWITCH

A. UL listed double-throw switch in NEMA 1 (indoor) NEMA 3R (outdoor) enclosure. Provide fuses as indicated on the Contract Drawings.

B. Handle shall be capable of being padlocked in top On, Neutral, or bottom On positions.

2.06 REMOTE ANNUNCIATOR PANEL

A. The remote annunciator panel shall be located as indicated on Drawings. The panel shall be a flush-mounted NEMA 1 enclosure with a lockable, hinged door.

B. Unit shall be equipped with a Level 1 type control panel including, but not limited to: visual indication of: overcrank, low water temperature (below 70°F), high engine temperature pre-alarm, high engine temperature, low lube oil pressure pre-alarm, low lube oil pressure, overspeed, low coolant level, EPS supplying load, control switch not in automatic position, high battery voltage, low battery voltage, battery charger AC failure, lamp test. Audible alarm indication of: overcrank, low water temperature (below 70°F), high engine temperature pre-alarm, high engine temperature, low lube oil pressure pre-alarm, low lube oil pressure, overspeed, low coolant level, control switch not in automatic position. Generator shutdown control of: overcrank, high engine temperature, low lube oil pressure, overspeed. A means shall be provided to shot off the audible

signal in the event of an alarm indication but the visual indication would remain on until the condition was rectified. Additional alarm, if specified, shall have indication at this panel. Provide a break-glass emergency manual stop station.

2.07 WEATHERPROOF SOUND ATTENUATED ENCLOSURE

A. Provide engine generator unit with a weatherproof housing suitable for the intended location. Housing shall be of 14-gauge steel with sufficient bracing and support and zinc phosphate rust inhibiting primer and two finish coats of color satisfactory to the Owner. Housing shall have lockable doors for unit maintenance with stainless steel hinges and locks. Unit shall have externally mounted generator stop button with vandal protection, and a window for full view of the control panel.

B. Provide 208/120 volt, three-phase panelboard within enclosure to power all generator appurtenances. Provide all necessary branch circuits to power generator accessories indicated above.

C. If the housing will not accept the panelboard due to the size of the generator, the panelboard shall be provided exterior to the housing as indicated on the drawings with branch circuits extended as required.

D. A ground bus bar shall be provided within the enclosure for equipment grounding of the generator and base.

2.08 EXHAUST SYSTEM

A. A complete exhaust system shall be provided by the generator manufacturer. The silencer, piping, and associated fittings shall not impose more than 27 inches H_2O restriction, and shall include aluminized side-in, end-out exhaust silencer limiting exhaust noise to a maximum 85 dBA measured at 10 feet. Silencer shall include a rain cap and provisions for draining moisture. Provide stainless steel flexible connection and mating weld flanges, gaskets, and Grade 8 hardware. Exhaust silencer shall be mounted within the weatherproof generator enclosure.

2.09 SKID-MOUNTED FUEL TANK

A. The emergency generator shall be supplied fuel by a double-wall, skid-mounted fuel tank located as indicated on the Drawings. The skid-mounted fuel tank shall also have alarm indication for high fuel, low fuel, and shutdown of the generator due to very low fuel, as a minimum. These alarms shall be tied into and have indication at the generator control panel and the generator annunciator panel.

B. The skid-mounted fuel tank operation shall be controlled by the level in the tank. The two control levels in the skid-mounted fuel tank shall be as follows:

1. Level 2: If the fuel level drops below this level the low-level alarm shall activated.
2. Level 3 (lowest): If the fuel level drops below this level, the generator shall shut off.

C. These levels shall be set by the manufacturer. The skid-mounted fuel tank shall also have a vent to the outside per the manufacturer. A weather cap shall be on the outside end of the vent.

D. The capacity of the skid-mounted fuel tank shall be such as to provide fuel for a minimum of 48 hours of standby use.

E. Provide a tank overfill audible and visual alarm at the tank fill location, visible to the person filling the tank. Set tank overfill alarm at 90% of tank capacity.

F. Provide an NFPA-compliant sign on the tank indicating tank identification number, capacity, and safe fill height or volume. The sign shall be completely visible and hall be located directly adjacent to the tank fill line.

G. The tank shall be equipped with an electrically operated float controlled fuel pump with shut-off and filter, to transfer fuel from an underground storage tank. Pump flow rate shall be coordinated with the fuel service at the remote underground storage tank.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation of all emergency power system equipment shall be in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the system fulfills requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator systems and accessories.

B. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground for system components.

C. Upon completion of installation of engine-generator system and after building circuitry has been energized with normal power source, test engine-generator and associated equipment in accordance with Section 26 08 00 to demonstrate standby capability and compliance with requirements. Engineer shall be notified five (5) days prior to the test.

D. Cooling system shall have manufacturer-recommended percentage of glycol added.

E. Phase sequencing between normal and emergency power sources shall be coordinated.

F. The Contractor shall coordinate with the environmental permitting agency (MDEP) and provide all permits, inspections, and certifications required, and shall include all auxiliary devices as required by the permit.

G. The Contractor shall provide fuel for all testing and start-up services and a full tank of fuel at the completion of the project before turn-over to Owner.

END OF SECTION

SECTION 26 32 13

ENGINE-GENERATOR LOAD TEST BANK

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Permanently mounted, freestanding engine-generator load test bank with an outdoor enclosure and integral controls.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 RELATED SECTIONS

A. Section 26 01 00 - Basic Electrical Requirements.

B. Section 26 06 00 - Grounding and Bonding.

C. Section 26 13 00 - Raceways.

D. Section 26 12 00 - Conductors and Cables.

E. Section 26 13 70 - Outlet Boxes and Enclosures.

F. Section 26 23 00 - Standby Generator System.

1.04 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Submit catalog cuts with bids for items proposed to be furnished and installed under this Section.

C. Submit shop drawings to show physical arrangements, connections, finishes, provisions for connections, access requirements for installation and maintenance, physical size, mechanical

and electrical characteristics and ratings, foundation and support details, and equipment weights, where such details are not indicated on the catalogue cuts. The drawings and sketches shall be prepared in CAD. Within twenty (20) days after the Award of Order, the vendor shall submit five (5) sets of complete shop drawings and product data along with the electronic drawing files on a CD-ROM for engineer's review and approval. Provide specific data on the following:

1. Outline drawings showing overall assembly and drawings illustrating arrangement (plan, front, and side views) and lifting provisions.
2. Certified outline plans, general arrangement (setting plan), and anchor bolt details. Drawings shall show the total weight and center of gravity of the load test bank.
3. Arrangement, size, and location of electrical interface points and detailed elementary, schematic, wiring, and interconnection diagrams of the load test bank.
4. Load test bank control panel.

D. Maintenance Manuals: Submittals shall include, but not be limited to, five (5) copies of the items listed below. Disc(s) shall be submitted with electronic files of drawings and sketches using REVIT. In addition, the vendor shall include additional procedures judged necessary by the manufacturer to insure the maximum performance and service reliability for the load test bank.

1. The load test bank shop manual(s) including complete service instructions.
2. Parts list with the manufacturer's or interchangeable part number.
3. Drawings of the load test bank with center of gravity clearly indicated.
4. Schematic and wiring diagrams of power and control circuits for the load test bank and its appliances and options.

1.05 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

B. ANSI/NFPA 70 - National Electrical Code.

C. ASTM International.

D. NEMA – National Electrical Manufacturers Association:

1. NEMA MG 1 — Standard for Motors and Generators
2. NEMA WC 5 — Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
3. NEMA AB 1 — Molded Case Circuit Breakers
4. NEMA ICS2 — Industrial Controls and Systems: Controllers, Contactors and Overload Relays Rated 600 Volts

E. NETA – National Electrical Testing Association:

1. "Acceptance Testing Specifications for Electrical Power Distribution and Equipment and Systems".

F. NFPA – National Fire Protection Association:

1. NFPA 70 National Electrical Code (NEC) - 2002
2. NFPA 110 "Emergency and Standby Power Systems"

G. UL – Underwriters' Laboratories:

1. UL 508 A Industrial Control Equipment

1.06 QUALITY ASSURANCE

A. Electrical equipment and materials shall be new and within one year of manufacture, complying with the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

B. Manufacturer's Representative: As part of the quotation, furnish the pricing for one (1) day's services of a qualified field engineer, experienced in the installation and operation of the type of system being provided, to inspect, test and adjust the system and to provide training for personnel if such services are required.

C. Manufacturer's Responsibility: The load test bank shall be manufactured by a single manufacturer who has been regularly engaged in the production of load test banks for a minimum of ten (10) years. The load test bank described herein shall be factory built, factory-tested at rated load, and shipped by this single manufacturer, so there is one source of supply and responsibility for guarantee, parts, and service. This manufacturer shall have a local representative in the New England Area who can provide factory-trained servicemen, required stock of replacement parts, and technical assistance.

D. The responsibility for performance to this Section in its entirety shall not be split up among individual suppliers of components comprising the system, but shall be assumed solely by the load test bank manufacturer. Controls shall be the standard of the load test bank manufacturer. Control parts shall be identified by parts numbers of this manufacturer and shall have second source listing where applicable. Control systems that are supplied by a vendor and not incorporated within the documentation drawings of the load test bank manufacturer are not acceptable.

E. Manufacturer's Qualifications: Company with ten (10) years minimum experience in manufacturing the products specified in this Section.

F. Primes, Sub- or Sub-sub- contractors performing electrical construction work shall have Electrical Construction License from the State of Vermont, USA with at least three (3) years of construction experience in the similar type of projects as specified in attached construction documents and specifications.

G. Seismic Anchoring: The Load Test Bank, as a complete assembly, shall conform to 2012 International Building Code, Section 1613 Earthquake Loads ASCE Standard ASCE/SEI 7-Chapter 13 Seismic Design Requirements for Nonstructural Components. See Section 26 0700 - Supporting Devices.

1.07 EXTRA MATERIALS

A. As a separate quote, the bidders shall submit a recommended spare parts list with prices for one (1) year of operation, assuming a total run time of one hundred (100) hours. The price list shall be valid for ninety (90) days from the date of the equipment delivery.

1.08 WARRANTY

A. The manufacturer shall provide load test bank warranty for a minimum of two (2) years from the date of commissioning against defects in material, equipment and workmanship.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Avtron

B. Load Technology, Inc. (LOADTEC)

C. Post Glover Resistors Inc.

2.02 LOAD TEST BANK

A. The load test bank shall be rated 250 kW, Unity power factor, 480 Volts, three-phase, three-wire.

B. The load test bank shall be furnished as a complete system with necessary controls and devices for manual control with automatic load dump on loss of utility power.

C. Load Step Resolution: The load shall be able to be stepped in a minimum of five (5) steps. Tolerance: ±5 percent overall tolerance, ±2 percent phase-to-phase balance.

D. Load resistors shall be fabricated of a corrosion-resistant chromium alloy with a minimum operating temperature of 1900 deg F (1038 deg C). Resistors shall be continuously supported to eliminate possible shorting contact with surrounding resistors.

E. Cooling: Forced-air cooled. Cooling fan motor to derive power from the test source. Provide temperature and air flow sensors to initiate load removal if airflow is insufficient for proper cooling.

F. Control Power: 120 VAC, single-phase control power shall be derived from the test source via a control power transformer.

G. Overload and overcurrent protection shall be provided for each individual load section and control circuit.

2.03 REMOTE CONTROL PANEL

A. A remote control panel with a NEMA 4 enclosure shall be provided for installation near the load bank. Devices, mounted on the control panel shall be approved for outdoor installation.

B. The remote control panel shall be furnished with:

1. Control Mode Selector Switch (Manual-Off-Automatic).
2. Fan Control/Failure Reset Switch (Off-Fan, On-Reset).
3. Master Load Switch (Off-On).
4. Load Step Switches (Off-On).
5. Fan Running Indication Light (Green).
6. Cooling Failure Light (Red).
7. Load Step Indication Lights (Blue).
8. Apply load when generator is under monthly exercising test.
9. Interlock wiring from the transfer switches that immediately disable the load bank if the transfer switches call for engine start upon loss of normal power.

2.04 WIRING

A. Internal wiring for the load test bank and control panel shall be stranded copper conductor, No. 14 AWG minimum, with 600 Volt insulation suitable for the application. Wiring to external points shall be brought to a common terminal block.

2.05 ENCLOSURE

A. Outdoor Weatherproof Enclosure: The enclosure shall be rated NEMA 3R and be of galvanized steel construction with bolt-down provisions for permanent mounting. Exhaust and intake louvers shall be screened for debris protection and shall be fabricated from stainless steel.

B. Space Heaters: Thermostatically controlled space heaters shall be provided to prevent the accumulation of condensation within the enclosure and on components. The space heaters shall operate at 120V.

C. Painting: The housing shall be thoroughly cleaned and prepared for painting. A rust inhibiting primer shall be applied inside and out and cover metal surfaces, edges, and inside corners of fabricated pieces. The housing shall then be finished with two (2) coats of high quality alkyd-resin automotive type paint system. Color of exposed portions of the housing shall be ANSI-61 light gray. Painting will not be required for parts of equipment that are manufactured of corrosion-resistant materials.

2.06 MAINTENANCE REQUIREMENTS

A. All replaceable parts shall be manufactured to definite standards for tolerance, clearance, and finish in order that such parts may be field installed without further machining or fitting. Parts shall be permanently and legibly marked with the original manufacturer's part number where practical. Parts or assemblies that require "fitting" for proper assembly shall be identified and separately listed in the parts manual.

PART 3 – EXECUTION

3.01 FIELD QUALITY CONTROL

A. The construction manager will inform the vendor when the load test bank installation is completed. Installation acceptance testing shall be performed in conjunction with testing of the engine-generator. An authorized representative of the manufacturer shall inspect the installation and shall perform the installation acceptance testing.

3.02 OPERATION AND MAINTENANCE TRAINING

A. The owner’s operating personnel shall be instructed by the vendor or manufacturer's representative in the proper operation and maintenance of the unit on the test day.

3.03 FINAL SUBMITTALS

A. Five (5) sets of bound copies of text and illustrations, delineating maintenance and repair procedures. Assemble data on like equipment in clearly identified and indexed three-ring binders or equal. Include the following:

1. Parts list of replaceable parts and special tools required.
2. Lists of component items not the product of the manufacturer of equipment on which used, with local source of supply, catalog cuts, and necessary information for ordering replacements.

3. Complete as-built electrical schematic and connection diagrams with internal and external connection points identified to match identification on equipment.
4. Test Reports: Submit certified test and inspection reports for work performed in Article 3.1.

B. Furnish a written Guarantee that the equipment will meet the specified performance. In addition, the guarantee shall cover the equipment against defects in design, workmanship and material for two (2) years from date of start-up.

END OF SECTION

SECTION 26 41 00

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide all motor and circuit disconnect switches as required by NEC and as indicated.

B. Provide UL listed company switches where indicated.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Submit data including switch or circuit breaker size, voltage, and NEMA rating.

C. Submit dimensional data of all motor and circuit switches, enclosed circuit breakers and company switches.

D. Submit test results in accordance with Section 26 08 00.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

1. Disconnect Switches:
   a. Siemens
   b. General Electric
   c. Square D
   d. Cutler-Hammer
2. Circuit Breakers:
   a. Siemens
   b. General Electric
   c. Square D
   d. Cutler-Hammer
3. Company Switches (see Article 2.05)

B. Substitutions: Items of equal quality, function, and performance may be proposed for substitution by following the procedures outlined in Section 26 01 00.

2.02 ENCLOSURES

A. Enclosures shall be fabricated from 16-gauge minimum galvanized or equivalent rust-resistant steel with rust-inhibiting primer and baked-enamel finish.

2.03 DISCONNECT SWITCHES

A. Shall be quick-make, quick-break single-throw externally operated manual type disconnect switches in NEMA 1 enclosure for interior dry use and NEMA 3R for exterior. If indicated on the Drawings, the unit shall be fused according to the protected equipment manufacturers' recommendations.

B. Switches shall be capable of being locked in the open position.

C. Switches shall be heavy-duty type.

D. Where required for elevator control, provide an auxiliary dry contact with a minimum rating of 1 ampere at 48 VDC. Contact shall be dry and isolated with a contract configuration of SPST. Contact set shall be sealed.

E. Where disconnect switches are located on the load side of Variable Frequency Drives (VFDs), switches shall have auxiliary contacts for controls to shut down VFD completely when power is interrupted to the motor. Contact shall be dry and isolated with a contact configuration of SPST. Contact set shall be sealed.

F. Provide one (1) set of spare fuses for each fused disconnect, at the unit.

2.04 ENCLOSED CIRCUIT BREAKERS

A. Enclosed circuit breakers shall be molded case, bolt-on heavy-duty type having quick-make, quick-break manually operated toggle mechanism. Handle shall be trip-free with three positions that clearly indicate when the breakers are "on," "off," or "tripped." Multiple-pole circuit breakers shall operate on a common trip principle. All circuit breakers shall provide overcurrent and short-circuit protection.

B. The minimum AIC rating shall be 22,000 amperes, unless otherwise indicated on the Drawings. It shall be the responsibility of the equipment supplier to coordinate all secondary breaker interrupting capacities and to indicate them on applicable submittals.

C. Circuit breakers shall be housed in a NEMA 1 enclosure for dry locations and NEMA 3R for damp or exterior locations.

D. Where sprinklers are provided in the elevator shaft, provide shunt trip unit on circuit breaker for elevator power.

2.05 COMPANY SWITCHES (ROADSHOW PANEL)

A. Shall be wall-mounted, rated 120V/208V, 3-pole, 65 KAIC at 240V, double (200%) neutral. Provide sizes as required.

B. Finish shall be powder-coated blue.

C. The front panel of the enclosure shall contain a recessed panel that exposes the circuit breaker handle. The top of the handle shall be below the plane of the front panel.

D. The rear panel of the enclosure shall contain four (4) mounting holes for contractor installation of the mounting fasteners.

E. Red indicator lights shall be provided to indicate phase voltage available on branch breaker.

F. Outlets shall be mounted on the bottom of the enclosure, and shall be UL listed devices.

G. Provide SafeCam type outlets with slots between outlets to eliminate historesis, as required by the NEC.

H. Company switches shall have warning label permanently attached to enclosure, as required by NEC Art. 520-53k3. This label shall specify the proper sequence for connection and removal of cable.

I. All bus shall be copper.

J. Complete assembly shall be UL listed, and labeled.

K. Company switches shall be rated suitable for use as Service Entrance Equipment.

1. Company switches (Roadshow Panel):

    a. Union Connector CSC Type
    b. Stagecraft
    c. Power Gate

PART 3 – EXECUTION

3.01 INSTALLATION

A. Surface-mount switches and circuit breakers so as not to interfere with other equipment.

B. Mount according to manufacturer's recommendations, NEC, and Section 26 07 00.

C. Verify exact wall dimensions in field to ensure that standard enclosures specified can be arranged in the space allocated.

D. Provide fuses for all disconnect switches.

END OF SECTION

SECTION 26 42 00

ENCLOSED CONTROLLERS AND ACCESSORIES

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide motor controls for all electric motor driven equipment unless furnished under other sections of these specifications.

B. Install motor controls furnished by Division 23.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Submit data including starter voltage, current and horsepower ratings.

C. For starters with automatic control, provide complete wiring diagrams.

D. Submit test results in accordance with Section 26 08 00.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. Provide motor protection switches of the appropriate NEMA size. For units not using NEMA rating, use equivalent NEMA size.

2. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
3. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

1. Motor Starters:

   a. Siemens
   b. General Electric
   c. Square D
   d. Allen Bradley
   e. Cutler-Hammer

B. Substitutions: Items of equal quality, function, and performance may be proposed for substitution by following the procedures outlined in Section 26 01 00.

2.02 MANUAL MOTOR STARTERS

A. Manual starters shall be full-voltage, non-reversing, single-speed, with resettable melting alloy type thermal overload relays, for 120 volt single-phase, 60 Hz induction motors, contained in enclosures designed for the location. NEMA size shall be as required for motor to be serviced.

B. Manual starters with Hand-Off-Auto switch shall have combination flushplate and neon indicating light. General Electric CR101-H12, Square D FG71P, or equivalent.

2.03 MAGNETIC MOTOR STARTERS

A. Magnetic motor starters, selected for full-voltage, single-speed starting of three-phase, 60 Hz, induction motors with bimetallic manually reset overload protection, run lights, and 120 volt secondary control power transformers if 120V is not available, cover mounted "Hand-Off-Auto" selector switches, and "ON-OFF" pushbuttons shall be furnished as indicated. NEMA size shall be as required for motor to be served with NEMA 1 being minimum. Starter shall have auxiliary NC and NO contacts and NO overload relay contact as a minimum.

B. Combination starters shall be as described above with integral lockable, fusible, disconnect switch operable from the exterior.

2.04 CONTACTOR

A. Contactors shall be mechanically held, electrically operated type with 120 VAC coil, 20A minimum contact rating at 0.75 of 120 VAC and enclosure suitable for the intended environment.

2.05 ENCLOSURES

A. Enclosures shall be as follows:

1. NEMA 1: Interior dry locations.
2. NEMA 4: Wet areas, on outdoor structures and in equipment vaults where moisture is present.
3. NEMA 12: Interior locations subject to oil seepage or dust. May be used in lieu of NEMA 1.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Surface mount motor starters and install suitable cover plates.

B. Install thermal overloads correlated with full-load current of motors provided.

C. Set overload devices to suit motors provided. If motors have integral power factor protection capacitor this should be taken into account.

D. Motor starters shall be mounted as indicated on the Drawings and in accordance with Section 26 07 00.

E. Provide all necessary conduit, wiring, switches, etc., for the proper operation of the equipment.

END OF SECTION

SECTION 26 44 00

SWITCHBOARDS AND PANELBOARDS

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide indicated switchboards and panelboards.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Submit as a minimum data including current, voltage and interrupting ratings and layout drawing including dimensions.

C. Submit time-current curves for all overcurrent protective devices with applicable settings indicated.

D. Submit complete surge protection specifications.

E. Submit test results in accordance with Section 26 08 00.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents.

The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

1. Switchboards and circuit breaker panelboards:

   a. Square D
   b. General Electric
   c. Siemens
   d. Eaton

2. Fused Panelboards:

   a. Bussman
   b. Eaton

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 26 01 00.

2.02 SWITCHBOARD

A. Switchboard shall be manufactured (sized) to accommodate space allowed on the Drawings in the Electrical Room(s), and contain all required options. Any equipment that does not fit the space will not be allowed.

B. Provide dead front, NEMA 1, front accessible, rear aligned, self-supporting, group mounted distribution switchboard constructed of heavy-gauge steel. Unit shall be braced for symmetrical amperes as indicated on the drawings. Adequate lifting means shall be provided.

C. Switchboard busbars shall be high conductivity copper with bolted connections between sections and shall have the capability for future extension to an additional section. Provide full capacity neutral. A ground bus shall be provided in each switchboard section.

D. Circuit breakers shall be manufactured such that amperages shall be clearly visible on all breakers (stamped or labeled) without having to remove any components of the switchboard to obtain this information.

E. Main Section:

1. The main switchboard section shall have provisions for feeder conductor terminations and contain current and voltage meters and the service entrance circuit breaker.
2. The main section shall be bottom or top fed as needed, capable of terminating the indicated feeder cables. Cable connectors shall be mechanical compression style and suitable for the intended purpose.
3. Voltage and current meters shall have phase selector switches.
4. Main overcurrent device shall be a draw out molded case power circuit breaker rated as indicated on the Drawings, suitable for service entrance applications with electronic tripping means and AIC rating as indicated on the drawings. Breaker shall have adjustable long and short time trip settings.

5. The main service circuit breaker shall be equipped with a protective trip unit system to protect against overloads, short circuits, and ground faults. The protective trip unit shall consist of a solid-state, microprocessor-based programmer, tripping means, current sensors, power supply, and other devices required for proper operation. Trip unit shall be equipped with adjustable long-time, short-time, instantaneous and ground fault.
6. All circuit breakers rated 1200 amps or larger shall include an Arc Flash Reduction Maintenance System as required by NEC 240.87. The Arc Flash Reduction Maintenance System Technology shall be provided in a system that shall reduce the trip unit Instantaneous pickup value when activated. The Arc Flash Reduction Maintenance System shall not compromise breaker phase protection even when enabled. Once the unit is disabled, the recalibration of trip unit phase protection shall not be required. Activation and deactivation of the Arc Flash Reduction Maintenance trip setting shall be accomplished without opening the circuit breaker door and exposing operators to energized parts. The device shall provide a clearing time of 0.04 seconds, adjustable with a minimum of five settings ranging from 2.5X to 10X of the sensor value. The Arc Flash Reduction Maintenance System shall be provided with a switchgear panel mounted enable padlockable selector switch and indication via pilot light. The selector switch and pilot light shall be clearly identified to describe its use and function using laminated phenolic nameplates.
7. Service entrance switchboards shall be provided with voltage surge protection rated and suitable for the service.

F. Surge Suppression:

1. Suppressors shall be listed in accordance with UL 1449 and UL 1283.
2. Suppressors shall provide redundant suppression modules between each phase conductor and the neutral conductor, between each phase conductor and the ground and between the neutral conductor and ground.
3. Suppressor manufacturer shall provide certified test data confirming a "fail-short" failure mode.
4. Visible indication of proper suppressor connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable.
5. The suppressor shall incorporate copper bus bars for the surge current path. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
6. Suppressors shall meet or exceed the following criteria:

   a. Maximum single impulse current rating shall be no less than 240kA per phase.
   b. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C transients without failure or degradation of UL 1449 clamp voltage by more than 10%.
   c. UL 1449 clamping voltage must not exceed the following:

Voltage	L-N	L-G	N-G	L-L
480/277	700V	700V	700V	1200V
208/120	330V	330V	330V	700V

   d. The ANSI/IEEE C62.41-1991 Category C3 clamping voltage shall not exceed the following:

Voltage	L-N	L-G	N-G
480/277	1250V	1250V	1250V
208/120	520V	520V	520V

7. The TVSS shall be constructed using surge current modules (MOV based). Each module shall be fused with user-replaceable 200,000 AIC rated fuses. The status of each module shall be monitored on the front of the TVSS enclosure as well as on the module.
8. The TVSS shall be installed internal to electrical distribution equipment by the electrical distribution equipment manufacturer.
9. The TVSS shall be equipped with an audible alarm which shall actuate when any one of the surge current modules has failed. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. Both switches and audible alarm shall be located on the front panel of the switchboard.
10. The suppressor shall have a response time no greater than 0.5 nanoseconds for any of the individual protection modes.
11. The suppressor will have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.
12. The suppressor shall include an internal UL listed disconnect switch.

G. Distribution Section:

1. The switchboard distribution section shall contain distribution circuit breakers as indicated on the Drawings.
2. The vertical main bus shall be full length furnished with provisions for future branch devices so that the entire available vertical space may be utilized.
3. The distribution section shall have provisions for a future additional distribution section. This includes appropriate space and bolt holes on the horizontal main bus and side panels.
4. Provide a minimum of two (2) 400A and (2) 250A full-size three-pole spaces for future equipment and additional spaces as indicated on the Drawings.

   a. All feeders breakers shall be Electronic Trip Circuit Breakers:
   b. Basis of Design: "PowerPact H-, J-, L-, P- and R-Frame" (200 amperes to 3000 amperes) as manufactured by Square D by Schneider Electric.
   c. Current trip ratings shall be as indicated on the Drawings.
   d. Circuit breaker trip system shall be a MICROLOGIC electronic trip unit with true RMS sensing.
   e. Current transformers shall be used to ensure accurate measurements from low current up to high currents.
   f. Electronic trip unit shall be fitted with thermal imaging.
   g. The following monitoring functions shall be integral parts of electronic trip units:

      1) A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.
      2) LED for load indication at 105 percent.
      3) LED for load indication at 90 percent of load for applications 600A and smaller.
      4) LED for visual verification of protection circuit functionality for applications 600A or smaller.
      5) Optional: LED for trip indication for applications above 600A.

   h. MICROLOGIC trip unit functions shall consist of adjustable protection settings with the capability to be set and read locally by rotating a switch.

      1) Long-time pick-up shall allow for adjustment to nine (9) long-time pick-up settings. This adjustment must be at least from 0.4 to 1 times the sensor plug (In), with finer adjustments available for more precise settings to match the application.
      2) Adjustable long-time delay shall be in nine (9) bands. At six times Ir, from 0.5 to 24 seconds above 600A, and 0.5 to 16 seconds for 600A and below.
      3) Short-time pick-up shall allow for nine (9) settings from 1.5 to 10 times Ir.
      4) Short-time delay shall be in nine (9) bands from 0.1–0.4 I 2 t ON and 0–0.4 I 2 t OFF.

5) Instantaneous settings on the trip units with LSI protection shall be available in nine (9) bands.

a) Above 600A, from 2 to 15 times In
b) 600A, from 1.5 to 11 times In
c) 400A from 1.5 to 12 times In
d) 250A and below, from 1.5 to 15 times In

i. It shall be possible to fit the trip unit with a seal to prevent unauthorized access to the settings in accordance with NEC Section 240-6(b).
j. Trip unit shall provide local trip indication and capability to locally and remotely indicate reason for trip, i.e., overload, short circuit, or ground fault.

H. Ground Fault Protection:

1. Switchboard main shall have integral zero sequence ground fault protection with adjustable pickup current and time delay. The ground fault relay shall initiate an instantaneous trip when a fault occurs downstream of it and will block all upstream devices from tripping for a preset adjustable delay time. This will allow the downstream breaker to clear the fault and provide system coordination.

I. Phase Failure Relay:

1. Provide protection against phase failure of three-phase supply by opening main electronic trip circuit breaker. Provide three-phase sensing relay, control power transformer and control fuses.

J. Metering:

1. Provide Microprocessor-based, door-mounted monitoring and protective device designed to perform compete electrical metering and system voltage protection.
2. Direct reading metered values shall include:

a. AC ampere - Phase 1, Phase B, Phase C
b. AC Voltage - Phase A-N, Phase B-N, Phase C-N - Phase A-B, Phase B-C, Phase C-A, and N-G
c. Watts
d. Vars
e. VA
f. Power Factor
g. Frequency
h. Watt demand
i. Watthours
j. Frequency
k. % THD
l. Distortion factory
m. K-factor
n. User configurable custom screens
o. Voltage phase imbalance
p. Current phase imbalance

3. Unit shall be capable of being connected to the building automation system (BAS). Coordinate requirements with the BAS contractor.
4. Unit shall operate with self-contained potential transformers and five (5) current transformers (provide neutral and ground current transformers).

5. Unit shall have harmonic analysis screens, cable to capture a high-speed waveform of two (2) cycles.
6. Web based

K. All steel surfaces are to be chemically cleaned and treated, providing a bond between paint and metal surfaces to help prevent the entrance of moisture and the formation of rust under the paint. Finish coat shall be manufacturer's standard color.

L. If more distribution sections are needed than what is indicated on the Drawings to provide space needed for the required overcurrent protection devices, such sections shall be provided at no additional cost to the Owner and the Engineer shall be contacted for approval.

2.03 PANELBOARDS

A. Panelboards shall be of a dead front safety type, equipped with thermal magnetic bolt-on molded case circuit breakers or Type CCPB-compact circuit protector as indicated on the Drawings. All panels shall be of the same manufacture.

B. Gutter space shall be a minimum of 4" on all sides.

C. Panelboards shall have full capacity neutral bus and ground bus.

D. All buses including neutral and ground buses shall be of high conductivity copper.

E. Service entrance panelboards shall be provided with voltage surge protection rated and suitable for the service.

F. Provide isolated/insulated ground bus where indicated on the Drawings.

G. Provide surge suppression where indicated on the Drawings.

H. Provide double neutral bus where indicated on the Drawings.

I. Panelboard Enclosures:

1. Enclosures shall be fabricated from 16-gauge minimum galvanized or equivalent rust-resistant steel with rust-inhibiting primer and baked-enamel finish.
2. Panels shall be furnished with standard doors and locks. Key all locks alike and furnish two sets of keys.
3. Enclosure for panels rated 100 amperes and over shall have a hinged front cover so as to be a "door-on-door" arrangement.

J. Circuit Breakers:

1. Circuit breakers shall be molded case, bolt on heavy-duty type having quick make, quick break manually operated toggle mechanism. Handle shall be trip free with three positions that clearly indicate when the breakers are "on," "off," or "tripped." Multiple pole circuit breakers shall operate on a common trip principle. All circuit breakers shall provide overcurrent and short circuit protection.
2. Circuit breakers shall be manufactured such that amperages shall be clearly visible on all breakers (stamped or labeled) without having to remove any components of the panelboard to obtain this information.
3. The minimum AIC rating shall be as indicated on the drawings. It shall be the responsibility of the equipment supplier to coordinate all secondary breaker interrupting capacities and to indicate them on applicable submittals.

4. Where new circuit breakers are to be added to existing panelboards, they shall be compatible with the panelboard. Where new circuit breakers are not part of an existing or new panelboard, they shall be housed in a NEMA 1 enclosure for dry locations and NEMA 3R for damp or exterior locations.
5. Where sprinklers are provided in the elevator shaft, provide shunt trip unit on circuit breaker for elevator power.
6. Special requirements shall be as indicated, including ground fault current interrupting (GFCI), shunt trip, arc fault, etc., on circuit breakers for indicated branch circuits on local distribution panels.
7. Circuit breakers shown as service entrance protection on the Drawings shall be rated for such use.
8. Arc fault circuit breakers shall be provided on all 120V, single-phase, 15 and 20 amp branch circuits supplying outlets installed in dwelling units.
9. Circuit breaker(s) for the fire alarm system shall be mechanically protected, have a red marking (be accessible to only authorized personnel), and be identified as "FIRE ALARM CIRCUIT", as required by NFPA 72.

K. Branch Fused Disconnects:

1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
2. Device shall provide open fuse indication via permanently installed neon indicating light.
3. Device shall be UL and cUL Listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
5. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. Devices shall have bolt-on style bus connectors.
8. Device housing shall be clearly marked with device amperage.
9. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
10. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A, and 100A.

L. Main and Branch Fused Overcurrent Protection:

1. All overcurrent protective devices shall have a minimum UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
2. Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J performance characteristics.
3. Main overcurrent protective devices shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR Class J time-delay fuses or Class J performance fuses.
4. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.

M. Surge Suppression:

1. Suppressors shall be listed in accordance with UL 1449 and UL 1283.
2. Suppressors shall provide redundant suppression modules between each phase conductor and the neutral conductor, between each phase conductor and the ground and between the neutral conductor and ground.

3. Suppressor manufacturer shall provide certified test data confirming a "fail-short" failure mode.
4. Visible indication of proper suppressor connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable.
5. The suppressor shall incorporate copper bus bars for the surge current path. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
6. Suppressors shall meet or exceed the following criteria:

   a. Maximum single impulse current rating shall be no less than 240kA per phase.
   b. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C transients without failure or degradation of UL 1449 clamp voltage by more than 10%.
   c. UL 1449 clamping voltage must not exceed the following:

Voltage	L-N	L-G	N-G	L-L
480/277	700V	700V	700V	1200V
208/120	330V	330V	330V	700V

   d. The ANSI/IEEE C62.41-1991 Category C3 clamping voltage shall not exceed the following:

Voltage	L-N	L-G	N-G
480/277	880V	880V	880V
208/120	520V	520V	520V

7. The SPD shall be constructed using surge current modules (MOV based). Each module shall be fused with user-replaceable 200,000 AIC rated fuses. The status of each module shall be monitored on the front of the TVSS enclosure as well as on the module.
8. The SPD shall be installed internal to electrical distribution equipment by the electrical distribution equipment manufacturer.
9. The SPD shall be equipped with an audible alarm which shall actuate when any one of the surge current modules has failed. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. Both switches and audible alarm shall be located on the front panel of the switchboard.
10. The suppressor shall have a response time no greater than 0.5 nanoseconds for any of the individual protection modes.
11. The suppressor will have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.
12. The suppressor shall include an internal UL listed disconnect switch.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Switchboard and panelboard installation shall conform to NEC requirements, in particular Article 110-16.

B. Install switchboards and panelboards according to manufacturer's recommendations.

C. Test switchboards and panelboards in accordance with Section 26 08 00.

D. Provide filler pieces for unused spaces in switchboards and panelboards.

E. Prepare and affix typewritten directory to inside cover of switchboard and panelboard doors indicating loads controlled by each circuit. Protect directory with plastic. Use of Engineer's panelboard schedule for panelboard directory is not allowed.

F. All panels shall be mounted in accordance with Section 26 07 00.

G. Unless otherwise indicated on the Drawings, install all switchboards and panelboards with the top breaker handle 6'6" maximum above the finished floor, or concrete pad.

H. Verify exact wall dimensions in field to ensure that standard panelboard cabinets specified can be arranged in the space allocated.

I. All scratched or marred surfaces shall be repaired to match original condition.

J. All switchboards and panelboards shall have permanently affixed circuit numbers at each circuit space.

K. All switchboards and panelboards shall be identified with permanent nameplate on the front identifying **"PANEL XXXXX, FED FROM PANEL XXXXX"** on two lines.

L. Provide five (5) spare 1" conduits from each new flush-mounted panelboard to accessible area above ceiling.

END OF SECTION

SECTION 26 50 30
LIGHTING CONTROL SYSTEMS
(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Central networked control systems including DMX dimming control.
2. Standalone lighting control systems.
3. UL 924 listed emergency lighting control.

B. The basis of design for the networked lighting control system is the Crestron Green Light Lighting Control System. By providing the listed pre-approved substitution Lutron the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power and control wiring).

C. All occupancy sensors (system connected and stand-alone) shall be by the same manufacturer.

D. See specification section 26 14 00 for occupancy sensor switch and timer switch specifications.

E. Provide UL 924 listed emergency lighting control that monitors the local normal branch circuit in each space. Emergency lighting control that monitors normal power at the panel level or that does not monitor the local branch circuit in the space served by the emergency will not be accepted.

F. Coordinate with mechanical contractor and building automation system (BAS) contractors for BACnet connection to BAS system.

G. Coordinate with the A/V Contractor to integrate the lighting controls with the A/V controls in all spaces indicated on the Drawings.

H. The electrical contractor, in cooperation with lighting control manufacturer and light fixture manufacturers, is responsible for ensuring compatibility between all LED Drivers and the lighting control system components. All proposed LED fixtures shall be tested by the lighting control manufacturer at the factory to verify compatibility prior to installation in the field. If any LED fixture is determined to be not compatible with the proposed lighting control system, it is the electrical contractor's responsibility to work with the light fixture manufacturer to provide a driver that is compatible with the lighting control system. All 0-10VDC LED dimming drivers shall meet the requirements of IEC 60929 for current sinking control and shall have an isolate 0-10VDC control circuit.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE):

1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

B. ASTM International (ASTM):

1. D4674-02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.

C. International Electrotechnical Commission (IEC):

1. IEC 801-2 Electrostatic Discharge Testing Standard:

a. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.

D. International Organization for Standardization (ISO):

1. 9001:2000 – Quality Management Systems.

E. National Electrical Manufacturers Association (NEMA):

1. WD1 (R2005) - General Color Requirements for Wiring Devices.

F. Underwriters Laboratories, Inc. (UL)

1. 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
2. 508 (1999) - Standard for Industrial Control Equipment.
3. 1472 (1996) - Solid-State Dimming Controls.
4. 924 (2003) - Emergency Lighting and Power Equipment

G. Federal Communications Commission (FCC) rules – Part 15 (Class B): Radio Frequency Devices

1.04 SYSTEM DESCRIPTION

A. Modular dimming control: Factory assembled dimming control, interfaces, and modules. Low voltage wall stations, control interfaces, and sensors.

B. Microprocessor-based, modular solid-state dimming and switching devices utilizing preset control software, in an integrated control system including the following:

1. Lighting Controller System: Concealed mounting, self-contained, multichannel controller with user-adjustable dimmer and equipment controls with network and expansion capabilities:

   a. Integrated lighting, dimming, and switching controls.

2. Lighting controller system integrates the following separate controls:

   a. Communication with building wide Audio Visual Systems.
   b. Keypad controls.
   c. Touch panel controls.
   d. Window treatment controls.
   e. Remote occupancy sensors.
   f. Room-combining partition sensor.
   g. Lighting load shedding.
   h. Timed room lighting.
   i. Daylight compensating lighting controls.
   j. Audio visual equipment controls.
   k. Interface to facility-wide room management.
   l. Interface to building automation system interface.

3. Slaved Controllers: Remote slaved controllers allowing master lighting controller system to control lighting circuits, and circuit loads, while emulating the function of the connected lighting controller system control channel.

1.05 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 26 01 00.

B. Specification Conformance Document: Indicate whether the submitted equipment:

1. Meets specification exactly as stated.
2. Meets specification via an alternate means and indicate the specific methodology used.

C. Submittals shall include:

1. Bill of Materials: Complete list of all parts needed to fully install selected system components.
2. Product Data: Submit product data, including catalog cut sheets, for all system components. Catalog cut sheets shall include performance specifications demonstrating compliance with specified requirements (interior and exterior) and physical dimensions of each item specific to this project.
3. Shop and Wiring Drawings: Submit shop drawings detailing all mechanical and electrical equipment including one-line diagrams, wire counts, coverage patterns, complete panel layouts.

4. Load schedules indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
5. Schematic of system including wiring diagrams for each unique area of control.
6. Installation Instructions: Manufacturer's installation instructions.
7. Sequence of Operation to describe how each area operates and how any building wide functionality is described.

D. The review of shop drawings and/or product data does not relieve the Contractor and lighting control manufacturer of the responsibility of providing a complete, coordinated, and functioning installation. Incompatibilities among equipment and components including, but not limited to, mismatched voltages, differing signal protocol, etc. shall be resolved at the sole responsibility and expense of the Contractor.

1.06 CLOSEOUT SUBMITTALS

A. Provide Operation and Maintenance Manuals in accordance with 260100:

1. In addition to the requirement in 260100 include the following:

a. Warranty Information.
b. System Start-up Information.
c. Installation Guide.
d. Set-up and Programming Guide.

B. Design Closeout Documentation:

1. Lighting Control System Manufacturer to provide Enhanced Start-up documentation that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents any test results.

1.07 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years' experience in manufacture of lighting management systems.

B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.

C. Lighting control system components:

1. Listed by UL specifically for the required loads.

1.08 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0 degrees to 40 degrees C (32 degrees to 104 degrees F).

a. Relative humidity: Maximum 90 percent, non-condensing.
b. Lighting control system must be protected from dust during installation.

1.09 WARRANTY

A. Lighting Control System: Provide manufacturer's 2-year parts warranty on all components.

B. Provide enhanced 8-year limited parts warranty; include:

1. Years 1-2:

   a. 100 Percent Replacement Parts for Manufacturer Lighting System Components
   b. 100 Percent Manufacturer Labor Coverage to Troubleshoot and Diagnose a Lighting Issue
   c. First-Available Onsite or Remote Response Time
   d. Remote Diagnostics for Applicable Systems

2. Four (4) Hours of Remote Programming for Applicable Systems.
3. Years 3-5: 50% Replacement Parts Coverage.
4. Years 6-8: 25% Replacement Parts Coverage.
5. 24 Hours per Day, 7 Days per Week Telephone Technical Support, Excluding Manufacturer Holidays.

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Make ordering of new equipment for expansions, replacements, and spare parts available to end-user.

B. Make new replacement parts available for minimum of 10 years from date of manufacture.

1.11 PROGRAMMING

A. Upon completion of installation the manufacturer shall schedule a meeting with the Architect, Lighting Consultant, Engineer, and Owner to determine system programming. The meeting shall be held on-site to determine operating schedules, preset programming and daylighting zone programming. The manufacturer shall supply all equipment and documentation required to determine system programming including a light meter for daylighting programming. The manufacturer shall carry a minimum of five (5) man-days (40 hours) for system programming.

B. Manufacturer shall provide all system programming including:

1. Wiring documentation.
2. Programmable Panel and System Dimming/Switch Operation.
3. Operating Schedules.
4. Daylighting Zone programming.
5. Preset programming.

1.12 SPARE PARTS

A. Provide spare parts to the Owner.

1. Five (5) of each occupancy sensor type.
2. Five (5) power packs and input/output modules.
3. One (1) of each lighting controller (room controller) type.
4. Two (2) of each lighting control station type, excluding touch screens.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Lighting Control System:

1. Crestron (Basis of Design)
2. Lutron QS with Energi Savr Nodes
3. Encellium

B. Emergency Lighting Control Device

1. LVS Controls, Inc.
2. Nine 24, Inc.

C. Photocell

1. Wattstopper
2. Hubbell Building Automation
3. Leviton

D. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 26 01 00.

E. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.02 LIGHTING CONTROL SYSTEM

A. General:

1. Provide system hardware that is designed, tested, manufactured, and warranted by a single manufacturer.
2. Architectural Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.

B. Dimming Performance Requirements:

1. Electrolytic capacitors to operate at least 20 degrees C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40 degrees C (104 degrees F) ambient temperature.
2. Load Handling Thyristors (SCRs and triacs), Field Effect Transistors (FETs), and Isolated Gate Bipolar Transistors (IGBTs): Manufacturer’s maximum current rating minimum two times control’s rated operating current.
3. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer.
4. Design and test dimmers to withstand line-side surges without impairment to performance.

    a. Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41.
    b. Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.

5. Utilize air gap off – activated when user selects “off” at any control to disconnect the load from line supply.
6. Power failure memory and dimmer/relay recovery:

    a. When power is interrupted and subsequently returned, within 3 seconds lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption.

7. Multiple load type, tested to UL 508 to specifically control incandescent/tungsten, magnetic low voltage, electronic low voltage, neon/cold cathode, digital fluorescent dimming ballasts, fluorescent dimming ballasts, and non-dim loads.
8. Each dimmer to be assigned a load type that will provide a proper dimming curve for the specific light source.
9. Possess ability to have load types assigned per circuit, configured in field.
10. Minimum and maximum light levels user adjustable on circuit-by-circuit basis.
11. Control all light sources in smooth and continuous manor. Dimmers with visible steps are not acceptable.
12. Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage/cycle), frequency shifts (plus or minus 2 Hz change in frequency/second), dynamic harmonics, and line noise. Systems not providing cycle-by-cycle compensation to include external power conditioning equipment to meet these requirements.
13. Systems not providing cycle-by-cycle compensation to include external power conditioning equipment as part of dimming system.
14. Each dimmer to incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
15. Line Voltage Dimmers; Meet following load-specific requirements:

    a. Magnetic Low Voltage (MLV) transformer:

        1) Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
        2) Dimmers using back-to-back SCR construction that could fail open causing DC power to flow into magnetic low voltage load are not acceptable.

    b. Electronic Low Voltage (ELV) transformer:

        1) Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.

    c. Neon and cold cathode transformers:

        1) Magnetic transformers: UL listed for use with normal (low) power factor magnetic transformers.

    d. Electronic transformers: Must be supported by the transformer equipment manufacturer for control of specific transformers being provided.
    e. Fluorescent electronic dimming ballast: Refer to Section 26 51 00 for dimming ballast specifications and performance.
    f. LED 0-10V analog dimming.
    g. Low Voltage Dimming Interface; Meet following requirements:

        1) Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.

h. Single low voltage dimming module; capable of controlling following light sources:

1) 0-10V analog voltage signal.

i. Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
j. Sink current via IEC 60929.

2.03 AUTOMATION CONTROL PROCESSOR (MAIN)

A. Manufacturers

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc.

B. Basis of Design Product:

1. Crestron CP3N

C. Minimum Characteristics:

1. Operating System:

a. Modular architecture supports multiple simultaneous running programs.

1) Number of simultaneously running user programs: 10

b. Real-time, pre-emptive multithreaded/multitasking kernel.
c. Vector floating point coprocessor.
d. Utilize a real time, event driven, multi-tasking, multi-threaded operating system.

2. Communication:

a. Control Processor shall support direct communication with the following devices:

1) Connected Ethernet devices.
2) Devices connected to built-in control ports.
3) Proprietary control network devices.
4) BACnet IP devices.
5) Control processors of same type.

3. Native BACnet/IP

a. Number of BACnet objects supported: 1000

4. File Structure:

a. Transaction-safe extended FAT32 file system

5. Memory:

a. RAM:

1) 512 MB

b. Flash:

1) Built-In: 4 GB
2) USB or MMC slot: up to 32 GB

c. External Storage

1) Supports up to 1 TB.

6. Network:

a. Two built-in 10/100/1000BaseT Ethernet ports.

1) Primary LAN port:

b. Isolated WAN connection

1) Subnet port

c. The control processor shall automatically discover and assign IP addresses to compatible devices.
d. Built-In Web Server: IIS v.6.0
e. SNMP remote management.
f. Active Directory support.
g. IPv6 ready.
h. TCP/IP Communications
i. DHCP and DNS Support
j. Native Email Client
k. Remote Diagnostics
l. Remote Program Loading and Administration
m. SSL security plug in
n. Support user assigned or dynamic IP address.

D. External Ports

The control system shall be equipped with the following external connection ports:

1. Infrared Output Port

a. Number of built-in ports: 8
b. Connector: 2 8-pin 3.5mm detachable terminal blocks.
c. Signal:

1) One-way infrared: up to 1.2 MHz
2) One-way serial output: TTL/RS-232 (0-5 Volts)

a) Baud rate: 9600 to 115,200 baud

2. Serial Communication Port - Type 1

a. Number of built-in ports: 1
b. Connector: 5-pin 3.5mm detachable terminal blocks.
c. Signal:

1) Bidirectional RS-232

a) Baud rate: 1200 to 115,000 baud
b) Software handshaking: off or XON

2) Bidirectional RS-422 or RS-485

a) Baud rate: 1200 to 115,000 baud
b) Hardware handshaking: CTS, RTS, or RTS/CTS
c) Software handshaking: off or XON

3. Serial Communication Port - Type 2

    a. Number of built-in ports: 2
    b. Connector: 3-pin 3.5mm detachable terminal blocks.
    c. Signal:

        1) Bidirectional RS-232

            a) Baud rate: up to 115,000 baud
            b) Software handshaking.

4. Input Output Port

    a. Number of built-in ports: 8
    b. One 9-pin 3.5mm detachable terminal block.
    c. Individual programmable 2Kohm pull-up resistor.
    d. Individually configurable to one of three modes.
    e. Digital Input Mode

        1) Digital contact closure inputs
        2) Rating:

            a) 0-24 VDC
            b) Impedance: 20Kohm
            c) Logic threshold High: >3.125V
            d) Logic threshold Low: < 1.875V

        3) Rated for 0-24 Volts DC, referenced to GND.

    f. Digital Output Mode

        1) Rating:

            a) 250 mA sync from maximum 24 VDC

    g. Analog Input Mode

        1) Rating:

            a) 0-10 VDC
            b) Protection: 24 VDC maximum
            c) Impedance: 21Kohm

5. Relay Port

    a. Number of built-in ports: 8
    b. Two 8-pin 3.5mm detachable terminal blocks.

        1) Normally open, isolated relays.
        2) Rating:

            a) 1 Amp, 30 Volts AC/DC.

        3) MOV arc suppression across contacts.

6. Ethernet

    a. Number of built-in ports: 2

        1) Port 1: Primary LAN
        2) Port 2: Control Subnet

b. Two 8-wire RJ45 with 2 LED indicators.

1) 10/100/1000BaseT Ethernet port.
2) Connection speed LED indicator.
3) Ethernet activity LED indicator.

7. Communication Network

a. Number of built-in ports: 1
b. Four 4-pin 3.5mm detachable terminal block.

1) Master net communications port.

8. USB Type 1

a. Programming and configuration interface.

1) Number of built-in ports: 1
2) Connector:

a) USB Type-B female USB 2.0

9. USB Type 2

a. Memory storage device port.
b. Number of built-in ports: 1
c. Connector:

1) USB Type-A female USB 2.0

E. Memory Expansion Card Slot

1. Number of built-in slots: 1
2. Slot Type:

a. MMC

3. Slot Capacity

a. 32 GB maximum

F. BACnet Protocol Implementation:

1. BACnet Standardized Device Profile:

a. Application Specific Controller (B-ASC)

2. BACnet Interoperability Building Blocks Supported:

a. Data Sharing - Read Property-A (DS-RP-A)
b. Data Sharing - Read Property-B (DS-RP-B)
c. Data Sharing - Read Property Multiple - A (DS-RPM-A)
d. Data Sharing - Read Property Multiple - B (DS-RPM-B)
e. Data Sharing - Write Property-A (DS-WP-A)
f. Data Sharing - Write Property-B (DS-WP-B)
g. Data Sharing - COV – A (DS-COV-A)
h. Data Sharing - COV – B (DS-COV-B)
i. Device Management-Dynamic Device Binding-A (DM-DDB-A)

j. Device Management-Dynamic Device Binding-B (DM-DDB-B)
k. Device Management-Dynamic Object Binding-B (DM-DOB-B)
l. Device Management-Device Communication Control-B (DM-DCC-B)

3. Standard Object Types Supported:

a. Device Object
b. Analog Input Object
c. Analog Value Object
d. Binary Input Object
e. Binary Value Object
f. Multi-State Input
g. Multi-State Value

4. Data Link Layer Options:

a. BACnet IP
b. BACnet IP, Foreign Device

5. Network Options:

a. BACnet/IP Broadcast Management Device (BBMD)

1) Supports registration by foreign devices.

6. Character Set Supported:

a. ANSI X3.4

G. Mounting

1. Standard 19 inch rack mount, 1 rack unit high.
2. Rack mounting ears shall be removable for free standing applications.

H. Front Panel Controls

1. Hardware reset button
2. Software reset button

I. Front Panel Indicators

1. Power
2. Control Network Communication
3. Control Processor Error

J. Power Requirements:

1. 15 Watts at 24 VDC

2.04 AUTOMATION CONTROL PROCESSOR (SUB)

A. Manufacturers:

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., www.crestron.com.

B. Basis of Design Product:

1. Crestron DIN-AP3 Automation Controller.

C. Minimum Characteristics:

1. Operating System:

a. Modular architecture supports multiple simultaneous running programs.

1) Number of simultaneously running user programs: 10

b. Real-time, preemptive multithreaded/multitasking kernel.
c. Vector floating point coprocessor.
d. Utilize a real time, event driven, multi-tasking, multi-threaded operating system.

2. Communication:

a. Control Processor shall support direct communication with the following devices:

1) Connected Ethernet devices.
2) Devices connected to built-in control ports.
3) Proprietary control network devices.
4) BACnet IP devices.
5) Control processors of same type.

3. File Structure:

a. Transaction-safe extended FAT32 file system

4. Memory:

a. RAM:

1) 256 MB

b. Flash:

1) Built-In: 2 GB
2) MMC slot: up to 2 GB

5. Network:

a. Built-in 10/100BaseT Ethernet port.
b. Built-In Web Server: IIS v.6.0
c. SNMP remote management.
d. Active Directory support.
e. IPv6 ready.
f. TCP/IP Communications
g. DHCP and DNS Support
h. Native Email Client
i. Remote Diagnostics
j. Remote Program Loading and Administration
k. SSL security plug in
l. Support user assigned or dynamic IP address.

D. External Ports: The control system shall be equipped with the following external connection ports:

1. Connections:

a. I/O 1 – 8: One 9-pin terminal block with 8 digital input/output or analog input ports.
b. Relays: One 8-pin terminal block with four normally open isolated relays.
c. Computer: One USB female 1.1 computer console port.
d. LAN: One 8-wire RJ-45 connector.
e. NET: Two 4-pin terminal blocks paralleled.
f. Com 1 – 2: Two 5-pin terminal blocks.
g. IR/Serial 1 – 4: One 8-pin terminal block with four IR/Serial output ports.

2. Character Set Supported:

a. ANSI X3.4

3. System Clock: Firmware-based internal clock.

E. Power Requirements:

1. Power Supply: External.

a. Power Requirement: 8 Watts (0.33 amps at 24VDC).

F. Automation control processor to be DIN rail mountable and provided in an enclosure (DIN-EN) with network distribution block(s) (DIN-BLOCK), 5-port power over Ethernet switch (CEN-SW-POE-5), power supply(s) (GLA-PWS50), and UPS (GLA-UPS).

2.05 MULTI-ZONE LIGHTING CONTROLLER

A. Lighting Controller: Integrated lighting, dimming, and equipment switching control system panel, with HVAC contacts in metal enclosure for mounting in concealed space.

1. Basis of Design Product: Crestron, Green Light GLPAC Integrated Lighting System, Models GLPAC-DIMFLV4-PM, GLPAC-DIMFLV8-PM.

B. Lighting Controller System Characteristics: Provide pre-configured lighting controller, with capabilities for manual setup, and software setup through programming port, configured as follows in layout indicated:

1. Controller networked to central lighting control processor specified in Article 2.03 - AUTOMATION CONTROL PROCESSOR (MAIN) and Article 2.04 – AUTOMATION CONTROL PROCESSOR (SUB).

C. Dimmable Load Types: 16A per channel at 100 to 277VAC, 50/60 Hz:

1. 0 - 10 V 4-wire fluorescent ballasts.
2. 0 - 10V LED drivers.

D. Switched Load Types:

1. Fluorescent ballast.
2. Incandescent.
3. Magnetic low voltage.
4. Electronic low voltage.

5. Neon/Cold cathode.
6. High-Intensity discharge.
7. Motors.

E. Power Requirements:

1. Main Power: 100 – 277 VAC, 50/60 Hz.
2. Available Network Power: 10W at 24VDC.

F. Input/Output:

1. Line Power Inputs: 4 or 8 terminal blocks, 2 connections per channel, paralleled.
2. Switch Channel Outputs: 4 or 8 terminal blocks.
3. 0 – 10V Dimmer Outputs: 1 or 2: 8-position terminal block for 4 or 8 dimmer channel outputs, Class 1 or Class 2.

G. Enclosure: Surface-mounted industrial control enclosure suitable for concealed locations, 14-1/8 by 12-5/16 by 4-3/8 inch (312 by 359 by 111 mm).

2.06 ROOM LIGHTING CONTROLLER

A. Lighting Controller: Integrated lighting, dimming, and switching control system, in metal enclosure for mounting in concealed space.

1. Basis of Design Product: Crestron, Green Light GLPP Integrated Lighting System, Model GLPP-SWCN, GLPP-1SW2CN, GLPP-1SW3CN, GLPP-DIMFLVCN-PM, GLPP-1DIMFLVCN2-PM, GLPP-1DIMFLVCN3-PM as required.

B. Lighting Controller System Characteristics: Provide pre-configured lighting controller, with capabilities for manual setup, and software setup through programming port, configured as follows in layout indicated:

1. Controller networked to central lighting control processor specified in Article 2.03 - AUTOMATION CONTROL PROCESSOR (MAIN) and Article 2.04 – AUTOMATION CONTROL PROCESSOR (SUB).

C. Dimmable Load Types: 16A per channel at 100 to 277VAC, 50/60 Hz:

1. 0 – 10V 4-wire fluorescent ballasts.
2. 0 – 10V LED drivers.

D. Switched Load Types:

1. Fluorescent ballast.
2. Incandescent.
3. Magnetic low voltage.
4. Electronic low voltage.
5. Neon/Cold cathode.
6. High-Intensity discharge.

E. Power Requirements:

1. Main Power: 100 – 277 VAC, 50/60 Hz.

F. Input/Output:

1. Line Power Inputs: flying leads, 2 connections.

2. Switch Channel Outputs: 1, 2, or 3 channels flying leads.
3. 0 – 10V Dimmer Outputs: 1, 2, or 3: flying leads for 1, 2, or 3 dimmer channel outputs, Class 1 or Class 2.

G. Enclosure: Surface-mounted industrial control enclosure mounts directly on two (2) side-by-side 4" square electrical junction boxes, suitable for concealed locations.

2.07 MULTI-ROOM LIGHTING CONTROLLER WITH POWER MANAGEMENT

A. Lighting Controller: Integrated lighting and equipment switching control system panel, in metal enclosure for mounting in concealed space.

1. Basis of Design Product: Crestron, Greenlight GL-IPAC-SW8 Integrated Lighting System, Model GL-IPAC-SW8.

B. Lighting Controller System Characteristics: Provide pre-configured lighting controller, with capabilities for manual setup, and software setup through programming port, configured as follows in layout indicated:

1. Controller networked to central lighting control processor.

C. Switched Load Types:

1. Fluorescent ballast.
2. Incandescent.
3. Magnetic low voltage.
4. Electronic low voltage.
5. Neon/Cold cathode.
6. High-Intensity discharge.
7. Motors.

D. Power Requirements:

1. Main Power: 120 – 277 VAC, 50/60 Hz.
2. Available Network Power: 15W at 24VDC.

E. Input/Output:

1. Line Power Inputs: 8 terminal blocks, 2 connections per channel, paralleled.
2. Switch Channel Outputs: 8 terminal blocks.

F. Enclosure: Surface-mounted industrial control enclosure suitable for concealed locations, 14.13 by 12.13 by 4.06 inch (308 by 359 by 104 mm).

2.08 LIGHTING CONTROLLER EXPANSION MODULES

A. Lighting Controller: Integrated lighting, dimming, and switching control system, in metal enclosure for mounting in concealed spaces.

1. Basis of Design Product: Crestron, Green Light Dimmer Expansion Module – Cresnet, Model GL-EXP-DIM-CN, GL-EXP-DIMFDB-CN, GL-EXP-DIMFLV-CN as required.

B. Lighting Controller System Characteristics: Provide pre-configured lighting controller, with capabilities for manual setup, and software setup through programming port, configured as follows in layout indicated:

1. Controller networked to central lighting control processor specified in Article 2.03 – AUTOMATION CONTROL PROCESSOR (MAIN) and in Article 2.04 – AUTOMATION CONTROL PROCESSOR (SUB).

C. Dimmable Load Types: 16A at 100-277VAC, 50/60 Hz:

1. Magnetic low voltage (GL-EXP-DIM-CN)
2. Incandescent (GL-EXP-DIM-CN)
3. Noen/Cold cathode (GL-EXP-DIM-CN)
4. 2-wire fluorescent (GL-EXP-DIM-CN)
5. 3-wire fluorescent (GL-EXP-DIM-FDB-CN)
6. 0-10V 4-wire fluorescent (GL-EXP-DIMFLV-CN)
7. 0-10V LED drivers (GL-EXP-DIMFLV-CN)

D. Switched Load Types:

1. Magnetic low voltage (GL-EXP-DIM-CN)
2. Incandescent (GL-EXP-DIM-CN)
3. Noen/Cold cathode (GL-EXP-DIM-CN)
4. 2-wire fluorescent (GL-EXP-DIM-CN)
5. 3-wire fluorescent (GL-EXP-DIM-FDB-CN)
6. 0-10V 4-wire fluorescent (GL-EXP-DIMFLV-CN)
7. 0-10V LED drivers (GL-EXP-DIMFLV-CN)

E. Power Requirements:

1. Main Power: 100-277 VAC, 50/60 Hz.

F. Input/Output:

1. Line Power Inputs: flying leads
2. Switch Channel Outputs: 1 flying lead (GLP-EXP-DIM-CN, GL-EXP-DIM-FDB-CN, GL-EXP-DIMFLV-CN)
3. 0-10V Dimmer Outputs: 1 flying lead for 1 dimmer channel output, Class 1 or Class 2.

2.09 LIGHTING MANAGEMENT SYSTEM SOFTWARE (FUSION-EM)

A. Definitions:

1. Control: Effecting a change in state by one PC program onto a microprocessor or device.
2. Daylight Harvesting: The dimming of electric lighting sources when natural daylight is available.
3. Dynamic Host Configuration Protocol (DHCP): is a computer networking protocol used by hosts (DHCP clients) to retrieve IP address assignments and other configuration information.
4. Load Shedding: Intentional reduction of power consumption to avoid total power disruption due to overloading the circuits or reduction of power consumption to avoid crossing an agreed on threshold of power usage. Load shedding lighting ballasts reduce the light level in response to a signal on the power line.
5. Monitor: Acquisition and presentation of status or operating condition of microprocessors or electrical devices in the network of the monitoring device or program.

6. Scene: Predetermined position of shades and light levels.
7. Scene Selection: Grouping of lighting and window shade controls into groups that will respond to a single scene command.
8. Secure Sockets Layer (SSL): A communications encryption protocol for managing the security of message transmissions over the internet or a local area network.
9. Shading Groups: Grouping rooms for common control of window shades.
10. Transmission Control Protocol/Internet Protocol (TCP/IP): Networking protocols for exchanging data over the World Wide Web and Local Area Networks.

B. Warranty:

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of wireless dimming and environmental controls system that fail in materials or workmanship within the specified warranty period following substantial completion.

   a. Warranty Period: Other components, 8 years.

2. Manufacturer's Basic Support Service: Telephone support: Unlimited period.
3. Manufacturer's Extended Support and Maintenance Program: Provide proposal to Owner for manufacturer's annually-renewable extended support and maintenance program to consist of the following:

   a. Parts and labor required for system maintenance.
   b. Technical hotline support.
   c. Remote diagnostics and programming support.
   d. Annual on-site maintenance visit to provide preventive maintenance, staff training, and limited re-programming.
   e. Response time for on-site system maintenance: 24 hour.

C. Software Support Agreement:

1. Software Agreement: Manufacturer to provide software and firmware updates and onsite software and firmware support for a period of five (5) years from the date of substantial completion at no charge to the Owner.
2. Provide proposed extended service agreement including fees for support beyond the five (5) years.

D. Manufacturers:

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (800) 237-2041, Fax: (201) 767-1903, www.crestron.com or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

E. Network Lighting and Energy Management Software:

1. Basis of Design Product: Crestron, FUSION-EM lighting and energy management software.

2. General: Web-accessible, network-connected, Windows-based energy and lighting management software running on Microsoft Server 2008 R2 communicating over TCP/IP networks to provide lighting and window shade control, daylight harvesting, load shedding, occupancy sensing, and occupied/unoccupied lighting schedules, with the following features:

    a. Real-time and historical energy consumption tracking.
    b. Dynamic automation – lighting and controlled building automation based on calendar data, occupancy, and energy usage.
    c. Network connectivity with lighting control panels, automation controllers, window shade controllers, light sensors, occupancy sensors, and local touch screens and keypads.
    d. Dynamic Host Configuration Protocol (DHCP) device recognition and IP addresses assignment.
    e. Secure Sockets Layer (SSL) network security.
    f. Administration:

        1) User Accounts: Administrator privileges allow the creation of new user accounts and editing of existing accounts.
        2) Backup and Importing Backup: Program allows the administrator to import and backup program settings.

3. System Requirements:

    a. Operating System Requirements. PC running Windows 2008 Server R2.

        1) Memory: 8 GB of RAM.
        2) Monitor Color: 256 color setting.
        3) Screen Resolution: 1024 by 768 Minimum.

    b. Hardware Requirements:

        1) Dell PowerEdge R310 (or equivalent) Processor: X3470 Xeon Processor 2.93 GHz, 8M Cache RAM: 8GB, Storage: Onboard SATA, 1-4 Hard Drives connected to onboard SATA Controller; Usable Drive Space: 200GB, Network Interface: On-Board Dual Gigabit Network Adapter.

    c. Database Server: Microsoft SQL Server 2005 or 2008 version R2.
    d. Scheduling Server: Exchange 2007; Exchange 2010; Lotus Notes/Domino Server versions 7.03, 8.0 and 8.5; FUSION-EM internal scheduler.
    e. Browser Requirements: IE 8 and newer or Firefox.

4. Building Configuration:

    a. Program automatically recognizes connected devices in the TCP/IP network using DHCP network protocol.
    b. Develop schedule of building spaces and display as a file tree.
    c. Assign rooms to zones.
    d. Program load shedding schedules and daylight harvesting algorithms.
    e. Capture and control lighting control panels, automation computers, occupancy and light sensors, local touch panels, and keyboards.
    f. Assign building assets (lighting control modules, electrical automation computers, and local touch panels) to individual rooms.
    g. Group spaces into common occupied-unoccupied schedules for turning lights on and off at the beginning and end of the day.

h. Schedule lighting equipment for emergency lighting and night lighting.
i. Group spaces that share common solar exposure and assign to window shade groups.
j. Define demand response rules for integrated devices.

5. Shade control facilitated by shade motor and hardware interface by same manufacturer:

a. Shade status provided by real-time feedback.
b. Shades control network protocol shall be native to Automation Software hardware controllers.
c. Shades operating without true feedback are not acceptable.

6. Programming and Monitoring Screen:

a. Occupancy monitoring and control:

1) Turn lighting on-off based on 7-day occupancy schedule.
2) Report irregular occupancy condition and override lighting status accordingly.
3) Schedule night lighting and emergency lighting.

b. Lights and Shades Control:

1) Report daylight readings and dim lights and scroll window shades accordingly.
2) Report glare condition and scroll window shades accordingly.
3) Dim lights and lower shades in response to commands from local touch screen.
4) Assign rooms to lighting and window shade scene presets.

c. Program time clock module:

1) Display calendar and timeclock.

d. Load shedding:

1) Program load shedding targets and assign targets to individual rooms.
2) Permit local override.

e. Demand Response:

1) Initiate preset demand response state.

f. Global Control:

1) Real time system wide master control.

7. Dynamic Automation:

    a. User preset conditions trigger automatic events:

        1) Conditions defined using:

            a) Sensor status.
            b) Schedule data.
            c) Demand response state.
            d) Energy usage data.

8. System Reporting:

    a. Report status of system devices.

9. Integrated Lighting and Shade Control:

    a. Daylight harvesting algorithm.

        1) Program different lighting scenes that automatically change lighting and window shade positions according to Owner's requirements and industry standards.

    b. Solar glare reduction algorithm:

        1) Adjust window shade positions according to Owner's requirements and industry standards.

    c. Groups and Zones:

        1) Develop window shade group presets for different space usage.
        2) Develop load shedding zones for different space usage.
        3) Assign spaces to load shedding zones.

10. System Administration:

    a. Multiple levels of authorization:

        1) Full access.
        2) Standard access.
        3) Reporting access.

    b. User Groups:

        1) Group by user role and authorization level.

F. Examination:

1. Prior to installation, examine host computer to confirm that it meets requirements for installation of manufacturer's software.

G. Pre-installation Meeting:

1. Manufacturer and installer of Network Lighting Management Software to coordinate a meeting of the mechanical and electrical engineer, mechanical and electrical contractor, lighting, window shade and HVAC equipment manufacturers. Include any designers and contractors for any other direct digital control system designed to interact with product of this Section.

    a. Discuss interconnection and interoperability of other equipment with lighting management software.

H. Software Installation:

1. Install and program software in accordance with this Section to meet the Owner's requirements. Provide current licenses and backup copies of the software for the Owner's use.

I. Adjusting:

1. Within two (2) months of the date of Substantial Completion provide onsite service to adjust the system to account for actual occupied conditions.

J. Demonstration:

1. Factory authorized service representative to instruct Owner's staff to adjust, operate, and maintain lighting management software.

K. Field Quality Control:

1. Manufacturer's Field Services: Qualified manufacturer's field representative to perform on-site system inspection, startup, and Owner demonstration and training.

    a. Participation in Pre-installation Conference and pre-wire inspection.
    b. Installation inspection.
    c. Owner programming conference.
    d. Installation of system software and database and system startup.
    e. Owner demonstration and training.

L. Closeout Activities:

1. Demonstration: Schedule demonstration with Owner.
2. Training: Train Owner's personnel to operate, maintain, and program network lighting management software.

    a. Furnish set of approved submittals and record drawings of actual installation for Owner's personnel in attendance at training session.

2.10 USER INTERFACES

A. Keypad:

1. Remote Keypad Controls: Field-configurable remote keypad with auto-adjusting backlight illuminating replaceable, engravable programmable buttons in number indicated, with white LED indicators, configured to fit in standard single-gang box.

   a. Basis of Design (Crestnet Device): Crestron, Cameo Series Keypad Model C2N-CBD-P Series.
   b. Basis of Design (GLPP Devices): Crestron, Keypad Model GLPPA-KP Series.
   c. Color: As selected from manufacturers' full range of minimum 12 colors.

2.11 SENSORS (NETWORKED SYSTEM SENSORS)

A. Remote Occupancy Sensor (24V): Detects movement within space while reducing false triggering or shutoffs while space is occupied. Combination of ultrasonic motion detection and passive infrared detection with internal microprocessor. Sensor independently adjustable for installed conditions. Delayed time off adjustment. Walk-through mode. Adjustable built-in photocell for daylight optimization. Equipped with 3-wire interface for direct connection to control system; 24 VDC power from network control bus.

1. Basis of Design: Crestron Dual Technology Occupany Sensor Model GLS-ODT-C-NS.
2. Coverage: As required based on sensor location and spacing.
3. Mounting: As indicated.

B. Sensors (Networked System Sensors)

1. Remote Occupancy Sensor (Cresnet): Detects movement within space while reducing false triggering or shutoffs while space is occupied. Combination of ultrasonic motion detection and passive infrared detection with internal microprocessor. Sensor independently adjustable for installed conditions. Delayed time off adjustment. Walk-through mode. Adjustable built-in photocell for daylight optimization. Equipped with 4-wire interface for direct connection to control bus;

   a. Basis of Design: Crestron Dual Technology Occupancy Sensor Model GLS-ODT-C-CN
   b. Photocell: Built-in ambient light photocell
   c. Additional Interfacing: includes connection port for additional photocell.
   d. Coverage: 360 deg., 2000 sq. ft.
   e. Set-up and commissioning: parameters shall be configurable via a handheld wireless remote.
   f. Mounting: 3" octagon box

C. Occupancy Sensor Interface Device: Integrates occupancy sensors and related sensors with control network. In separate enclosure. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs.

1. Basis of Design: Crestron Sensor Integration Module Model GLS-SIM.

D. Photocell Sensor, Open Loop Type: Continually monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight. Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.

1. Basis of Design: Crestron Photocell Model GLS-LOL.
2. Mounting: As indicated.

E. Photocell Sensor, Closed Loop Type: Continually monitors daylight at work station location to enable daylight harvesting applications to provide control of room lighting based on lighting level at workstation. Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.

1. Basis of Design: Crestron Photocell GLS-LCL.
2. Mounting: As indicated.

F. Power Supply: 50W, 24V regulated power supply with two 4-pin network connectors, fuse-protected.

1. Basis of Design: Crestron Cresnet Power Supply Model GLA-PWS-50.

2.12 SENSORS (STANDALONE)

A. Low-Voltage Dual-Technology Ceiling-Mount:

1. Shall incorporate Doppler shift ultrasonic and passive infrared motion detection technologies.
2. Shall mount on the ceiling.
3. Shall be available in 180º and 360º coverage patterns.
4. Infrared lenses shall have a 360º field of view.
5. Shall be available in 40kHz ultrasonic frequencies.
6. Shall automatically adapt to changing room conditions - including background PIR levels and continuous airflow
7. Sensor shall have two modes of operation:

   a. Multi-technology mode: where the sensors send infrared signal to the microprocessor, which makes the decision to turn on lighting based on the level of the signal.
   b. Single technology mode: where the user chooses technology that will turn on lighting.

8. Shall incorporate a real-time motion indicator LED, which is visible from the front of unit.
9. Shall have mask inserts for PIR rejection to prevent false tripping.
10. Low-Voltage Ultrasonic Ceiling-Mount:

    a. Shall utilize Doppler shift ultrasonic detection technology.
    b. Shall mount on the ceiling.
    c. Shall be available in 180º and 360º coverage patterns.
    d. Shall be available in 40kHz ultrasonic frequencies.
    e. Shall automatically adapt to continuous airflow conditions.
    f. Shall incorporate a real-time motion indicator LED, which is visible from the front of unit.
    g. Operating status and setting confirmation shall be available via LED motion indicators.

11. Power Pack:

    a. Shall be compatible with incandescent, magnetic, or electronic low voltage, and magnetic or electronic fluorescent, as well as motor loads.
    b. Ratings: 20A incandescent, 20A fluorescent; shall utilize normally open, silver alloy dry contacts rated for a 20A-ballast load at 120V, 277V.
    c. Power Pack shall allow for separation of Class 1 and Class 2 wiring
    d. Shall incorporate a dedicated HVAC Relay included in power pack. HVAC Relay – SPDT 500ma@24VDC three-wire isolated. Ratings: .5A, 125VAC; 1A, 30VDC.

2.13 CONDUCTORS AND CABLING

A. Power Supply Side of Remote-Control Power Sources: Comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors."

B. UTP Cable: 100-ohm, UTP. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

1. Communications Control Cable, Non-Plenum Rated: 22 AWG data pair stranded bare copper, and 18 AWG power pair stranded bare copper, Type CM.

    a. Basis of Design Product: Crestron CRESNET-NP.

2. Communications Control Cable, Plenum Rated: 22 AWG data pair, stranded bare copper and 18 AWG power pair, stranded bare copper, Type CMP, complying with NFPA 262.

    a. Basis of Design Product: Crestron CRESNET-P.

3. Communications High-Power Control Cable, Non-Plenum Rated: 22 AWG stranded bare copper data pair, and 12 AWG stranded bare copper power pair, Type CM.

    a. Basis of Design Product: Crestron CRESNET-HP-NP.

2.14 DMX CONTROL INTERFACE

A. Interface General Requirements

1. Basis of Design Product: Crestron, Model GLA-PHAROS DMX-512 Interface.
2. The DMX Control Interface shall be a microprocessor based lighting system designed specifically as a multi-purpose lighting and show playback controller for entertainment and architectural applications. A personal computer running emulation software shall not be acceptable.
3. The DMX Control Interface shall be an integrated device that combines DMX-based lighting playback with architectural control features, scripting capability, and web-based control.
4. The DMX Control Interface shall store all of its programming data in non-volitale flash memory, including built-in flash memory and/or a removable flash memory card and can be transferred to/from a remote personal computer via Ethernet.
5. The DMX Control Interface shall have an internal real-time clock and calendar that operates from an internal lithium battery even in the absence of external power and be able to trigger shows and other events based on time of day, sunrise, sunset, day of week, day of year and/or a combination of these events.
6. The DMX Control Interface shall be capable of synchronizing its operation with and/or remotely controlling other DMX Control Interfaces of the same kind across an Ethernet network.

7. The DMX Control Interface shall support standard theatrical lighting playback models including direct channel control, fixture level control, groups, channel parking, scaling, disabling, offsets, transparency, tracking and overrides, which can be used to create submasters and grandmaster control, partitioning, zones and other control setups.

B. System Capacity

1. The DMX Control Interface shall support:

   a. Up to 2000 cues.
   b. Up to 200 macros.
   c. Up to 100 groups.
   d. Up to 100 timer events.
   e. Up to 500 timecode event triggers.
   f. Up to 256 DMX input triggers.
   g. Up to 512 button station buttons.
   h. Up to 512 contact closures.
   i. Up to 16 TCP/UDP packet triggers.
   j. Reception of 512 DMX input levels.

2. Processing of 512 DMX output levels.

   a. Additional DMX outputs may be supported by networking multiple DMX control interfaces together via Ethernet.

2.15 EMERGENCY LIGHTING CONTROL DEVICE

A. Remote-Mounted Emergency Lighting Transfer Device:

1. Provide UL 924 listed emergency lighting control that monitors the local normal branch circuit in each space. Emergency lighting control that monitors normal power at the panel level or that does not monitor the local branch circuit in the space served by the emergency will not be accepted.
2. Ballast load transfer control device shall be used in conjunction with building generator to provide automatic emergency lighting from switched light fixtures on emergency standby circuits. Unit shall have test switch and LED indicator to indicate presence of utility power.
3. Unit shall control up to 20 amperes of electronic or magnetic ballast load and shall mount in a single gang or square 4" box.
4. Unit shall be permanently sealed and enclosed in a white thermoplastic square housing.
5. Unit shall be UL 924 listed for field installation and shall meet all pertinent codes.
6. Unit shall be LVS Controls Inc. EPC-1 (on/off loads), EPC-1-D (0-10volt dimming loads) and EPC-D-F (2, 3, and 4 wire dimming loads) or equivalent.

2.16 SOURCE QUALITY CONTROL

A. Perform full-function testing on completed assemblies at end of line. Statistical sampling is not acceptable.

2.17 LIGHTING CONTACTORS

A. Lighting contactors shall be electrically held and rated for 30 amps at 600 volts. Contactor shall have a control power transformer for 120V switching control circuit if line voltage is higher than 120V.

2.18 PHOTOCELL

A. Interior

1. Ceiling mount unit.
2. Low voltage indoor photosensor.
3. Closed loop system.
4. Compatible with 0-10V dimming ballast.
5. Wattstopper LS-301 (dimming) or LS-102 (on/off) or equivalent.

2.19 SEQUENCES OF OPERATIONS (All Sequences of Operations shall be verified, prior to implementation, in meeting with Owner, Architect, and Engineer. Any modifications or additions to the Sequences of Operations shall be performed at no cost to the Owner.)

A. The following sequences describe in general the required operation of the lighting fixtures and control zones in each major space. Lighting control sequences shall be further developed by the Owner, Contractor, Engineer, and Lighting Manufacturer in the field.

B. Due to the unique nature of each listed manufacturers lighting control system it is the Electrical Contractor's and Lighting Control System Manufacturer's responsibility to determine the exact configuration, equipment and wiring required to meet the sequences below.

C. Time of day schedules and preset scenes shall be determined by the Manufacturer, Architect, Engineer, and Owner in the programming meeting.

D. A BACnet connection shall be made from the lighting control system to the HVAC system to indicate space occupancy.

E. General Daylighting Dimming and On/Off Controls:

1. Controller shall dim or turn on/off daylighting control zones to maintain a minimum interior foot-candle level in response to available ambient daylight. The controller shall be capable of providing means for the photo sensor input to control light fixture light outputs to ensure optimum light levels and energy savings. Where multiple photo sensors are indicated, the system shall average the sensors.
2. The daylighting control shall be integrated with a local occupancy sensor.
3. Daylighting control zone dimming sequences and occupancy sensor settings shall be determined by the Manufacturer, Owner, and Engineer at the project site based upon actual field conditions.

F. Corridors and Stairwells (time clock and occupancy sensor control with manual override on/off low voltage switch):

1. Corridor and stairwell lighting shall be controlled by the occupancy sensors where indicated on the Drawings.

   a. 6am - 4pm: The light fixtures shall dim to 50% after a predetermined unoccupied time determined by the Owner, and return to 95% upon detection of occupancy.
   b. 4pm - 6am: The light fixtures shall turn off after a predetermined unoccupied time determined by the Owner, and return to 95% upon detection of occupancy.

2. The emergency lighting in the corridors shall be by emergency standby generator. Fixtures designated as emergency shall come on (full brightness) upon loss of power to the fixtures.
3. Night lights shall be provided at corridor intersections and stairs. These lights shall remain on at all times (during both normal and emergency operation).

4. A corridor override switch shall be located in Electric Room A193. The switch shall be programmed to bring the corridors, vestibules, and stairways to full brightness for a period of two (2) hours when pressed. Provide nameplate above switch indicating "Corridor Lighting Override".

G. Vestibules and Lobbies (time clock, occupancy sensor control and daylighting control where indicated):

1. Vestibule and Lobby lighting shall be controlled by the occupancy sensors where indicated on the Drawings.

   a. 6am - 4pm: The light fixtures shall dim to 50% after a predetermined unoccupied time determined by the Owner, and return to 95% upon detection of occupancy.
   b. 4pm - 6am: The light fixtures shall dim to 20% after a predetermined unoccupied time determined by the Owner, and return to 95% upon detection of occupancy.
   c. The daylighting controlled circuits shall dim to maintain a predetermined foot-candle level.

2. The emergency lighting in the vestibule shall be by emergency standby generator. The emergency lighting shall be programmed to come on (full brightness) upon loss of power. The emergency shall also be wired to come on in the event of a relay failure.

H. Restrooms, Locker Rooms (Occupancy Sensor Control):

1. Lighting shall be controlled by occupancy sensor within the space. The light fixtures shall be turned off after a predetermined unoccupied time determined by the Owner.
2. The emergency lighting shall be provided by emergency standby generator. Emergency lighting to come on (full brightness) upon loss of power of the local normal circuit. The emergency lighting shall also be wired to come on in the event of a relay failure.

I. Gymnasium (Time Clock Control/Occupancy Sensors):

1. Gymnasium lighting shall be controlled by time clock, occupancy sensors and control stations where indicated on the Drawings.

   a. 6am: The light fixtures shall turn on to 30%.
   b. Control Stations within the gymnasium shall be available to adjust the light levels to 50% and 100% (100% setting shall turn fixtures to 95%).
   c. If lighting is on in the gymnasium at a level higher than 30% and no occupancy is sensed for a period of 30 minutes then fixtures shall revert to 30% light output.
   d. 8pm: Automatic off of all gymnasium lighting if no occupancy is sensed.
   e. Prior to automatic "Off" at 8pm, the lights shall flash to warn occupants. If no override is initiated, the lights will turn off.
   f. If the "OVERRIDE" button is pushed, lights shall remain on (at present level) for a 2-hour period. At the conclusion of the 2-hour period, if no occupancy is sensed, the lights shall flash to warn occupants. If no override is initiated, the lights will turn off.
   g. All on/off times shall be adjustable through the lighting control system software.
   h. Full lighting control shall be available at multiple stations located as indicated on the Drawings. These control stations shall be programmed for 3 scenes (to be determined by Owner prior to system startup) plus manual raise/lower for all individual circuits of the gymnasium.
   i. The emergency lighting in the gymnasium shall be by emergency standby generator. Fixtures designated as emergency shall come on upon loss of power to the fixtures.

J. Dining/Servery

1. The Dining lighting shall be controlled by time clock and control stations where indicated on the Drawings.

   a. 5am: The light fixtures shall turn on to 30% in the Dining and Servery.
   b. Control stations within the dining area shall manually adjust the light levels.
   c. Control station within the servery area shall manually adjust the light levels in the servery.
   d. 5pm: Automatic off of all cafeteria/server lighting.
   e. The emergency lighting in the Dining/Servery shall be by emergency standby generator. Fixtures designated as emergency shall come on (full brightness) upon loss of power to the fixtures.

2. The Kitchen lighting controls shall be by manual switches only. No automatic controls shall be provided.

   a. Emergency lighting fixtures in the Kitchen shall be by emergency standby generator. Fixtures designated as emergency shall come on upon loss of power to the fixtures.

K. Electrical Rooms/Emergency Electrical Rooms/Mechanical Rooms/IT Rooms (Manual Control)

1. The lighting controls in these spaces shall be by manual switches only. No automatic controls shall be provided.

   a. Emergency lighting fixtures in these spaces shall be by emergency standby generator. Fixtures designated as emergency shall come on upon loss of power to the fixtures.
   b. Additional emergency lighting battery pack units shall be provided in each electrical and emergency electrical room.

L. Storage Rooms (Time Clock Switch Control)

1. The lighting in storage rooms shall be controlled by time switches. Time switches shall have push buttons to turn lights on for up to 60 minutes. Initially, buttons shall be programmed for 2, 4, 8, 12, 15, and 30 minutes in storage rooms.

M. Exterior site lighting shall be controlled by astronomical time clock to each individual parking lot and each area of walkway lighting (see Plans and Details).

1. Each parking lot/walkway will turn on at dusk (½-hour before sunset) to 95% and off at dawn (½-hour after sunrise).
2. Schedule for each parking lot shall be manually adjusted.
3. Intensity of each parking lot shall be capable of manual adjustment through the Lighting Control System.
4. Provide override switch for system maintenance located in Electric Room E127B.

N. Building-mounted site lighting shall be controlled by astronomical timeclock.

1. Building mounted site lighting will turn on at dusk (½-hour before sunset) to 100% and off at dawn (½-hour after sunrise).
2. Intensity of each building-mounted circuit shall be capable of manual adjustment through the control system software.

O. Offices (Vacancy Sensor Control):

1. Occupancy sensing (vacancy sensing) shall be utilized only for auto-off of all fixtures in the space, not for turning fixtures on.
2. Low voltage lighting control stations for control of lighting zones as indicated on the drawings.
3. Emergency Lighting – Where indicated, light fixtures shall be wired for emergency. This fixture shall function (switch and dim) as the others under normal operating conditions. The fixture shall be forced on (full brightness) in an emergency condition (loss of normal power).

P. Classrooms, Conference Rooms and Similar Spaces (vacancy sensing and daylighting control where indicated, integration to AV systems where indicated):

1. Occupancy sensing (vacancy sensing) shall be utilized only for auto-off of all fixtures in the space, not for turning fixtures on.
2. Daylight dimming shall maintain a minimum interior foot-candle level in response to available ambient daylight.
3. Multi-button low voltage control stations as indicated on the drawings.
4. Emergency Lighting – Where indicated, light fixtures shall be wired for emergency. The fixtures shall function (switch and dim) as the others under normal operating conditions. The fixtures shall be forced (full brightness) on in an emergency condition (loss of normal power).
5. Lighting controllers shall integrate with the AV system where indicated on the plans. The AV system touchscreens shall have control over the lighting scenes and zones.

Q. Classrooms with Folding Panel Partition – Partition closed – system shall operate as individual spaces.

1. Occupancy sensing (Vacancy sensing) shall be utilized only for auto-off of all fixtures in the space, not for turning fixtures on.
2. Daylight dimming shall maintain a minimum interior foot-candle level in response to available ambient daylight.
3. Multi-button and/or touch-screen low voltage control stations as indicated on the drawings.
4. Emergency Lighting – Where indicated, light fixtures shall be wired for emergency. The fixtures shall function (switch and dim) as the others under normal operating conditions. The fixtures shall be forced (full brightness) on in an emergency condition (loss of normal power).
5. Lighting controllers shall integrate with the AV system where indicated on the plans. The AV system touchscreens shall have control over the lighting scenes and zones.

R. Classrooms with Folding Panel Partition – Partition open – system shall operate as one space.

1. Occupancy sensing (Vacancy sensing) shall be utilized only for auto-off of all fixtures in the space, not for turning fixtures on.
2. Daylight dimming shall maintain a minimum interior foot-candle level in response to available ambient daylight.
3. Multi-button low voltage control stations as indicated on the drawings.
4. Emergency Lighting – Where indicated, light fixtures shall be wired for emergency. The fixtures shall function (switch and dim) as the others under normal operating conditions. The fixtures shall be forced (full brightness) on in an emergency condition (loss of normal power).
5. Lighting controllers shall integrate with the AV system where indicated on the plans. The AV system touchscreens shall have control over the lighting scenes and zones.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions.

B. Provide complete installation of system in accordance with Contract Documents.

C. Define each dimmer's load type, shade settings, and set control functions.

D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

E. Mount exterior daylight sensors to point due north with constant view of daylight.

F. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.

G. It shall be the Contractor's and manufacturer's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The Contractor shall provide additional sensors if required to properly and completely cover the respective room.

H. Locate Emergency Transfer Devices at accessible locations. Coordinate with Owner/Engineer.

I. It is the Contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.

J. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The Contractor shall also provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

K. Systems Integration:

1. Equipment Integration Meeting Visit

a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer, and other related equipment manufacturers to discuss equipment and integration procedures.

3.02 SERVICE AND SUPPORT

A. Startup and Programming:

1. Provide factory certified field service engineer to make minimum of three site visits to ensure proper system installation and operation under following parameters

a. Qualifications for factory certified field service engineer:

1) Minimum experience of 2 years training in the electrical/electronic field.
2) Certified by the equipment manufacturer on the system installed.

b. Make first visit prior to installation of wiring. Review:

1) Low voltage wiring requirements.
2) Separation of power and low voltage/data wiring.
3) Wire labeling.
4) Lighting Management Panel locations and installations.
5) Control locations.
6) Computer jack locations.
7) Load circuit wiring.
8) Network wiring requirements.
9) Connections to other equipment and other Lutron equipment.
10) Installer responsibilities.
11) Power Panel locations.

c. Make second visit upon completion of installation of Network Lighting Control System:

1) Verify connection of power wiring and load circuits.
2) Verify connection and location of controls.
3) Energize Lighting Management Panels and download system data program.
4) Address devices.
5) Verify proper connection of panel links (low voltage/data) and address panel.
6) Download system panel data to dimming/switching panels
7) Check dimming panel load types and currents and supervise removal of by-pass jumpers.
8) Verify system operation control by control.
9) Verify proper operation of manufacturers interfacing equipment.
10) Configure initial groupings of ballast for wall controls, daylight sensors, and occupancy sensors.
11) Initial calibration of sensors.
12) Obtain sign-off on system functions.

d. Make third visit to demonstrate and educate Owner on system capabilities, operation, and maintenance.

B. Tech Support:

1. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.03 FIELD QUALITY CONTROL

A. Manufacturer Services:

1. Aim and Focus Visit:

a. The Electrical Contractor shall coordinate an on-site meeting with Lighting Control System Manufacturer, architect, engineer, and Lighting Design Consultant to make required lighting adjustments to the system for conformance with the Lighting Design Consultant's original design intent.

3.04 CLOSEOUT ACTIVITIES

A. Training Visit:

1. Lighting Control System Manufacturer to provide 8 hours (2-hours users, 6-hours maintenance personnel) of on-site system training to the Owner's personnel.

B. On-site Walkthrough:

1. Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

3.05 MAINTENANCE

A. Capable of providing on-site service support within 24 hours anywhere in continental United States and within 72 hours worldwide except where special visas are required.

B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup.

C. System Optimization Visit:

1. Lighting Control System Manufacturer to visit site 6 months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION

SECTION 26 51 00

LIGHTING

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.02 SUMMARY

A. Section Includes:

1. Fixtures
2. Lamps
3. Ballasts
4. Solid State Lighting/Light Emitting Diode (LED)

B. General Requirements:

1. Provide all lighting fixtures as shown complete with all lamps, completely wired, controlled, and securely attached to supports.
2. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:

    a. Fixture performance is equal or improved.
    b. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
    c. Cost to the Owner is reduced or equal.
    d. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

C. Regulatory References:

1. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 01 00.

a. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
b. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

2. Materials and installation shall be in accordance with the latest revision of the National Electrical Code, and with any applicable Federal, State, and local codes and regulations.

3. The standards and regulating committees referred in this specification and to which compliance with is required are:

a. ANSI C78.379 – Electric Lamps – Incandescent and High-Intensity Discharge Reflector Lamps – Classification of Beam Patterns.
b. ANSI C82.1 – Ballasts for Fluorescent Lamps – Specifications.
c. ANSI C82.4 – Ballasts for High-Intensity Discharge and Low-Pressure Sodium Lamps (Multiple Supply Type).
d. ANSI/NFPA 70 – National Electrical Code.
e. ANSI/NFPA 101 – Life Safety Code.
f. NEMA WD 6 – Wiring Device – Dimensional Requirements.
g. ASHRAE/IESNA Standard 90.1 – Energy Standard for Buildings (current version or most recent approved version by the local authority).
h. IEEC – International Energy Conservation Code (current version or most recent approved version by the local authority).
i. IESNA Standards LM-79 and LM-80 – Electric and Photometric Measurements of Solid State Lighting Products, and Measuring Lumen Maintenance of LED Light Sources, respectively.
j. UL Underwriters Laboratories
k. NRTL Nationally Recognized Testing Laboratory

4. All fixtures and assembled components shall be new, of good quality, and be approved by and bear the label of UL for the applicable location and conditions (wet, damp, dry, etc.) or other approved testing agencies, i.e. ETL, unless otherwise specified in writing.

a. Label shall not interfere with fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.

1.03 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

H. TCLP: Toxicity Characteristic Leaching Procedure.

1.04 SUBMITTALS

A. Submit shop drawings and product data including photometric and pertinent physical characteristics of luminaire data in accordance with Section 26 01 00. All submittals shall have project name and fixture type clearly shown.

1. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification.) If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.
2. For custom fixtures, modified fixtures or linear fluorescent fixtures mounted in continuous rows, submit a drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamping layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required. If scallop shields, wallwash reflectors, or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.
3. The review of shop drawings and/or product data does not relieve the Contractor and lighting control manufacturer of the responsibility of providing a complete, coordinated, and functioning installation. Incompatibilities among equipment and components including, but not limited to, mismatched voltages, differing signal protocol, etc., shall be resolved at the sole responsibility and expense of the Contractor.

B. Substitutions:

1. Reference in the specifications to any lighting fixture by name shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any product, which in the judgment of the Consultant expressed in writing to all Bidders before opening of bids as an addendum, is an acceptable substitute to the specified.
2. Substitutions during bid time: Whenever any particular brand or make of material or apparatus is called for in the specifications, a Bidders Proposal must be based upon such material or apparatus, or upon a brand or make which has been specifically approved as a substitution in an Addendum issued to all Bidders during the bidding time.
3. If a Bidder, firm, etc., desires that consideration be given to another brand or make, etc., then he may submit to the Consultant, not later than ten (10) days before the hour and day set for bid opening, a written request for the "Acceptable Substitute" of such material or apparatus, and clearly defining and describing same, together with necessary manufacturer's literature, specifications, drawings and performance data. Requests received after above deadline will not be considered.
4. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometric, mechanical, and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect and the Lighting Designer.
5. If the Consultant approves the material submitted, or if he should accept a substitute, then an Addendum would be issued to each Bidder who has received a set of bidding documents, so that all Bidders may avail themselves of the change in submitting their proposals.
6. Substitutions after bid opening: No substitutions will be considered after bids have been opened unless necessary due to strikes, lockouts, bankruptcy, or discontinuance of manufacturer, etc. In such cases, the Contractor shall apply to the Consultant/Engineer, in writing, within ten (10) days of realizing his inability to furnish the article specified, describing completely the substitution he desires to make.

7. The fixture manufacturer and model number listed first for each fixture type in the lighting fixture schedules establishes the performance specification for that fixture type. Manufacturers that are subsequently listed for a specific fixture type, but without model numbers, are believed to be able to produce an acceptable alternate to the specified fixture. These manufacturers must provide equipment identical in appearance, materials, and performance to the fixture listed by model number in the fixture schedule. The lighting fixture manufacturer may be required to submit samples, photometric data, and point-by-point calculations of the areas where the lighting fixtures will be located. The Architect, Engineer, and Lighting designer shall be the sole judges in determining whether a manufacturer's fixture complies with the specifications, and shall reserve the right to disqualify any manufacturer.
8. Where noted on the lighting fixture schedules, the Contractor shall provide individual unit prices for alternates listed for a particular fixture type.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals per 260100.

B. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.06 EXTRA STOCK

A. Furnish to the owner and store at the site where directed, items in the following table: two (2) extra stock of each type of interior and exterior building mounted lighting fixture type and lamp type installed in the Project. Extra stock for site lighting poles and pole-mounted fixtures is not required. Extra stock shall be packaged in manufacturer's unopened cartoons and identified as to contents by fixture type.

B. Extra stock for site lighting poles and pole-mounted fixtures is not required.

C. Extra stock shall be packaged in manufacturer's unopened cartons and identified as to contents by fixture type.

D. Furnish items above with appropriate quantity of each exposed trim, fastener, bracket and other items as required for a complete installation.

1.07 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

E. Mockups: Provide interior lighting fixtures for room or module mockups complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 COORDINATION

A. Confirm compatibility and interface of other materials with fixture and area. Report discrepancies to the Engineer, and defer ordering until clarified.

B. Supply frames, trim rings, and backboxes to other trades, as may be required.

C. Coordinate with other trades to avoid conflicts between fixtures, supports, fittings, mechanical equipment, and other utilities.

D. Subsequent to review of shop drawings and prior to ordering fixtures verify voltage at each fixture also consult with all others to determine the type of ceiling and ceiling suspension system in each and every room and order fixtures to suit and fit the particular ceiling and ceiling suspension system. Any extra costs because of failure on the part of this Contractor to verify voltage or ceiling requirements shall be paid for by this Contractor. It is not the intent of fixture catalog numbers shown to classify the voltage, ceiling or ceiling suspension.

E. Fixtures shall be described herein and on the Drawings and be appropriate for the intended location. All necessary lamps shall be provided with the fixtures. Where indicated on the Drawings, fixtures shall have emergency ballast suitable for emergency use.

1.09 WARRANTIES

A. All fixtures and workmanship shall be guaranteed free of defects and fully operational for a minimum of one year after the acceptance of the project by the Owner. Any fixtures or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the Owner.

B. Ballasts for fluorescent fixtures shall be covered by a five year warranty and high intensity discharge fixtures shall be covered by a two year warranty against defects in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative, in- warranty ballasts. LED Fixtures shall carry a full warranty for a minimum of five (5) years.

C. Incandescent lamps shall be warranted for a period of 30 days from the date of acceptance. Incandescent halogen lamps shall be warranted for a period of 60 days from the date of acceptance. Fluorescent and HID lamps shall be warranted for a period of one year from the date of acceptance.

D. Neon and cold cathode lighting systems shall be warranted for two (2) years from the date of acceptance.

E. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: five (5) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four (4) years.
2. Warranty Period for [Emergency Fluorescent Ballast] Batteries: five (5) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four (4) years.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Provide light fixtures as indicated on the Drawings. See Lighting Fixture Schedule.

2.02 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of adjacent materials.

B. For weatherproof and vaportight installation, painted finishes of fixtures and accessories shall be weatherproof enamel using proper primers or hot dipped galvanized and bonderized epoxy, in accordance with manufacturer's requirements. Unless otherwise specified all painted surfaces shall have a life expectancy of not less than twenty years.

C. Where dissimilar metal parts come in contact with each other, apply to both surfaces a coating material to prevent corrosion.

D. Fasteners shall be manufactured of non-magnetic stainless steel or anodized aluminum, except in indoor applications where galvanized steel shall be acceptable.

E. Fixtures shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required.

F. All recessed fluorescent, incandescent, high-intensity discharge, and LED lighting fixtures shall be provided with an integral, automatic resetting, thermal cut-out.

G. Outdoor fixtures shall have wire mesh corrosion resistant screens in the vent holes properly sized to prevent incursion of insects, small animals, and/or other small rodents.

H. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. All sheet metal shall be free of light leaks. All edges shall be finished so there are no sharp edges exposed. All miters shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship shall not be acceptable. Sheet metal work shall be properly fabricated so that planes will not deform (i.e. become concave or convex, due to normal expected ambient and operating conditions).

I. In adjustable fixtures, aiming and positive locking devices shall be provided. Fixtures with an adjustable lamp and using a lamp with an asymmetrical light pattern shall have an aiming stop which can be permanently set so that the lamp shall remain correctly positioned after service or relamping.

J. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic. The quality of the raw material must meet American Society of Testing Materials (ASTM) standards, as tested by an independent testing laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded, or extruded, as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years. Glass used for lenses, refractors, and diffusers in incandescent lighting fixtures shall be tempered for high impact and heat resistance; the glass shall be crystal clear in quality with a transmittance of no less than 88%. Exterior fixtures shall use tempered Borosilicate glass, Corning #7740, or equal. For fixtures directly exposed to the elements and aimed above the horizontal, use Corning Vycor glass or equal. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections that may hinder their functional performance.

K. All lenses, louvers, and other light-diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.

L. All “open” metal halide fixtures without protective lenses must have an exclusionary socket to prevent the use of lamps that are not “O” rated.

M. All light fixtures with integral daylight or occupancy sensors shall have said sensors installed by the fixture manufacturer, in accordance with the sensor manufacturer’s requirements, and at the location as shown or described in the specifications or plans. Proper wiring, either to an integral device in the fixture or to an external system, shall be provided in the factory.

N. All aircraft cable suspended pendants or linear fluorescent light fixtures shall be provided with a minimum slack of 24” of cable in addition to the specified suspension length (or mounting height as the case may be) and adjustable, locking cable grippers so that the mounting height may be adjusted in the field. The Contractor shall not cut the spare cable length before the Architect has approved the final mounting height.

O. Any fixture or part thereof that has been specified with an incompatible, part, lamp, or accessory, as determined by the Contractor and/or fixture manufacturer shall not be ordered and or installed and shall instead be immediately brought to the attention of the Architect, Lighting Designer, and Engineer. Failure of the Contractor to address any known issues, which results in the delay of procuring the proper equipment, shall be the responsibility of the Contractor.

2.03 LAMPS

A. Fluorescent Lamps - T8

1. Fluorescent lamps shall be provided as indicated in the lighting fixture schedules. Incomplete or unclear lamp specifications must be clarified via the lamp submittal process, or through other formal requests for clarification. Any substitutions or cross-referencing must be approved with lamp submittals through the submittal process. Lamps shall be manufactured by General Electric, Osram-Sylvania, or Philips, unless otherwise specified.
2. Unless otherwise indicated in the lighting fixture schedules, all linear T8 fluorescent lamps shall be 3000K, 3500K, 4100K color temperature as indicated and, 82 minimum CRI, with a minimum 24,000-hour rated average life, for 3-hour starts.
3. Lamps shall be TCLP compliant.
4. Lamps shall be listed on CEE Qualified Product List.
5. Reduced wattage lamps will not be accepted.

B. Incandescent Lamps

1. Incandescent lamps shall be provided as indicated in the lighting fixture schedules. Incomplete or unclear lamp specifications must be clarified via the lamp submittal process, or through other formal requests for clarification. Any substitutions or cross-referencing must be

approved with lamp submittals through the submittal process. Lamps shall be manufactured by General Electric, Osram-Sylvania, or Philips, unless otherwise specified.

2. Incandescent halogen lamps shall be used only in fixtures designed for such application. When required by the lamp manufacturer, a protective glass shielding shall be used in all open fixtures with incandescent halogen lamps. For reflector lamps, if no beam spread is designated, the Contractor shall confirm this through the submittal process. Lamps shall be manufactured by GE, Osram-Sylvania, Philips, or USHIO, unless otherwise specified.

2.04 BALLASTS

A. Fluorescent Ballasts - T8

1. Ballasts shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.
2. Ballasts shall be provided with integral leads color coded per ANSI C82.11.
3. Ballasts shall be Programmed Start.
4. Ballasts shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail.
5. Ballasts shall contain auto restart circuitry in order to restart lamps without resetting power.
6. Ballasts shall operate from 60 Hz input source of 120V, 277V as applicable with sustained variations of ±10% (voltage and frequency) with no damage to the ballasts.
7. Ballasts shall be high frequency electronic type and operate lamps at a frequency above 42 kHz ("GCN" models between 20kHz and 30kHz) to avoid interference with infrared devices and eliminate visible flicker.
8. Ballasts shall have a Power Factor greater than 0.98 for primary lamp.
9. Ballast shall have a minimum ballast factor of 1.00 for primary lamp application.
10. Ballasts shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.
11. Ballasts input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.
12. Ballasts shall have a Class A sound rating.
13. Ballasts shall have a minimum starting temperature of -18 deg. C (0 deg. F).
14. Ballasts shall tolerate sustained open circuit and short circuit output conditions without damage.
15. Ballasts shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor where applicable.
16. Ballasts shall comply with ANSI C62.41 Category A for transient protection.
17. Ballasts shall comply with ANSI C82.11 where applicable.
18. Ballasts shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
19. Ballasts shall be manufactured in a factory certified to ISO 9002 Quality System Standards.
20. Ballasts shall carry a 5-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70 deg. C.
21. Manufacturer shall have a 15-year history of producing electronic ballasts for the North American market.
22. Ballast shall provide independent lamp operation (ILO) allowing remaining lamp(s) to maintain full light output when one or more lamps fail.
23. Ballast shall have lamp striation-reduction circuitry.
24. IOP ballast shall comply with UL Type CC rating.
25. Ballast shall comply with NEMA 410 for in-rush current limits.
26. Advance Optanium T8 or equivalent. Ballasts shall be Osram-Sylvania, Advance, GE, Universal, or Robertson, unless otherwise specified.

B. Fluorescent Dimming Ballasts (0-10v Control):

1. Ballasts shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.
2. Ballasts shall be available in plastic/metal can or all metal can construction to meet all plenum requirements.
3. Ballasts shall be provided with poke-in wire trap connectors or integral leads color coded per ANSI C82.11.
4. Ballasts shall be Programmed Start.
5. Ballasts shall be provided with integral protection circuitry to withstand connection of low voltage control leads to mains power supply. In this event, ballasts shall default to maximum light output.
6. Ballasts shall contain auto restart circuitry in order to restart lamps without resetting power.
7. Ballasts shall operate from 50/60 Hz input source of 120V or 277V with sustained variations of ±10% (voltage and frequency) with no damage to the ballasts.
8. Ballasts shall be high frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.
9. Ballasts shall have a Power Factor greater than 0.98 at full light output and greater than 0.90 throughout the dimming range for primary lamp.
10. Ballasts shall have a minimum ballast factor of 1.00 at maximum light output and 0.03 at minimum light output for primary lamp application.
11. Ballasts shall provide for a Lamp Current Crest Factor of 1.7 or less throughout the dimming range in accordance with lamp manufacturer recommendations.
12. Ballasts input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.
13. Ballasts shall have a Class A sound rating.
14. Ballasts shall have a minimum starting temperature of 50 deg. F (10 deg. C) for primary lamp.
15. Ballasts shall provide Lamp EOL Protection Circuit for all T5, T5/HO, CFL lamps, and T8 lamps operating on 4-lamp ballasts.
16. Ballasts shall control lamp light output from 100% - 3% relative light output for T8 and CFL lamps and 100% - 1% relative light output for T5/HO lamps.
17. Ballasts shall ignite the lamps at any light output setting without first going to another output setting.
18. Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.
19. Ballasts shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor where applicable.
20. Ballasts shall comply with ANSI C62.41 Category A for transient protection.
21. Ballasts shall comply with ANSI C82.11 where applicable.
22. Ballasts shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
23. Ballasts shall be manufactured in a factory certified to ISO 9002 Quality System Standards.
24. Ballasts shall carry a 5-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70 deg. C.
25. Manufacturer shall have a 15-year history of producing electronic ballasts for the North American market.
26. Ballasts shall be controlled by a Class 1 or Class 2 low voltage 0-10VDC controller.
27. Advance Mark 7 (0-10V) or equivalent. Ballasts shall be Osram-Sylvania, Advance, GE, Universal, or Robertson, unless otherwise specified.

2.05 SOLID STATE LIGHTING/LIGHT EMITTING DIODE (LED) LAMPS AND LUMINAIRES

A. General:

1. The electrical contractor, in cooperation with lighting control manufacturer and light fixture manufacturers, is responsible for ensuring compatibility between all LED Drivers and the lighting control system components. All proposed LED fixtures shall be tested by the lighting control manufacturer at the factory to verify compatibility prior to installation in the field. If any LED fixture is determined to be not compatible with the proposed lighting control system, it is the electrical contractor's responsibility to work with the light fixture manufacturer to provide a driver that is compatible with the lighting control system.
2. All 0-10VDC LED dimming drivers shall meet the requirements of IEC 60929 for current sinking control and shall have an isolate 0-10VDC control circuit.
3. Luminaire manufacturer shall have a minimum of five (5) years' experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.
4. Unless otherwise specified, all LED luminaires and power/data supplies shall be provided by a single manufacturer to ensure compatibility.
5. All components, peripheral devices, and control software are to be provided by and shall be the responsibility of a single entity. All components shall perform successfully as a complete system.
6. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.
7. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products.
8. White LEDs shall have a rated source life of 50,000 hours under normal operating conditions. RGB LEDs shall have a rated source life of 100,000 hours. LED “rated source life” is defined as the time when a minimum of 70% of initial lumen output remains.
9. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. Optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory.
10. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers and shall have been fabricated after 2007. Acceptable LED lamp manufacturers unless otherwise noted are:

    a. Cree, Inc.
    b. Philips Lighting
    c. Nichia Corporation
    d. Norlux
    e. Opto Technology, Inc.
    f. Osram Optronic Semiconductors

B. Replacement and Spares:

1. Manufacturer shall provide written guarantee of the following:

    a. Manufacturer will keep record of original bin for each LED module and have replacement modules from the same bin available for three (3) years after date of installation.
    b. Manufacturer will keep an inventory of replacement parts (source assembly, power, and control components).
    c. Manufacturer’s LED system will not become obsolete for ten (10) years: Manufacturer will provide exact replacement parts, or provide upgraded parts that are designed to fit into the original luminaire and provide equivalent distribution and lumen output to the original, without any negative consequences.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Lighting Fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install specified lamps in each luminaire.
3. Install accessories furnished with each luminaire.

B. Install all lighting fixtures in accordance with manufacturer's instructions.

C. The care and protection of all fixtures shall be the responsibility of this contractor until the work under this contract is accepted by the owner.

D. Shipping and Storage:

1. All fixtures received at the site shall be stored in clean and dry space until fixtures are installed.
2. Manufacturer shall clearly mark each box with fixture designation prior to shipping.
3. Reflector cones, baffles, louvers, aperture plates, gimbal rings, and decorative elements shall be packed by the manufacturer separate from the housing body (body, stem, etc.) of the fixture.

E. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

F. Remote Mounting of Ballast: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturer, maximum distance between ballast and luminaire.

G. All fixture wiring shall be in accordance with NEC article 410 whenever high temperature insulation is required instead of normal branch circuit wiring.

H. Install fixtures to dissipate ballast and lamp heat.

I. Exit signs and emergency lighting units shall be wired ahead of all switching.

J. Verify lighting switching with Engineer, if necessary for intended operation.

K. Install exterior fixtures so as to prevent the entrance of water or other substances.

L. Fixtures recessed in ceilings which have a fire resistive rating of one hour or more shall be enclosed in a box/structure which has a fire resistive rating equal to or greater than that of the ceiling.

M. Luminaires containing ballasts shall be supported directly to the building structure by wire, chain, or threaded rod of sufficient strength to carry the luminaire.

N. In no case shall fixtures be supported from ductwork, piping, or other equipment.

O. Fixtures and/or fixture outlet boxes shall be provided with hangers that adequately support the full weight of the fixture. Design of hangers and method of fastening other than herein specified shall

be submitted to the Architect for approval. Fixtures mounted on outlet boxes shall be rigidly secured to fixture studs in outlet box. Hickies or extension pieces shall be installed where required to facilitate proper installation. Fixtures weighing more than 50lbs shall be supported independently of the outlet box.

P. Fixtures shall be installed in accordance will any applicable seismic codes.

Q. For fixtures with variable position lamp holder assemblies, contractor shall confirm prior to installation proper lamp holder (socket) position in field, and shall adjust, if necessary, after coordination with manufacturer.

R. Contractor shall be responsible for adjusting aperture rings on all ceiling recessed fixtures to accommodate various ceiling material thickness. Contractor shall be responsible for coordinating the cut-out size in ceiling to ensure aperture covers cut-out entirely. The bottom of aperture rings shall be flush with finished ceiling or not more than 1/16” above. Under no circumstances will the aperture ring extend below the finished ceiling surface.

S. Fixtures shall be installed so that no labels will be visible under normal operating conditions of the fixture.

T. Do not install lenses, trims, reflectors, cones, baffles, louvers, or decorative elements until completion of ceiling installation, plastering, painting, and clean-up. All non-removable lenses, trims, reflectors, cones, baffles, louvers, and decorative elements shall be protected from damage during construction. Replace painted, scratched, dented, or otherwise damaged fixture components at no cost to the owner.

U. Locations of fixtures are show diagrammatically. Verify exact location and spacing with Reflected Ceiling Plans and other reference data before ordering of fixtures and during installation.

V. Fixture locations in mechanical and electrical rooms, unless otherwise noted, are approximate. Coordinate mounting height and location of lighting fixtures to clear mechanical, electrical, plumbing, and fire protection equipment and to adequately illuminate meters, gauges, and equipment. Pendant mounted fixtures shall be secured appropriately in areas of high air movement.

3.02 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes.

3.03 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery/generator and retransfer to normal.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of test, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to the lighting system, retest to demonstrate compliance with standards.

3.04 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by owner. Burn-in all fluorescent and compact fluorescent lamps intended to be dimmed, for at least 12 hours at full voltage.

B. Fixtures shall be thoroughly cleaned of all dust, dirt, debris, and fingerprints, following manufacturer's instructions. If the fixtures are deemed dirty by the Architect at the completion of the project, the contractor shall clean them at no additional cost to the owner.

C. Orient all adjustable wallwasher reflectors to aim flat against nearest adjacent walls.

D. All adjustable lighting units shall be aimed, focused, locked, etc. by the contractor, under the supervision of the Lighting Designer. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc. required shall be furnished by the contractor. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely. Where possible, units shall be focused during the normal working day. However, where daylight interferes with accurate assessment of fixture focus, aiming shall be accomplished at night.

E. Replace any failed lamps concurrent with owner's final acceptance of project.

3.05 ADJUSTING

A. Occupancy Adjustments: Within two (2) months of date of substantial completion, provide on-site assistance in adjusting amiable luminaires to suit actual occupied conditions. Provide one (1) 8-hour visit to project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

END OF SECTION

SECTION 26 71 00

FIRE ALARM SYSTEM

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide complete and operable analog addressable fire alarm system.

B. All work shall conform to Sanford Fire Department Fire Alarm Rules.

C. Provide complete and operable smoke control panel per Sanford Fire Department (SFD) requirements. The fire alarm system shall be UL Listed for smoke control and shall control and monitor all smoke control systems per IBC 909. The smoke control panel shall be a separate panel with approved graphic display, located adjacent to the main entry fire alarm control panel/annunciator. All equipment and components to comply with UL 864, 9th edition.

D. Coordinate with Special Inspector for the smoke control systems and include all costs in the Contract for inspections and witness testing.

E. Coordinate with Sanford Fire Department and include all costs in this Contract for the following:

1. SFD witness testing including but not limited to Fire Alarm and Smoke Control Systems.
2. All review, permits, and approvals.

F. See specification section 267120 for Elevator Lobby Communication System.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to e understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required for the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

D. The following specifications:

Section 26 01 00	Basic Electrical Requirements
Section 26 06 00	Grounding and Bonding
Section 26 07 00 -	Supporting Devices
Section 26 13 00 -	Raceways
Section 26 13 70 -	Outlet Boxes and Enclosures
Section 26 79 13 -	Mass Notification System
Section 23 32 50 -	Fire Protection
Division 23 -	HVAC Systems
Sanford Fire Department Fire Alarm Rules (See Website for current set)	

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Submittals shall be as a complete set. Partial submittals will not be acceptable.

C. Submit construction documents including but not limited to all of the following:

1. Floor plans with devices shown.
2. Locations of alarm initiating and notification appliances.
3. Alarm control and trouble signaling equipment.
4. Annunciation.
5. Power connections.
6. Battery calculations.
7. Riser diagram showing room numbers, devices, conductor types and sizes, all alarm circuits and systems interconnections.
8. Manufacturers, model numbers, and listing information for equipment, devices, and materials.
9. Detail of ceiling height and construction.
10. The interface of fire safety control functions.

D. Documentation of all voltage drop calculations to verify a maximum of 10% voltage drop or less, if required by the manufacturer of all notification devices and .5 dB drop of all audio circuits.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 26 0100.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

B. All work shall be in accordance with the latest edition of Pamphlet No. 71 and No. 72 of the National Fire Protection Association's National Fire Code, local code requirements, and National Electrical Code. Contractor should obtain a copy of the latest AHJ codes and specifications.

C. All equipment shall be UL listed and designed for the intended use. All equipment shall be of the same manufacturer.

D. All necessary permits and approvals shall be obtained from the fire department responsible for the area. All associated fees shall be included in this contract.

E. NFPA Compliance: Provide fire alarm and detection systems conforming to the requirements of the 2010 NFPA 72 "National Fire Alarm Code."

F. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listings shall NOT be acceptable.

G. All control equipment must have transient protection and comply with current edition of UL 864 requirements.

1.05 SYSTEM WARRANTY

A. The warranty coverage shall cover both components and labor for a period of one (1) year or greater.

B. Transfer manufacturer's warranties to the Owner in addition to the General System Guarantee. Submit these warranties on each item in list form with shop drawings. Detail specific parts within equipment that are subject to separate conditional warranty. Warranty proprietary equipment and systems involved in this contract during the guarantee period. Final payment shall not relieve the Fire Alarm Contractor of these obligations.

1.06 SYSTEM DESCRIPTION

A. General: Complete, non-coded, analogue addressable, microprocessor-based fire detection and alarm system with manual and automatic alarm initiation, addressable analog initiating devices.

B. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

C. Audible Alarm Notification: Shall be speaker/strobes as noted on plans. Strobes shall be synchronized.

D. System connections for alarm-initiation and alarm-notification circuits shall be: Class A wiring.

E. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform:

1. Fire Alarm and Detection Operations.
2. Remote Manual and Automatic Control of Elevators, Door Hold-Open devices, Fire Suppression Appliances, Remote Monitoring of Sprinkler, Fire Pump and Emergency Power Systems.
3. Interface and control of Building Security and Access Control Systems.

F. Transmission to Remote Central Station:

1. Automatically route alarm signals using listed and approved equipment. Method of transmission shall be by auto dialer to Sanford Fire Department.
2. Loss of primary power at the FACP shall sound a trouble signal at the FACP and shall indicate at the FACP when the system is operating on an alternate power supply.
3. Annunciation: Manual and automatic operation of alarm and supervisory initiating devices shall be annunciated on the FACP and at the remote LCD annunciator(s).

4. FACP Alpha numeric Display: Shall display plain-language description of alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
5. General Alarm: A system general alarm shall include:

    a. Indicating the general alarm condition at the panel.
    b. Identifying the device that is in alarm at the FACP readout.
    c. Displaying the alarm on an 80-character LCD display.
    d. Operating audible and visible alarm notification signals throughout the building. The strobes shall be synchronized throughout the building.
    e. Sounding a continuous fire alarm signal until silenced by the alarm silence switch at the control unit.
    f. Initiating digitized tone and voice notification.
    g. All visible alarm notification appliances shall flash continuously until the System Reset Switch is operated.
    h. Any subsequent zone alarm shall reactivate the alarm notification appliances.
    i. Closing fire and smoke doors normally held open by magnetic door control devices. Use control modules for this purpose.
    j. Override A/V system audio output upon system activation.
    k. Initiating automatic elevator recall per ASME/ANSI A17.1 and A17.3. Use control modules for this application.
    l. Close smoke dampers and shutdown HVAC equipment. Use control modules for this application.
    m. Release of locked egress doors through Building Security and Access Control System.
    n. All control relays shall be installed and located per NFPA 72-6.16.2.2.

G. Manual Voice Paging

1. One-Way Supervised Automatic Voice Alarm Operations via internal microphone. Separate voice panels and remote power supplies are NOT ACCEPTABLE. The remote subpanels, if any, shall house their own respective signal card, amplifiers, power supplies, and addressable cards designed to communicate back to the main panel.
2. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
3. If any speaker manual control switches are activated, the control panel operator shall be able to make announcements via the push-to-talk paging microphone over the preselected speakers. When the microphone button is released, the Alarm tone shall resume.
4. Facility for total building paging shall be accomplished by the means of an "All Circuits" switch.
5. Speaking in the fire alarm panel microphone will permit the voice signal to be heard over all speaker/strobes in the building simultaneously.

H. Alarm Silencing:

1. If the "Alarm Silence" button is pressed, all audio signals shall cease operation.

I. System Reset

1. The "System Reset" button shall be used to return the system to its normal state after an alarm condition has been remedied. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur, should all alarm conditions be cleared.
2. Should an alarm condition continue, the system will remain in an alarmed state. System control relays shall not reset. The control unit alarm LED shall remain on. The alarmed points will not require acknowledgment if they were previously acknowledged.

3. Upon reset of the fire alarm control unit, air handling units shall sequentially start up to minimize power demand.

J. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activate. However, should an actual alarm occur, all alarm functions would occur as described previously.

K. Power Requirements:

1. The control unit shall receive 120 VAC power.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 60 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control unit.
4. The incoming power to the system shall be supervised so that any power failure must be audibly and visibly indicated at the control unit and the graphic annunciator. A green "power on" LED shall be displayed continuously while incoming power is present.
5. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the control panel and any annunciator(s).

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Fire Alarm System:

Silent Knight

B. Alternate:

Notifier
Fire Lite

C. Automatic Dialer:

Keltron Corporation
Silent Knight
AES Corp.

D. Smoke Control Panel:

Space Age Electronics

E. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 26 01 00.

2.02 CONTROL PANEL

A. Fire system control panel shall be an analog addressable panel containing all necessary control devices and circuits to make a complete and operable system. The panel shall have the following features:

1. 120 VAC supply, low voltage DC operation with automatically recharging emergency battery backup.
2. Equip panel for the number of devices indicated on the Drawings plus thirty for future use. Zone wiring shall be Class A type.
3. Enclosure shall be painted red and gasketed to be dust tight and keyed in accordance with the local authority.
4. Alarm test switch.
5. Flashing light when in an alarm or trouble condition for each zone.
6. Alarm shut off switch to silence the alarms. The light described above shall flash until the alarm condition is removed.
7. Voice splicing capabilities.
8. Handset or Microphone for direct connection with fire alarm speaker units.
9. LCD display to indicate alarm status and trouble alarms.
10. Provide two (2) dry contacts to BAS out of FACP for trouble and alarm.

B. The automatic actuation of any system, Thermo detector, smoke detector, flow switch, or pull station shall cause the following to occur simultaneously.

1. Supervised Fire Alarm Speaker/strobe units to sound and the strobes to flash.
2. Activate control module to override A/V system audio output.
3. Activate interface relays to release held smoke doors and/or control HVAC equipment. Provide one control module per floor for smoke doors.
4. Activate municipal alarm interconnection to local fire department via automatic dialer.
5. Activate indication on Control Panel module and at remote annunciators to indicate zone in alarm conditions.
6. Activate atrium smoke evacuation system, including SEF-1, SEF-2 and supply air damper located on each level.
7. Activate pre-recorded message over speaker systems.
8. Initiate automatic elevator recall per ASME/ANSI A17.1 and A17.3.
9. Initiate override of A/V system audio output.

C. The alarm activation of any elevator lobby smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled in the following sequence:

1. If the alarmed device is on any floor other than the main level of egress, the elevator cabs shall be recalled to the main level of egress.
2. If the alarmed device is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.

D. The alarm activation of any heat detector in the elevator shaft or elevator machine room shall act to disconnect power (via shunt trip device) to the elevator.

E. The alarm indicating appliances may be silenced after three minutes by authorized personnel upon entering the locked control cabinet and operating the Alarm Silence Switch or by use of the key-operated switch at the remote annunciator (if any). A subsequent zone alarm shall reactivate the signals.

2.03 ADDRESSABLE MODULES

A. Addressable Modules: Arrange to monitor one or more system components that are not otherwise equipped for multiplexing communication. Provide one (1) monitoring device for each individual device; sprinkler system tamper, water flow and pressure switches, kitchen hood fire suppression systems, sprinkler system valve cabinet tamper switches, etc.

B. Control Modules: Provide addressable control modules as required. Each module shall provide double pole double throw relay switching for voltages up to 120 VAC. It shall contain easily replaceable 2 amp fuses, one on each common leg of the relay. Provide separate modules for each elevator control room which shall be used to perform primary, secondary, and shunt trip elevator recall operations.

2.04 LCD ANNUNCIATOR PANELS

A. The LCD annunciator panels shall be located as indicated and shall identify the zone in which there is an alarm condition. All trouble alarms shall be indicated at each annunciator panel.

B. The liquid crystal display shall have an eighty- (80) character capacity and be back-lighted.

C. The annunciator panel shall have control switches for system acknowledge, signal silence and system reset which are key enabled. A local audible sounder shall indicate alarm or trouble conditions.

D. The annunciator panel shall be powered from the fire system control panel. The fire system control panel backup battery shall be sized to accommodate this.

E. Panel shall be finished red, flush-mounted and designed for intended location.

F. Provide clear protective cover for each annunciator panel.

2.05 GRAPHIC ANNUNCIATOR PANEL

A. Where shown on the plans provide and install a graphic display annunciator showing a building plan. Annunciator LEDs shall show the location of the alarm or trouble conditions graphically. Graphic annunciator site plan drawing shall be as shown on Drawings FPO.1 and FPO.2.

B. Graphic annunciator shall be in a weatherproof housing capable of being flush mounted at the exterior of the building.

2.06 AUTOMATIC DIALER

A. Provide automatic dialer, hardware and associated programming for alarm transmission via public switched telephone network (PSTN).

1. Dialer shall have 2 RJ45 connections.
2. Dialer shall have sixteen reporting zones.

2.07 ANALOG ADDRESSABLE THERMAL SENSORS

A. Heat detectors shall be of the combination, compensated rate of rise and fixed temperature, restorable type. Fixed temperature rating shall be as recommended by the manufacturer for the intended area.

B. Heat detectors shall be of the fixed temperature, restorable type for utility or mechanical rooms which might have a sudden increase in the temperature due to equipment. These detectors shall be rated 200 deg. F.

C. Unit shall have plug-in addressable base and alarm indication lamp. Unit shall have a communication transmitter and receiver with unique identification and capability for status reporting to the control panel.

2.08 ANALOG ADDRESSABLE SMOKE DETECTORS

A. Automatic smoke detectors shall be of the photoelectric restorable type with pulsed infrared LED light source. Detector shall be designed to be mounted on an addressable interchangeable type base. Detector construction shall have a twist lockable detecting head. Removal of the detector head shall cause a trouble signal. Unit shall have a communication transmitter receiver with unique identification and capability for status reporting to the control panel.

B. Duct-Mounted Smoke Detector:

1. Addressable duct-mounted smoke detector shall be photoelectric type with local alarm indication, alarm test, alarm reset, and full-width sampling tube. Adequate auxiliary alarm contacts shall be provided for required mechanical interlocks. The smoke detector should be tied into the control panel for annunciation with the local fire alarm zone. If the air ducts serve more than one fire alarm zone, then the duct-mounted smoke detector shall be annunciated with each of the zones.
2. Unit shall be installed in an accessible location in accordance with NFPA and the manufacturer's recommendations.
3. Installation and equipment interlocks shall be coordinated with the mechanical trade.
4. Provide remote test station with alarm LED and "CAT 30" test switch for each duct detector.

C. Projected Beam Type Smoke Detector:

1. Long-range photoelectric smoke detector consisting of a separate transmitter and receiver. Light source shall be infrared beam. Range: 30 feet to 350 feet long, 30 feet to 45 feet wide.
2. Remote indicator/test unit shall be provided. Test key switch and normal alarm or trouble lights shall be provided.

2.09 SINGLE STATION CARBON MONOXIDE DETECTOR

A. Automatic CO detectors shall be system connected and have the following features:

1. Detector shall utilize a biomimetic sensor.
2. Detector shall be system connected and powered.
3. Provide monitor modules as required.
4. Speaker output shall be rated at 85dB at 10 feet utilizing a temporal 4 signal.

2.10 GAS DETECTOR

A. Automatic gas detectors shall be system connected and have the following features:

1. Detector shall be system connected and powered.
2. Provide monitor modules as required.
3. Detector shall monitor for Hydrocarbons, H^2S, CO & O^2.

2.11 ADDRESSABLE MANUAL FIRE ALARM STATIONS

A. Manual fire alarm stations shall be manufacturer's standard double-action, keyed reset construction, painted red, semi-flush mounted where possible. Pull stations shall contain communication transmitter and receiver having a unique identification and capability for status reporting to the control panel. Addressable module shall be contained within the pull station.

2.12 NOTIFICATION DEVICES

A. Audible and visual light alarm units shall be provided to alert building occupants of a fire alarm condition. Audible devices shall be of suitable size to provide alarm indicated in the intended area during normal operational conditions. Number indicated on the Drawings is a minimum. Manufacturer shall approve the final layout.

1. Strobes shall be xenon type, with an intensity level as indicated on the drawings and a flash rate between 1 Hz and 3 Hz. The color shall be clear or nominal white.
2. Speaker/strobe alarms shall be provided to alert occupants of alarm condition by means of a pre-recorded message in all assembly areas which require occupant notification. Speaker shall have power taps to obtain the appropriate decibel level for the intended area and a frequency range of 400 to 4000 Hz. Strobe shall be as specified above.
3. Exterior bells or Speaker/strobes shall be UL listed for wet locations. The bell shall be steel finished in red enamel with a sound level of no less than 85 dBA.
4. All strobes shall be synchronized.
5. Where required, provide manufacturer supplied backbox and skirt for surface mount installation.
6. Provide amber mass notification strobe and combination mounting plate as shown in detail in drawings.

2.13 SMOKE DAMPERS AND FIRE SHUTTERS

A. Provide control modules to close all smoke dampers and fire shutters upon activation of local duct mounted smoke detector.

2.14 ATRIUM SMOKE EVACUATION

A. Provide control modules and all wiring necessary to activate the atrium smoke exhaust system upon the activation of any smoke detector or sprinkler zone in the atrium area.

B. Provide firefighter smoke evacuation control panel next to the fire alarm control panel per Building Code of ME. The panel shall have annunciation and control as required in section 909.16.

2.15 ELEVATOR SHAFT VENTS

A. Provide control modules and line voltage thermostats to open the elevator shaft vents upon the following:

1. Power loss
2. Temperature in shaft is above 85 degrees Fahrenheit
3. Fire alarm activates

2.16 FLOW AND TAMPER SWITCHES

A. Flow and tamper switches shall have individual addressable modules.

2.17 ELECTROMAGNETIC DOOR HOLDERS

A. Provide electromagnetic door holders.

1. Rated for multi-voltage (24 VDC/24 VAC/120 VAC).
2. Wall-mounted holders shall be aluminum construction, have 25-pound holding force and shall have all necessary mounting hardware.
3. Magnet protected against transients and surges up to 600 volts.
4. Fail-safe operation; power failure releases door to close.

B. Provide control module to close all smoke doors upon fire alarm activation.

C. The electrical contractor shall wire all electromagnetic door holders furnished by door hardware contractor.

2.18 ELECTRO-MECHANICAL DOOR HOLDER-CLOSERS

A. Provide door holder-closers as shown on drawings. The holder shall allow the door to be held open during normal operation of the building, while providing for automatic closing during fire (emergency) conditions**.** Equipment shall equal to existing or, Sargent 2407 series Fireguard.

1. Closer shall have operating voltages of 24 VAC or 24VDC, or 120VAC at 0.25 amp.
2. Rack and pinion operation, adjustable spring power, door speed, latch speed and back check.
3. Aluminum alloy die cast case, high strength silicon alloy.
4. Test switch and fail safe operation.
5. Magnetic door holders shall be floor or wall mounted adjacent to the doors as noted on the drawings.
6. Holder-closers shall be supplied suitable for the door and frame.
7. Magnetic door holders and closers shall be provided complete by Division 26. Install all door holders and closers in accordance with manufacturer's specifications.

B. The electrical contractor shall wire all electromagnetic door holder closers furnished by door hardware contractor.

2.19 LOCKED KEY BOX

A. Provide an exterior semi-flush mounted vandal-proof lockable weatherproof enclosure shall be and used to hold door keys for the fire department. Knox Box Provide 2 4402 or 4431 and 4 3262 or 3271 per SFD.

B. Key boxes shall have a baked-on enamel finish. Provide color choices for Architect selection.

C. Coordinate requirements with Sanford Fire Department.

2.20 STANDBY BATTERIES

A. Battery cabinet and charger shall be housed in fire alarm control panel. It shall provide low, no, and high voltage battery trouble.

B. Batteries shall be sixty (60) hour capacity in standby mode, followed by alarm mode for ten (10) minutes. Provide sizing calculations with submission of shop drawings.

2.21 TAGS

A. Tags for identifying tested components: Comply with NFPA 72.

2.22 DOCUMENT STORAGE CABINET

A. Provide a secure cabinet designed for storage of fire alarm as-built documents at the fire alarm control location.

2.23 GRAPHIC MAP

A. A diagram/layout of the building divided into numerical and alphabetical grids identifying the location of detection devices, zones, pull stations, and hazardous conditions must be laminated or placed behind a plastic protection cover in a "C" or "D" size print and must be displayed next to the fire alarm control panel and remote fire panels.

2.24 FIREFIGHTERS SMOKE CONTROL PANEL

A. This defines the basic construction and components for a Firefighter's Smoke Control Panel for override functions and monitoring. The panel shall be designed for use with a UL 864, 9th edition UUKL engineered smoke control system in accordance with IBC 909.16. Panel location shall be indoor dry only. The panel design and all equipment connecting to this panel must be approved by the Authority Having Jurisdiction (AHJ).

B. The control panel shall be constructed with a 0.125-inch aluminum substrate and graphic film overlay. The graphic film overlay shall be protected by a non-glare textured coating, which is non-yellowing, durable, and scratch resistant. LEDs, resistors, diodes, etc. shall be mounted on printed circuit boards (PCBs). All switches shall be securely mounted to the panel.

C. The graphic film overlay (graphic face) shall be a multi-colored graphic image as shown in the architect's plan. Important areas such as elevator shafts, stairwells, and main air ducts shall be highlighted for easy identification. The panel supplier shall furnish a color chart with a minimum of 40 accent colors for architect selection.

D. The graphic face shall be bonded to the aluminum substrate with an adhesive that has been proven not to delaminate in similar applications. The adhesive shall achieve 100% bonding without any creases, bumps, or blemishes in the graphic face. The graphic face shall be textured and non-glare. Translucent areas shall be made in the graphic face for backlighted indicators. LEDs shall not protrude through the graphic face. Backlit areas shall be subdued until the LED is illuminated. The illumination of any indicator shall be clearly visible from any viewing angle in front of the graphic face.

E. The aluminum substrate shall have punched holes for LEDs and switches and drilled and tapped mounting holes for PCBs. To prevent oxidation, the aluminum substrate shall have a clear irridited finish.

F. The indicators shall be high intensity LEDs, T-1 3⁄4" size, and rated for normal operation at a maximum current of 20mA. The LEDs shall have an operating life of a minimum of 170,000 hours of continuous or pulsed operation. The LED lens body shall be constructed of high impact plastic. Blue, green, amber, yellow, red, and white LEDs shall be mounted on 0.062" PCBs constructed of epoxy glass material, NEMA Type FR-4, Grade 10. Resistors and diodes for current limiting and LED test shall also be mounted on the PCBs. Solder type, pressed in turrets shall be provided for electrical connections to the LEDs. All field wiring shall terminate on modular screw clamp type terminals or other qualified electronic equipment mounted in the enclosure.

1. Fans, dampers and other operating equipment with “normal” status – white.
2. Fans, dampers and other operating equipment with “off or closed” status – red.
3. Fans, dampers and other operating equipment with “on or open” status – green.
4. Fans, dampers and other operating equipment with “fault” status – yellow/amber.

G. Toggle switches shall be used for smoke control operations unless other switch types are specified. Either a key switch shall be used for panel enable operation or all switches on the smoke control panel shall be key operated. Switches shall be rated for the load served. A key switch with the key removable in the normal position shall be used to silence a trouble sounding device, or a push button switch located in a locked cabinet shall be used to silence a trouble sounding device. A momentary push button shall be provided for simultaneous testing of all LEDs. All switch wiring shall be terminated on modular screw clamp type terminal strips or other qualified electronic equipment mounted in the rear of the enclosure. Switches indicating "on-off-auto" control over each piece of operating smoke control equipment that can also be controlled from other sources. Switches indicating "open-auto-close" control over individual dampers relating to smoke control and that are controlled from other sources in the building. Switches indicating "on-off" or "open-close" control over smoke control and other critical equipment associated with a fire or smoke emergency that can only be controlled from the firefighter’s panel.

H. The enclosure shall be made from cold rolled steel and be assembled using all welded and formed steel construction. The enclosure shall be primed and painted baked enamel with a textured finish or powder coated with a textured finish. A security door with viewing window may be supplied to prevent unauthorized operation of the control panel switches. All enclosures shall be constructed according to UL 864, 9th edition, Section 6 specifications.

I. See drawings for proposed panel layout.

J. Contractor is responsible for meeting with AHJ and engineer to determine final panel layout prior to submittals and fabrication.

K. Panel shall be manufactured by Space Age Electronics.

2.25 SMOKE CONTROL SYSTEMS

A. Smoke control systems shall be equipped with a control unit complying with UL864, 9th edition and listed as smoke control equipment.

B. Provide control modules as required to meet the sequence of operations including but not limited to following:

1. Control on/off operation of smoke exhaust fans.
2. Control open/close operation of doors used for makeup air.
3. Control on/off operation of smoke supply fans.
4. Control on/off operation of smoke accordion doors.
5. Control shutdown of building air handling units and major fans.

C. Provide addressable modules to meet verification requirements of the sequence of operations including but not limited to following:

1. Monitor presence of power to smoke exhaust fans via variable frequency drives and position indication at fan disconnect switches.
2. Monitor presence of power to door operators.
3. Monitor presence of power to accordion doors.
4. Monitor run/off/fail status of smoke exhaust fans via variable frequency drives.
5. Monitor open/close status of doors used for makeup air via position indication switch at door operators.

6. Monitor open/close status of smoke accordion doors via position indication switch at operators.
7. Monitor on/off status of building air handling units and major fans.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Fire alarm system shall be installed in accordance with manufacturer's recommendations. All detector and alarm wiring shall be in 1/2" conduit minimum. Wires shall not have splices, and connections shall be at equipment terminals. Manufacturer recommended wire size, taking into account voltage drop, ampacity, etc., shall be used with #16 AWG for initiating circuits and #14 AWG for alarm circuits being minimum. Provide all necessary wiring to and from the control panel.

B. Fire alarm system shall be approved by the local authority.

C. Fire alarm system shall be tested and if any equipment is faulty or does not operate as intended, that equipment shall be replaced until the system is in proper working order. This shall be done at no additional cost to the Owner.

D. Number and location of heat and smoke detectors shown on the Drawings is approximate only. Coordinate actual number and location with manufacturer's recommended spacing and NFPA 72. If necessary, additional detectors shall be provided to meet these requirements at no cost to the Owner.

E. Audible fire alarms shall be tested to ensure suitable decibel level throughout the building. Low noise areas shall have assumed 40 dBA ambient noise level and high noise areas 80 dBA. Refer to NFPA 72. Additional speaker units shall be provided if necessary to meet NFPA requirements at no cost to the Owner.

F. Power for the control panel shall be provided as shown on the Drawings.

G. Number and location of flow and tamper switches for sprinkler system is approximate only. Coordinate actual number and locations with sprinkler system contractor prior to the installation of any cable or conduit. If necessary, additional devices shall be provided at no cost to the Owner.

H. Provide wire guards on all fire alarm devices in gymnasium and where indicated on the drawings.

I. All fire alarm devices shall be mounted on recessed outlet boxes, wherever possible. If surface mounted fire alarm devices are necessary, all devices shall be mounted on manufacturer supplied, surface mount backboxes or backbox skirts that are designed for use with the specific device.

J. Manufacturer's recommended spacing for heat and smoke detectors shall not be exceeded.

K. All indicated or required interlocks with mechanical equipment shall be provided.

L. Maximum installed loop capacity shall be 80% of allowable. Provide 20% spare capacity on all loops for future expansion.

M. Provide as-built plans with addresses to Owner.

N. Provide a label on each initiation device to identify the system address to comply with local AHJ requirements.

O. Magnetic door Holders shall be floor or wall mounted adjacent to the doors as noted on the drawings.

P. Magnetic door holders shall be provided complete by Division 26. Install all door holders in accordance with installation detail on the drawings. A maximum of fifty door holders shall be wired to each power circuit.

3.02 GROUNDING

A. Ground equipment and conductor and cable shields as specified by the equipment manufacturer. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system. Manufacturer's representative shall provide all final connections within FACP and remote transponders and shall be present during final fire department sign off of system.

B. Provide 100% system test at the end of the installation and provide testing reports to the Owner.

3.04 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.05 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel. Extend training to local fire department. Include in-depth maintenance training to maintenance staff. Include an additional 8 hours above and beyond standard training and testing for this specific purpose.

3.06 DRAWINGS

A. Manufacturer shall supply to the electrical contractor a complete set of engineering documents depicting the following information, the cost of which shall be included in the base price:

1. Complete riser diagrams showing overall system wiring.
2. FACP internal card locations with wire termination points shown.
3. Battery calculations showing standby and alarm current draws for a TRUE indication of the required 60-hour calculation.
4. Architectural prints with just fire alarm equipment and devices using vendor symbology to include address, loop number, and NAC wiring circuit and termination points on the architectural drawings. These should be provided on a per section basis and by floor.
5. A complete table showing all addressable devices, recommenced labeling of devices, and proper switch settings for desired address contained on the drawings.
6. Depiction of wiring with recommended cable chart and point to point wiring layout between all devices.
7. All above items shall be performed on CAD and supplied to the Owner.

END OF SECTION

SECTION 26 71 20

ELEVATOR LOBBY COMMUNICATION SYSTEM

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish and install all Area of Rescue System equipment including, but not limited to, outlet boxes, conduit, wiring, telephones, Master Station and Area Stations, transformers, battery back-ups and dialer as shown on the plans, and all other equipment necessary to provide a complete and operating Area of Rescue Assistance system for the project. Equipment furnished under the terms of this specification shall be the standard product of a single manufacturer.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Product data shall include a detailed system operation description, equipment ratings and capacities, and wiring riser diagrams.

C. Internal control cabinet drawings showing internal block diagram connections shall be provided.

1.04 REGULATORY REFERENCES

A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 260100.

1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALIFICATIONS

A. The Contractor shall be from an established business that has been operating in the area for a minimum of five years.

B. The Contractor shall show evidence that he maintains a service organization and parts inventory to adequately support the supplied equipment.

C. The Contractor shall provide all equipment and accessories for a complete area of rescue system as described herein and shown in the drawings.

D. The Contractor shall currently maintain a locally run business for a minimum of five years and shall be an authorized distributor of the supplied equipment with full warranty privileges.

E. The Contractor shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the equipment Manufacturer to maintain and service the equipment being supplied. This facility shall be available for inspection by the Engineer.

F. The supplying Contractor shall have attended the Manufacturer's installation and service school or have been authorized by the Manufacturer to install the equipment.

G. The Contractor shall furnish Manufacturer's manuals of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper operation of the system must be included. Any bidder using other than the specified equipment must provide this information prior to bidding.

H. As built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied upon completion of project.

1.06 BASIC SYSTEM OPERATION

A. When the system is in normal operating mode, the Master Station shall display an illuminated “green” LED system ready light indicating the system is functioning and operating correctly on AC or battery back-up power. When operated, the system shall provide two-way audio and visual communications between the Master Station or remote location via integrated dialer and each Area Station initiating a request for help. Communication at each Area Station shall be hands-free after initial contact from the Area Station.

B. When a “call for help” is placed by an Area Station, the system shall initiate audio and visual alarms at both the Master Station and each of the affected Area Stations. The audible alarm shall be at least 90 decibels and the visual display shall be indicated by a SuperBrite® LED light and surface engraved or attached engraved location name (ID) directory of the calling Area Station.

C. Communication is established by simply answering via the Master Station. When communication is completed and the Master Station communication link has been broken, the LED display will continue to show the Area Station location (ID) until the system has been reset at the Master Station.

D. When a “call for help” is placed by an Area Station, several indications must be provided at the Area Station to assure the caller that the call is being processed. After pressing the 3” “Push For Help” call button the caller will be provided with both an audio and visual confirmation. A “Help Requested” LED shall illuminate and an alarm will sound at both the Area Station and the Master

Station. When the security attendant at the Master Station has answered the call, the “Help Coming” LED will illuminate and the security attendant’s voice can be heard through the speaker at the Area Station. Full two-way voice “hands-free” communication shall be provided at the Area Stations. The caller simply talks in the direction of the Area Station speaker, which acts as a microphone and enables the caller’s voice to be reproduced at the Master Station. Upon completion of the call, a LED on the Area Station indicating “Help Coming” shall remain illuminated, providing visual indication that the “HELP REQUESTED” LED is acknowledged from the Master Station. The LED will not extinguish until building personnel have reported to the Area of Rescue Assistance and the system has been reset. Resetting the system shall be accomplished by turning a momentary key switch at the Master Station. The system shall also incorporate a momentary key switch at the Area Station if required

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

1. Rath Microtech
2. Talk-A-Phone

2.02 MASTER STATION

A. The Master Station shall be constructed of 16 gauge (0.062) 304 stainless steel. The station enclosure shall be 14”W x 16.11"H x 3”D, be capable of flush mounting and utilize tamper proof mounting hardware. It shall include the following:

B. Panel capacity for a minimum of the specified number of Area Stations.

C. A corded handset and location button for (“Talk”, “Listen”) per Area Station to initiate and respond to a request for assistance from each specific Area Station in the system.

D. When in standby mode, a “green” LED shall be illuminated to indicate the system is operational. Depressing the “Talk” button shall illuminate a “Help Coming” LED at the respective Area Station, silence the piezoelectric alarm, and open up two-way voice communication between the Master Station and Area Station(s).

E. Two SuperBrite® colored LEDs per Area Station to visually indicate “Help Requested” (red LED) or a line fault (amber LED) for each specific Area Station in the system, and to indicate that a fault has occurred at a particular Area Station(s), wiring between Area Station(s) and Master Station, or other system components shall be provided.

F. A piezoelectric alarm shall generate a 90 dBA signal sounding through the Master Station to aurally indicate “Help Requested” from an Area Station.

G. An audio confirmation signal shall be generated from the Master to the Area Station to acknowledge the request for assistance.

H. Acknowledgment of the “Help Requested” call from the Area Station to the Master Station shall also be indicated at the Area Station by the illumination of a red LED (“Help Coming”) on the Area Station.

I. The system shall be able to provide an optional set of N/O dry contacts (if specified) for connection to a secondary Master Station, paging system, fire alarm system, or other optional devices such as a DTMF telephone dialer or PBX telephone system. All communication between Master Stations or DTMF telephones shall be non-blocking.

J. The system shall have the capability to add Master Stations and sub-annunciator panels as specified.

K. It shall be possible to redirect “Help Requested” calls to a secondary Master Station, PBX system, or other outside telephone if there is no answer at the primary Master Station.

L. Provide battery backup capable of sustaining equipment for 90 minutes under normal operating conditions, and 24 hours in standby mode.

Rath Microtech Product#2500-205FM

2.03 AREA STATIONS

A. The Area Station assembly shall be constructed of 16 gauge (0.062) 304 stainless steel. The station faceplate shall be 4.75”W x 7.25"H, be capable of surface or flush mounting and utilize tamper proof mounting hardware. The faceplate shall have the following features:

1. A large stainless steel momentary pushbutton. It shall be activated with a minimum of effort and engineered so that it may be not be accidently depressed. No other hardware shall protrude from the station as high as the pushbutton.
2. A “SuperBrite®” red colored LEDs shall visually indicate and confirm request status to the caller. A solid light for calling and a blinking light indicating call received with the words surface engraved and backfill painted as labels next to the LED.
3. A 3" Mylar 45 ohm speaker shall be provided.
4. A piezoelectric alarm shall generate a 90 dBA signal sounding through the Area Station to aurally indicate “Help Requested” from an Area Station.
5. An extra set of dry contacts shall be provided (if specified) for connection to optional equipment, such as, strobe light, video camera, DTMF dialer, etc.
6. Braille Instructional Signs shall be provided for each Area Station. Signs shall be enclosed in 18 gauge stainless steel frames with tamper proof mounting hardware. Text shall conform with the Americans with Disabilities Act Sec. 4.30.4 for text size and style, be in Braille and English, and read: “HELP PHONE”

   Rath Microtech Product#2100-956S_D

2.04 POWER SUPPLY AND BATTERY BACK-UP

A. The Area Station central power supply shall be constructed of 16 gauge (0.062) steel. The power supply shall be 9.25” H x 8.125” W x 3.75” D and be surface mounted. The power supply shall have the following features:

1. Provide nine (9) 24vdc outputs and each may support up to 5 area stations per output.
2. Shall have internal surge protection.

   Rath Microtech Product# 2500-PWR24

B. The battery back-up shall be provided to support the full system including the Master and Area stations. The battery back-up system shall have the following features.

1. Battery cabinet and charger shall be housed in an appropriate enclosure.

2. Batteries shall be sized to support full system operation for a minimum of 4 hours. Provide sizing calculations with submission of shop drawings.

2.05 WIRING

A. The master to area station wiring shall be MI cable consisting of two (2) pair, 22 AWG, Class B, shielded twisted pair stranded copper wire. Cable shall include a 24 AWG 7 strand tinned copper drain wire.

B. The power supply wiring shall be MI cabling consisting of 18/2 AWG stranded wire minimum. Contractor shall calculate loss based on distance from power supply and upsize conductors as necessary.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

B. Install all wiring in accordance with manufacturer's recommendations.

C. All wiring shall be stranded copper and installed in accordance with specified requirements.

D. System wiring shall be in accordance with good engineering practices as established by the EIA and NEC. Wiring shall meet all established state and local electrical codes. All wiring shall test free from shorts and grounded as specified.

E. All cable shall be as recommended by the manufacturer or an approved equivalent. All Area Station wiring must be home run with individually jacketed cable.

F. Provide a dedicated 120 volt circuit in separate conduit as a source of primary power for the master control/communicator.

G. Provide instruction to the Owner's satisfaction with regard to proper use and operation of the system.

H. The Contractor shall furnish training with the system. These sessions shall be broken into segments that will facilitate the training of individuals in operating the Master Station as well as Area Stations. Operating manuals and users guides shall be provided at the time of the training.

I. Complete system shall be installed in strict accordance with manufacturer's recommendations.

J. All wiring shall be installed in raceways where routed through ceiling areas.

K. Master Station and Area Station mounting shall be in accordance with the ADA recommendations and specifications.

3.02 WARRANTY

A. The entire system shall be warranted against failure and installation defects for a period of one (1) year from the date of the acknowledged Owner acceptance of the final test.

3.03 DRAWINGS

A. Manufacturer shall supply to the electrical contractor a complete set of engineering documents depicting the following information, the cost of which shall be included in the base price:

1. Complete riser diagrams showing overall system wiring.
2. Battery backup indication in panel.
3. Architectural prints with symbols shown using vendor symbology to include address, loop number, and siren wiring circuit and termination points on the architectural drawings. These should be provided on a per section basis and by floor.
4. Depiction of wiring with recommended cable chart and point to point wiring layout between all devices.
5. All above items shall be performed on CAD and supplied to the electrical contractor if so requested.

The proper number of prints required for submission shall be supplied by the manufacturer.

END OF SECTION

SECTION 26 71 70

CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide a complete and operable closed circuit television (CCTV) system, as indicated in specifications and drawings.

B. Work shall be coordinated with the Owner and all costs shall be included in this contract.

C. After installation, the system shall be tested by factory-trained personnel for proper operation.

D. All cameras and hardware shall be provided with all licenses and costs included in the proposal

E. System shall incorporate a remote monitoring station at the main reception desk and at the CTE reception desk.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

D. All trade subcontractors are to note that the organization of these Specifications into divisions, sections, and paragraphs, and likewise the arrangement of the Drawings, is set up for the convenience of understanding the scope of the Work only. This structuring shall not control the General Contractor in dividing the Work among trade subcontractors or in establishing the extent of the Work to be performed by any trade.

1.03 SUBMITTALS

A. Submit product data for wire, cameras, digital video recorder, and other related equipment in accordance with Section 26 01 00.

B. See Section 3.02 for CAD drawing requirements.

C. Provide riser diagram depicting all components and cabling for the proposed system configuration.

D. Bill of materials, including quantities.

E. Provide proof of manufacturer certification.

F. Provide references for previous projects of like size and nature.

1.04 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacturer of CCTV systems of type required, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. Installers' Qualifications: Firms with at least five (5) years of successful installation experience with projects utilizing electrical connections and CCTV equipment similar to that required for this project.

C. CCTV installation Contractor shall be certified by the product manufacturer.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Closed Circuit Television (CCTV) System:

1. Exaqvision

B. IP Cameras:

1. Axis
2. Arecont Vision
3. Panasonic
4. Sony

C. Intercom:

1. Aiphone

D. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 26 01 00.

2.02 GENERAL

A. All equipment and materials used shall be standard components, regularly manufactured, regularly utilized in the manufacturer's system.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. All systems and components shall be provided with the availability of a toll free (U.S. and Canada only) 24-hour, technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge.

D. All systems and components shall be provided with a one day turn around, repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non-warranty items.

2.03 INTERIOR AND EXTERIOR IP PTZ CAMERA SYSTEM

A. The camera system shall be quick and easy to install and is perfect for both indoor and outdoor applications. It shall have a versatile design allowing for multiple mounting options. The integrated camera system shall provide a pole mount installation. Camera shall be a pan/tilt/zoom type camera.

B. The camera shall be provided a smoked bubble.

C. The camera system shall offer a large selection of camera and lens options.

D. The camera system shall meet or exceed the following design and performance specifications.

E. General Specifications:

1. Constructed of aluminum with steel camera mounting bracket and polycarbonate dome
2. Finish with light gray polyester powder coat.
3. Light Attenuation for smoked dome shall be 1.5 F-stops light loss.
4. Weight: 9.46 lbs.

F. Electrical Specifications:

1. Input camera Voltage of 24 VAC (±10%).
2. Power consumption:

   a. Camera, 7.6 watts.
   b. Heaters, 85 watts when active, thermostatically controlled.

G. Mechanical Specifications:

1. Cable Entries:

   a. One 3/4-inch (1.91 cm) NPT threaded opening on side.
   b. Two 3/4-inch (1.91 cm) openings on base.

2. Pan/Tilt Adjustment: Manual, 360° pan; 180° tilt.

H. Video Specifications:

1. Signal System shall be Color NTSC.
2. Video connector: RJ45.
3. Scanning system: 2:1 interlace.
4. Video out: 1 Vp-p composite (75 ohms).
5. Camera resolution: High.
6. Camera shall have a focal length of 3.8-114mm.

I. Environmental Specifications:

1. Environment: Low temperature, indoor/outdoor.
2. Operating temperature: -40°F to 122°F (-40°C to 50°C); de-ices to 25°F (-4°C).
3. Thermostat operation: Heater is thermostatically controlled to activate ON at 50°F (10°C) and OFF at 80°F (27°C).

J. Certifications and Ratings:

1. CE and FCC Class B
2. UL Listed

3. UL listed to Canadian safety standards
4. Meets NEMA Type 4X and IP66 standards
5. Tested in accordance with MIL-STD 810D as follows:

    a. Shock test; Section 516.4
    b. Humidity test; Sections 520.1 and 507.3
    c. Vibration test; Section 514.4

6. ASTM Shipping Standard
7. ISTA Shipping Standard

K. Warranty:

1. 1 year, parts and labor.

2.04 EXTERIOR IP CAMERA SYSTEM TYPE 180 DEGREE

A. The camera system shall be quick and easy to install and is perfect for both indoor and outdoor applications. It shall have a versatile design allowing for multiple mounting options. The integrated camera system shall provide a ceiling mount installation.

B. The camera shall have a clear bubble.

C. The camera system shall offer a 180 degree panoramic view.

D. The camera system shall meet or exceed the following design and performance specifications.

E. General Specifications:

1. Constructed of aluminum with steel camera mounting bracket and polycarbonate dome
2. Finish with light gray polyester powder coat.
3. Unit weight 4.18 lbs. (1.9 kg).

F. Electrical Specifications:

1. Input Voltage of 24 VAC (±10%) PoE.
2. Power consumption:

    a. Camera, 9.2 watts.
    b. Heaters, 43 watts when active, thermostatically controlled.

G. Mechanical Specifications:

1. Cable Entries:

    a. One 3/4-inch (1.91 cm) NPT threaded opening on side.
    b. Two 3/4-inch (1.91 cm) openings on base.

H. Video Specifications:

1. Signal System shall be Color NTSC.
2. Video connector: RJ45.
3. Scanning system: 2:1 interlace.
4. Video out: 1 Vp-p composite (75 ohms).
5. Lens shall have a Varifocal length of 3.8-8.0mm.
6. Camera resolution: High.

I. Environmental Specifications:

1. Environment: Low temperature, indoor/outdoor.
2. Operating temperature: -40°F to 122°F (-40°C to 50°C); de-ices to 25°F (-4°C).
3. Thermostat operation: Heater is thermostatically controlled to activate ON at 50°F (10°C) and OFF at 80°F (27°C).

J. Certifications and Ratings:

1. CE and FCC Class B.
2. UL Listed.
3. UL listed to Canadian safety standards.
4. Meets NEMA Type 4X and IP66 standards.
5. Tested in accordance with MIL-STD 810D as follows:

   a. Shock test; Section 516.4
   b. Humidity test; Sections 520.1 and 507.3
   c. Vibration test; Section 514.4

6. ASTM Shipping Standard.
7. ISTA Shipping Standard.

K. Warranty:

1. One (1) year, parts and labor.

2.05 EXTERIOR IP CAMERA SYSTEM TYPE 360 DEGREE

A. The camera system shall be quick and easy to install and is perfect for both indoor and outdoor applications. It shall have a versatile design allowing for multiple mounting options. The integrated camera system shall provide a ceiling mount installation.

B. The camera shall have a clear bubble.

C. The camera system shall offer a 360 degree panoramic view.

D. The camera system shall meet or exceed the following design and performance specifications.

E. General Specifications:

1. Constructed of aluminum with steel camera mounting bracket and polycarbonate dome
2. Finish with light gray polyester powder coat.
3. Unit weight 4.18 lbs. (1.9 kg).

F. Electrical Specifications:

1. Input Voltage of 24 VAC (±10%) PoE.
2. Power consumption:

   a. Camera, 9.2 watts.
   b. Heaters, 43 watts when active, thermostatically controlled.

G. Mechanical Specifications:

1. Cable Entries:

   a. One 3/4-inch (1.91 cm) NPT threaded opening on side.
   b. Two 3/4-inch (1.91 cm) openings on base.

H. Video Specifications:

1. Signal System shall be Color NTSC.
2. Video connector: RJ45.
3. Scanning system: 2:1 interlace.
4. Video out: 1 Vp-p composite (75 ohms).
5. Lens shall have a Varifocal length of 3.8-8.0mm.
6. Camera resolution: High.

I. Environmental Specifications:

1. Environment: Low temperature, indoor/outdoor.
2. Operating temperature: -40°F to 122°F (-40°C to 50°C); de-ices to 25°F (-4°C).
3. Thermostat operation: Heater is thermostatically controlled to activate ON at 50°F (10°C) and OFF at 80°F (27°C).

J. Certifications and Ratings:

1. CE and FCC Class B.
2. UL Listed.
3. UL listed to Canadian safety standards.
4. Meets NEMA Type 4X and IP66 standards.
5. Tested in accordance with MIL-STD 810D as follows:

   a. Shock test; Section 516.4
   b. Humidity test; Sections 520.1 and 507.3
   c. Vibration test; Section 514.4

6. ASTM Shipping Standard.
7. ISTA Shipping Standard.

K. Warranty:

1. One (1) year, parts and labor.

2.06 INDOOR/OUTDOOR FIXED DOME CAMERA TYPE C

A. The integrated camera and lens shall consist of a high-resolution camera and varifocal lens module that is prepackaged for shipment and which shall allow the installation of the enclosure to precede installation of the camera and lens.

B. The integrated camera system shall provide multiple methods of installation, including the following: surface mounting onto ceiling or wall, recessed mounting in ceiling or wall, and pendant mounting with an optional parapet mount.

C. The DSP color CCTV camera shall meet or exceed the following design and performance specifications:

D. Electrical Specifications

1. Input Voltage:	24 VAC line lock or 12 VDC, autosensing
2. Power Consumption:	5.9 watts or less
3. Video Output:	75 ohms terminated
4. Frequency:	60 Hz
5. Power Connection:	Power over Ethernet
6. Video Connector:	RJ 45

E. Environmental Specifications

1. Operating Temperature: 32° to 122°F (0° to 50°C)

F. Physical Specifications

1. Construction: ABS plastic back box and surface mount ring
2. Dome: Polycarbonate, smoked or clear, with a discrete liner
3. Finish: White or black
4. Dimensions: Recessed: 5.8 inches (148 mm) maximum diameter, 4.1 inches (104 mm) total height, exposed below ceiling, 3.80 inches (9.91 mm) bubble diameter
   Surface Mount: 5.72 inches (14.53 mm) diameter, 4.04 inches (10.26 mm) height, 3.90 inches (9.91 mm) bubble diameter
5. Weight: 0.52 lb (0.24 kg)

G. Mechanical Specifications

1. Camera Mount: 3-axis gimbals mount allowing for 360° of pan, 140° of tilt, and 360° of rotation; once view is set, mount will not move
2. Video Service Connector: On-board service connector port
3. UTP Output: Available

   a. Axis P33 series provide model based on focal range and indoor or outdoor placement.
   b. Provide heater and blower for outdoor mounted cameras

2.07 POWER SUPPLY

A. Cameras within the buildings shall be PoE and mounted building fixed and PTZs shall be powered by local supply as shown on the riser diagram. The power supply shall meet or exceed the following specifications.

1. 24 VAC power supply unit and cabinet
2. 20-ampere capacity
3. Circuit breaker protection; resettable breakers included
4. UL and CE approval
5. AC power indicator with power on/off switch
6. Compatible with supplied cameras
7. Cabinet enclosure suitable for wall mounting

B. The power supplies shall be provided with a manufacturer's warranty covering repair or replacement of defective parts for a period of three years from the date of system commissioning.

C. Individual PTZ cameras provide power supply within 50'.

2.08 NETWORK VIDEO RECORDER

A. Network Video Recorder (NVR) will support IP cameras and have 48 TB of storage. NVR will be mounted in the MDF.

B. Features:

1. Dual redundant hot swappable power supplies.
2. Storage shall provide for a minimum of 30 days of recording.
3. Scheduling and motion detection allow for maximum use of hard drives.
4. Recorder shall be accessible via remote client software.

5. Full unit health monitoring and reporting.

C. Electrical:

1. Input voltage: 100/240 VAC switchable, 50/60 Hz
2. Signal System: NTSC/PAL switchable
3. Compression: H.264, MPEG-4 and MJPEG
4. Video Inputs: IP cameras
5. Video Outputs: Analog composite video (monitor)
6. Remote Connection: LAN, WAN, or internet-based on TCP/IP

D. Mechanical:

1. Connectors 15 pin, D-type, 9 pin, USB, D-type and RJ-45

E. General:

1. Operating temperature 32°to 95°F
2. Mounting: Fits 19-inch EIA standard rack (4RU)
3. Include all necessary components for a complete and operable CCTV video storage system.

F. The NVR shall support RAID 1, 10 & 5 configurations.

G. The NVR shall be rack mountable.

H. The NVR shall run VMS operating system and capable of reporting alarm notifications through SNMP.

2.09 CAMERA POWER SUPPLY

The outdoor power supply will be mounted in a weatherproof, pole-mounted enclosure mounted at pole base. One power supply shall be supplied at each pole-mounted camera location.

A. The power supply shall be as manufactured by Altronics or equivalent.

B. The electrical specifications for the power supply shall be as follows:

1. Input voltage: 120 VAC
2. Input power: 200 VA
3. Output voltage: 24 VAC
4. Output power: 50 VA

C. The environmental specifications for the power supply shall be as follows:

1. Operating temperature shall be 14 to 122 degrees Fahrenheit or -10 to 50 degrees Celsius.
2. Relative humidity shall be up to 90 percent, non-condensing.

The power supply shall conform to these internationally recognized compliance standards: UL.

2.10 WEATHERPROOF ENCLOSURE

A. Provide 16” x 14” x 8” enclosure minimum for pole mounting of power supply, power outlet and camera cabling and transceivers.

1. Provide mounting brackets and mounting board in enclosure.
2. Provide locking hasp for door. Hoffman AQRLSS6 or equivalent
3. Provide thermostatically controlled heater for enclosure.

Hoffman Product #D16148WF or equivalent

2.11 MEDIA CONVERTORS

A. Provide 10/100/1000 TX to 1000SX media convertors to support pole mounted camera locations. Media convertor shall have an SC multi-mode input and Category 6 UTP output.

Transitions Networks

2.12 VIDEO INTERCOM

A. Provide video intercom system at the entrance doors to Main entry, EDC and select other entries. Intercom shall be network ready and consist of a master control unit, flush stainless steel door station and a power supply. Master stations will be located at the reception desks for all door stations.

Aiphone Product #JKW-IP or equivalent

Aiphone Product #JK-DV door station or equivalent

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

1. Proceed with installation only after pathway has been established and unsatisfactory conditions have been corrected.
2. Install systems per the manufacturer's instructions.

3.02 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Coordinate first paragraph below with Drawings.

C. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

D. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

E. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

F. Retain first paragraph below if not indicated on Drawings, or coordinate with Drawings, schedules, and other Sections. Indicate which components are to be fitted with tamper switches and which Section covers tamper-switch connection.

G. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

H. Avoid ground loops by making ground connections only at the control station.

1. For 12- and 24-VDC cameras, connect the coaxial cable shields only at the monitor end.

I. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pre-testing: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

   a. Prepare equipment list described in "Submittals" Article.
   b. Verify operation of auto-iris lenses.
   c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
   d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
   e. Set and name all preset positions; consult Owner's personnel.
   f. Set sensitivity of motion detection.
   g. Connect and verify responses to alarms.
   h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pre-testing has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.04 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.05 SOFTWARE & SUPPORT

A. The CCTV system shall be supported by the manufacturer for no less than one year from date of system turnover.

B. The contractor shall provide forty (40) hours of owner training and setup support at system delivery to owner.

C. The contractor shall provide eight (8) hours of follow up support and set up to owner after 30 days of system use for additional training and system adjustment.

3.06 WARRANTY

A. The system shall be warranted for a period of 1 year from date of acceptance or first beneficial use, whichever occurs first. Written notification shall be sent to the owner stating the date this warranty period has started.

B. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two inspections and preventative tests per year.

3.07 DRAWINGS

A. Manufacturer shall supply to the Electrical Contractor a complete set of engineering documents depicting the following information, the cost of which shall be included in the base price:

1. Complete riser diagrams showing overall system wiring.
2. Connection diagram showing cable between components and interface cabling requirements between systems.
3. Architectural prints with just security/access/camera alarm symbols shown using vendor symbology to include wiring circuit and termination points on the architectural drawings. These should be provided on a per section basis and by floor.
4. A head end depiction showing how equipment is to be laid out and terminated.
5. Depiction of wiring and recommended cable chart and point-to-point wiring layout between all devices.
6. Typical mounting details for each type of camera mounting system.
7. All above items shall be performed on CAD.

END OF SECTION

SECTION 26 72 10

PUBLIC SAFETY RADIO DISTRIBUTED ANTENNAE SYSTEM (DAS)

(Electrical Trade Bid Required)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide Fire Fighter Communication Systems.

B. System shall comply with local Sanford Fire Department requirements.

C. Prior to construction, submit documentation to Fire Department for approval.

1.02 RELATED DOCUMENTS

A. Procurement and Contracting Requirements and Division 01 General Requirements apply to this Section.

1.03 SUMMARY

A. This specification describes the criteria for deploying an Public Safety Radio Distributed Antenna System (DAS). The DAS components specified in this document include: Bi-Directional Amplifiers (BDA), Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, Splitters, Combiners and Couplers. These devices shall be used as part of a system, by the DAS integrator, experienced with designing projects for in-building, public safety, 2-way radio systems.

B. The system specified is based upon TX/RX Systems Bird Technologies Group RescueLine Signal Booster and represents the performance standard upon which any equivalent solution shall be based. It shall be the integrator's responsibility to base the design on the frequency ranges used by and the Fire department. The system provided shall meet IFC 2009 and NFPA 1 2009 codes and shall be designed as such. It shall include a true, integrated battery backup unit which is serially connected to the main BDA system. A remote monitor display panel shall also be included and shall be located in the emergency command center to annunciate all 5 potential conditions of the BDA system. The 5 conditions to be monitored include: Normal AC Power, Signal Booster Trouble, Loss of Normal AC Power, Failure of Battery Charger, Low Battery Power.

1.04 ABBREVIATIONS AND ACRONYMS

A. ACG: Automatic Gain Control

B. AHJ: Authority Having Jurisdiction

C. ATP: Acceptance Test Plan

D. BDA: Bi-Direction Amplifier

E. BOM: Bill-of-Material

F. DAS: Distributed Antenna System

G. EBS: Educational Broadband Service

H. ESMR: Enhanced Specialized Mobile Radio

I. FCC: Federal Communications Commission

J. GUI: Graphical User Interface

K. LMR: Land Mobile Radio

L. MTBF: Mean Time Between Failure

M. NFPA: National Fire Protection Association

N. NMS: Network Management System

O. PSN: Public Safety Network

P. RoF: Radio-over-Fiber

Q. RSL: Received Signal Level

R. SMR: Specialized Mobile Radio

S. SMS: Short Message Service

T. SNIR: Signal-to-Noise Interference Ratio

U. SOW: Statement of Work

V. VSWR: Voltage Standing Wave Ratio

1.05 DEFINITIONS

A. Acceptance: Expressed approval by the AHJ and owners representative

1.06 GENERAL DESCRIPTION

A. The building shall be both pre and post tested for fire department radio signal strength. A test shall be scheduled with the Fire Department. Any expense incurred by the test shall be the responsibility of this trade contractor.

B. A site survey to determine the RF signal strength on or near the building grounds to determine the level of amplification necessary to provide clear and reliable radio communications over 95% of the overall area inside the building will be required.

C. The Fire Department radio test shall check the signal reception in several locations on the floor area. Signal strength shall be for clear reception throughout the building utilizing the type of hand held radio unit that is used by the Fire Department. Quantity of test locations shall be determined and conducted by the local department representative. Each floor of the building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of one (1) area will be allowed to fail the test per floor. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Field strength testing instruments are to be recently calibrated (1 year) and of the frequency selective type incorporating a flexible antenna similar to the ones used on the hand held transceivers.

D. Required Signal Levels:

1. Signal strength shall be for clear reception throughout the building utilizing hand held radio units of the type(s), which are used by the Fire Department. Signal strength testing shall follow TSB-88 standards using delivered audio quality measurements (DAQ).
2. A minimum signal strength of –95 dBm (DAQ4) shall be available on over 95% of the floor area required to be covered when transmitted from the fire department.
3. A minimum signal strength of –100 dBm (DAQ4) shall be received at the fire department system from over 95% of the floor area required to be covered.
4. Critical Areas of coverage include emergency command center, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and similar critical areas.

E. Required Broadcasting Frequency:

1. Frequency to be compatible with Fire Department equipment.

F. The bi-directional antenna type system shall consist of the following components:

1. Bi-directional radio amplifier
2. Plenum rated coaxial cable
3. Antennas (internal and external)
4. Terminators
5. T-taps (if required)
6. Other components and interconnecting circuitry
7. Battery Backup NFPA Compliant unit (not UPS system)
8. Connect power supply to emergency circuit

G. It is the intent of these specifications that where a BDA system is required, a complete fully functioning system shall be installed, approved and tested before an Occupancy Permit is issued.

H. Areas requiring coverage include stairwells corridors, hallways, and other areas designated by the Fire Marshalls and/or the Authority Having Jurisdiction (AHJ).

I. The Contractor shall coordinate with the Fire Marshall's office Communications Division to obtain the correct frequencies and other similar information necessary to deploy a complete and fully operational system at this location.

J. Expansion: Without replacing or adding to the Infrastructure, the system shall have expansion capabilities to support the addition or changes of radio frequencies and future building renovations. Any additional Components required for system expansion shall comply with all specifications of this Section.

K. Alarming: The BDA shall include the following outputs which shall interface to the fire alarm system:

1. Signal booster malfunction alarm
2. Loss of AC Power Alarm
3. Low Battery Alarm
4. Antenna Circuit Malfunction
5. Charge Failure Alarm

Coordinate the installation of these alarms with the Fire Alarm Contractor.

1.07 DESIGN SUBMISSIONS

A. This trade contractor will complete a Fire Alarm Permit Application acquired from the Fire Prevention Division stating a “BDA” installation.

B. Plan Review: Provide one line, schematic and detail drawings of the proposed system architecture. Indicate proposed locations for system components. Provide specifications for procurement and installation of a complete system for review by the Fire Department.

C. Testing and Commissioning: Coordinate the completion date of the Fire Department radio signal repeater system so as to permit a Certificate of Occupancy to be obtained in a timely manner, in accordance with a schedule established by the owner’s project manager.

D. The entire system shall meet with the approval of the Fire Department before a Certificate of Occupancy will be issued.

1.08 QUALITY ASSURANCE

A. Qualifications: The Installer shall employ NICET certified technicians.

1.09 CODES, STANDARDS AND CERTIFICATIONS

A. All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Fire Protection Association (NFPA), National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractors Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the Contractor shall satisfy the most stringent requirements.

B. Requirements set forth by first-responder code, ordinance, or the AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor’s responsibility to ensure that the system complies with local code, ordinances or requirements established by the PSN AHJ.

1.10 REQUIREMENTS

A. WSP DAS:

1. On a per channel basis, the downlink RSL for each frequency band shall meet or exceed Design Audio Quality (DAQ) testing criteria.
2. Prior to installation, Contractors shall confirm the channel count, loading and frequenciesuse in the serving area, and shall guarantee coverage for these channels per DAQ 3.4t criteria. The complete list shall be included as part of the Contractor's submittal
3. The system shall be housed in a NEMA 4 cabinet and shall include specified battery backup.
4. The system shall maintain maximum required output power while preventing excessive emissions per FCC requirements.
5. A sign will be located at the dedicated monitor panel which shall include the name and telephone number of the radio service provider.

1.11 SUBMITTALS

A. The Contractor, prior to beginning the on-site installation, is required to submit , for approval by the owner, a complete list of the proposed equipment with a system diagram showing how the various components are interconnected and their function. Included in the submittal shall be:

1. Product Data: Submit manufacturer datasheets for the following components:

   a. Bi-Directional Amplifiers (BDA)
   b. Donor and Coverage Antennas

c. Coaxial Cable and Connectors
d. Splitters, Combiners and Couplers

2. Shop Drawings: Submit the following items:

a. RF site survey results
b. System overview and riser diagram.
c. Overlay of system components on floor plans.
d. Donor Antenna lightning suppression and grounding details

3. Statement of Work (SOW): Submit a brief description of the DAS integrator role and responsibilities on this project. At a minimum, the services included shall be to perform the RF survey, systems design, test, optimization and commissioning of the DAS system
4. Acceptance Test Plan (ATP): Submit a proposed ATP including cable testing reports. At a minimum, testing requirements shall be design to satisfy requirements of section 3.02
5. Warranty Documents:

a. Submit for all manufactured Components specified in this Section.
b. Submit Contractor's System Warranty.

B. Submittal Requirements at Close Out

1. Drawings: Submit as-built drawings indicating:

a. A final, signed copy of all previously submitted documents reflecting the final, as-built representation, equipment used and details
b. Cable routing, splitters, couplers and coverage antenna final locations
c. Active component locations, layout, configuration and programmed parameters

2. Test Reports

a. Submit Accepted ATP reports confirming the requirements of Section 1.07 have been met.

3. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
4. Warranty Documents:

a. Submit for all manufactured components specified in this Section.
b. Submit Contractor's System Warranty.

1.12 WARRANTY

A. Contractor shall warranty that the BDA equipment furnished shall be free from defects of material for a period of 5 years, beginning on the date of substantial completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. The battery backup unit may carry a standard 1 year warranty. Include any costs necessary to extend the BDA warranty to 5 years.

B. Contractor shall warranty that all other materials furnished shall be free from defects of material for a period of 1 year, from the date of Substantial Completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. Contractor shall warranty the workmanship for a period of 1 year, from the date of Substantial Completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. Contractor shall warranty the system's performance for a period of 1 year, from

the date of Substantial Completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. Immediately upon receipt of written notice from the Owner, the Contractor shall repair or replace at no expense to the Owner, any defective material or work that may be discovered before final acceptance of work or within the warranty period; any material or work damaged thereby; and adjacent material or work that may be displaced in repair or replacement. Examination of or failure to examine work by the Owner will not relieve Contractor from these obligations.

C. Manufacturer Warranty:

1. Splitters, Couplers and Coverage Antennas: standard manufacturer's warranty
2. Coaxial Cable and Connectors: standard manufacturer's warranty
3. Active Components: standard

PART 2 - PRODUCTS

2.01 DAS SYSTEM INTEGRATORS

A. SimplexGrinnell

B. Worad, Inc.

C. Comtronics

D. Or approved equal.

2.02 MANUFACTURERS

A. Specified BDA Manufacturers:

1. TX/RX- Bird Electronics
2. CommScope/Andrew
3. Cellwave Inc.
4. Or approved equal.

2.03 GENERAL

A. The system shall be completed with all components and wiring required for compliance with all applicable codes and regulations, and for its operation as described hereinafter. No exclusion from or limitation in the symbolism used on the drawings or the language used in these specifications shall be interpreted as a reason for omitting any appurtenances or accessories required to enable the system to perform the specified functions.

B. Upon completion of the installation, the work shall include making all arrangements with the owner's project manager and providing any assistance necessary for inspection and test required for approval by the Fire Department. Modifications, adjustments and/or corrective work necessary to obtain approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" shall precede any consideration of formal acceptance by the building owner. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system shall also form a part of the required work. Provide four hours of training.

2.04 POWER SUPPLY

A. The central equipment shall be supplied with an emergency power unit including batteries and battery charging equipment that maintains this cabinet and all outlying equipment . Include 2 each 12VDC/100 A/H batteries in battery backup unit. Batteries shall be of the sealed maintenance free type.

B. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source shall cause a change in system status.

C. Serially connected battery backup interconnecting battery cabinet to BDA unit.

2.05 EQUIPMENT LOCATION AND PROTECTION

A. Secured Space: The bi-directional radio amplifiers shall not be located in electric closet as shown on plans. They shall be located in a suitable non-finished space as approved by the engineer and/or where specifically shown on the drawings. The entrance to the secured space shall clearly identify the space as having the " Fire Department" radio signal repeater equipment, by the use of an attached engraved nameplate.

B. Unsecured Space: The bi-directional amplifiers shall be provided with NEMA 4 enclosures, hinged lockable doors, electric supervision against unauthorized access and the removal of any components, and shall each have an attached engraved nameplate identifying the unit.

C. The bi-directional amplifier shall be supplied with cavity style filtering in order to minimize unwanted frequencies from entering the amplifier. Cavities shall be tuned to the frequencies provided by the Fire Department. Cavity filters will be housed to allow access by technicians, but will be protected from tampering, or accidental damage.

D. The bi-directional amplifier shall contain automatic limiting control circuitry to avoid producing overdriven outputs from the amplifier.

2.06 MAINTENANCE

A. Inspection and Test: Provide all material and labor to test system by verifying operation of the system throughout the building. Adjust to provide optimum system performance. Parts and labor for repairs and/or replacements is excluded.

2.07 COMPONENTS

A. Yagi Donor (Outdoor) Antennas:

1. Electrical:

   a. Frequency band: In accordance with Fire Department requirements
   b. Bandwidth > 1.5 VSWR: 20
   c. Gain: ≥ 15 dB
   d. Maximum input power: 250 watts
   e. Vertical Beamwidth: 44 Deg.
   f. Front-to-back ratio: ≥ 16 dB
   g. Impedance: 50 Ω
   h. Beamwidth, Horizontal, degrees: 60
   i. Azimuth Pattern: As proposed by the manufacturer to meet the specifications in this Section.

j. Include lightning protector

2. Mechanical:

a. Connector: 50 Ω N Type Female
b. Mounting: Pole

3. Environmental:

a. Temperature: -40 °C to +60 °C
b. Lighting protection: Direct ground
c. Waterproof level: IP 66
d. Wind Speed, maximum: 125 mph
e. Wind Load: 0.45 sq. ft.

B. Bi-Directional Amplifier (BDA):

1. Characteristics

a. Frequency: As determined by Fire Department requirements
b. Gain: +80dB maximum
c. Programmable Gain adjustment attenuation, 0-30dB, 0.5 dB steps
d. Maximum Output Power: + 32 dBm
e. Noise Figure: 8 dB maximum
f. Operating Temperature Range: -30 °C to +50 °C

Chassis: Shall be capable of rack or wall mounting by the DAS integrators design.

g. Filtering: Digital
h. Separate Control: Each RF amplifier shall be capable of adjusting and controlling power levels for each WSP when multiple WSPs share a single amplifier.
i. FCC Part 90.219 Type Classification: Class A
j. Alarming: Dry contacts for remote alarms
k. Mounting Options: shall support wall mounting
l. Power Consumption: less than 100VA

2. Compliance:

a. NFPA: The BDA shall comply with NFPA-1 2009 edition Annex O In-Building Public Safety Radio Enhancement Systems.
b. FCC: Shall be FCC type certified.

C. Air Dielectric, Plenum Rated Coaxial Cable (equal to ICA12-50JPLW):

1. Material Characteristics:

a. Jacket: Halogenated, Fire-Retardant, Plenum rated
b. Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
c. Inner Conductor Material: Copper-Clad Aluminum Wire

2. Electrical Characteristics:

a. Impedance: 50 ± 2.0 Ω
b. Frequency Band: 1 - 8800 MHz
c. Peak Power Rating: ≥ 40.0 kW

3. Mechanical Characteristics:

   a. Diameter Over Jacket: ≤ .627 in
   b. Minimum Bending Radius: ≤ 5 in
   c. One Time Minimum Bending Radius: ≤ 3 in
   d. Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

D. Foam Dielectric Cable: To be used for donor antenna and outdoors.

1. Material Characteristics:

   a. Jacket: Non-halogenated, Fire-Retardant Polyolefin
   b. Outer Conductor Material: Corrugated Copper
   c. Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube

2. Electrical Characteristics:

   a. Impedance: 50 ± 1.0 Ω
   b. Frequency Band: 1/2” Nominal: 1 - 8800 MHz, 7/8” Nominal: 1 - 5000 MHz
   c. Peak Power Rating: ≥ 40.0 kW

3. Mechanical Characteristics:

   a. Diameter Over Jacket: 1/2” Nominal: ≤ .630 in, 7/8” Nominal: ≤ 1.1 in
   b. Minimum Bending Radius: 1/2” Nominal: ≤ 5 in, 7/8” Nominal: ≤ 10 in
   c. One Time Minimum Bending Radius: 1/2” Nominal: ≤ 2 in, 7/8” Nominal: ≤ 5 in

4. Attenuation Characteristics: 1/2” Nominal

   Frequency (MHz) Attenuation (dB/100ft)

   450 ≤ 1.447

   Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Attenuation Characteristics: 7/8” Nominal:

   Frequency (MHz) Attenuation (dB/100ft)

   450 ≤ .744

   Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall install the DAS in accordance with the integrator’s instructions and recommendations.

B. Installation shall include the delivery, unloading, setting in place, fastening to walls, floors, ceiling, or other structures and where required, penetration fire-stop, interconnecting wiring of the system components, equipment alignment and adjustments, and all other work whether or not expressly required herein which is necessary to result in complete operational system.

C. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements and recommendations of National, State, and Local Authorities having jurisdiction. All distributed antenna cables shall be installed such that the cables are straight as possible.

D. During the installation, and up to the date of final acceptance, the integrator shall be under obligation to protect his finished and unfinished work against damage and loss. In the event of such damage or loss, he shall replace or repair such work at no cost to the owner.

E. All equipment shall be properly mounted on equipment racks or walls and secured in place. Wall mounted equipment shall be mounted over a ½" plywood securely attached to the wall.

F. Cables shall be properly supported with dedicated hangers or brackets. Cable trays shall be used only if they are dedicated low voltage trays and only with approval from the owner.

G. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three.

H. All boxes, equipment, etc shall be secured plumb, level and square.

I. In the installation of equipment and cable, consideration shall be given to operational efficiency and overall aesthetic factors. Antennas shall be centered and in-line with other ceiling mounted devices

J. All cables, regardless of length, shall be marked with cable markers reading "Public Safety Radio", at regular intervals but not less than every 30 ft. There shall be no unmarked cables in the system. In addition, markings codes at each end of the cables and patch panels shall correspond to codes shown on drawings and/or run sheets.

K. All cables the integrator installs must be handled in accordance with the manufacturers guidelines. Transmission line cables have minimum bending radius specifications that shall be followed. In the event a cable is kinked or bent excessively during installation that section of cable cannot be used, even if subsequently straightened. The damaged area of the cable shall be removed and a new section installed using correct splice methods. Ultimately the cable must pass the testing and meet the manufacturers requirements

L. Radio communications cabling shall not be grouped with electrical cabling. It can only share sleeves and raceways with other low voltage data and communications cables.

M. Connection between cables and other antenna components shall use N-Type premium connectors. No splicing is permitted.

N. All power dividers shall be securely mounted in place by bolting the mount to a solid surface or securing each by suspension on the cables within 4 inches of each connector termination at the power divider. The transmission lines connecting to the device shall be routed in the shortest possible path.

3.02 GROUNDING PROCEDURE

A. In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:

B. System Ground: A signal primary "system ground" shall be established for the system. All grounding conductors in that area shall connect to this primary system ground. The system ground shall consist of a copper bar of sufficient size to accommodate all secondary ground

conductors. An extension of the ground shall connect to the buildings lightning protection system per the direction of the on-site electrical engineer.

C. A copper conductor, having a maximum of 0.1 Ohms total resistance, shall connect the primary system ground bar to the primary system ground ring.

D. Secondary system grounding conductors shall be provided from all racks, radio consoles, and undergrounded radio equipment in each area, to the primary system grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.

E. Under no conditions shall the AC neutral conductor, either in the power panel or in receptacle outlets, be used for a BDA system ground.

F. Radio cable Shields: All radio cable shields shall be grounded at both ends.

G. General: Because of the great number of possible variations in grounding systems, it shall be the responsibility of the installer to follow good engineering practice, as outlined above, and to deviate from these practices only when necessary to minimize crosstalk and to maximize signal to- noise ratios and reduce interference in the radio systems.

3.03 CABLE AND CONDUIT

A. Note the following circuitry requirements:

1. Conduit intended for use with the firefighter's communication bi-directional radio amplifier system shall be steel electric metallic tubing (EMT), except as follows:

   a. It shall be galvanized steel intermediate conduit where mounted within 8'-0" of the floor in mechanical spaces or otherwise exposed to mechanical damage, or where intended for embedment in concrete.
   b. It shall be galvanized steel intermediate conduit if local authorities prohibit use of EMT.
   c. It shall be rigid galvanized steel conduit for the power supply to the central equipment and to all outlying equipment cabinets requiring a 120-volt or 120/208- volt supply.

2. Where wires and cables are permitted to be run without conduit, they shall be independently supported from the building structure or ceiling suspension systems at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables shall not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners or bars in the plane of the ceiling), nor shall they be supported from pipes, ducts or conduits. Bundling and/or supporting ties shall be of a type suitable for sue in a ceiling air handling plenum regardless of whether or not installed in a plenum.

3. Cables shall be tagged or labeled at each termination point and in each intermediate junction box, pull box or cabinet through which they pass, as well as intervals not exceeding 50 feet on centers where cables are run without conduit.
4. Comply with applicable building and electrical code requirements for locating and routing circuitry, for installing circuitry, and for fire stopping.
5. The covers of all dedicated junction, pull boxes shall be painted red and labeled "Fire Dept. Radio System". Junction and pull boxes will not be shared with other systems.
6. Cables other than radiating coaxial cables shall be run in conduit where indicated by the Engineer. Where not indicated, cable shall be installed per manufacturer's recommendation. Conduit shall be electric metallic or threaded conduit subject to the restrictions specified elsewhere for light and power circuitry.

7. Radiating coaxial cables shall be run without conduit. Where installed in a plenum type ceiling cable insulation shall be of a fire-resistant low-smoke producing type, with a minimum rating of CATVR. This classification shall be clearly marked on the outer surface of the cable at regular intervals.

3.04 ACCEPTANCE TESTING

A. Submit certification that system is compatible with Fire Department radio systems prior to installation.

B. Verify proper operation of system by means of field test with:

1. Fire Department requirements, and include all adjustments and modifications to the system required for proper operation. Coverage of each floor of the building to a minimum of 95% is required for acceptance.
2. No activation, or power up of any RF equipment is permitted without first obtaining permission of the Fire Department. This includes any testing or calibration.
3. The Contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.

C. Acceptance Test Procedure: Upon completion of installation, the building Owner will have the option to participate in the radio system tested to ensure that two-way radio coverage on each floor of the building is a minimum of 90 percent. and be tested as follows:

1. Each floor of the building shall be divided into a grid of 20 or more, approximately equal areas. No two test locations shall be greater than 50 ft apart
2. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communications system.
3. No area designated as critical and no two adjacent areas shall be allowed to fail the test.
4. In the event that any three non-adjacent, non-critical areas fail the test, in order to be more statistically accurate, the floor may be divided into smaller areas. In the event that three noncritical, non-adjacent areas still fail the test, the Contractor shall reconfigure the system to meet the 90-percent coverage requirement with no three adjacent areas failing.
5. A test location approximately in the center of each grid area shall be selected for the test by the public safety or owner's representative, then the radio shall be enabled to verify two-way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected, that location shall represent the entire area. If the test fails in the selected test location, that grid area shall fail, and prospecting for a better spot within the grid area shall not be allowed.
6. The gain values of all amplifiers shall be measured and the test measurement results shall be noted on the as-built drawings and the O&M manuals so that the measurements can be verified during annual tests.
7. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to insure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at time of system acceptance.

END OF SECTION

SECTION 26 72 30

ACCESS CONTROL SYSTEM

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 SUMMARY

A. Work Included:

1. The project is being bid to authorized dealers of Security Management Systems (SMS) only.
2. Provide new main control panel in new server room and nodes as required.
3. Provide capacity on system and all boards, controllers and power supplies for system as designed and 20% future growth.
4. The work includes providing all labor, materials, tools, equipment, programming, and documentation required for a complete and working security management system as specified in this document.
5. Work shall be coordinated with the Door Hardware Contractor.
6. Contractor to provide complete and operable Security Management System.
7. System shall be integrated and coordinated with the active shooter lockdown & mass notification system.
8. Provide all necessary licenses as required.
9. Provide client software and set-up of four (4) security stations on Owner-provided workstations.

B. Related Work Provided By Others:

1. The Contractor shall coordinate the work with the related work provided by other contractors including but not limited to the following:

   a. Power and pathways by Electrical Contractor.
   b. Network connections by Telecommunications Contractor.
   c. Mass Notification system (MNS) by MNS Contractor.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

D. All related specification sections shall be used in conjunction with this section.

1.03 QUALITY ASSURANCE

A. Product Standards:

1. All materials included in the completed Security System installation shall be new and shall fully comply with the latest published specifications of the manufacturer.
2. Unless otherwise specified, all components included in the completed Security System shall be standard, unmodified production models.
3. All equipment provided shall be fully supported by the manufacturer. The manufacturer shall provide written policies identifying product support and continued support policies for discontinued equipment. The manufacturer shall provide examples of continuing support for discontinued equipment.
4. References:

   a. Design and operation of the system shall conform to the following referenced codes, regulations, and standards as applicable:

      1) National Electrical Code (NEC)
      2) UL 294, UL864 and UL 1076
      3) FCC Rules and Regulations
      4) Part 15, Radio Frequency Devices
      5) National Electrical Manufacturers Association (NEMA)
      6) Section 250 Enclosures for Electrical Equipment
      7) Applicable Federal, State, and Local laws, regulations, and codes.

B. Contractor Qualifications:

1. Only qualified manufacturer licensed dealers are approved to bid on this Project. No other bids will be considered.
2. The Contractor shall have a minimum of five years' experience in the fabrication, assembly, and installation of systems of the magnitude and quality equivalent to those specified herein.
3. The Contractor shall have completed at least three projects of similar size and nature.
4. The Contractor shall have installed the products bid for this project at a minimum of one other location.
5. The Contractor shall maintain a local service center within 150 miles of the installation location. The service center shall be staffed and adequately equipped to provide emergency service within four (4) hours after being called during normal business hours.
6. The Contractor shall provide factory-certified technicians to install and maintain the systems provided. The Bidder shall furnish information in the Bid Package to demonstrate compliance with this requirement.
7. The Contractor shall ensure compliance with and an understanding of all local codes and contract conditions pertaining to this Project.
8. The Contractor shall comply with union trade requirements.
9. The Contractor shall assign a project manager to the Project that has been approved by the Owner and Engineer.
10. The approved project manager shall be assigned for the duration of the Project and must not allow other contracts or assignments to interfere with his/her duties and responsibilities to this Project.
11. The approved project manager shall have a minimum of five years' experience as a project manager in the security integration industry.
12. Security vendor shall organize and facilitate a one-day on-site installation coordination meeting with Owner representatives, Architect, Engineer, and door hardware supplier to coordinate sequence of operation, door hardware, and wiring, etc., for all doors included in the system.

13. All Security Management System equipment shall be coordinated with Door Hardware specification section.

1.04 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Provide product data for all equipment to be provided.

C. Provide a complete riser diagram showing all components, power supply calculations and wiring diagrams.

D. Submit backboard elevation.

E. Floor plans indicating all devices and locations.

1.05 WARRANTY

A. Provide a two-year product warranty on all hardware from date of completion.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Access Control System:

1. RS2
2. S2
3. Software House

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 26 01 00.

2.02 ACCESS CONTROL SYSTEM

A. General:

1. The Security Management System shall be implemented through network appliance architecture with a three-tiered modular hardware hierarchy and embedded three-tier software architecture.

    a. The network appliance shall be capable of running on an existing TCP/IP network and shall be accessible, configurable, and manageable from any network-connected PC with a browser.
    b. Browser access for configuration and administration of the system shall be possible from a PC on the same subnet, through routers and gateways from other subnets, and from the Internet. Control and management of the system shall therefore be geographically independent.
    c. Security of the data communicated over the network to and from the browser, Network Controller, and nodes are protected by encryption (SSL 128-bit) and authentication (SHA-1).

2. The system shall integrate, within a browser interface, access control, alarm monitoring, video monitoring, and temperature monitoring applications. These applications shall be embedded in a three-tier software architecture.

    a. The database tier shall be a full featured, high performance database management system. This shall provide a small footprint, low administration, and high reliability relational database that is embedded without requiring the use of a separate PC server.
    b. The web browser shall provide UL 1076 compliant browser-based monitoring and incorporate asynchronous Javascript™ and XML technology (AJAX) for a faster user experience.
    c. The security application software tier contains the business logic. This application shall also be embedded on the network device and requires no additional memory or processing power.
    d. This three tiered embedded software design runs within an embedded Linux operating system and shall require no client-side software other than a web browser.

3. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.
4. All systems and components shall have been thoroughly tested and proven in actual use.
5. All systems and components shall be provided with an explicit manufacturer warranty of one year for software and two years for hardware.

2.03 OVERALL SYSTEM CAPABILITY

A. The Security Management System shall meet the requirements of school access control systems. The system shall monitor and control facility access, and shall perform alarm monitoring, camera and video monitoring, communications loss monitoring, and temperature monitoring. The system shall also maintain a database of system activity, personnel access control information, and system user passwords and user role permissions. The system shall be controlled from a web browser and require no software installation or client licenses. The system shall provide control and access to users on Local Area Networks (LAN), Wide Area Networks (WAN), wireless networks, and the Internet. The system shall provide email and/or text message alerts for all alarm conditions and threats.

B. Widget Desktop (as applicable): The system shall provide a widget-based user interface that enables users to create custom monitoring layouts by selecting and arranging widgets on a desktop. Each widget shall provide easy access to a frequently used function—allowing users to, for example, view an activity log, a camera view, or real-time web content. System administrators can save custom layouts for subsequent call up by users, who can then arrange the widgets as desired on their desktops. The administrator shall determine which widgets are available in a layout and the extent to which users can customize the layout.

C. System Partitioning: The system administrator shall have the ability to divide the system into partitions, allowing subsets of the overall population and/or resources to be managed separately.

    1. From the default Master partition, one or more additional partitions can be created.
    2. Each partition shall contain some number of administrators, card holders with their credentials, and resources.
    3. When performing administrative functions, the administrator of a partition shall have the ability to affect only the cardholders and resources in that partition. However, resources can be shared across partitions through the mapping of access levels from one partition to another.
    4. System partitioning shall have a precision feature that allows administrators in one or more partitions to view and perform edit functions on person records that belong to another partition.
    5. System shall be provided with all necessary Enterprise partitioning licensing.

D. The system shall provide the following Access Control capabilities:

1. Integrated photo ID creation capability with video verification.
2. User interface secured access under encrypted password control.
3. System-wide timed anti-passback function.
4. Regional anti-passback with mustering and roll call functions.
5. Region occupancy counting and control.
6. “First-in-unlock” rule enforcement.
7. Multiple access levels and cards per person.
8. 128-bit card support for Weigand card readers.
9. Detailed time specifications.
10. Simultaneous support for multiple card data formats.
11. Elevator control.
12. Access privileges variable by threat level.
13. Scheduled portal unlock by time and threat level.
14. Card format decoder quickly discovers unknown card formats.
15. Card enrollment by reader or keyboard.
16. Compatibility with various input devices, including biometric readers.
17. Activation/expiration date/time by person with one minute resolution.
18. Access level disable for immediate lockdown.
19. Use of Threat Levels to alter security system behavior globally.
20. Multiple holiday schedules.
21. Timed unlock schedules.
22. Scheduled actions for arming inputs, activating outputs, and locking and unlocking portals.
23. Card enrollment reader support.
24. Counted-use access control.
25. Dual-reader portal support.
26. Wiegand Reader support.
27. Magnetic-stripe reader support with cards using ABA Track 2 format for up to 200 bits.
28. Wiegand keypad PIN support for 4-digit or 6-digit PINs.
29. 8-bit and 4-bit burst keypad support for 4-digit or 6-digit PINs.
30. Integration with supported alarm panels.
31. Optional storage and recall of ID photos and personal/emergency data.
32. Up to 395,000 card records.

E. The system shall provide the following Monitoring capabilities:

1. Common alarm panel integration for disarm on access, and arm on egress.
2. Integrated alarm monitoring and event management with alarm panels.
3. Support for the direct viewing of IP cameras.
4. Integrated real-time IP, DVR, and NVR systems with stored video replay for events.
5. Provides alarms on video loss, video motion detection, and video restore events.
6. Virtual inputs for video loss and building-occupancy-limits-exceeded.
7. Provides alarms on communication loss and temperature variation.
8. Support for the creation of custom sets of alarm event actions.
9. Provides the ability to record video and link to video for alarm events.
10. Available video control and playback through the system user interface.
11. Provides the ability to assign threat levels to various alarms according to severity.
12. Provides the ability to select up to 20 levels of priority for event actions.
13. Support for electronic supervision of alarm inputs.
14. Support for the use of output relays for enabling circuits under alarm event control.
15. A monitoring desktop that integrates video, system activity logs, floor plans, ID photos, and alarm notifications.
16. Support for the creation of unlimited customized monitoring layouts through the use of widgets.
17. Graphic floor plans with active icons of security system resources.

18. System user permissions to grant whole or partial access to system resources, commands, and personal data.
19. Secure access to the user interface under encrypted password control
20. Delivery of alerts via browsers, email, and text messages.

F. The system shall provide the following Video Management capabilities:

1. Real-time video monitoring displays, including unlimited cameras simultaneously.
2. Playback of event-related video.
3. Video switching and video widget pop-ups based on access activity or event activation.
4. Integrated alarm inputs from the video management system.
5. Digital playback of video events.
6. Linking of video and events based on triggers provided by the system or video system.
7. Support for multiple DVR and NVR systems.
8. Multiple pre-programmed supported cameras.
9. Recall of photo ID and real-time image for comparison.
10. Monitoring and control through a web browser interface.
11. System user permissions to grant whole or partial access to system cameras and video resources.

G. The system shall provide the following Security Database capabilities:

1. Maintain data of system activity, personnel access control information, system user passwords and custom user role permissions for whole or partial access to system resources and data.
2. Partitions: It shall be possible to partition the system to create independent, virtual security management systems for multiple populations.
3. Support for the sharing of access levels and user privileges across partitions in a system.
4. Built-in Open Database Connectivity (ODBC) compliant database for personal data.
5. LDAP integration for single-user logon authentication.
6. Up to 395,000 card records.
7. Network-secure API for external application integration.
8. Extensive and easy to use custom report generator.
9. User-defined data fields in personnel records.
10. Record recall by vehicle tag, name, or card.
11. ODBC compliant Database.
12. An API for adding to, deleting from, and modifying the database.
13. Storage of system user passwords and permissions.
14. Storage and recall of ID photos and emergency personal information.
15. Pre-defined reports on system configuration, system activity history, and people.
16. English-based query language for instant custom reports.
17. Custom report writer interface that allows the interactive creation of custom reports. Reports may be saved for later reuse. No third party software (such as Crystal Reports) shall be necessary.
18. Periodic backup to on-board flash ROM and optional network attached storage (NAS), including FTP servers.
19. Periodic archive creation for historical custom reporting and improved on-board database performance.
20. Email and text messaging (SMS) alert notifications.

2.04 HARDWARE REQUIREMENTS

A. The Security Management System shall employ a modular hardware concept that enables simple system expansion:

1. Network Control Processor: Shall contain the database engine, web server, application software, and configuration data. Users shall interact with a browser interface to set configurations, monitor activities, run reports, and manage alarms.

2. Network Node: An intelligent device with native TCP/IP support, which shall make and manage access control decisions.
3. Application extension boards: Each of these boards shall connect to and manage a set of inputs, outputs, readers, cameras, or temperature monitoring points.
4. The network device shall run on existing building TCP/IP networks and shall be configurable for access from separate subnets, through gateways and routers, and from the Internet. A MicroNode shall also be available that combines an Access Control boards and Network Nodes.

B. The System Control Processor shall be housed in a wall-mount enclosure. It shall contain a motherboard with an Intel® Atom™ processor and solid-state disk drive. An Ethernet connector shall be provided for network connection. The Network Controller shall have the following capabilities:

1.	Reader inputs:	64
2.	Access cards:	395,000
3.	Access levels:	32 per card
4.	Concurrent system users:	10
5.	Transaction buffer:	50,000
6.	Control point outputs:	16 per board
7.	Ethernet switch ports:	1
8.	Access levels per person:	32 per partition

2.05 HARDWARE PACKAGING REQUIREMENTS

A. The Wall-Mount enclosure supports one solid-state Network Control processor and up to eight application boards. The dimensions are: 24" (610 mm) H x 18" (457 mm) W x 4.5" (114 mm) D.

B. The solid-state Controller shall be powered by 110V AC at 50-60 Hz at 3 amps. Power must come from a separate circuit with an isolated earth ground. If AC power is supplied it must be connected to the internal power supply. If DC power is supplied the internal power supply shall be bypassed. It shall be possible to backup power supplied to the system with an Uninterruptible Power Supply (UPS). It shall also be possible to place within the wall-mount enclosure an SLA battery backup sufficient for an orderly shutdown in case of external power loss.

C. The wall-mount enclosures shall have a lock requiring a key, and a cabinet door tamper switch.

D. Input board: The input board shall receive power via the on board power supply. It shall support a wide variety of input supervision types including normally-open circuit and normally-closed circuits, and zero, one or two resistor configurations.

1.	2-pin supervised programmable input connectors	16
2.	Maximum input wire length	4000 feet (1200 m) (22 AWG twisted, shielded

E. Output board: The output board shall receive power via the on board power supply. Both normally-open circuit and normally-closed circuit output devices shall be supported. The relay outputs shall support any output devices that operate on the following maximum electrical ratings: 28 Volts DC, 5.0 Amps inductive or 5.0 Amps non-inductive.

1.	3-pin relay output connectors	15
2.	Maximum output wire length	4000 feet (1200 m) (22 AWG twisted, shielded)

2.06 SOFTWARE REQUIREMENTS

A. Operating System and Application Software:

1. The software system for the system shall be of an Outlook® style configuration. The operating system kernel shall be open-source and no operating system training or certification shall be necessary.

B. Software Licensing:

1. Software licensing shall be based upon the total number of readers for one Network Controller board. Software license upgrades shall be available if system reader and camera capacity must be raised. The user license shall be valid in perpetuity and shall include one year of software updates from the date of shipment from the factory.
2. Licensing shall be controlled by a Product Key and an Activation Key. The Product Key contains the licensed system features and limits. To upgrade your system license to enable more cameras or more doors you will need a new Product Key. The Activation Key contains the warranty expiration date. The keys are locked to the system license number. The system license number shall be viewable on-screen on the Support: About page.

C. Software Upgrades: Software upgrades shall be possible from a browser on any network-connected PC, by uploading a software update to the Controller. Controllers shall automatically upgrade all connected nodes. No client software installation shall be necessary.

D. Online Help and Documentation: The system shall be provided with complete embedded documentation. The on-line documentation shall include:

1. Context-sensitive online Help. (The Help displayed is specifically relevant to the current screen.) The online Help system shall provide explanations and procedures for all monitoring, administrative, and system configuration and maintenance functions. The Help system shall have linked table of contents, a linked index, and frequently asked questions pages. Each topic shall also have links to related topics. Each Help topic shall be printable.
2. Technical Support Notes: These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
3. Installation Guides: These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
4. Video Integration Guides: These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
5. System Administration Guide: This document shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
6. The Help system shall also be available in a zip file format (xxx.zip) and it shall be possible to install the online Help system on any computer for purposes of reference and use by support personnel.

E. Language Support: The system shall be provided with multiple language support. The ability to switch from one language to another shall be accomplished through the user interface. Translation of the user interface, online help and documentation into other languages shall be available. The languages supported shall include:

1. English
2. Spanish
3. Portuguese
4. French
5. Italian
6. Thai

7. Chinese
8. Japanese

F. Date Formats: The system shall support global date formats as follows:

1. mm/dd/yyyy
2. dd/mm/yyyy
3. yyyy/mm/dd

G. Floor Plans: The system shall provide graphic floor plan capability including graphic display of links to other floor plans, alarms, system resources such as portals, IP video cameras, inputs, outputs, and temperature monitoring points.

1. The Network Administrator holding at least a 'Setup' user role shall be able to graphically configure device icons onto the floor plan images, and to upload additional floor plan images. JPEG images shall be supported, and the maximum size for a floor plan image shall be 256K.
2. It shall be possible to create floor plan groups for the purpose of assigning or withholding assignment of these groups to system user permissions known as Custom User Roles. If a floor plan group is assigned to a particular system user then the floor plans in that group shall be viewable by that system user.

H. Personnel Data: The system shall maintain person data relating to access control, system user privileges, photo identification, system activity, and contact information.

1. All person data in the system shall be integrated onto one tabbed page for viewing, editing, and deletion by system users.
2. A system user holding at least an 'Administer' user role shall be able to create, delete, and modify person records, including access levels.

I. Data Import and Export: A Data Management Tool shall be provided that supports, via an API, the import and export of personnel data. This tool shall make possible the pre-populating, and ongoing populating, of cardholders into the system database. Data that shall be importable shall include:

1. LASTNAME
2. FIRSTNAME
3. MIDDLENAME
4. ACTDATE (activation date)
5. EXPDATE (expiration date)
6. NOTES
7. TEXT1...TEXT20 (user defined fields 1 through 20)
8. ACCESSLEVEL1...ACCESSLEVEL32
9. PERSONID
10. PIN
11. ENCODEDNUM1...ENCODEDNUM10
12. HOTSTAMPNUM1...HOTSTAMPNUM10
13. CARDFORMAT1...CARDFORMAT10
14. BADGELAYOUT
15. JPEG ID PHOTO
16. CONTACT PHONE
17. CONTACT EMAIL
18. CONTACT SMS EMAIL
19. CONTACT LOCATION
20. OTHER CONTACT NAME

21. OTHER CONTACT TELEPHONE
22. OTHER CONTACT TELEPHONE2
23. VEHICLE 1 COLOR
24. VEHICLE 1 MAKE
25. VEHICLE 1 MODEL
26. VEHICLE 1 STATE
27. VEHICLE 1 LICENSE#
28. VEHICLE 1 TAG#
29. VEHICLE 2 COLOR
30. VEHICLE 2 MAKE
31. VEHICLE 2 MODEL
32. VEHICLE 2 STATE
33. VEHICLE 2 LICENSE#
34. VEHICLE 2 TAG#

J. Data Security:

1. Communication between the Network Controller and the browser shall be secured using SSL. In addition, administrative access to the security management application and the personnel data shall be password protected and controlled by roles-based authorizations.
2. Communication between the Network Controller and the Network Nodes shall be encrypted and authentication/tamper detection shall be done using the SHA-1 algorithm.

K. Data Backups: It shall be possible to configure regular automatic database backups.

1. It shall be possible to back up a solid-state Network Controller to an on-board compact flash.
2. It shall also be possible to save backups from any controller to separate network attached storage (NAS) and file transfer protocol (FTP) servers.
3. It shall also be possible to setup regular automatic creation of database archive files.

L. Partitions: It shall be possible to create multiple partitions for the management of multiple security systems or multiple populations.

1. It shall be possible to limit access to the data and resources of one partition to those with permissions for that partition.
2. It shall be possible for each partition to have its own population, resources, rules, events, video management, log data, reports, and network resources.
3. It shall be possible to grant Monitor, Administer, and Setup privileges for multiple partitions to the same user. It shall also be possible to create custom user roles for each partition.
4. Each partition shall require at least one Node.

M. User Roles and Permissions: There shall be four pre-programmed levels of User Roles, and a total of 16 possible Custom User Roles that can be configured in the system with different permissions for each user:

1. Master Partition Monitor: These users may use the functions in the Monitor menu only within the Master (default) partition. Monitor functions shall include viewing the activity log, cameras, and floor plans.
2. Master Partition Administer: These users may use the functions of both the Administration and Monitor menus only within the Master (default) partition. Administrative functions shall include adding and editing person information in the enrollment database, issuing and revoking cards, generating reports, and performing database backups.
3. Master Partition Setup: These users may use the functions of the Setup, Administration, and Monitor menus only within the Master (default) partition. Setup functions shall include defining access control, alarm event behavior, camera settings, floor plan images and

configurations, holiday and time specifications. Setup functions shall also include: designation of network resources such as time and DNS servers, email and network storage settings; performance of system maintenance such as database backup and restore, software updates and file cleanups; designation of time zone, daily backup schedule, and enrollment readers.

4. Full System Setup: These users may use the functions of all menus in all partitions.
5. Custom User Roles: In addition to the roles above the system shall also support the creation of detailed user permissions regarding which cameras, floorplans, elevators, events, access levels, portals, reports, and personal data fields the system user may see, edit, delete, or control.

N. Alarm Events: The system shall be capable of managing alarm events.

1. It shall be possible to associate specific actions with each alarm event. These actions may include, but are not limited to:

   a. Lock and Unlock portals.
   b. Activate and Deactivate relay outputs.
   c. Arm and Disarm input groups.
   d. Pulse outputs or output groups.
   e. Arm and Disarm alarm panels.
   f. Send emails and SMS messages.
   g. Move cameras to preset positions.
   h. Switch to a video monitor.
   i. Record video.
   j. Momentarily unlock portals.
   k. Display ID photos.
   l. Change the system threat level.
   m. Make entries in the activity log.
   n. Play a digital sound file.
   o. Display alarms in different colors.
   p. Set a priority for an alarm (one of 20 levels, with 1 being the highest).
   q. Require a duty log entry.
   r. Clear alarm automatically or require an acknowledgement.

2. A system user holding at least a “Setup” user role shall be able to create, delete, and modify alarm system inputs, input groups, outputs, output groups, alarm panels, and events.
3. It shall be possible to trigger events based on system activity such as:

   a. Video motion detection.
   b. Camera failure and camera restore events.
   c. Valid or Invalid card reads.
   d. Portals held or forced open.
   e. Valid card reads with a specified access level.
   f. Inputs entering an alarm state.
   g. High and low temperature events.
   h. Alarm panel arming failures.
   i. Alarm panel zone faults.
   j. Tailgating and passback violations.
   k. Occupancy limit violations.
   l. Zone empty violations.
   m. Node power failure, communication failure, timeout, and tamper events.

O. Activity Monitoring:

1. The system shall support a monitoring desktop that integrates video, system activity logs, floor plans, ID photos, and alarm notifications.
2. The system shall support the creation of custom monitoring layouts for the display of live video, system activity logs, alarm notifications, ID photos, floorplans, duty log entries, and portal status displays.
3. It shall also be possible to view cameras, activity logs, and floor plans on separate monitoring pages within the application.

P. Access Control:

1. The system shall be able to make access control decisions, define a variety of access levels and time specifications, write system activity into a log file, maintain a personnel enrollment database, receive signals from input devices such as door switch monitors, card readers and motion detectors, energize devices such as door locks and alarms via outputs.
2. Time Specifications: The system shall be capable of storing up to 512 time specifications. Each time specification must be assigned a unique alphanumeric name of up to 64 characters. The definition of a time specification shall require the assignment of both a start time and an end time. Each day of the week shall be individually assignable for inclusion in time specifications. Up to three holiday groups shall be assignable for inclusion in time specifications. If no holidays are assigned to a time specification then no holiday access shall be allowed.

    a. Time specifications shall be assignable to access levels, output groups, portal groups, input groups, and alarm events.
    b. Time specifications shall function appropriately per node for the time zone specified for that node.

3. Card Formats: The system shall support the use of readers that use the Wiegand Reader Interface. The system shall default to the Wiegand 26 bit format unless a different bit length format is created in the system. The system shall support but not require the use of the card facility code. The system shall also support the use of the Magnetic Stripe ABA track 2 card data formats.

    a. It shall be possible to create new card formats, designate start bits, and bit lengths for facility codes and card ID numbers, as well as designate parity bits. The system shall support up to 32 different card formats. The system shall support card formats up to 128 bits.
    b. It shall be possible to reverse the read order of the bits in the facility code and/or card ID portions of a card format.
    c. It shall be possible to view and change the default parity bit definitions for a card format.

4. Access Levels: The system shall be capable of storing up to 512 access levels in each partition. Each access level must be assigned a unique alphanumeric name of up to 64 characters. The definition of an access level shall require the assignment of a reader or reader group, and a time specification. It shall be possible to also assign an elevator floor group to an access level.
5. First-in Unlock Rule: The system shall support the use of a first in unlock rule. It shall be possible to use this rule to control the unlock behavior of portal groups with assigned unlock time specs. The unlock rule shall require a card read of a specified access level. The portals in the group shall unlock only when the First-in Unlock rule is satisfied and the unlock time spec is valid.
6. Holidays: The system shall be capable of storing up to 30 holidays per partition. Each holiday must be assigned a unique alphanumeric name of up to 64 characters. The definition of a holiday shall require a start date and an end date. Holidays shall have the ability to span

several days using only one holiday slot. Holiday definitions shall support the designation of a start time and an end time. If no start time is designated then the system shall default to 00:00 (start-of-day). If no end time is designated then the system shall default to 24:00 (end-of-day). Holidays shall require the use of 24-hour time format, e.g. 17:00 is 5:00 PM.

7. Portals: A portal is any access point and each portal supports up to two access reader devices. The System User, holding at least a "Setup" user role, shall be able to view current portal definitions, change portal definitions, delete portals, and create new portals. Creating a portal defines the access and alarm behavior of the access point. This can include:

    a. Card readers and keypads.
    b. Output for locking.
    c. Input for monitoring the door switch.
    d. Input for a Request-to-Exit function.
    e. Local alarm outputs and system alarm events.

8. Portal Groups: It shall be possible to create groups of portals and to assign an unlock time specification to the entire group. All the portals in the group shall remain unlocked during the time specified.

    a. It shall be possible to use portal groups for the purpose of assigning or withholding assignment of these groups to system user permissions known as Custom User Roles. If a portal group is assigned to a particular system user then the portals in that group shall be viewable and unlockable by that system user.

9. Portal Alarm Conditions: Portals shall have four alarm conditions. The four alarm conditions are as follows:

    a. Forced: When a portal is opened and there has been no card read, nor request to exit.
    b. Held: When a portal is held open past the expiration of the shunt timer.
    c. Invalid: When the portal reader reads a card for which there is no entry in the database.
    d. Valid: When the portal reader reads a card for which there is a valid entry in the database.

10. Anti-passback: The system shall support both regional and timed anti-passback access control. For anti-passback functions, it shall be possible to configure regions, assign readers to those regions, and specify events for response to tailgate, passback, and occupancy limit violations. It shall also be possible to designate parent regions for hierarchical anti-passback.

    a. Grace: It shall be possible for a system Monitor or Administrator to Grace card holders from passback and tailgate violations.
    b. It shall also be possible to set a specific time for all cardholders to be graced daily.
    c. The system shall be able to automatically place the cardholder in a predefined region upon the selection of the grace option.

11. Mustering: To aid in evacuation management it shall be possible to designate a region or regions for mustering. It shall be possible to quickly get an occupancy count and occupant list for any region.
12. Scheduled Actions: It shall be possible to specify system actions to occur at scheduled times. These actions can include:

    a. Arming and disarming inputs.
    b. Activating and deactivating outputs.
    c. Locking and unlocking portals.

13. Floorplans: The system shall be capable of displaying active graphic floor plans and configuring each floor plan with icons representing system resources: cameras, portals, temperature points, and alarms. A network administrator holding at least a 'Setup' user role shall be able to upload floor plan images and graphically configure device icons onto the floor plan images. Viewing floor plans will require the Macromedia Flash Player 9.0 plug-in for the browser.

    a. It shall be possible to create floor plan groups for the purpose of assigning or withholding assignment of these groups to system user permissions known as Custom User Roles. If a floor plan group is assigned to a particular system user then the floor plans in that group shall be viewable by that system user.

14. Elevator Control: The system shall be capable of controlling elevator access to floors. The system shall be capable of controlling up to 52 floor buttons per node. It shall be possible to create, change, or delete floor groups to assign a free access time specification to a floor group. The floors in this group will be freely accessible during the times defined by the chosen time specification.

    a. It shall be possible to create elevator groups for the purpose of assigning or withholding assignment of these groups to system user permissions known as Custom User Roles. If an elevator group is assigned to a particular system user then the elevators in that group shall be viewable by that system user.

Q. Threat Levels:

1. It shall be possible to configure up to eight threat levels. It shall be possible to alter security system behavior through the use of threat levels. Groups of threat levels may be created and assigned to portal groups, access levels, input groups, output groups, floor groups, and event actions. The behavior of groups, access levels, and event actions with assigned threat level groups shall change based upon the current system threat level.
2. The system shall support 32 threat level groups.
3. It shall also be possible to change the system threat level in response to an alarm event.
4. The current system threat level shall display in the title bar of the security application interface and on floor plans.

R. Reports:

1. The system shall be capable of producing a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system. In addition, an easy to use query language shall be included to create ad hoc reports. The query language shall be documented in the online help system. Alternatively, it shall be possible to specify a query by use of point-and-click.
2. It shall also be possible to produce reports directly from the Network Controller based on data in archive files on FTP servers, network attached storage, or the controller-attached compact flash.
3. The system shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters can be inserted into reports to prompt for data input at report runtime. Report results can be printed, output to a PDF file or put into a spreadsheet.
4. It shall also be possible to group reports for assignment to custom user roles. Any reports not grouped and assigned to a custom user role shall not be viewable by that system user.
5. Report generation shall not affect the real-time operation of the system.

6. The specific reports provided shall include the following:

   a. Configuration Reports:

      1) As Built: A graphical report that displays an image of each Application board in a node and the specific resources (inputs, outputs, readers, etc.) configured for that board. The network settings for the node shall also be included.
      2) Elevators: Displays elevator configuration information including Node, Reader, and Floor to output mappings.
      3) Floor Groups: Displays all configured floor groups for use in elevator control.
      4) Holidays: Displays holiday specification information.
      5) Portals: Displays portal definition information including reader, DSM input, REX input, alarm outputs, and events.
      6) Portal Groups: Displays a list of all defined portal groups.
      7) Reader Groups: Displays defined groups of readers.
      8) Resources: Displays all configured system resources including readers, inputs, outputs, elevators, and temperature points.
      9) Threat Level Groups: Displays all configured threat level groups and the threat levels assigned to them.
      10) Threat Levels: Displays all configured threat levels including the description and color assignment.

   b. History Reports:

      1) Access History: Displays access history based on an entered query. The system user can specify the query using either the keyboard or point-and-click selection.
      2) Custom Report: This provides the capability to create custom reports of historical data. A graphic interface provides the user with the ability to interactively create and save reports for later use. Parameters can be inserted into reports to prompt for data input at report runtime. Report results can be printed, output to a PDF file or put into a spreadsheet.
      3) General Event History: Displays time, type of activity, and activity details for a variety of event types. The system user can select the specific event types for the report.
      4) Portal Access Count: Display how many times users have used a portal.
      5) Audit Trail: Displays an audit trail of system changes and the name of the system user that made the changes. It shall be possible to specify the dates and times covered in the report.

   c. People Reports:

      1) Access Levels: Displays all access levels entered into the system including time specification, reader/reader group, and floor group.
      2) Current Users: Displays a list of all security system users currently logged in to the security system website.
      3) Custom Report: This provides the capability to create custom reports of personnel data. A graphic interface provides the user with the ability to interactively create and save reports for later use. Parameters can be inserted into reports to prompt for data input at report runtime. Report results can be printed, output to a PDF file or put into a spreadsheet.
      4) Occupancy: Displays a list of defined regions with the number of people currently occupying each region and the maximum number of occupants allowed, if a maximum has been specified.
      5) Photo ID Gallery: Displays all the photo ID pictures in the system and the person's name.
      6) Photo ID Requests: Displays all outstanding badge print requests and lists ID, name, badge layout, activation date, request date.
      7) Portal Access: Lists people with access for a selected portal.

8) Roll Call: Allows you to select a defined Region from the drop-down and see a list of people currently in that region.
9) Roster: Displays every person entered into the system and it lists name, ID photo, expiration date, username, and access level.
10) Time Specifications: Displays all defined time specifications currently in the system.

S. Administration: The system shall provide for the performance of system administration tasks from any network-connected computer with a browser. Most of the administrative, maintenance, and configuration utilities and functions shall require a system user with at least a "Setup" user role. Information from the network administrator shall, in many cases, also be required. These administrative tasks shall include but not be limited to:

1. Database backups:

   a. The system shall create database, or full system data backups, each night at 00:15 hours. These backups shall be stored in ROM and compact flash onboard the solid-state Network Controller, and written to the drive on the disk-based controller.
   b. Backups shall also be written to network attached storage (NAS) or an FTP server if such storage has been configured in the system.
   c. It shall also be possible for the system users to create such database backups at any time. Any database backups onboard the Network Controller may also be downloaded to off board storage by the system user at any time.

2. System restore:

   a. The system shall be able to restore its database, or the full system data, from a backup. Restoration of the system shall only be possible from a backup copy onboard the Network Controller. It shall, therefore, be possible to upload a copy of a database backup from any network attached storage.
   b. It shall be possible to review backups by date and description and select the desired backup for upload to the Network Controller or restoration as the current system database.

3. Software updates:

   a. Software updates, upgrades, and patches shall be provided from time to time. The system shall be able to update its software from these .tgz files. Update of the application software shall only be possible from an update file onboard the Network Controller. It shall, therefore, be possible to upload a copy of the software update from any network attached storage or from any PC drive or desktop.
   b. Software updates may involve the Network Controller only or may include updates for the node(s) also. The monitoring of the security system may be unavailable for several minutes during this process.

4. File cleanup: A utility shall be provided to assist in file cleanup. This utility will display for review and deletion all floor plan jpeg files, photo IDs, database backups, badge layouts, and software updates.
5. File upload: The system shall support uploads of files for use in and with the system. Files which shall be uploadable include:

   a. Floorplans in .jpg format
   b. Badge layouts
   c. ID photos in .jpg format
   d. Database backups
   e. Software license files
   f. software updates

g. Threat level icons in .jpg format
h. Sound files (.wav) for use in event alerts

6. Setting system time, time zones, and time servers:

   a. The system shall support the setting of time zones by selection off of a drop down pick list. Time zones shall be separately settable for the controller and for each node or MicroNode in the system. An extensive list of world-wide time zones shall be provided. Adjustments for daylight saving time (summer time) shall be automatic.
   b. The system shall support the use of network time servers. Up to three time servers can be designated. Use of a network time server ensures that the Network Controller and its nodes will be regularly synchronized with the exact time used by all other network resources.
   c. It shall also be possible to manually set the system date and time.

7. Changing passwords:

   a. Person data maintained in the system may also contain a user name and password for logging on to the security application website as a system user. The system shall support the changing of administrator passwords. It shall be required to enter the password twice for verification purposes. Passwords may contain neither double-quote (“) nor single-quote (‘) characters.
   b. It shall also be possible to integrate an LDAP server for single-user logon authentication. This will reference the LDAP-stored password for use by the system.

8. Issuing and revoking cards (credentials):

   a. Access cards shall be assignable by the system user either by entering card data directly into the person record or by use of an enrollment reader. Access levels shall be assignable through the user interface by selection from a drop-down list.
   b. Access cards shall be revocable at any time. A system user holding at least the Administer user role may perform this action. Revoked cards shall stop functioning immediately.

9. Enrolling new people: All person data entered into the system shall be held in the system database and shall be available only to system users holding at least the Administrator user role. Person data can be added, deleted, and edited by such system users.
10. Creating Photo IDs: The system shall include an integrated photo ID function. It shall be possible:

    a. To design badge layouts,
    b. To upload badge layouts for badge printing,
    c. To capture ID photo images, print badges, and delete uploaded badge layouts.
    d. For the system user to manage all photo ID functions entirely from within the browser.

11. Generating reports:

    a. The system shall be capable of producing a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system.
    b. Alternatively, the system shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters can be inserted into reports to prompt for data input at report runtime. Report results can be printed, output to a .pdf file or put into a spreadsheet.
    c. It shall also be possible to group reports for assignment to custom user roles. Any reports not grouped and assigned to a custom user role shall not be viewable by that system user.

d. A system user holding 'Administrator' permissions shall be able to view and create reports.

12. Configuring network resources:

a. LDAP: It shall be possible to configure an LDAP server for directory services and single-user login. This will reference the LDAP-stored password for use by the system.
b. DNS: The system shall support setting IP addresses for up to two domain name servers.
c. Email settings: The system shall support the use of email notifications of alarm events. The system user must setup the email server IP address or DNS name and the email address of the Network Controller. A network administrator must setup the network mail server to relay email for the IP address of the Network Controller.
d. File transfer protocol (FTP): The system shall support the use of an FTP Server for backups. Once configured, backups are automatically saved to the FTP server each night.
e. NAS: The system shall support the use of network attached storage devices for backups. The network administrator must create a domain user account for the Network Controller and a password. The system user must configure the network attached storage in the system including the domain name, server IP address, share name, and the directory where the Network Controller may store data.
f. Time Servers: The system shall support the use of network time servers. Up to three time servers can be designated. Use of a network time server ensures that the Network Controller and its nodes will be regularly synchronized with the exact time used by all other network resources.
g. A system user holding 'Setup' permissions shall be able to configure network resources.

2.07 CARD READERS

A. The readers shall be of the 125 KHz proximity type, 12 VDC and shall include a multi-color LED and a beeper which shall change state on presentation of a valid card. All readers shall also perform an internal self-diagnostics test and initialization on power-up.

B. For mullion mounting, provide HID Model #5365. For single-gang box mounting, provide HID Model #5395.

2.08 REQUEST TO EXIT MOTION DETECTORS

A. The Contractor shall provide request to exit motion (RTE) devices on each card reader controlled door to shut the door position switch and allow free egress without initiating an alarm condition on the ACS. The RTE device shall be configured to activate for two seconds and automatically reset after that time to prevent extended shunting of the local alarm. Bosch DS 160 Series.

2.09 DOOR POSITION SWITCHES

A. Provide 1" double-pole, double-throw door position switches. General Electric 1076D.

2.10 DOOR RELEASE BUTTONS

A. The Contractor shall provide door release buttons for entry door remote release assistance in areas shown on Drawings. Provide momentary flush-mounted release button. Coordinate button mounting location with owner and architect prior to installation.

2.11 DURESS PUSH BUTTONS

A. The Contractor shall provide duress buttons for security assistance in areas shown on Drawings. Provide concealed flush-mounted Inovonics Model #EN 1235SF or equal.

2.12 CREDENTIALS

A. Provide plain white vinyl, sequentially marked, Model #1326 Proxcard II with vertical slot.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. Installation Requirements:

1. Install system per the manufacturer's instructions.
2. Coordinate the operational compatibility of all locking devices not supplied by the Access Control manufacturer with the Access Control manufacturer.
3. If required by the Access Control manufacturer, the locking devices supplier shall include electronic suppression and be rated for continuous duty operation.
4. All locking device wiring shall be run separate from all other system wiring except wire specifically permitted by the Access Control supplier.

B. Testing and Commissioning:

1. The SMS supplier shall be responsible for final system hardware hook up and checkout prior to commissioning the system to the end user.
2. The SMS supplier shall be responsible for:

    a. Construction schedule of product and services
    b. Schedule of values
    c. Project Folder
    d. Routinely Scheduled Project Progress Management
    e. Factory Consultation Services

C. Training and Instruction:

1. Before the system is turned over to the owner, the manufacturer shall provide 3 days of system operations training at the project site using the customer's equipment for up to 10 of the Owner's representatives meeting a minimum expected level of computer competence.
2. This training shall be conducted during normal business hours of the equipment supplier at a date and time of mutual convenience.
3. This training shall be conducted by a dedicated trainer employed full-time for the purpose by the manufacturer of the access control system. Representatives of a local dealer operation shall not be considered acceptable.

D. Software Support:

1. The SMS shall be supported by the manufacturer for no less than one year from date of system turnover.

E. Warranty:

1. The system shall be warranted for a period of 2 years from date of acceptance or first beneficial use, whichever occurs first. Written notification shall be sent to the owner stating the date this warranty period has started.
2. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two inspections and preventative tests per year.

F. Additional Items Required:

1. Provide battery backup of DAP so all systems remain fully operational for a minimum of 30 minutes.

END OF SECTION

SECTION 26 73 10

WIRELESS MASTER CLOCK SYSTEM

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide wireless synchronized precision time that is traceable through GPS satellites to the US Government's official NIST time standard (coordinated universal time). Each WT generator and every other component in the system shall use both precise time and synchronized time.

B. System shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired.

C. System Description:

1. Clocks shall be synchronized to within 10 milliseconds, 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
2. The system shall include internal clock so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
3. The system shall incorporate fail-safe design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
4. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.
5. The WT generator system shall provide a tone at predefined times to the intercom system. The tone shall actuate all devices programmed to operate on receipt of the tone.
6. Timing and operation of the WT generator system shall be controlled by software provided by system manufacturer, housed in the transmitter and programmed by installer.
7. The system shall not require wiring from the transmitter to WT generator.

D. WT Generator:

1. Initially and at scheduled intervals, the WT Generator receives the time data and command packet for the transmitter. Using that information the WT Generator can send an audio tone to and an existing PA-type announcement system and/or an existing bell system.
2. The transmitter shall continuously broadcast (transmit) a time data packet and command packets to the WT Generator. The transmitter shall operate on FCC licensed frequencies which have good building penetration and which are regulated by the FCC to minimize interference on the selected channel.
3. The GPS unit shall receive the precise time via satellite from its vantage point with a "view of the sky" and continuously provide this precise time to the transmitter.
4. System shall be fully integrated with intercom system.

1.02 RELATED DOCUMENTS

A. The general provisions of Contract, including General and Supplemental General Conditions of the Contract and Division 01 Specification Sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required for the proper execution and completion of the Work.

C. All trade subcontractors are to note that the organization of these Specifications into divisions, sections, and paragraphs, and likewise the arrangement of the Drawings, is set up for the convenience of understanding the scope of the Work only. This structuring shall not control the General Contractor in dividing the Work among trade subcontractors or in establishing the extent of the Work to be performed by any trade.

D. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

E. The following sections:

1. Section 26 01 00 - Basic Electrical Requirements
2. Section 26 06 00 - Grounding and Bonding
3. Section 26 07 00 - Supporting Devices
4. Section 26 13 00 - Raceways
5. Section 26 13 70 - Outlet Boxes & Enclosures

1.03 SUBMITTALS

A. Submit manufacturer's product data in accordance with Section 26 01 00.

B. Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure color card showing available colors and finishes of clocks.

C. Operating License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the engineer prior to operating the equipment. When license is received, deliver original license to owner.

D. Samples: Submit one clock and one switch for approval. Approved sample shall be tagged and shall be installed in the work at location directed.

E. Manufacturer's Instructions: Submit complete installation, set-up, and maintenance instructions. Submit software programming instructions, coordinated with the Owner's requirements for timing and sequencing of the equipment.

F. Manufacturer's and Installer's Qualifications: Submit evidence of qualifications of manufacturer and installer as specified below to Engineer.

1.04 REGULATORY REFERENCES

A. Equipment and components furnished shall be of manufacturer's latest model.

B. Transmitter and receiver shall comply with Part 15 and Part 90 of FCC rules, as follows:

C. The equipment shall not cause harmful interference.

D. The equipment shall accept interference that will cause adverse on equipment operation.

E. Transmitter frequency shall be governed by FCC Part 90.35.

F. Transmitter output power shall be governed by FCC Part 90.257 (b).

G. System shall be installed in compliance with local and state authorities having jurisdiction'

H. All equipment shall be UL listed and designed for the intended use.

I. All work shall be in accordance with the latest edition of the National Electric Code and local code requirements.

1.05 QUALITY ASSURANCE

A. Permits: Obtain operating license for the transmitter from the FCC.

B. Qualifications:

1. Manufacturer: Company specializing in manufacturing time systems with a minimum of 10 continuous years of documented experience.
2. Installer: Company with documented experience in the installation of computer controlled, time actuated control systems.

C. Wireless master clock system to fully integrate with intercom system.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Clock System:

1. Primex Wireless
2. Substitutions: Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 260100.

2.02 SEQUENCE OF OPERATION

A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version, and then it checks the positioning of the switches and stores their position in memory. The transmitter then looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.

B. Transmitter Programming: After the transmitter has been set up and is operating correctly, it is programmed by the installer to transmit a signal to the WT generator at predetermined intervals.

C. WT Operation: When the WT generator receives a signal from the transmitter, it shall generate a tone and actuate the devices that have been predetermined to operate upon receipt of that tone.

2.03 EQUIPMENT

A. General: The time system shall include a transmitter, a roof- or window-mounted GPS receiver, indicating clocks, WT generator, programming software, and all accessories for complete operation.

B. Transmitter: Wireless transmitter with GPS receiver. Unit shall obtain current atomic time from satellite. The system shall transmit time and control packets continuously to one or more WT generators and all clocks in the system.

1. Transmission:

   a. Frequency range: One watt at frequency of 72.100 to 72.400 MHz.
   b. Transmission range: One mile, open field.
   c. Radio technology: Narrowband FM
   d. Number of channels: 16
   e. Channel bandwidth: 20 kHz maximum
   f. Transition mode: One-way communication
   g. Data rate: 2KBps
   h. Operating range: 0°C to 70°C.

2. Transmitter:

   a. Transmitter output power: +30 dBm (one watt)
   b. Frequency deviation: ±4 kHz
   c. Transmitter power requirements: 120 VAC 60 Hz
   d. Internal power requirements: 5 volts DC
   e. Carrier frequency stability +/1 20 ppm
   f. Operating range: 0°C to 70°C.
   g. Primex Wireless Model FM-72
   h. Provide as required for full coverage of complete system.

3. Transmitter shall have 16 selectable channels to assure interference-free reception.
4. Transmitter shall have the following switches:

   a. Time zone adjust switches for all time zones in the world.
   b. Daylight saving time bypass switch.
   c. Twelve- (12) hour or 24-hour display.

5. Transmitter housing shall be black metal case, 16-3/4 inches by 12 inches by 1-7/8 inches in size.
6. Antenna shall be 46 inches high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be > 110dBm. Antenna polarization shall be data logic, zero to 5 volts.
7. Transmitter housing shall incorporate a display which shall include the following:

   a. Time readout
   b. AM and Pm indicator if 12-hour time display is set
   c. Day and date readout
   d. Indicator for daylight savings or standard time
   e. LED which shall flash red in event of reception problem
   f. GPS reception indicator

8. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks or WT generators.

C. Wall-Mounted Rack: Provide wall-mounted rack for the installation of transmitter. Primex Wireless Model Number 14005 or equivalent.

D. Power Supply:

1. Model Number Q11666 or equivalent.
2. Input: 120 Volt AC 50/60 Hz, 0.4 amp.
3. Output: 9 volt DC 1.5 amp.

E. GPS Receiver: Roof mounted GPS, with coaxial extension cable as required.

1. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, 3-7/8 inches by 4-3/16 inches by 2 inches, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
2. Model Q 11722 or equivalent.
3. Provide as required for full coverage of complete system.

F. Wireless Tone Generator: Complete with cables and antenna required for complete installation. Model Number 14002 or equivalent.

1. Size: Approximately 7-1/4 inches wide by 5 inches long by 1-1/2 inches high, not including antenna.
2. Generator shall be housed in a black plastic case.
3. Nine (9) volt switching power supply (fed from 120 volt line)
4. Switching contacts "Form D," two sets: one, normally open; one normally closed.
5. Switch ratings:

   a. Contact ratings:

      1) 5 amp, 1/6hp, 125v, 250v, AC.
      2) 5 amp, 20 volts DC.

   b. DC break ratings:

      1) 30 watt maximum.
      2) One amp, 30 volts, DC; 24 amp, 125 volts DC.

6. Audio output:

   a. Isolation transformer with center tap, 600/150 ohms output impedance.
   b. Variable output and line level.

7. Relay output.
8. Test and reset buttons.
9. Signal indicator.
10. One hundred switch identification codes. Any number of switches for each identification code.
11. Selectable channels: 16.
12. Twenty-four (24) programmable events with 7-day selectable operations. Expandable to 48 programmable events.
13. Selectable options for each event, as follows:

    a. None.
    b. Turn on and stay on.
    c. Turn off and stay off.
    d. Turn on for one second, then off for one second, repeat 5 times.
    e. Turn on for 3 seconds.
    f. Turn on for 5 seconds.

14. Selectable daylight saving time bypass.
15. Selectable automatic channel scanning.
16. Computer programmable through transmitter, with automatic backup, and schedule changes easy to make.
17. Switching information stored in non-volatile memory in the transmitter and broadcast at regular intervals. Each switch retains its instructions in non-volatile memory.
18. WT generator shall be factory preset as follows:

    a. Channel I.D. No. 1
    b. Switch: 00
    c. Volume: 50 percent

G. Clocks: Wireless clocks, 12-1/2 inch diameter in classrooms and offices and 16-inch round in gymnasiums, auditoriums, cafeterias, large group and multipurpose rooms. Color and finish as selected by the architect from manufacturer's standard colors and finishes. Clocks shall be semi-flush wall-mounted. 12-1/2 inch diameter clocks shall have polycarbonate frame and polycarbonate lens. Face shall be whit. Hour and minute hands shall be black. Clocks shall be provided with red sweep second hand. Primex wireless or equivalent.

1. Clocks shall be battery operated, and shall have 5-year battery life.
2. Clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
3. Time shall be automatically updated from the transmitter 6 times per day.
4. Clocks shall remember the time during changing of batteries.
5. Clock lock: Tamper-proof/theft-resistant hangers and slots in the backs of the clocks.
6. Provide two (2) alkaline D cell batteries with each clock.
7. Clock receivers shall be as follows:

    a. Decode sensitivity: >-110 dBm.
    b. Receiver power: Two alkaline "D" cells.
    c. Antenna type: Internal.
    d. Antenna gain: -7 dBd.

8. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
9. Back boxes: Back boxes shall be provided for semi-flush installation.
10. Clocks in classrooms shall be mounted in a combination time/tone unit as indicated in Specifications.

H. Wire Guards: Provide one for each clock as specified in drawings.

1. For 12.5-inch clocks, provide 14-inch by 14-inch. Model No. 14131 or equivalent
2. For 16-inch clocks, provide 18-inch by 18-inch. Model No. 14123 or equivalent.

I. Cable Connection Sealant: Coaxial cable connector Sealant or approved electrical grade silicone sealant.

J. Software: Provide Primex Compusync or equivalent as required for the installation and programming of the system.

1. Software shall be in form of a CD, suitable for operation in standard CD-ROM drives.

PART 3 – EXECUTION

3.01 INSTALLATION

A. GPS Unit: Install on roof near roof hatch or access. Install unit in location free from standing water, and above accumulation of leaves or debris. Seal cable connection to GPS with cable connection sealant.

B. Transmitter:

1. Locate transmitter in wall mount a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers, or metal framed walls.
2. Attach receiver to transmitter using coaxial cable.
3. Connect antenna to transmitter, using care not to strip threads.
4. Connect power supply to the transmitter.
5. Set the channel number on the display to correspond to the FCC license.
6. Plug power supply into electrical outlet.

C. WT Generator:

1. Install the WT generator within eight feet of the transmitter.
2. Align the antenna vertically.
3. Verify that the factory switch settings as specified above are correct.

D. Clocks:

1. Install D cell batteries.
2. Set clock to correct time in accordance with manufacturer's instructions.
3. Observe clock until valid signals are received and clock adjusts itself to correct time.
4. Install clocks according to manufacturer's recommendations where indicated on the Drawings.
5. Wire Guards: Secure to wall, using approved theft-resistant fasteners.
6. Interface with the intercom system for class change tone.
7. Provide three (3) 12" and 15" clocks for Owners shelf stock upon completion of project.

END OF SECTION

SECTION 26 76 00

INTERCOM SYSTEM

(Electrical Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification Sections, apply to this Section.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.02 SUMMARY

A. Section Includes: Microprocessor-switched intercommunications and program systems with the following components:

1. Talkback intercom system.
2. Administrative phone.
3. Cards and adapters.
4. Rack and wall-mount chassis.
5. Power supplies.
6. Talkback and one-way speakers.
7. Loudspeaker horns.
8. Speaker back boxes.
9. Conductors and cables.
10. Raceways.

B. The contractor shall furnish and install all equipment including, but not limited to, outlet boxes, conduit (with pull strings), wiring, cable, and speakers, as shown on the plans, and all other equipment necessary to provide a complete and operating system for the Project. Intercom system shall be capable to accommodate existing speakers and existing zone paging for the duration of the phased construction, telephone system, and shall provide internet access for remote control of bell schedule tone changes as well as program group changes over high speed internet access. The system shall integrate with a telephone system via four (4) administrative ports minimum to CO line interface.

C. The contractor shall work with the owner to define the paging zones and grouping of zones during the various phases of the project and provide a final zone map upon completion of the project.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For intercom system. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include scaled drawings for station arrangement of built-in equipment.
3. Wiring Diagrams: For power, signal, and control wiring.

    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

4. Power supply sizing calculations.

C. LEED Submittal:

1. Product Data for Credit MR4: Indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
2. For credit IEQU 4.2: Manufacturers' product data for paints, including printed statement of VOC content.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For qualified Installer.

1. The Contractor shall be from an established and locally run business which has been operating in the area for a minimum of five years and shall be an authorized distributor of the supplied equipment with full warranty privileges.
2. Authorized distributor for the equipment supplied with full manufacturer's warranty privileges.
3. Maintains a fully equipped service organization capable of providing full maintenance and service of the installed system within 4 hours.
4. Maintains the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed.
5. The Contractor shall furnish manufacturer's manuals of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper operation of the system must be included.
6. The supplying Contractor shall have attended the manufacturer's installation and service school.

C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intercom system to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. A record of final matching transformer-tap settings and signal ground-resistance measurement certified by Installer.
2. A record of Owner's equipment-programming option decisions.

B. Component Operating Manual including technical data sheets.

1. Control settings.
2. Power supply loads.

C. Information for reordering replacement parts:

1. Provide a replacement parts list.
2. Provide a list of recommended parts, tools, and instruments for testing and maintenance purposes.

D. Wiring Diagrams/Details:

1. System functional block diagrams.
2. System zone diagrams.
3. System schematic diagrams.
4. System wiring list.
5. Identify terminals to facilitate installation, operating and maintenance.
6. Indicate terminals to facilitate installation, operating and maintenance.
7. Indicating and distinguish between field and factory wiring.

E. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

F. Update to include any information necessitated by construction. Complete "as installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.

G. Component Service Manual: Include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Testing Agency's Field Supervisor: Certified by manufacturer.

B. Source Limitations: Obtain intercom system from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for location and application.

D. Comply with NFPA 70.

1.07 WARRANTY AND MAINTENANCE

A. Provide a one (1) year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal working hours. The warranty period shall begin on the date of system acceptance by the Owner or Engineer.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

1.08 COORDINATION

A. Coordinate layout and installation of ceiling-mounted speakers and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Valcom Class Connection
2. Bogen
3. Rauland
4. No substitutions will be accepted.

2.02 FUNCTIONAL DESCRIPTION OF INTERCOMMUNICATION SYSTEMS

The System shall provide at least the following functions and features:

A. Direct dialed, hands-free, two-way communication from all administrative telephones to any location equipped with a talkback speaker.

B. Automatic gain control on intercom speech to assure constant talkback speech level.

C. Microprocessor based system capable of handling up to seven hundred twenty (720) points. A point is defined as a call-in switch or a speaker output.

D. System shall be modular in design and capable of expanding in increments of 48 points allowing for budget flexibility and expandability.

E. The system shall be connected to a switched, multi-cast enabled network. This connection shall be via a standard Ethernet RJ-45 jack and shall provide all system functionality across the LAN/WAN to remote cabinets housing remote station cards, eliminating the need for individual peripherals to be wired back to the main system. All devices connected to these remote shelves (speakers, staff assist call buttons, cameras, etc.) shall provide the same capabilities as those connected directly to the MDF.

F. System shall interface with any telephone system, thus allowing the school(s) to upgrade or replace their telephone system without suffering a requirement to replace, or lose any feature of, their internal communications (intercom) system. Any system that limits system features based upon any selected telephone system, and/or is proprietary to one or only a few telephone systems shall not be acceptable.

G. Automatically sound a tone or play a pre-page WAV file over any loudspeaker connected for two-way communication to alert the classroom teacher that this two-way call has been established. This is intended to prevent unauthorized monitoring. A privacy tone must repeat every fifteen (15) seconds.

H. Distribution of emergency announcement(s) from any authorized telephone to all areas furnished with a loudspeaker. Emergency announcements shall have the highest system priority.

I. Distribution of general announcements from any administrative telephone, staff telephone, or classroom telephone. The system shall be capable of providing all-call, group calls, multiple group call, or dial-on-the-fly page groups.

J. Classroom speakers shall be software assignable to any or all of seventy-two (72) audio paging/distribution groups.

K. Provide the ability to define and archive unlimited time tone schedules with up to 255 events per schedule. Each scheduled event shall be capable of controlling any one of six (6) internal tones; user selected custom audio/voice phrases, audio from any of three (3) auxiliary sources or up to forty (40) relays for building control. Each scheduled audio event shall be distributable to up to seventy-two (72) audio groups. The system shall feature the ability to automatically initiate up to eight (8) schedules per day, based upon the day of the week or calendar dates up to one year in advance. Up to eight (8) daily schedules shall operate simultaneously. Schedule administration, modification, and creation functions must be available through administration PC software. Systems that do not allow the school to manage their own schedules with PC software or do not offer calendar-based scheduling up to one (1) year in advance or require separate page and time groups shall not be acceptable.

L. Provide a 1-, 2-, 3- or 4-digit numbering plan, thus allowing the classroom speaker and the classroom telephone to be the same architectural number.

M. Provide facilities for up to seven (7) call-in priority levels. Each classroom call button shall be assignable to any one (1) or two (2) of these priority levels. The call button priority levels shall have the capacity to change state on a time-of-day basis. The priority levels shall be as follows:

1. Normal
2. Security
3. Normal/Emergency
4. Urgent/Emergency
5. Overhead Ring
6. Emergency Only
7. Ignore

N. Call button priority levels shall determine call queue placement. Emergency calls will be answered first, urgent calls second and normal calls last.

O. In the event of a crisis situation, and the Administrative lines have many calls in queue, it shall be possible to cancel all incoming queued calls in order to make emergency announcements. Systems that do not have this ability will not be accepted as equals.

P. Any classroom/area loudspeaker must have the flexibility to be programmed as a testing room. A testing room shall be excluded from receiving general announcements, class change tones, group announcements, and program material. The testing room must receive emergency tones and announcements. A dial code must be provided that will access all testing rooms at the same time, allowing for common instruction during standardized testing. The testing rooms may

be reactivated to normal operation at any time by the administration staff as needed. As an option, testing rooms shall feature the ability to automatically reset to normal operation before start of class the next day.

Q. Programmable features shall be stored in non-volatile memory and shall not be lost due to power failures.

R. Classroom initiated intercom calls must be assignable to ring at specific administrative ports. These administrative ports shall have the flexibility to be forwarded to other administrative ports should a call go unanswered or should the assigned administrative port be busy.

S. Facilities to annunciate incoming intercom calls at multiple administrative phones simultaneously. Calls may be answered from any of the administrative telephones by simply lifting handset, dialing the room number or pressing a button on the telephone. Once answered, the call will automatically be cancelled for other administrative phones.

T. System functionality must include the capability to manually distribute up to five (5) alert emergency tones and/or 60+ custom audio files via pushbuttons, contact closure, or dial code from administrative telephones. The tones shall be customizable with respect to cadence, type, and duration. Dial-up tones must only be accessible by authorized users.

U. The system must provide a minimum of four (4) ports to be connected to the telephone system from the intercom system. These four (4) intercom lines shall provide built-in Enhanced Caller Line Identification which will visually announce the name of the teacher or location, the architectural classroom number, and call priority level; thus allowing interface to any telephone system. Systems that require integration to a specific telephone system or systems in order to offer this feature, or any system feature, shall not be acceptable.

V. The system shall have the ability to control integrated relays. Relays shall be controlled through the administrative software, DTMF controlled, automatically cycle at a programmed time of day, follow time schedule events, follow audio group events, follow security calls, and follow emergency and ADA calls. All relays must be software programmable with the flexibility to change as required. A minimum of eight (8) relays shall be provided.

W. The system shall provide at least three (3) simultaneously operating, non-restrictive program distribution channels. The audio program material shall be controlled and distributed with administration PC software allowing simple and easy changes. Systems that require manual operated switch-banks or cumbersome DTMF telephone codes for distribution shall not be acceptable.

X. The System shall feature voice call progress. When two (2) or more system users attempt to announce into the same area, the unsuccessful user shall be notified via a voice message. When a user's announcement attempt is overridden by a higher priority announcement, the overridden user shall be notified via a voice message.

Y. The system shall have the ability to store up to sixty (60) minutes of WAV files directly onto the CPU and shall not be lost due to power outage.

Z. The WAV files shall feature programmable priority levels. They shall be programmable as to override any class change tones, normal all call, music, and intercom in the event of an emergency.

AA. The WAV files shall have the ability to be broadcast into any one or all of the seventy-two (72) audio groups as well to any zone within the system.

BB. The WAV files shall have the ability to be broadcast via a schedule for any day of the week or time of the day. They shall have the ability to broadcast for any duration of time and/or repeat.

CC. The WAV files shall be able to be broadcast via a pushbutton selecting which WAV file is broadcast, the priority level, where it is broadcast, and how many times it shall play.

DD. The WAV files shall have the ability to be utilized as class change tones within the system. These files shall be able to replace any tone within the class change schedules as to offer the flexibility of customizable tones and or phrases in this class change mode.

EE. The WAV files shall be programmable as to replace all system alert tones.

FF. One zone homerun per classroom, offices, and other staff locations. Corridors can be daisy-chained per voltage drop limitations and pre-designated zones.

2.03 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS

A. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.

C. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz. Comply with UL 813.

D. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

E. System shall have the capability to be connected to the local area network.

2.04 ADMINISTRATIVE TELEPHONE

A. Microprocessor-based instrument to process outside and internal calls with a 12-digit keypad selector. Unit shall be utilized to program and operate system in the event of loss of telephone system connection.

2.05 INTERCOM CONTROL UNIT

A. Shall be capable of expanding to thirty-two (32) zones.

B. Provide pre-alert tone to classroom for intercom calls and general announcements.

C. Ability to produce user-defined tone signals for time tones or emergency tones.

D. Ability to select the tone on an all-call basis from any, or selected, administrative telephones.

E. Provide an RS-232 and Ethernet port, which will give ability to monitor operations and functions of the systems.

F. Provide off-site programming and diagnostics of the system. It shall also be capable of determining basic circuit faults.

G. The system shall be capable of simultaneous conversations between administrative ports.

H. The system shall have a Windows® based PC administration programming tool which allows the administrative personnel to easily manage audio sources, class change schedules, paging groups, time updates, caller ID descriptions, holiday schedules and day/night mode operation from their desktop PC across a standard Ethernet LAN. It shall also have the ability to activate on-board WAV files on a schedule and/or immediately in the event of an emergency at the highest priority override level. Systems that require propriety consoles, special LCD displays or solely utilize DTMF for changes to perform these functions shall not be acceptable.

I. System shall provide calendar-based scheduling up to one (1) year in advance.

J. The system shall be programmable via Ethernet or direct COM port cable connection.

K. System shall be capable of utilizing forty-five (45) ohm or 25-volt speakers for classroom type speakers. Systems that require re-tapping existing classroom 25-volt speakers shall not be acceptable.

L. System speakers shall be capable of utilizing standard CAT 3 or 5 telephone/data wiring for installation, thus allowing for only one (1) type of wiring infrastructure within the school. The speakers and call buttons shall be capable of utilizing spare pairs in the telephone wire connected to the classroom, allowing for lower installation cost. Systems that waste infrastructure by requiring separate heavy-gauge infrastructure wire shall not be acceptable.

M. Capable of directly connecting IP speakers to system without the need of remote shelves or network cards. Speakers shall plug directly into a standard Ethernet LAN and be accessed by system. IP speakers shall have all the same capabilities as speakers connected on home runs directly to the MDF.

N. Provide eight (8) unrestricted, simultaneous audio paths for communication between administrative phones, program material, time tone distribution, and paging. Systems that do not allow simultaneous pages to different paging groups will not be accepted.

O. Provide six (6) software programmable pushbutton inputs that can be used to activate tones, emergency tones, time tones, schedules, set system time, force a holiday schedule, door entry, etc.

P. Provide eight (8) software programmable output contact closures which can be activated manually to turn on cameras, unlock doors, emergency lockdown, etc., or automatically via Master Time Control Center.

Q. Provide voice-synthesized call-in, which allows the administrative telephones to hear the room number of the originating station over the handset.

R. Provide a call confirmation tone at speaker when an intercom call is placed. This verifies that the call has been placed in queue. If the call is upgraded to an emergency, a second confirmation tone shall be activated.

S. Automatically announce the architectural room number over any one, group, or all speakers if an emergency call-in goes unanswered for a programmable period of time. Systems that do not announce emergency call-ins shall not be acceptable.

T. Provide Emergency Override On-Board Voice Messaging via the following methods:

1. Any authorized PC on the school's LAN/WAN
2. Any authorized telephone
3. Any pushbutton

U. System must have the capability to tie to a WAN to provide district-wide all-call paging as well as multi-building paging for the purposes of mass notification. Access to individual rooms for intercom purposes via the WAN must also be supported.

V. Provide rack- or wall-mounted chassis as required, remote card adapters and expansion cards as necessary.

2.06 POWER SUPPLY

A. The wall- or rack-mountable power supply, Model Number VC-6124P, shall be a -24 VDC power supply capable of providing 6 amperes of current. The design of this regulated power supply shall use switching technology, shall provide auto recovery short-circuit protection and shall feature three (3) individual class "B" outputs each capable of providing 1/3 of the supply's rated current. Additionally the supply's design shall incorporate EMI filtering, a minimum 88.5% efficiency, a 3-second power-up delay, a working input frequency range of 47 to 63 Hertz and an LED status indicator. The supply shall also feature ±2% voltage regulation and over-voltage protection.

2.07 SPEAKERS

A. The Lay-in Ceiling Speakers shall consist of a white 2' x 2' perforated grille, a speaker and integral back box. A volume control shall be accessible through the perforated grille. The speaker shall be 8" (20.32 cm) in diameter and have a 5 oz. (142 g) ceramic magnet. The 8" speaker cone material shall be paper. The speaker impedance shall be 45 ohms. The diameter of the voice coil shall be 0.75" (1.91 cm) diameter. The speaker shall produce a sound pressure level of 95 dB at 1 meter on axis with 1 watt applied. Frequency response shall be 80Hz to 15KHz. Operating temperature shall be +32° to +122° F (0° to +50° C). The One-Way model shall include an amplifier assembly and volume control. Distortion shall be less than 1.5% at rated output of 1 watt RMS. Signal to noise ratio shall be -70dB. The amplifier shall operate on a -24VDC nominal, positive ground power supply. Operating current shall be 50mA at -24VDC. The baffle shall be constructed with a single piece of perforated steel with a white baked-on acrylic enamel finish. The back box meets or exceeds A.S.T.M. E84 flame and smoke test and has a three-hour burn rating (UL181). Four (4) seismic tabs provided for additional mounting integrity.

B. In gypsum wallboard ceiling and other fixed ceiling panels, provide Atlas Sound back box Product #BMT95-8.

C. In exposed ceiling provide self-supported steel back box enclosure attached to steel structure.

D. In locker and shower rooms provide weatherproof speakers and enclosures suitable for location.

2.08 LOUDSPEAKERS

A. Loudspeakers shall be provided where indicated on Drawings and include enclosure speaker and cover.

2.09 WIRE GUARD

A. Provide wire guards where indicated on plans.

2.10 VOLUME CONTROL KNOBS

A. Where indicated, provide adjustment control for volume of speaker in a remote, flush-mounted, single-gang, stainless steel wall plate device with minimum setting adjustment.

2.11 CONDUCTORS AND CABLES

A. Conductors: Category 5 UTP, riser rated. Plenum rated in courts 3&4/Temp classrooms.

2.12 RACEWAYS

A. Intercom System Raceways and Boxes: Comply with requirements in Division 26.

B. Intercom System Raceways and Boxes in Walls: ¾" EMT.

C. Intercom System Raceways in Exposed and Inaccessible Ceilings: ¾" EMT.

D. Above Accessible Ceilings: Cable tray or J-hooks every 5'.

E. Flexible metal conduit is prohibited.

PART 3 - EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.02 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.03 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.04 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

3.05 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding."

3.06 SYSTEM PROGRAMMING

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.07 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing intercom system and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
4. Check-out and final connections to the systems shall be made by a factory-trained technician in the employ of a manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner.
5. All materials and installation shall be guaranteed to be free of defects in material and workmanship for one year after final acceptance of installation and test.
6. Upon completion of the installation, four (4) copies of complete operational instructions shall be furnished, complete with record drawings. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source. Final payment shall not be made until operational manuals have been received.
7. Upon completion of the installation of the equipment, the electrical contractor shall provide to the engineer a signed statement form the equipment supplier that the system has been wired, tested, and functions properly according to the specifications.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.

E. Intercom system will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.08 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service and initial system programming.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.09 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intercom system.

1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.

END OF SECTION

SECTION 26 79 13

MASS NOTIFICATION SYSTEM

(Electrical Trade Bid Required)

PART 1 – GENERAL

1.01 SUMMARY

A. Work Included:

1. The project is being bid to fully authorized dealers of Mass Notification Systems (MNS) only.
2. Provide capacity on system and all boards, controllers and power supplies for system as designed and 20% future growth.
3. The work includes providing all labor, materials, tools, equipment, programming, and documentation required for a complete and working Mass Notification System as specified in this document.
4. Work shall be coordinated with the Access Control and Fire Alarm Contractor throughout the entire installation.
5. Contractor to provide complete and operable Mass Notification System.
6. Provide all necessary licenses as required.
7. Provide client software and set-up of four (4) security stations on Owner-provided workstations.

B. Related Work Provided By Others:

1. The Contractor shall coordinate the work with the related work provided by other contractors including but not limited to the following:

   a. Power and pathways by Electrical Contractor.
   b. Network connections by Telecommunications Contractor.
   c. Security Management System (SMS) by SMS Contractor.
   d. Fire Alarm System by Fire Alarm Contractor.
   e. Workstation/Server and PoE switch by owner.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

D. All related specification sections shall be used in conjunction with this section.

1.03 QUALITY ASSURANCE

A. Product Standards:

1. All materials included in the completed Security System installation shall be new and shall fully comply with the latest published specifications of the manufacturer.
2. Unless otherwise specified, all components included in the completed Security System shall be standard, unmodified production models.
3. All equipment provided shall be fully supported by the manufacturer. The manufacturer shall provide written policies identifying product support and continued support policies for discontinued equipment. The manufacturer shall provide examples of continuing support for discontinued equipment.
4. References:

   a. Design and operation of the system shall conform to the following referenced codes, regulations, and standards as applicable:

      1) National Electrical Code (NEC)
      2) NFPA 2010 Chapter 24 Mass Notification
      3) UL 294, UL864 and UL 1076
      4) FCC Rules and Regulations
         Part 15, Radio Frequency Devices
      5) National Electrical Manufacturers Association (NEMA)
         Section 250 Enclosures for Electrical Equipment
      6) Applicable Federal, State, and Local laws, regulations, and codes.

B. Contractor Qualifications:

1. Only qualified manufacturer licensed dealers are approved to bid on this Project. No other bids will be considered.
2. The Contractor shall have a minimum of five years' experience in the fabrication, assembly, and installation of systems of the magnitude and quality equivalent to those specified herein.
3. The Contractor shall have completed at least three projects of similar size and nature.
4. The Contractor shall have installed the products bid for this project at a minimum of one other location.
5. The Contractor shall maintain a local service center within 150 miles of the installation location. The service center shall be staffed and adequately equipped to provide emergency service within four (4) hours after being called during normal business hours.
6. The Contractor shall provide factory-certified technicians to install and maintain the systems provided. The Bidder shall furnish information in the Bid Package to demonstrate compliance with this requirement.
7. The Contractor shall ensure compliance with and an understanding of all local codes and contract conditions pertaining to this Project.
8. The Contractor shall comply with union trade requirements.
9. The Contractor shall assign a project manager to the Project that has been approved by the Owner and Engineer.
10. The approved project manager shall be assigned for the duration of the Project and must not allow other contracts or assignments to interfere with his/her duties and responsibilities to this Project.
11. The approved project manager shall have a minimum of five years' experience as a project manager in the security integration industry.
12. Security vendor shall organize and facilitate a one-day on-site installation coordination meeting with Owner representatives, Architect, Engineer, and door hardware supplier to coordinate sequence of operation, door hardware, and wiring, etc., for all doors included in the system.

13. All Security Management System equipment shall be coordinated with Door Hardware specification section.

1.04 SUBMITTALS

A. Submit product data in accordance with Section 26 01 00.

B. Provide product data for all equipment to be provided.

C. Provide Contractor's current Manufacturer's certification documents and status. Non-current or uncertified contractor submissions shall not be accepted.

D. Provide a complete riser diagram showing all components, power supply calculations and wiring diagrams.

E. Floor plans indicating all devices and locations.

1.05 WARRANTY

A. Provide a two-year product warranty on all hardware from date of completion.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Mass Notification System:

1. Alertus

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures outlined in Section 26 01 00.

2.02 MASS NOTIFICATION SYSTEM

A. General:

1. The MNS system shall be software-operated, network-based communications system with wired and wireless access points for control interface. Designated operators shall be able to log in via a web browser and have complete access to their own portion of the MNS.
2. An autonomous voice notification control unit shall monitor and control the notification appliance network and provide consoles for local operation. Authorized personnel shall be able to use a console to initiate delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe and optional textual message notification appliances. The autonomous voice notification control unit shall temporarily override audible fire alarm notification while delivering mass notification messages to ensure they are intelligible.
3. The MNS messaging system shall be capable of the following:

   a. Communicating through the use of wired or wireless networks for one- or two-way communications and control between a building or area and emergency personnel.
   b. Automatically distribute at least 100 simultaneous and unique messages to the appropriate notification appliances.
   c. Allow multiple operators to send messages simultaneously.
   d. Grant access for control to another control station if the location in control becomes inoperable and/or the authorized operator at that control station can no longer operate the control station.

e. Send voice messages and text messages with an indication of the source of the message that can only be sent from the message source.
f. Send alert messages to end users (recipients) via multiple delivery methods, including but not limited to the following:

1) Audio-visual network alerts to computers via desktop pop-up.
2) Text alerts to mobile phones and pagers.
3) Text alerts to email clients.
4) Text alerts to textual visible appliances.
5) Provide digital signage, LCD display and projection override.
6) Alerts to visible appliances.
7) Audio alerts to phones.
8) Audio alerts to speakers.
9) Audio alerts to existing wide-area or building voice and/or other MNS.
10) Network alerts to any other IP-connected devices via standard XML and CAP protocols.

g. Suppress contact information for other end users with messages or in message headers.

4. Live announcements or prerecorded messages. Live messages shall take precedence over prerecorded messages.
5. Notification appliance network shall consist of speakers and visual notification devices located to provide intelligible instructions.
6. Interface with the fire alarm system to utilize the voice modules, visual alarms, and speakers of the fire alarm system.
7. Give priority to MNS announcements over other audible announcements of the system including fire alarm system in a normal or alarm state. When an announcement is activated during a fire alarm, fire alarm system functions shall continue in an alarm state, except for the output signals of the fire alarm audible and visual notification appliances.
8. Comply with speech intelligibility requirements of NFPA 72 as measured according to ANSI/ASA S3.2.
9. Capable of overriding local control of speaker volume levels for emergency communications. Local controls shall be permitted to adjust volume levels of non-emergency signals only, such as, but not limited to, background music and convenience paging.
10. Capable of providing separate messages to one individual building or to multiple buildings at any given time if the MNS serves more than one building.
11. Capable of monitoring emergency notifications from multiple data sources (National Weather Service, Emergency Managers Weather Information Network, Naval Meteorology and Oceanography, and others as determined locally) and automatically send out notifications to designated facilities and personnel based on pre-defined rules.
12. Capable of centrally tracking, in real-time, all alerting activities for each individual recipient, including sending, receiving, and responding to alerts, and of generating reports based on tracked information.
13. Capable of operating remote printer via a USB output. Provide matching printer listed and labeled as part of the MNS.

2.03 NOTIFICATION COMPONENTS

A. Voice/Alarm Signaling Service:

1. One-way, multichannel voice notification system incorporating at least eight distinct sounds selectable by user for tone signaling and incorporating a voice module for delivery of prerecorded messages.
2. Redundant microphones, preamplifiers, amplifiers, and tone generators provided in separate main and remote cabinets.
3. Voice notification system shall support facility public address paging.

4. Audible appliances shall produce a code 3 temporal tone for three cycles followed by a voice message that is repeated until the control panel is reset or silenced.
5. Automatic messages shall be broadcast through speakers throughout the building or facility, but not in stairs or elevators.
6. When using microphones, live messages shall be broadcast throughout a selected floor or floors or all call, including stairs and elevators.
7. Live voice message shall override automatic or recorded audible output through use of a microphone input at the main control panel or the remote cabinet.
8. Number of alarm channels shall be indicated for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone.

    a. Allow sending an evacuation signal to selected zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.
    c. Standard digitally recorded messages for "Evacuation" and "All Clear."

B. Audible Notification System: Comply with the requirements of NFPA 72 and ISO 7240-16 for Emergency Voice/Alarm Communications System, except where more stringent requirements are specified. Voice intelligibility shall be evaluated according to IEC 60268-16.

1. Amplifiers:

    a. Comply with UL 1711.
    b. Audio output shall be selectable for line level. Minimum amplifier output shall be 100 W rms.
    c. Capable of operating all speakers at the same time.
    d. Loss of operating power, supervisory power, or any other malfunction that could render the voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

2. Audible Notification Devices:

    a. Handheld push-to-talk microphone shall be supervised and a key shall be required to enable remote microphone use.
    b. Microprocessor shall actively integrate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of stored voice data into appropriate amplifier input.

C. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Indoor Speakers for Voice Notification:

    a. Construction: High-efficiency, sealed back; for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz.
    b. Standard: UL 1480.
    c. Speaker Locations: Comply with NFPA 72, "Notification Appliances" and "Emergency Communications Systems" chapters.
    d. High-Range Units: Rated 2 to 15 W.
    e. Low-Range Units: Rated 1 to 2 W.

D. Text Displays:

1. Programmable, digital text displays having a minimum of 4-inch (100-mm) high letters for hearing-impaired occupants displaying the content of the voice message being played.
2. Capable of sending static, flashing, or scrolling messages to textual visible appliances.
3. Mass notification control panel shall interface with and control the programmable display controller to activate the proper message.
4. Textual visible notification shall be primary notification when it is the only method used to convey emergency MNS information to the general public or to specific individuals.

E. Visual Notification Appliances:

1. Strobes used solely for MNS shall be amber complying with UL 1971 and with the word "ALERT" factory printed on the trim.
2. Strobes used for MNS shall be synchronized.
3. External beacon shall be blue in color.

F. Alert Beacons:

1. Provide a Single device with integrated audible and visual signaling and text notification device shall conform to the following:

   a. InGaAIP Strobes with typical luminous intensity of 1495 mcd and 640 nm
   b. Visual signaling viewing angle of 270 degree (horizontal and vertical) and text viewing angle of 105 degree
   c. Selectable multi-tone siren with 106 dBA at 10 cm and 2,800 Hz
   d. Several independent multi-color strobe clusters which enable multiple visual flash patterns
   e. Rechargeable battery system which trickle charges batteries at a safe charge rate to maximize battery life and ensure peak charge
   f. Input voltage range 12 to 24 volts DC or AC, or Power-over-Ethernet (PoE)
   g. Zoneable and individually addressable.

G. Text To Speech Interface:

1. Provide text to speech interface for connection to systems as required.

H. Web Interfaces:

1. Capable of utilizing dedicated or existing IP networks to send alert messages. System shall be able to communicate with multiple modalities to include but not limited to pop-up alerts on personal computers, text messages to cellular phones, email messaging to IP-capable computers or devices, and recorded voice messages to voice-over-IP (VoIP) telephones and PCs.
2. Capable of activating, through a single interface, non-IP alerting systems such as wide-area alerting systems, fire alarm systems, PA systems, handheld radio systems, radio broadcast systems, personal pager systems, nurse call systems, and traditional dial-up telephone alerting systems.
3. Capable of accessing user screens via multiple web browsers such as MS Explorer, Mozilla Firefox, or Apple Safari.
4. Capable of sending live video stream from an IP-based camera or security camera system to any PC or video display.

I. Primary Power:

1. 24-V dc obtained from 120-V ac service and a power-supply module.

   a. Power supplies shall be sized to furnish a minimum of 125% of the total connected load in a worst-case condition.

2. Devices Powered by 24-V dc:

   a. Control panels.
   b. Notification appliances.
   c. Text displays.
   d. Trouble signals.
   e. Supervisory signals.
   f. Supervisory and digital alarm communicator transmitters.
   g. Digital alarm radio transmitters.

J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.
2. Batteries: Sealed, valve-regulated, recombinant lead acid.
3. Batteries: Sealed lead calcium, valve-regulated, recombinant lead acid.
4. Battery size shall be a minimum of 125% of the calculated requirement.

K. Overvoltage and Surge Protection:

1. Signaling Line Circuit Surge Protection: Protected against surges induced on any signaling line circuit located outdoors, and complying with IEEE C62.41.1 and IEEE C62.41.2.
2. Protect cables and conductors that serve as communications links with surge protection devices installed at each end that meet the following waveforms:

   a. 10 by 1000 mic.sec. waveform with a peak of 1500 V and a peak current of 60 A.
   b. 8 by 20 mic.sec. waveform with a peak of 1000 V and a peak current of 500 A. Protection shall be provided at the equipment. Additional surge protectors, rated for the application, shall be installed on each circuit within 36 inches (900 mm) of the cable entrance to the building.
   c. Fuses shall not be used for surge protection.

3. Sensor Wiring Surge Protection: Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring. The inputs and outputs shall be tested with the following waveforms:

   a. 10 by 1000 mic.sec. waveform with a peak of 1500 V and a peak current of 60 A.
   b. 8 by 20 mic.sec. waveform with a peak of 1000 V and a peak current of 500 A.
   c. Fuses shall not be used for surge protection.

2.04 SOFTWARE REQUIREMENTS

A. Operating System and Application Software:

1. The software system for the system shall be of an Outlook® style configuration. The operating system kernel shall be open-source and no operating system training or certification shall be necessary.

B. Software Licensing:

1. Software licensing shall be based upon the total number of readers for one Network Controller board. Software license upgrades shall be available if system reader and camera capacity must be raised. The user license shall be valid in perpetuity and shall include one year of software updates from the date of shipment from the factory.
2. Licensing shall be controlled by a Product Key and an Activation Key. The Product Key contains the licensed system features and limits. To upgrade your system license to enable more cameras or more doors you will need a new Product Key. The Activation Key contains the warranty expiration date. The keys are locked to the system license number. The system license number shall be viewable on-screen on the Support: About page.

C. Software Upgrades: Software upgrades shall be possible from a browser on any network-connected PC, by uploading a software update to the Controller. Controllers shall automatically upgrade all connected nodes. No client software installation shall be necessary.

D. Online Help and Documentation: The system shall be provided with complete embedded documentation. The on-line documentation shall include:

1. Context-sensitive online Help. (The Help displayed is specifically relevant to the current screen.) The online Help system shall provide explanations and procedures for all monitoring, administrative, and system configuration and maintenance functions. The Help system shall have linked table of contents, a linked index, and frequently asked questions pages. Each topic shall also have links to related topics. Each Help topic shall be printable.
2. Technical Support Notes: These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
3. Installation Guides: These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
4. Video Integration Guides: These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
5. System Administration Guide: This document shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
6. The Help system shall also be available in a zip file format (xxx.zip) and it shall be possible to install the online Help system on any computer for purposes of reference and use by support personnel.

E. Language Support: The system shall be provided with multiple language support. The ability to switch from one language to another shall be accomplished through the user interface. Translation of the user interface, online help and documentation into other languages shall be available. The languages supported shall include:

1. English
2. Spanish
3. Portuguese
4. French
5. Italian
6. Thai
7. Chinese
8. Japanese

F. Date Formats: The system shall support global date formats as follows:

1. mm/dd/yyyy
2. dd/mm/yyyy
3. yyyy/mm/dd

G. Floor Plans: The system shall provide graphic floor plan capability including graphic display of links to other floor plans, alarms, system resources such as portals, IP video cameras, inputs, outputs, and temperature monitoring points.

1. The Network Administrator holding at least a 'Setup' user role shall be able to graphically configure device icons onto the floor plan images, and to upload additional floor plan images. JPEG images shall be supported, and the maximum size for a floor plan image shall be 256K.
2. It shall be possible to create floor plan groups for the purpose of assigning or withholding assignment of these groups to system user permissions known as Custom User Roles. If a floor plan group is assigned to a particular system user then the floor plans in that group shall be viewable by that system user.

2.05 DURESS PUSH BUTTONS

A. The Contractor shall provide duress buttons for security assistance in areas shown on Drawings. Provide concealed flush-mounted Inovonics Model #EN 1235SF or equal.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. Installation Requirements:

1. Comply with installation requirements in NFPA 70, NFPA 72, and NECA 1.
2. Install remote amplification and control units in terminal cabinets. Power each remote amplification and control unit from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote unit.
3. Retain "Equipment Installation" Paragraph below for installation of equipment with seismic restraints, without vibration isolation devices, and without concrete bases.
4. Equipment Installation: Install MNS cabinets with seismic rated anchors and mounting apparatus. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
5. Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for mass notification systems.
6. Retain one of two "Wiring Method" paragraphs below and coordinate with Drawings. Delete both if wiring methods for system are indicated on Drawings.
7. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used]. Conceal raceway and cables except in unfinished spaces.

   a. Retain first subparagraph below if retaining unenclosed wiring method option in "Wiring Method" Paragraph above.
   b. Install plenum cable in environmental air spaces, including plenum ceilings and in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring is used.
   c. Comply with requirements for cable trays specified in Section 270536 "Cable Trays for Communications Systems."
   d. Comply with requirements for raceways and boxes specified in Section 280528 "Pathways for Electronic Safety and Security."
   e. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible. Suspend cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than [60 inches (1500 mm)] <Insert dimension> apart.
   f. Do not install cable through structural members or in contact with pipes, ducts, or other potentially damaging items.

g. Secure and support cables at intervals not exceeding 30 inches (750 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
h. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Maintain separation of conductor types as recommended by manufacturer. Install lacing bars and distribution spools.
i. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
j. Cold-Weather Installation: Bring cable to room temperature before dereeling. The use of heat lamps is prohibited.
k. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
l. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install MNS wiring in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker-microphone wiring and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
m. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools. Route conductors to allow accessibility to equipment for adjustment and maintenance.
n. Connections:

    1) Make all terminations on numbered terminal strips in terminal cabinets or equipment enclosures. No splices or butt joints will be accepted.
    2) Terminate all conductors; no cable shall contain unterminated elements.
    3) Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

o. Mount all devices and appliances to or in an approved electrical box.
p. Install operating instruction placard on the interior of the mass notification control panel.
q. Install operating instruction placard on the frame in a location acceptable to the Architect and observable from the mass notification control panel.

B. Grounding:

1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. An instrument ground system is assumed in the following paragraph. If one does not exist in the building, coordinate with Drawings to ensure an instrument ground system is installed and is isolated from other ground systems, except at the single point of connection required by NFPA 70.
3. Signal Ground Terminal: Locate at main equipment cabinet. Connect to instrument ground system and isolate from power system and equipment grounding.

C. Testing and Commissioning:

1. The SMS supplier shall be responsible for final system hardware hook up and checkout prior to commissioning the system to the end user.
2. The SMS supplier shall be responsible for:

    a. Construction schedule of product and services
    b. Schedule of values
    c. Project Folder
    d. Routinely Scheduled Project Progress Management

e. Factory Consultation Services

D. Training and Instruction:

1. Before the system is turned over to the owner, the manufacturer shall provide 3 days of system operations training at the project site using the customer's equipment for up to 10 of the Owner's representatives meeting a minimum expected level of computer competence.
2. This training shall be conducted during normal business hours of the equipment supplier at a date and time of mutual convenience.
3. This training shall be conducted by a dedicated trainer employed full-time for the purpose by the manufacturer of the access control system. Representatives of a local dealer operation shall not be considered acceptable.

E. Software Support:

1. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two (2) years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

   a. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. The MNS shall be supported by the manufacturer for no less than two years from date of system turnover.

F. Demonstration:

1. Installation contractor and factory representative shall train Owner's maintenance personnel to adjust, operate, and maintain units.

   a. Train a minimum of four (4) employees of the Owner.
   b. Conduct training on the installed equipment after acceptance testing.
   c. Train on system operation, including manual control of output functions from the system control panel.
   d. Train on testing of the system, including logging of system tests, field test of devices, and response to common troubles.
   e. The total training requirement shall be a minimum of [**four**] <**Insert number**> hours but shall be sufficient to cover all items specified.

G. Warranty:

1. The system shall be warranted for a period of 2 years from date of acceptance or first beneficial use, whichever occurs first. Written notification shall be sent to the owner stating the date this warranty period has started.
2. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two inspections and preventative tests per year.

END OF SECTION

SECTION 27 01 00

BASIC TELECOMMUNICATIONS REQUIREMENTS

(Telecommunications Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Basic telecommunications requirements specifically applicable to Division 27 sections, in addition to Division 01 - General Requirements.

B. Furnish all labor, materials, services, supplies, tools, equipment, apparatus, transportation, facilities and incidentals required and perform all operations necessary to accomplish and complete installation of the voice, data, and audio-video communications systems, and communications accessories as shown on the Contract Drawings, specified herein or as reasonably may be implied as being incidental to this work, and as required for complete telecommunications systems.

C. The performance of the work under Division 27 shall be in accordance with the regulations and rulings of all authorities having jurisdiction over the work.

D. The scope of work involves and includes but is not limited to the following:

1. Data System.
2. Voice System.
3. Cable Television System (CATV).

E. Work indicated below shall be coordinated with others to provide the intended operable systems. The Contractor shall include all costs associated with the coordination and provision of this work in this Contract.

1. Coordinate with Owner for the following:

a. Approval of all telecommunication system components.
b. Telecommunication system labeling.
c. Approval of all telecommunication system installations

F. Work of Division 27 shall include the coordination of all arrangements and payment of all required fees for agency permits and associated inspections.

1.02 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations.

B. This Specification is partially of the abbreviated or "streamlined" type and includes incomplete sentences. Omitted words or phrases shall be supplied in inference in the same manner as they are when a "note" occurs on the Drawings. Words "shall be" will be supplied by inference where colon (:) is used within sentences or phrases.

C. Drawings and general provisions of the Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

D. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to

be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

E. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

F. All related Specification Sections shall be used in conjunction with this Section.

1.03 DEFINITIONS

A. Definitions pertaining to Division 27:

1. Provide: Furnish, install, and connect.
2. Furnish: Supply materials only.
3. Indicated: On Contract Drawings.
4. Concealed: Hidden from sight at completion of work.
5. Trade: General Contractor, HVAC, plumbing, etc.
6. Contractor: The person, firm, or corporation performing the work called for in this Telecommunications Specification, whether they be prime or sub.
7. Whenever the word "Engineer" appears, it shall be construed as meaning the Owner's representative.

1.04 SUBMITTALS

A. Refer to Division 01 for submittal requirements. The following paragraphs supplement the requirements of Division 01.

B. Submit shop drawings and product data as requested by other Division 27 sections. All submittals to follow requirements of General Conditions, modifications to General Conditions, and Division 01.

C. The Contractor will be held responsible for checking and verifying all field measurements, and shall submit promptly, as to cause no delay in any work, shop drawings, and schedules required for the work. The Contractor shall check and approve all submittals before forwarding to the Architect. All submittals shall be transmitted to the Architect using the submittal transmittal form contained in Division 01. The Architect will forward submittals to the Engineer. The Engineer will check and review the submittals with reasonable promptness, but only for conformance with design concept of the project and for compliance with information given in Contract Documents. The Contractor shall make any corrections required by the Engineer. The Engineer's review of submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications, unless he has, in writing, called the Engineer's attention to such deviations at the time of submission and has secured the Engineer's written approval. Additionally, the Engineer's review of submittals shall not relieve the Contractor from responsibility for any errors or omissions contained in the submittals.

D. Submittals shall be clear and concise. The submittals shall clearly indicate the product name, applicable Specification Section, proposed location and all features and ratings. The intended product shall be differentiated from others with a model number or highlighting.

E. When necessary, shop and setting drawings shall be based upon actual measurements taken at the site and upon other job conditions. Show any variations and revisions to Drawings or Specifications that are necessary for proper installation.

F. Submit copies of manufacturer's shop drawings showing illustrated cuts of item to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, installation instructions, wiring diagrams and controls and all pertinent information. Submit the quantity of copies indicated in Division 01.

G. The Contractor shall note that where more than one manufacturer's name is listed for the various major items of equipment and materials specified herein, the plans and specifications have been developed on the basis of equipment as manufactured by the first manufacturer name. Other manufacturers names are included to indicate the equipment manufactured by them may be considered acceptable for this project, provided that the equipment meets all requirements as to quality, size, adaptability to space requirements, etc. It shall be the Contractor's responsibility to assure that the equipment, as manufactured by other than the first name manufacturer, shall meet all requirements as to equipment ratings, quality, size, capacity, function, adaptability to space requirements, etc. The Engineer's review of shop drawings for equipment as manufactured by other than the first named manufacturer shall in no way relieve the Contractor of this responsibility.

H. Upon request, samples of telecommunications items shall be furnished to the Engineer. Samples shall be properly tagged, noting Section and paragraph of Specifications where item is proposed for use and listing project name, Contractor's name, manufacturer's name and identifying number and where applicable.

1.05 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 for operation and maintenance manual requirements. The following paragraphs supplement the requirements of Division 01.

B. The Contractor shall provide the following information in a bound manual:

1. Description of function, normal operating characteristics and limitations, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, routine and normal operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and schedules.
5. Manufacturers' catalogs, photographic equipment cuts, wiring diagrams, and final reviewed shop drawings for all equipment and devices furnished under this section.
6. Include copies of all test results and certifications.

C. Two (2) copies of operations and maintenance data shall be submitted to the Architect for review: one (1) copy shall be returned to the Contractor (with any instructions for changes). After implementing any changes, five (5) copies of instructions covering all equipment shall be furnished to the Architect who will forward two (2) copies to the Owner for his information and use.

D. Append to the manual, the name, address and telephone number of the Contractors and Subcontractors and for telecommunications items, provide the name, address and telephone number of companies servicing installed equipment on a 24-hour basis.

E. After submission and approval of the operating and maintenance data, the Contractor shall furnish competent Operation Engineer(s) at such time or times as directed by the Architect to meet with the Owner or his representative, to fully explain instructions and to demonstrate and fully familiarize the Owner or his representative with all of the equipment and all phases of its operation and maintenance. The amount of time devoted to instructions shall be reasonable and consistent with the size of the installation and the complexity therefore. Instructions shall be adequate to the extent that the Owner's personnel may proceed with normal operations in a safe and efficient manner.

1.06 FINAL SUBMITTALS

A. As a requisite for final acceptance, the following are required:

1. Project Record Documents:
   a. During progress of the Work, maintain an accurate record of the installation of the telecommunication system, locating each concealed conduit precisely by dimension. This shall include, but not be limited to: conduit below ground level and in or below building slab. All service, sub-service and main riser conduits for communication systems. All spare conduits stubbed in concealed spaces and the locations of all electrical equipment essential for system operation (such as end of line resistors, etc.).
   b. Upon completion of the telecommunication installation, transfer all record data to prints of the original Drawings. Where required by Division 01, provide project record documents in AutoCAD file format.
2. Manual: Upon completion of the telecommunication installation, and as a condition of its acceptance, deliver to the Owner and the Engineer operation manuals compiled in accordance with the provisions of Division 01 and Article 1.05 of this specification Section; include one copy of as-built Project Record Drawings in each copy of the manual. Provide quantity of manuals as required in Division 01.
3. Certificates:
   a. Two (2) copies of the City Building Inspector's Certificate of Approval showing acceptability of work done under this Contract. Deliver to the Owner with a copy to the Engineer.
   b. Two (2) copies of any other Certificates of Approval. Deliver to the Owner with a copy to the Engineer.
4. At completion of construction, the Contractor shall furnish the Owner with one (1) unused copy of all reviewed shop drawings, manufacturer's diagrams, installation instructions, literature, etc., that were used in execution of the work.
5. Warranties: Provide all indicated warranties in accordance with Division 01.

1.07 SUBSTITUTIONS

A. Any and all proposed substitutions must be approved by the Architect during the bid phase and must be indicated on the form of proposal. For specific substitution requirements, refer to Division 01.

1.08 COORDINATION

A. Prepare and submit coordination drawings for <u>all</u> work performed under Division 27 as specified in Division 01.

B. Coordinate scheduling, proposed routing, and critical dimensions with all other trades prior to roughing and equipment installation.

C. Coordinate with each utility company and make all installations for their services in accordance with all utility company requirements.

D. It shall be the responsibility of the Contractor to verify dimensions and elevations shown or scaled on Drawings by actual field measurements after building construction has progressed to the point where such measurements may be taken.

E. Advise Owner in writing regarding those critical dimensions which must be held by other Trades as they perform their work.

F. Assume full responsibility for accuracy of all work under this Division and make corrections as required.

G. It shall be this Division's responsibility to coordinate with all other Trades and separate equipment contracts regarding mechanical equipment layouts, space requirements, mounting details, "roughing-in" dimensions, and for items substituted for those specified herein to avoid conflict.

H. Layouts of backbones and wiring shown on Drawings are diagrammatic, and shall be constructed as such, intended to show scope of work and general arrangement, unless otherwise noted.

I. Where telecommunication items are shown in conflict with locations of structural members and mechanical or electrical equipment, furnish and install all required supports and wiring to clear the encroachment.

J. Where job conditions require reasonable changes in indicated locations or arrangements prior to roughing, make such changes without extra cost to the Owner.

K. Any Work installed contrary to or without approval of the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed the Contractor for making these changes.

L. Provide all communications wiring to equipment furnished by this and other Trades (electrical, heating, ventilation, plumbing, general construction, etc.) unless otherwise indicated or specified.

M. Where locations are dimensioned on the Drawings, they may be changed only with the written approval of the Owner or his representative. If interferences are found between the telecommunication work and that of other Trades, Owner shall decide which must be relocated.

N. Contractor shall study and compare all Contract Drawings, Specifications, and other instructions and shall at once report to the Engineer any error, inconsistency or omission which he may discover.

O. Where a conflict occurs between this Specification and other Contract Documents, the more stringent requirements shall govern.

P. Contractor shall have a competent foreman in charge of work with authority to receive verbal and written instructions from Owner. Contractor shall inform Owner of foreman's name and title.

Q. The Drawings are diagrammatic and functional only, and are not intended to show exact layouts, number of fittings, or other installation details. The Contractor shall furnish all labor and materials necessary to install and place in satisfactory operation all telecommunication systems shown. Additional circuits shall be installed by the Contractor wherever needed to conform to the specific requirements of the equipment.

R. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be verified during construction so that they shall coordinate with all other work and equipment. The Contractor shall obtain in the field all information relevant to the placing of telecommunication work and, in case of any interference with other work, shall proceed as directed by the Engineer and shall furnish all labor and materials necessary to complete the Work in an approved manner.

S. The electrical contractor shall be responsible for properly preparing the project for telecommunications installation, as specified.

1. Electrical Subcontractor shall provide and install all 4" square backboxes for outlet locations and provide single or double gang plaster rings for all single and double gang outlet locations as specified.
2. Electrical Subcontractor shall provide and install all outlet boxes, plaster rings, floor boxes, pathways, poke through devices, power, cableways, cable tray, cable protection, surface mounted metal raceway, conduits, bushings, stubs with bushings, backboxes, pull strings, grounding and bonding, core drilling, cutting, patching, fireproofing, of penetrations, environmental seals, smoke and firestopping seals including all conduits, raceways, sleeves, slots etc. where cables pass from one location to another for a completely operational system.
3. Electrical Contractor shall provide and install cable tray over each rack and cabinet as required to facilitate a neat and orderly installation of cables and secure the rack to structure. Including all radius drops which will allow cable to drop straight into the rack and proper support to secure tray to the structure.
4. The subcontract between the General Contractor and the Electrical Subcontractor shall contain a provision whereby the Electrical Subcontractor shall be obligated to coordinate its work with the Telecommunications Contractor for this section.
5. Section 27 74 00: The Electrical Subcontractor shall read 27 74 00 in its entirety and shall provide all requirements for the Electrical Subcontractor as detailed in Section 27 74 00.

T. Telecommunication Contractor responsibilities for this section shall be: The Telecommunication Contractor shall be responsible for providing, installing, troubleshooting, training, and warranty service of all cabling and components required for a complete and operational system.

1. Keep fully informed as to the shape, size, and position of all openings, required for all system components and give information in advance to build openings into work. The Electrical Subcontractor shall furnish and set in place all sleeves, pockets, supports and incidentals.
2. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interferences or to provide adequate clearances for code and maintenance requirements shall be made at no additional costs.
3. Structural elements of the project shall not be relocated, altered, or changed to accommodate the work without written authorization from the Architect.
4. Obtain a full set of Drawings and Specifications for coordination and to determine the full scope of work.
5. Attend project coordination meetings to coordinate work of this section, work of other trades and project phasing requirements.

U. The Drawings are diagrammatic and functional only, and are not intended to show exact layouts, number of fittings, or other installation details. The Contractor shall furnish all labor and materials necessary to install and place in satisfactory operation all telecommunication systems shown. Additional circuits shall be installed by the Contractor wherever needed to conform to the specific requirements of the equipment.

V. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be verified during construction so that they shall coordinate with all other work and equipment. The Contractor shall obtain in the field all

information relevant to the placing of telecommunication work and, in case of any interference with other work, shall proceed as directed by the Engineer and shall furnish all labor and materials necessary to complete the Work in an approved manner.

1.09 QUALITY ASSURANCE

A. Qualifications of Installers:

1. For the actual fabrication, installation, and testing of the Work of this Division, use only thoroughly trained and experienced personnel who are completely familiar with the codes and requirements for this Work and with the installation recommendations of the manufacturers of the specified items.

B. Workmanship:

1. Complete telecommunications installation shall be made in a neat and workmanlike manner and to the full satisfaction and approval of the Owner and Engineer.
2. Work not meeting Owner's standard for adequate workmanship shall be removed and replaced at once, at no additional Contract cost to the Owner.
3. Remove and replace all work rejected by Owner as defective, non-operational or not in conformance with intent of this Contract.

C. Electrical products used shall be UL listed by Underwriters Laboratories. To assure the proper use of electrical equipment, the Electrical Contractor shall verify compliance by reference to the UL Guide Information for Electrical Equipment - The White Book.

1.10 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

1.11 REGULATORY REQUIREMENTS

A. Perform the work and provide material under this Division in strict accordance with applicable provisions of all governing codes, rules, laws and ordinances as amended and in effect on date of issue for bids, specifically including but without being limited to:

1. American National Standards Institute (ANSI).
2. American Society for Testing Materials (ASTM).
3. Americans with Disabilities Act (ADA).
4. Building Industry Consulting Service International (BICSI).
5. Canadian Standards Association (CSA)
6. Environmental Protection Agency (EPA)
7. Federal Communications Commission (FCC)
8. Institute of Electrical and Electronics Engineers (IEEE).
9. Insulated Cable Engineers Association (ICEA).
10. International Building Code (IBC)
11. Local ordinances, regulations, and electric codes.
12. Occupational Safety and Health Act (OSHA).
13. National Electrical Code (NEC).
14. National Electrical Safety Code (NESC).

15. National Electrical Manufacturers' Association (NEMA).
16. National Fire Protection Association (NFPA).
17. Telecommunications Industry Association and Electronics Industry Association (TIA/EIA)
18. Requirements for Underwriters' Laboratories, Incorporated for all items installed for which UL standards have been established.
19. Pertinent requirements of the local utility companies.

B. In each case, codes are minimum requirements.

C. It shall be understood that all codes and standards mentioned shall be those in force at the time the Contract is signed. If any code is changed during the construction period, these Specifications may be changed by change order.

D. Each item of equipment and material shall conform to requirements of these applicable publications which make them most suitable for environmental conditions where they shall be installed.

E. Items which are within scope of items tested by Underwriter's Laboratories, Inc., or other suitable nationally recognized independent testing laboratories shall have their conformance with these applicable publications evidenced by attachment of authorized seal, label, or stamp of those testing laboratories.

F. The Contractor shall cooperate with and assist Owner in securing from the authority enforcing the codes any "special permission" or interpretation needed to complete work.

G. The work required by the Drawings and the Specifications shall comply with applicable codes. Conflicting provisions of the Contract Documents to the contrary notwithstanding, it shall be the sole responsibility of the Contractor as part of the base Contract to execute the work so as to obtain the approval of the Local Authority at completion of the work.

H. On preparing his bid, the Contractor shall carefully check the Drawings and Specifications for compliance with applicable codes and other legal requirements. He shall inform the Engineer in writing of any non-conformance before he submits his bid.

1.12 PROJECT/SITE CONDITIONS

A. Install work in locations shown on the Drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect before proceeding.

1.13 PRODUCTS

A. In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays and other items is essential. All similar items shall be of the same manufacturer, type, model, and dimensions or, in the case of special systems which are a composite of a number of manufacturers' products, shall be supplied and/or serviced from an organization with one source of responsibility.

B. Provide products which are compatible within systems and other connected items.

C. For ease of maintenance and parts replacement, to the maximum extent possible, use equipment of a single manufacturer.

D. The Engineer reserves with the right to reject any submittal which contains equipment from various manufacturers if suitable materials can be secured from fewer manufacturers and to require that source of materials be unified to the maximum extent possible.

E. All equipment and fixtures shall be of the capacity and type shown on the Drawings and specified herein and shall be as manufactured by one of the manufacturers designated or shall be an equal approved in advance by the Engineer.

F. All other materials, not specifically described but required for a complete and operable electrical installation, shall be new, first quality of their respective kinds, and as selected by the Contractor subject to the approval of the Engineer.

G. Install all equipment and fixtures in complete accordance with the manufacturer's recommendations and all pertinent codes and regulations.

H. Materials and equipment shall be listed by Underwriters Laboratories unless it can be demonstrated that no UL standards exist for a specific items or class of equipment.

1.14 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly packaged and protected to prevent damage during shipment, storage, and handling.

B. Use all means necessary to protect telecommunication system materials during and after installation and to protect the installed work and materials of all trades until testing and final acceptance.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Product stored equipment and materials from damage.

D. Provide approved protection of all work and property against damage, injury, loss, etc., until testing and final acceptance. Follow manufacturer's recommendations for protection of equipment and materials during storage and construction; protect equipment outlets, pipe and conduit openings with temporary plugs or caps.

E. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

F. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

G. The Contractor shall be responsible for the work of other trades that may be damaged or disturbed in the course of his work and he shall restore the damaged work to the condition existing prior to damage without additional cost to the Owner.

1.15 TELECOMMUNICATION INSTALLATION

A. Coordinate telecommunication equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for telecommunication installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of telecommunications materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

G. Install telecommunication equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

H. Coordinate the installation of telecommunication materials and equipment in ceilings with suspension system, mechanical equipment, and other piping installations.

I. Coordinate connection of telecommunication systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

J. Note that special efforts have been made to layout mechanical and telecommunication systems exposed to view in order to achieve a certain aesthetic quality. The Contractor is responsible to layout and install all systems, especially those exposed to view, in a neat, orderly, and workmanlike manner in order to provide a high quality installation, and to maintain the desired aesthetic quality, as appropriate.

1.16 CUTTING AND PATCHING

A. Unnecessary cutting and patching shall be avoided through proper planning of work, provision of pipe and duct sleeves and cooperation with other Contractors. Each Contractor shall be responsible for all cutting, patching, and restoration of his own work at no expense to the Owner and to the satisfaction and approval of the Owner.

B. In no case shall structural members be cut or notched without approval of the Engineer.

C. All patching shall be done only by mechanics who are skilled in this line of work to produce a neat finished job acceptable to the Owner in all respects.

D. Repair and/or replace the work of Trades damaged as a result of work performed under this Division, at no additional cost to the Owner.

1.17 SURFACE CONDITIONS

A. Inspection:

1. Prior to all work of this Division, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that the telecommunication installation may be made in complete accordance with all pertinent codes and regulations and the original design.

B. Discrepancies:

1. In the event of discrepancy, immediately notify the Engineer.

2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

C. Reconditioning for Surfaces:

1. Unpaved surfaces disturbed during the installation of ductbanks shall be restored to their original elevation and condition. Sod or topsoil shall be preserved carefully and replaced by sod or topsoil of quality equal to that removed. Where the surface is disturbed in a newly seeded area, the restored surface shall be reseeded with the same quantity and formula of seed as that used in the original seeding.
2. The Contractor shall patch pavement, sidewalks, curbs, and gutters where existing surfaces are removed for construction. Cut pavement edges shall be sawn. Concrete or brick pavers, or other similar surface finishes, that are removed during the installation of duct, shall be replaced and restored to match surrounding surfaces.

1.18 CLEANING

A. Thoroughly inspect all equipment and any items dented, scratched, or otherwise damaged in any manner shall be replaced or repaired and painted to match original finish.

1. All items so repaired and refinished shall be brought to the attention of the Engineer for inspection and approval.

B. Upon completion of all installation and testing, thoroughly inspect all exposed portions of the telecommunication installation and completely remove all exposed labels, soil, markings and foreign material.

1.19 VISIT TO SITE

A. As there may be various conditions at the site which do not show on the accompanying Drawings, or which are at variance with the conditions indicated on the Drawings, it is important that each Bidder visit the site and acquaint himself with existing conditions, and take there conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

1.20 WARRANTIES

A. Refer to Division 01 for warranty requirements. The following paragraphs supplement the requirements of Division 01.

B. Compile and assemble all warranties for equipment specified in Division 27 into vinyl-covered three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Include product or equipment, date of beginning of warranty or bond, duration of warranty or bond, and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Provide extended warrantees, at no additional cost to the Owner, for equipment and materials whose basic warranty will expire prior to full beneficial use of the Owner and/or acceptance of the building by the Owner, because of the timing of shipment or installation. (For example, a piece of equipment with a one-year warranty which is installed 18 months prior to completion of the project, due to the enclosing of the building shall be provided with an extended warranty coverage after the building's completion.) The extended warranty may be through the manufacturer or the installing Contractor. However, all benefits of the original manufacturer's warranty shall be conveyed to the Owner for the specified warranty period, commencing with acceptance of the building by the Owner.

1.21 GUARANTEE

A. The Contractor shall guarantee all work to be free from defects for a period of one (1) year after acceptance. Any and all work found defective or not in accordance with the Contract during this period shall be corrected promptly by the Contractor after written notification from the Owner. The Contractor shall repair or correct the work within ten (10) days of the written notification and if the Contractor does not comply, the Owner may have the work corrected and charge all such work to the Contractor.

1.22 REVIT FILES

A. Following the receipt of a written request from the Contractor, RFS will furnish REVIT electronic files for telecommunications drawings. Signing of the Rist-Frost-Shumway Engineering, P.C. Electronic Document File/Digital License Agreement shall be considered prerequisite for the release of the files.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 27 74 00

TELECOMMUNICATIONS SYSTEM

(Telecommunications Trade Bid Required)

PART 1 – GENERAL

1.01 WORK INCLUDED

A. This document describes the products and execution requirements relating to furnishing and installing a structured telecommunications system for Salem High School and Technical Center. Horizontal cabling comprised of copper and optical fiber cabling, and support systems are covered under this document

B. The qualified Telecommunications Contractor shall meet all of the requirements of sections 1 and all sub sections of this document to be eligible to bid this project.

C. Provide indicated telecommunication system including voice, data, and video distribution (CATV) systems. Provide all equipment, materials, labor, and services, not specifically mentioned or shown, which may be necessary to complete or perfect all parts of the installation. Ensure that they are in compliance with requirements stated or reasonably inferred by the Contract Documents.

D. Work shall be coordinated with General Contractor and all costs shall be included in this Contract.

E. Work shall be coordinated with the Electrical Contractor. The Electrical Contractor shall provide all outlet boxes, conduits, surface raceway, cable tray, sleeves into rooms, and grounding associated with the telecommunications systems. The Telecommunications Contractor shall provide all J-hooks and conduit sleeves, where required other than those provided by Electrical Contractor.

F. The Horizontal (MDF, IDF and workstation) Cabling System shall consist of 4-pair Unshielded Twisted Pair (UTP) Copper Cables to each work area outlet as indicated on the drawings. The cables shall be installed from the Work Area Outlet to the MDF or IDF Room located on the same floor, and routed to the appropriate rack serving that area and terminated as specified in this document.

G. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types will be provided on the drawings. If the bid documents are in conflict, this specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

H. This section includes minimum requirements for the following:

- UTP cable from MDF/IDF room to work area.
- Optical fiber from MDF to IDF Room.
- UTP/fiber/coax WA patch cords.
- Category 6A and 6 UTP connector modules.
- Optical fiber connector modules.
- Faceplates and modules.
- CATV distribution system.

I. All cables and related terminations shall be furnished, installed, wired, 100% tested, labeled, and documented by the Telecommunications Contractor as detailed in this document. The Telecommunications Contractor shall be certified by the manufacturer of material in this specification.

J. Video distribution system design is of diagrammatic form depicting solution as outlined by user needs. Telecommunications Contractor shall coordinate with CATV provider to determine input signal strength to provide a complete and operable video distribution system. Actual design depicting dB calculations with tap, splitter, and amplifier values shall be by the Telecommunications Contractor.

K. Telecommunications Contractor shall be responsible for the mounting of owner supplied wireless access points. Owner shall be responsible for procurement, programming, and labeling of access points and shall supply appropriate mounting hardware.

L. After installation, the system shall be 100% tested for proper operation per TIA/EIA 568-C performance standards certification and hard copy test results shall be provided.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.

B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph, or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.

C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

D. All related specification sections shall be used in conjunction with this section.

E. Specification Sections:

Section 27 01 00 - Basic Telecommunications Requirements
Section 26 06 00 - Grounding and Bonding
Section 26 07 00 - Supporting Devices
Section 26 13 00 - Raceways
Section 26 13 30 - Cable Tray
Section 26 13 70 - Outlet Boxes and Enclosures

1.03 REGULATORY REFERENCES

A. The following industry standards are the basis for the structured cabling system described in this document. All materials and work specified herein shall comply with these standards.

1. ANSI/TIA/EIA:

ANSI/TIA/EIA-568-C.0	Generic Telecommunications Cabling for Customer Premises
ANSI/TIA/EIA-568-C.1	Commercial Building Telecommunications Cabling Standards- Part 1 General Requirements
ANSI/TIA/EIA-568-C.2	Balanced Twisted Pair Cabling Components Standard
ANSI/TIA/EIA-568-C.3	Optical Fiber Cabling Components Standard
ANSI/TIA/EIA-568-C.4	Broadband Coaxial Cabling and Components Standard
ANSI/TIA/EIA-569-B	Commercial Building Standard for Telecom Pathways and Spaces
ANSI/TIA/EIA-606-A	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/TIA/EIA J-STD-607-B	Commercial Building Grounding/Bonding Requirements for Telecommunications
ANSI/TIA/EIA-758	Customer-Owned Outside Plant Telecommunications Cabling Standard

2. NFPA:

NFPA 70	National Electric Code (NEC)

3. ISO/IEC:

ISO 11801	Generic Cabling for Customer Premises

4. BICSI :

Telecommunications Distribution Methods Manual

Telecommunications Cabling Installation Manual

Outside Plant Design Manual

Wireless Design Reference Manual

5. Underwriters Laboratory
6. Federal Communications Commission (including CFR 47 and Part 68 - subpart F)
7. National Electric Code
8. Local and State Codes
9. ISO/IEC 11801
10. IEC 1000-5-2
11. CSA C22.2
12. IEC 60603-7

B. If there is a conflict between applicable documents, then the more stringent requirement shall apply. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

C. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.04 CONTRACTOR QUALIFICATIONS AND TRAINING

A. The Certified Contractor shall have a full working knowledge of cabling low voltage applications such as, but not limited to data, voice, and imaging network systems. The Certified Contractor shall have the following qualifications:

1. Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
2. Provide at least three (3) references from institutions of similar size and scope where comparable work was completed in the last two years.
3. The Telecommunications Cabling and Wiring Contractor must have a current RCDD (Registered Communications Distribution Designer) on staff as a full-time employee. A copy of the RCDD certificate and BICSI member number must be provided with bidding documents.
4. Have BICSI trained personnel experienced in twisted pair cabling installation, termination, testing.
5. Have BICSI trained personnel experienced in optic fiber cabling, splicing, and termination and testing techniques.
6. Personnel must have experience using a light meter and OTDR.
7. Have personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
8. Have personnel knowledgeable in local, state, and national codes and the latest TIA Telecommunications Standards and Manufacturer's recommendations.
9. Be in business a minimum of five (5) years. Firm shall also have at least three (3) years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.
10. Have personnel fluent in the use of Computer-Aided Design and possess and operate CAD software using .DWG or .DXF format.
11. This project shall be directly supervised by an on-site BICSI registered Technician. A copy of current certification and BICSI member number.

1.05 QUALITY ASSURANCE

A. All equipment rooms shall be installed in a neat and workmanlike manner.

B. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's representative.

C. Equipment and materials shall be of the quality and Manufacturer indicated.

D. The equipment specified is based on the acceptable manufacturers listed.

E. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to approval.

F. Wiring shall be routed to avoid all sources of EMI or ambient electrical noise whenever possible. Minimum distances from EMI sources are as follows:

1. Five (5) inches from unshielded power lines of < 2 KVA.
2. Twelve (12) inches from unshielded power lines of 2 to 5 KVA.
3. Twenty-four (24) inches from unshielded power lines of > 5 KVA.

4. Twelve (12) inches from high voltage lighting including fluorescent.
5. Forty (40) inches from transformers and electric motors.
6. No cable runs should be in parallel with AC lines.

G. Wiring shall be installed in a logical and accessible path from the Telecommunications Room to the work area outlet. Cable paths to the work area outlet shall be perpendicular from the main bundle. “B lining” of cables is unacceptable. Cables installed in inaccessible locations shall be in conduit.

H. All cabling shall utilize the corridor tray system as far as practicable and transition to conduits or J hooks. Cabling improperly installed or supported shall be corrected by the contractor at no expense to the owner.

I. Communication grounding/earthing and bonding shall be in accordance with applicable codes and regulations. It is recommended that the requirements of IEC 1000-5-2, ANSI/TIA/EIA J-STD-607-B, or both be observed throughout the entire cabling system

1.06 WARRANTY

A. This warranty program shall guarantee system performance as defined in ANSI/TIA/EIA 568C, 569B, and 606-A. The warranty coverage shall cover both components and labor for a minimum period of twenty (20) years.

B. Transfer manufacturer's warranties to the Owner in addition to the General System Guarantee. Submit these warranties on each item in list form with shop drawings. Detail specific parts within equipment that are subject to separate conditional warranty. Warranty proprietary equipment and systems involved in this contract during the guarantee period. Final payment shall not relieve the Telecommunications Contractor of these obligations.

C. This warranty program shall guarantee system performance and installation compliance with ANSI/TIA/EIA 568, 569, and 606-A.

1.07 SUBMITTALS

A. Submit product data in accordance with Section 27 01 00. All submittals shall be complete and include all items and supporting documentation. Partial submissions shall be returned to contractor for resubmission.

B. Project will not be considered complete until all submittals in their entirety are presented to owner and accepted as well as all items as listed in sections 3.16 and 3.17 of this document.

C. Provide product data for all equipment including but not limited to the following:

1. Floor-mounted relay racks, brackets, and cabinets.
2. Wall-mounted relay racks, brackets, and cabinets.
3. Cable supports.
4. Cable management hardware.
5. Patch panels, enclosures and adapter panels.
6. Cable and connectors.
7. Grounding bars.
8. Surge protection/power strips.
9. Patch cords.
10. Labeling and administration products.
11. Firestopping materials.

D. Submit dB calculations and size amplifiers for video distribution system. Submit complete riser diagram including all video distribution equipment.

E. Submit riser diagram showing all telecommunications cabling.

F. Submit rack and backboard elevations. Submittals may be in AutoCAD or Visio format. ¼ scale or greater in format.

G. All submittals shall have approval by Owner and/or Engineer.

1.08 SEQUENCE AND SCHEDULING

A. Submit schedule for installation of equipment and cabling. Indicate delivery, installation, and testing for conformance to specific job completion dates. As a minimum, dates are to be provided for bid award, installation start date, completion of station cabling, completion of riser cabling, completion of testing and labeling, cut over, completion of the final punch list, and Owner acceptance.

1.09 USE OF THE SITE

A. Use of the site shall be at Owner's direction in matters in which the Owner deems it necessary to place restriction.

B. Access to building wherein the work is performed shall be as directed by Owner.

C. Proceed with the work without interfering with ordinary use of streets, aisles, passages, exits, and operations of the Owner.

D. Refer to section 27 01 00 for additional requirements.

1.10 CONTINUITY OF SERVICES

A. Take no action that will interfere with, or interrupt, existing building services unless previous arrangements have been made with the Owner's representative. Arrange the work to minimize shutdown time.

B. Should services be inadvertently interrupted, immediately furnish labor, including overtime, material, and equipment necessary for prompt restoration of interrupted service.

1.11 TELECOMMUNICATIONS RACEWAY SYSTEM REQUIREMENTS

A. Installation methods for telecommunication system conduits shall comply with Installation Methods – 26 13 00 General section, unless superseded by more stringent requirements of this section. Telecommunications conduits shall comply with the requirements of ANSI/EIA/TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces and the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual. Note that some of these requirements are more stringent than the requirements of the National Electrical Code.

B. There shall be no more than two 90-degree bends between pull points in telecommunications conduit. Pull boxes added to conduit runs as a result of this requirement shall be in accordance with Section 26 13 70 - Outlet Boxes and Enclosures. If it is not practical to install a pull box in the run due to field conditions the conduit size shall be increased to the next trade size for each additional 90-degree bend. Offsets shall be considered as equivalent to a 90-degree bend.

C. Inside radius of conduit bends shall be at least 6 times the internal diameter of the conduit for sizes up to 2-inch trade size; 10 times the internal diameter of the conduit for sizes larger than 2-inch trade size. Where bending machine shoes are not available with the required bending radius for a one-shot field bend, factory bent, large radius 90-degree elbows shall be provided. Conduits of all sizes for use as optical fiber raceways shall have a minimum inside bend radius of 10 times the internal diameter of the conduit.

D. All telecommunication cables shall be routed in conduit in areas within the cable path that are not fully accessible. Areas that are considered "Inaccessible" are including but not limited to, fixed ceilings, inside walls and spans where proper cable support systems cannot be installed and maintained.

E. Conduits shall be terminated and supported at cable trays in accordance with Section 26 13 30 - Cable Tray.

F. Use of flexible conduit for telecommunications shall be at the discretion of the Engineer. Obtain prior written approval for the use of flexible conduit. Where required due to physical considerations, flexible metal conduit may be allowed in lengths not exceeding 4 feet. If used, flexible metal conduit shall be increased by one trade size for the application used.

G. Conduits entering the telecommunications closet or equipment room through the floor shall be terminated 4 inches above finished floor. Conduits entering the telecommunications closet or equipment room from above shall be terminated 4 inches below the finished ceiling, but in no case shall the conduits terminate more than 12 inches above the ladder racking or distribution frame.

H. Conduit sleeves connecting vertically "stacked" telecommunications equipment rooms and closets shall be terminated 4 inches above finished floor. Conduits and cutout openings between floors shall be sealed with firestopping material that is removable and reusable, to accommodate ads, moves and changes in the cabling system.

I. Layout of conduits shall give consideration to nearby sources of electromagnetic energy such as electrical power wiring, large electric motors and generators, induction heaters, arc welders, variable frequency drives, etc. Maintain the greatest separation practicable between telecommunication raceways and sources of electromagnetic interference (EMI). A minimum of 5 inches of separation shall be maintained between telecommunication raceways and fluorescent lighting ballasts.

J. Provide 200 lb. test nylon pull cord in all spare and unused conduits.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Backbone Cable:

1. Voice:

a. Inside/outside plant multi-pair cable:

Belden
General
Hitachi
Berk-Tek

2. Data:

   a. Inside/outside plant multi-mode fiber:

      Corning
      General
      Hitachi
      Berk-Tek
      CommScope

   b. Inside/outside plant single-mode fiber:

      Corning
      General
      Hitachi
      Berk-Tek
      CommScope

3. Video Distribution (CATV):

   a. Inside/outside plant multi-mode fiber.

      Corning
      General
      Hitachi
      Berk-Tek
      CommScope

   b. Inside/outside plant single-mode fiber.

      Corning
      General
      Hitachi
      Berk-Tek
      CommScope

   c. Inside plant coaxial.

      CommScope
      Belden

   d. Outside plant coaxial.

      CommScope

4. Connectors and Hardware:

   a. As specified in this section or manufacturer's recommended connectors.

B. Horizontal Cable:

1. Voice and Data:

Berk-Tek
General
Hitachi
Belden

Multimedia:

CommScope
Belden

2. Connectors and Hardware:

a. As specified in this section or manufacturer's recommended connectors.

C. Telecommunication Solution:

Solution to include but not limited to Equipment Rack, Patch Panels, Wire Management, and IDC Termination blocks, Wall Plates, Inserts and Patch Cords:

Hubbell
Leviton
TE Connectivity

D. Equipment Racks:

If not part of solution, the following may be substituted when approved.

Chatsworth
Cooper B-Line

E. Security Phones:

Code Blue
Gai Tronics

F. Cable Supports:

1. Caddy/Erico or equivalent.

G. Surge Protection:

1. Hubbell
2. Leviton

H. Lightning Protection:

CommScope
Circa

I. Labeling:

1. Structured Cabling Solution Manufacturer approved Labeling System or equivalent.

J. Firestopping:

Nelson
3M
Hilti
STI

K. Substitutions: No substitutions will be permitted.

2.02 BACKBONE CABLE

A. Voice:

1. Multi-pair backbone cable:

a. Provide riser copper backbone cable as shown on Drawings. Copper backbone cable shall be shielded 24 or 22 AWG solid copper conductors insulated with color-coded PVC. When requirements exceed 100 pair, provide multiple cables. Cables shall be UL verified to TIA/EIA 568-C for Category 3 performance.

2. Outside plant multi-pair cable:

a. Provide copper multi-pair cable as shown on drawings. Cable shall be 24AWG PE-89 with aluminum shield and black polyethylene jacket. Twisted pairs shall be polyolefin and color-coded in accordance with telephone industry standards.

B. Data:

1. Single-mode fiber:

a. All fiber optic cables shall meet or exceed TIA/EIA 568-C specifications for performance. Size as indicated on drawings strand single-mode, 8/125micron, Zero Water Peak NEC 770, UL listed OFNR, (riser)] rated. Fibers shall be individually wrapped in a 900 micron tight buffer, color coded and accepting direct termination of specified connectors.

2. Outside plant single-mode fiber:

a. All fiber optic cables shall meet or exceed TIA/EIA 568-C specifications for performance size as indicated on Drawings. Strand single mode, 8/125 micron, Zero Water Peak, outdoor, buried, duct rated all dielectric design, fully water blocked core using a dry water blocking system.

3. Outside plant Multi-mode fiber:

a. All fiber optic cables shall meet or exceed TIA/EIA 568-C specifications for performance size as indicated on drawings strand multi-mode 50/125micron OM4 outdoor, rated. All dielectric design, fully water blocked cable using a dry water blocking system.

C. Multimedia:

1. Coaxial cable:

a. Riser rated CATV 0.500, 75 Ohm, foamed dielectric, and coaxial cable with 100% aluminum tube coverage shielding. Supporting frequencies 1-1000MHz. The nominal attenuation period shall not exceed 2.41 at 1000MHz.

CommScope Product #P3 500-JCAR Riser

b. Riser rated CATV RG-11, 75 Ohm, foamed dielectric, coaxial cable with at least 60% braid shielding. Supporting frequencies ranging between 5 and 1000 MHz. The nominal attenuation shall not exceed 2.9 dB per 100 feet at 500MHz.

CommScope Product 5940R Riser

c. Outside plant underground coaxial CATV cable, 0.750, 75 Ohm foamed dielectric, 100% solid aluminum tube coverage shielding. Supporting frequencies 1-1000 MHz with nominal attenuation per 100' of 1.62 dB at 1000 MHz.

CommScope Product #P3 750 JCASS

D. Associated Products:

1. Innerduct:

a. All fiber optic cables shall be installed in innerduct unless otherwise specified.

1) Provide 1", riser rated innerduct or equivalent with pull string for fiber installation in Outside Plant pathways.
2) Provide manufacturer recommended splice connector where joining of innerducts is required.
3) When installing into new conduits in the outside backbone pathways, provide maximum number of installed innerducts (i.e., 4- 1" innerducts in a 4" conduit, etc.) allowing maximum flexibility and safety of existing cables when adding future cables.

2.03 FIBER OPTIC CONNECTORS AND FURCATION KIT

A. Connectors:

1. LC ceramic type cleave and polish connectors.
2. Multi-mode connectors shall be either 50/125 micron and have ceramic insert. Single-mode connectors shall be 8/125 micron and have ceramic with metal hardware.

Corning Product #95-201-98-SP (Single-mode)
Corning Product #95-051-98-SP (Multi-mode)

B. Furcation Kits:

1. Provide 900-micron, six-strand fanout kits as required for the termination of loose tube fiber optic cables.

Corning Product #FAN-OD47-06/12

2.04 PRIMARY TELECOMMUNICATION CIRCUIT PROTECTION

A. Provide wall-mounted primary circuit protection for all telecommunication circuit entrances (100 pairs).

1. Building entrance protector (100 pair):

a. Shall have 110 type input and output.
b. Shall be stackable, with side exits and common trough to facilitate dressing and tracing of wire.

c. Shall provide grounding for cable armor, building ground, and other protection cabinets.

CommScope Product #489ACA1-100
Circa Product #1880ECA1-100G

2. Plug-in protector units:

a. Protector units shall be standard gas tube.

CommScope Product #3B1EW
Circa Product #3B1E

b. Protector units for digital shall be solid state.

CommScope Product #4C1S
Circa Product #4B1S

2.05 HORIZONTAL CABLE

A. Voice Cable:

1. Category 6:

a. 23 AWG, 4-pair, Category 6, UTP, tested to 500 MHz with riser rated jacket. All cable shall meet ANSI/TIA/EIA 568C.2-1 Category 6 Standards. No minimally compliant or manufacturer's entry level cable will be accepted. Cable shall be marked suitable for its purpose. Category 6 voice cable shall be White in color.

Berk-Tek product #10065418
Hubbell product #C6ERR(X)
Hitachi product #30212-8
General product #7131900
Uniprise product #75N4

B. Data Cable:

1. Category 6:

a. 23 AWG, 4-pair, Category 6, UTP, tested to 500 MHz with riser rated jacket. All cable shall meet ANSI/TIA/EIA 568C.2-1 Category 6 Standards. No minimally compliant or manufacturer's entry level cable will be accepted. Cable shall be marked suitable for its purpose. Category 6 Data cable shall be Blue in color.

Berk-Tek product #10065418
Hubbell product #C6ERR(X)
Hitachi product #30212-8
General product #7131900
Uniprise product #75N4

C. Wireless Data Cable:

1. Category 6A:

a. 23 AWG, 4-pair, Category 6A, UTP, tested to 500 MHz with riser rated jacket. All cable shall meet ANSI/TIA/EIA 568C.2-1 Category 6A Standards. No minimally compliant or manufacturer's entry level cable will be accepted. Cable shall be marked suitable for its purpose. Category 6A Data cable shall be Blue in color.

Berk-Tek product #10137700
Hubbell product #C6ASR(X)
Hitachi product #30222-8
General product #7133819
Uniprise product #10GN4

D. Multimedia Cable:

1. Coaxial video:

a. Work area outlet cable for video shall be riser rated RG-6U, 18 AWG, solid bare copper-covered steel core, with bonded foil braid and 60% aluminum braid, Quad shield.

Belden Product #1322R
CommScope Product #5740R

E. Connectors:

1. LC Duplex ceramic type cleave and polish connectors. Multi-mode connectors shall have ceramic insert. Single-mode connectors ceramic with metal hardware.

Corning anaerobic or Solution Provider equivalent

2. Compression type RG-6 connectors per cable manufacturer's specifications.

2.06 BOXES

A. Outlet boxes shall be provided at all wall, column, floor data, telephone, or multi-communication location per drawings and specification Section 26 13 00.

B. Surface-mounted boxes shall be provided for all outlets in surface raceway per drawings and specification Section 26 13 70.

C. Floor boxes and fire rated poke-through assemblies as shown on drawings and in specification Section 26 13 00.

D. Outlets in moveable partition walls shall be made for the purpose.

2.07 TELECOMMUNICATIONS OUTLET WALL PLATES

A. Provide flush-mounted single gang stainless steel wall plates with label fields as indicated on drawings. Outlet plates shall be sized per location requirements.

B. Provide flush-mounted, stainless steel, single gang, wall phone plates as indicated on drawings.

2.08 TELECOMMUNICATIONS OUTLET FRAMES

A. Provide outlet frames for use in floor boxes as indicated on drawings.

B. Provide 106 type frames in Duplex style or Decora style as required.

Duplex Style	Decora Style
Hubbell product # BR(2) or Q(4) 106(XX)	ISF2,3,4 or 6(XX)
Leviton product # 41087-2orQxx xx= color	4164(x)-00(y) x=port y= color

2.09 TELECOMMUNICATIONS OUTLET INSERTS

A. Voice:

1. Category 6 jacks shall meet or exceed ANSI/TIA/EIA-568-C.2-1 performance requirements for Category 6 component testing. Jacks shall be keystone style with 110 type IDC termination. Category 6 voice inserts shall be White in color.

   Hubbell product #HXJ6-W
   Leviton product # 61110-RW6

B. Data:

1. Category 6 jacks shall meet or exceed ANSI/TIA/EIA-568-C.2-1 performance requirements for Category 6 component testing. Jacks shall be keystone style with 110 type IDC termination. Category 6 data inserts shall be Blue in color.

   Hubbell product #HXJ6-B
   Leviton product #61110-RL6

C. Wireless Data:

1. Category 6A jacks shall meet or exceed ANSI/TIA/EIA-568-C.2-1 performance requirements for Category 6A component testing. Jacks shall be keystone style with 110 type IDC termination. Category 6A data inserts shall be Blue in color.

   Hubbell product #HJ6A-B
   Leviton product #6A10G-RB6

D. Video:

1. Provide as represented on the drawings at each TV location one (1) RG-6 F-type coupler insert. Shall be keystone style and White in color.

   Hubbell product #SFFW
   Leviton product #41084-FWF

E. A/V: Provide as represented on the drawings for each A1, A2 and A3 location the required USB and HDMI outlet to fit faceplate to support A/V inputs. (See drawing T0.12)

F. Other:

1. Provide blank jack inserts as required. Color shall match that of the outlet wall plates. When more than one color is in use, coordinate with Architect.

2.10 EQUIPMENT RACKS

A. Provide a seven-foot open bay rack.

1. Rack shall have universal hole pattern, tapped front and rear #12-24.
2. Rack shall have a durable black powder coated finish.
3. Rack shall be extruded aluminum.

   CB-Line product#SB556084XUFB (2 post)
   CB-Line product#SB8361908436FB (4 post)

B. Provide Vertical Cable Management Channel with Integral Cover:

1. Management channel shall be 6" wide.
2. Management channel shall consist of front and rear cabling bays.
3. Management channel shall have holes for routing cables front to rear.
4. Management channel shall be cold-rolled steel with durable black powder coat finish.
5. Cover shall be hinged cold-rolled steel or extruded aluminum with durable black powder coat finish.

   CB-Line product#SB86086D084FB

C. Wall Mount Enclosure:

1. Enclosure shall have universal hole pattern, EIA 310-D compliant.
2. Tapped front and rear #12-24.
3. Rack shall have a durable black powder coated finish.
4. Rack shall be 12-gauge steel construction.
5. Sixteen inches (16") on-center mounting.
6. Minimum 100-pound load capacity.
7. 48.625" H x 24.7" D x 19" W rack with 26 rack mount units.
8. Provide fan kit for enclosure for thermal management.

   CB-Line product #VLWM4825P

D. Equipment Shelves:

1. Shelf shall be 16-gauge cold rolled steel or extruded aluminum.
2. Black powder coat paint.
3. Provide as required.

2.11 PATCH PANELS

Provide termination ports for all horizontal cables plus 20% spare ports for future expansion.

A. Category 6 Patch Panels:

1. Provide 19" rack-mountable, two-position, 48-port, T568B wired Category 6 patch panels for the termination of all Category 6 cables.

   a. Panel shall be ANSI/TIA/EIA-568-C.2-1and ISO/IEC 11801 category 6 compliant and be UL verified for TIA/EIA Category 6 compliant.
   b. Panel shall have 110 type IDC for cable termination, accepting 22-26AWG solid conductors.
   c. Panel circuit board shall be fully enclosed front and rear for physical protection.
   d. Panel shall be manufactured with rolled edges top and bottom for strength.
   e. Panel shall be made of six (6) or eight (8) port removable modules with label strips for each port.

      Hubbell product #P6E48U
      Leviton product #69586-U48

B. Category 6A Patch Panels:

1. Provide 19" rack-mountable, two-position, 48-port, T568B wired Category 6A patch panels for the termination of all Category 6A cables.

   a. Panel shall be ANSI/TIA/EIA-568-C.2-1and ISO/IEC 11801 Category 6A compliant and be UL verified for TIA/EIA Category 6A compliance.
   b. Panel shall have 110 type IDC for cable termination, accepting 22-26AWG solid conductors.
   c. Panel circuit board shall be fully enclosed front and rear for physical protection.
   d. Panel shall be manufactured with rolled edges top and bottom for strength.
   e. Panel shall be made of six (6) or eight (8) port removable modules with label strips for each port.

      Hubbell product #HP6A-48U
      Leviton product #6A586-U48

C. Fiber Optic Rack Mount Enclosures:

1. Provide rack-mounted fiber optic enclosure for housing terminated fiber optic cables as specified in drawings.

   a. Enclosure shall have Plexiglas front cover and optional lock kit. Removable top front and rear covers. Includes 19" or 23" rack mounting brackets.
   b. Enclosure shall be equipped with multiple cable entrance points with blanks for unused entries.
   c. Enclosure shall be cold-rolled steel with durable black powder coat paint.
   d. Enclosure shall be equipped with multiple attachment points for the incoming fiber optic cable and cable management fixtures for spare slack on individual 900 micron strands of fiber.
   e. Size enclosure to fit connector panels required for the 20% spare port requirement.
   f. Provide blank panels for unused spaces in enclosures.

      1) [Large] Hubbell product #FCR525SPR as required.

         Leviton product #RDP4U-F12
         Corning Cable Systems #CCH-04U

      2) [Small] Hubbell product #FPR3SP

         Leviton product #RDP1U-S03
         Corning Cable Systems product #CCH-01U

D. Fiber Optic Connector Panels:

1. Provide adapter panels as required to house fiber strands as specified in drawings. Panels shall be loaded with 6 duplex LC adapters.

   a. Provide enough adapter panels for 20% spare ports for future expansion.

      Single Mode:

      Hubbell Product #FSPLCDS12B
      Leviton product #5F100-2LL
      Corning Cable Systems product #CCH-CP-A9

Multi Mode (50/125um):

Hubbell Product #FSPLCDS3AQ
Leviton product #5F100-2QL
Corning Cable Systems product #CCH-CP-E4

E. Cable Management Panels:

1. Provide cable management panels as required for proper cable management in equipment racks above and below patch panels or active equipment (see Drawings).

   a. Panel shall be two-position with sturdy management rings, durable black powder coat paint and be cold-rolled steel.
   b. Panel shall have holes with rolled edges for passing cables from front to rear.
   c. Panel rings shall be (1.75" or 3.0" or 6.0") deep. (Specify covers, rear rings and depth, transition posts, side rings, etc.)

   1U:

   Hubbell product #HC119CE3H
   Leviton product #491RU-HFO

   2U:

   Hubbell product #HC219CE3N
   Leviton product #492RU-HFO

F. Rear Cable Management Bar:

1. Provide a rear cable management bar for securing cables at termination point.

   a. Bar shall be 19" and attach to rear rack flange or Patch Panel if so designed and provide attachment point for securing Velcro straps.

      Hubbell product #Included with PP
      Leviton product #Included with PP

2.12 IDC TERMINATION BLOCKS

A. Provide 110 type IDC Termination blocks with legs for termination of UTP cables as specified, plus 20% spare growth ports. Blocks shall meet a minimum Category 5E performance.

B. Provide label sheets and plastic label holder.

C. Utilize 4 pair clips for work station locations and 5 pair clips for multi pair backbone cables. Finish all 4 pair clip rows with 5 pair clip provided with kit.

D. Provide cable management troughs above and below each block. Troughs shall be with legs.

   100 Pair:

   Hubbell product #110BLK-100FTK (4 OR 5)
   Leviton product #41AB2-1F (4 or 5)

   300 Pair:

   Hubbell product #110BLK-300FTK (4 OR 5)
   Leviton product #41AB2-3F (4 or 5)

2.13 CATV DISTRIBUTION SYSTEM EQUIPMENT

A. The bandwidth of all passive components on the network shall be from 5 MHz to 1000 MHz. The bandwidth of all in-line amplifiers is depending on the network design shall be 54 MHz to 1000 MHz in the forward direction with a reverse path of 5 MHz to 36 MHz.

B. In-line amplifiers must be hybrid push-pull design providing high gain and low distortion characteristics along with minimizing harmonics and beat frequencies. Line amplifiers must provide adjustable gain and slope controls.

C. Directional couplers and taps shall be provided as required for signal distribution. The taps shall be fully shielded and in compliance with FCC rules pertaining to radiation. Directional couplers shall be available in one-, two-, or four-port outputs. Nominal tap values or 8, 11, 24, 17, 20, 23, 26, 29, and 32 dB shall be available with a return loss of 16 dB or higher. Frequency range through any port shall be from 5 MHz to 900 MHz.

D. Splitters shall be provided as required for signal distribution. The splitters shall be fully shielded and in compliance with FCC rules pertaining to radiation. Splitters shall be available in two, three, or four outputs. Shall have standard F-type connectors and support bandwidths from 5 MHz to 900 MHz.

E. Provide all required adapters for mating cables of different sizes.

2.14 BACKBOARD

A. Backboard shall be provided in accordance with Specification Section 26 07 00.

2.15 CABLE TRAY

A. Cable Tray shall be provided in accordance with Specification Section 26 13 30.

2.16 CABLE SUPPORTS

A. Provide J-hooks as specified in Drawings. J hooks shall be wide based and sized appropriately to allow correct fill ratio with 20% expansion.

1. Hooks shall be provided as required. Fill ratios are for information only and based on 4 pair cables.

   Erico/Caddy

P/N	Fill ratio
CAT 12	10 cables
CAT 21	32 cables
CAT 32	50 cables
CAT 64	185 cables
CAT 425	265 cables

   Utilize the appropriate attachment hardware as required (i.e., straps, clamps, brackets, etc.)

2.17 SURFACE RACEWAY

A. Surface raceway shall be provided in accordance with specification Section 26 13 10.

2.18 PATCH CORDS

A. Voice:

1. One pair 24AWG crosswire (blue) shall be provided as required to cross-connect voice cables between termination blocks.

B. Category 6 Enhanced or Category 6A Patch Cords:

1. Work area outlet cords:

   a. Work area outlet cords shall be 24AWG stranded; lengths shall be 25% -6', 25% - 8', 25% - 10', and 25% - 16'. (Or manufacturers nearest standard length).
   b. Color to be selected by owner from manufacturers full color range. Multiple colors will be selected for telephone and data.
   c. Provide outlet patch cords for 50% of terminated data outlets.
   d. Provide Category 6A 1' outlet patch cords for 100% of installed Category 6A data outlets.

2. Patch panel cords:

   a. Patch panel patch cords shall be 24AWG stranded; lengths shall be 25% - 1', 25% -3' and 50% 5'.
   b. Color to be selected by owner from manufacturers full color range. Multiple colors will be selected for telephone and data.
   c. Patch cords shall be ETL verified to TIA/EIA Category 6 compliance.
   d. Provide patch cords for 50% of terminated data outlets

3. Wireless Patch Panel cords:

   a. Patch panel patch cords shall be 24AWG stranded; lengths shall be 25% - 1', 25% -3' and 50% 5'.
   b. Color to be selected by owner from manufacturers full color range. Multiple colors will be selected for telephone and data.
   c. Patch cords shall be ETL verified to TIA/EIA Category 6A compliance.
   d. Provide patch cords for 100% of terminated data outlets.

C. Fiber Optic Patch Cords:

1. Provide fiber optic patch cords for cross-connection to backbones or active equipment as required.

   a. Patch cords shall be two strand single-mode or multi-mode with LC duplex type connectors.
   b. Provide 50% -5' and 50% - 10'.
   c. Provide patch cords for 50% of terminated fibers.

D. Multimedia:

1. Provide RG-6 coaxial patch cords for TV locations as required.

   a. Patch cords will be required for closet and work area outlet ends.
   b. Provide 33% -5', 33% - 10' and 33% - 15' patch cords for outlet end.
   c. Provide 50% - 5' and 50% - 3' for closet end.
   d. Provide patch cords for 75% of the total TV outlets.

2.19 SURGE PROTECTION

A. Provide one (1) surge protected power strip per rack.

1. Power strip shall include LED indicator, 19" rack mountable, and one rack unit high with 10' cord meeting UL1363 / UL 1449 and have circuit breakers.
2. Power strip shall be 15 AMP with 10 rear outlets and an on/off switch.

   Hubbell product #MCCPSS19

2.20 SECURITY PHONES

A. Standard Speakerphone:

1. Pedestal Mount

   a. The unit shall be an easily identifiable, vandal resistant communications device that is Americans with Disabilities Act (ADA) compliant, multi-functional, freestanding, and constructed of heavy steel.
   b. The unit shall be include a high quality, vandal resistant, hands-free communications device, a powerful strobe light, and a vivid blue beacon that serves to identify the unit from a great distance. The unit shall be a concentric steel cylinder (bollard) with a 12.75 inch diameter, a 0.25 inch wall thickness, and a height of 9 feet.
   c. The speakerphone shall have a 1.5 inch piezoelectric button labeled “PUSH FOR HELP,” The button when touched will automatically activate the strobe and place a call. The speakerphone shall have an internally mounted electronics enclosure, auxiliary power, and shall be capable of playing up to two digitally stored voice messages upon activation. The electronics enclosure shall be capable of using interchangeable faceplates: a single-button faceplate, a two-button faceplate, or a two-button faceplate with keypad. The speakerphone shall be programmable from a remote location and have a three number dialing capability per button. Battery backup shall be rated for 16 hours of active talk time and 32 hours of standby. Line powered phone devices, DIP switch programming, and push-to-talk devices are not acceptable. (Code Blue CB3100-FP1-K).
   d. Unit shall be 120 v AC and safety blue in color. (Code Blue CB 1-s).
   e. Unit shall be supplied with an overhead camera mount (Code Blue Overhead Camera mount)

2. Wall Mount

   a. The unit shall be an easily identifiable, vandal resistant communications device that is Americans with Disabilities Act (ADA) compliant, multi-functional, wall mounted, and constructed of heavy stainless steel. The unit shall be virtually impervious to damage, and shall include a high quality, vandal resistant, hands-free communications device, and a powerful combination blue beacon and strobe that serve to identify the unit from a great distance.

b. The speakerphone shall have a 1.5 inch piezoelectric button labeled “PUSH FOR HELP,” The button when touched will automatically activate the strobe and place a call. The speakerphone shall have an internally mounted electronics enclosure, auxiliary power, and shall be capable of playing up to two digitally stored voice messages upon activation. The electronics enclosure shall be capable of using interchangeable faceplates: a single-button faceplate, a two-button faceplate, or a two-button faceplate with keypad. The speakerphone shall be programmable from a remote location and have a three number dialing capability per button. Battery backup shall be rated for 16 hours of active talk time and 32 hours of standby. Line powered phone devices, DIP switch programming, and push-to-talk devices are not acceptable. (Code Blue CB3100-FP1-K).
c. The housing front shall be fabricated from 12-gauge, stainless steel that is brushed to a number 4B finish after fabrication, and shall be 32 inches high, 11.9 inches wide, and 7.6 inches deep. There shall be a back plate fabricated of 12 gauge stainless steel that shall be welded to the housing front.
d. Unit shall be Safety blue with 120v AC transformer kit. (Code Blue CB II-e).

2.21 GROUNDING

A. Provide appropriate split bolt connectors and lugs as required to ground system.

B. Provide grounding busbar for attachment of ground lugs and cables.

C. Grounding shall be by Electrical Contractor, Telecommunication Contractor to coordinate with Electrical Contractor. See Specification Section 26 06 00.

2.22 LABELING

A. Utilize solution manufacturers approved labeling system.

2.23 FIRESTOPPING

A. Use assemblies as required to maintain fire rating of any walls penetrated during the structured cabling installation.

2.24 VELCRO FASTENERS

A. Provide Velcro fasteners as required for a neat cable installation. **Tie wraps will not be accepted**.

PART 3 – EXECUTION

3.01 PRE-INSTALLATION SITE SURVEY

A. Prior to start of systems installation, meet at the project site with the Owner's representative and representatives of trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with the work. Facilitation with the General Contractor will be necessary to plan the crucial scheduled completions of the equipment room and telecommunications closets.

B. Examine areas and conditions under which the system is to be installed. Do not proceed with the work until satisfactory conditions have been achieved.

C. Prior to any voice or data cable installation, verify that any pathways used do not exceed length limitations for TIA/EIA standards. In some cases, the shortest route may not be in the cable tray or J-hook paths on drawings. The shortest path should be utilized and proper support installed. The Contractor shall consult with owner and engineer prior to deviating from the tray system.

D. Prior to installing any cabling, verify locations of outlets for architectural coordination. Where conflicts exist, notify General Contractor for direction.

3.02 HANDLING AND PROTECTION OF EQUIPMENT AND MATERIALS

A. Be responsible for safekeeping of your own and your subcontractors' property, such as equipment and materials, on the job site. The Owner assumes no responsibility for protection of above named property against fire, theft, and environmental conditions.

3.03 PROTECTION OF OWNER'S FACILITIES

A. Effectively protect the Owner's facilities, equipment, and materials from dust, dirt, and damage during construction.

B. Remove protection at completion of the work.

3.04 WORK AREA OUTLETS

A. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

B. Provide 10' slack above outlet locations, loosely bundled wherever possible.

C. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C documents, manufacturer's recommendations, and best industry practices.

D. Pair untwist at the termination shall not exceed 3.18mm (0.125 inch).

E. Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.

F. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.

3.05 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.

B. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type or 40%.

C. Cables shall be installed in continuous lengths from origin to destination (no splices).

D. Adhere to manufacturer's published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing cables.

1. Where manufacturer does not provide bending radii information, minimum bending radius shall be 10 times cable diameter. Arrange and mount equipment and materials in a manner acceptable to the engineer and the Owner.

E. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48- to 60-inch (1.2- to 1.5-meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

1. J-Hooks shall be installed 48" to a maximum of 60" apart. Spacing shall maintain maximum sag of 12" between hooks. Closer spacing will be required anytime the condition exists.
2. J-Hooks shall be installed at the point of elevation change as well as change of direction.

F. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

G. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

H. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.

I. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

J. Cables shall be identified by a self-adhesive, self-laminating wrap around label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

K. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.

L. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf.

3.06 CATV CABLE INSTALLATION

A. All CATV cables shall be installed with a minimum of bending and no kinks, in accordance with manufacturers recommended installation procedures.

B. All CATV outlets will be homerun from the designated telecommunication room. Cabling shall be selected per loss budget.

3.07 HORIZONTAL CROSS CONNECT INSTALLATION

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C standard, manufacturer's recommendations, and best industry practices.

B. Pair untwist at the termination shall not exceed 3.18 mm (0.125 inch).

C. Bend radius of the cable in the termination area shall not exceed four times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. The cable jacket shall be maintained as close as possible to the termination point.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable. Cables shall be identified by a self-adhesive, self-laminating wrap around label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A

G. Provide a minimum of 3' of service slack stored uniformly in cable tray.

3.08 OPTICAL FIBER TERMINATION HARDWARE

A. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed mounted to the external portion of the fiber panel. Mount slack loop to backboard or other appropriate location.

B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

C. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable. Cables shall be identified by a self-adhesive, self-laminating wrap around label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A.

3.09 BACKBONE CABLE INSTALLATION

A. Backbone cables shall be installed separately in all conduit sleeves and pathways from horizontal distribution cables. All relocation of cabling due to not adhering shall be at the contractor's expense.

B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

C. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.

D. Where riser rated cables are installed in an air return plenum, cable shall be installed in metallic IMC or Rigid conduit with threaded fittings.

E. Where backbone cables and distribution cables are installed in a cable tray or wire way, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

F. All backbone cables shall be securely fastened to the sidewall of the MDF/IDF Room on each floor.

G. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.

1. Limit number of four-pair data riser cables per grip to fifty (50).

H. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.

I. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

J. Mark all innerduct with plastic, pre-printed, FIBER OPTIC identification tags.

K. When installing fiber optic cable in conduit install spare innerducts so as not to render the conduit unusable for future cable pulls.

L. All splices shall be waterproof and properly secured in manholes or on strand as required for a proper installation.

M. All outside plant cables shall be labeled at origination demarcation in man/hand holes with type of cable, amount of strands or pairs, origination and demarcation points. Labels shall be 1/8” thick laminated phenolic with engraved block letters, white on a black background, securely fasten label to cable using cable ties.

3.10 COPPER TERMINATION HARDWARE

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C standard, manufacturer's recommendations, and best industry practice.

B. Pair untwist at the termination shall not exceed 3.18mm (0.125 inch).

C. Bend radius of the cable in the termination area shall not exceed four times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.11 RACKS

A. Racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.

B. Racks shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.

C. All racks shall be grounded to the telecommunications ground bus bar in accordance with all applicable sections of this document.

D. Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

E. Wall-mounted termination block fields shall be mounted on 4' x 8' x 0.75" void-free plywood. The plywood shall be mounted vertically 12" above the finished floor. The plywood shall be painted with two coats of white fire-retardant paint.

F. Wall-mounted termination block fields shall be installed with the lowest edge of the mounting frame 18" from the finished floor.

3.12 FIRESTOP SYSTEM

A. A firestop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor, and pressurized water stream.

B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item, i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc., shall be properly firestopped.

C. Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (P.E.), licensed (actual or reciprocal) in the State of New Hampshire. A drawing showing the proposed firestop system, stamped/embossed by the P.E. shall be provided to the Owner's Technical Representative prior to installing the firestop system(s).

3.13 GROUNDING AND BONDING SYSTEM

A. Grounding shall be provided by Electrical Contractor, Telecommunication Contractor is responsible to coordinate with Electrical Contractor to assure a proper installation is achieved.

B. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA J-STD-607-B Telecommunications Bonding and Grounding Standard.

C. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bus bar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.

D. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc., entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

E. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the System Documentation Section of this specification.

F. Each telecommunications grounding and bonding conductor shall be shall be labeled. Labels shall be located on conductors as close as possible and practicable to their point of termination in a readable position. Labels shall be nonmetallic and include the following information. "If this connector or cable is loose or must be removed, please call the building Telecommunications Manager."

3.14 IDENTIFICATION AND LABELING [VERIFY WITH OWNER]

A. All telecommunications cables and terminals shall be clearly and permanently labeled in accordance with the Owner's standard labeling system. Comply with ANSI/TIA/EIA-606-A administration standard for telecommunications infrastructure of commercial buildings. In particular, data jacks shall be labeled with numbers based upon their room number (i.e., Dxxx-n where xxx is the room number and -n can be -1, -2, or -A1, -A2, -B1, -B2, etc., as needed), voice shall be labeled with V and then the room number (i.e., V-100B) and CATV shall be labeled with C and then the room number (i.e., C-100B). There shall be no duplicate jack numbers throughout the building. The labels shall be applied at both the room jack and patch panel or 110 block.

B. All labels shall be created with laser printer or acceptable label maker.

C. All cables that are provided for future use shall be labeled "FOR FUTURE USE" or terminated and labeled.

D. Cable labels shall be wrap-around, self laminating, and adhesive backed.

E. Color Coding of Termination Fields: Apply industry standard color-coding to termination fields. Always apply the same color to both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the backboard behind the termination equipment, maybe the color of the color of the cover on the termination equipment or maybe the color of the label insert on the termination equipment. Use the following color code:

1. Orange: Identification of the telecommunications service (telephone company) demarcation point.
2. Green: Identification of network connections on the customer side of the demarcation point.
3. White: Identification of the first level backbone in the building containing the main cross-connect, or may be used to identify the second level backbone in buildings not containing the main cross connect.
4. Gray: Identification of the second level backbone in the building containing the main cross-connect.
5. Blue: Identification of the horizontal distribution (station) cables. A blue color-coding is only required at the telecommunications room end of the cable, not the station end of the cable.
6. Brown: Identification of the inter-building backbone cables.
7. Yellow: Identification of auxiliary circuits, alarms, maintenance, security and other miscellaneous circuits.
8. Red: Identification of key telephone systems.

F. Prior to any cable installation, coordinate with owner exact cabling scheme to be utilized.

3.15 TESTING AND ACCEPTANCE

A. General:

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-C. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
2. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of Owner for clarification and resolution.

B. Permanent Link Testing:

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens, and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level IIE test unit for Category 5e or level III test unit for Category 6 performance compliance, respectively.
2. Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
3. Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block-to-block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-C Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
4. Category 6 and 6A Performance:

    a. Follow the Standards requirements established in ANSI/TIA/EIA-568-C.
    b. The basic tests required are:

        1) Wire map.
        2) Length.
        3) Attenuation.
        4) NEXT (Near end crosstalk)
        5) Return loss.
        6) ELFEXT loss.
        7) Propagation delay.
        8) Delay skew.
        9) PSNEXT (power sum near-end crosstalk loss).
        10) PSELFEXT (power sum equal level far-end crosstalk loss).

C. Backbone Multi Pair Testing:

1. Conduct a wire map and continuity test for outside plant multi pair cables.

D. Fiber Testing:

1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly defined in the contract documents. Testing shall consist of an end-to-end power meter test performed per ANSI/TIA/EIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multi-mode fibers and 1310 and/or 1550 nanometers for single-mode fibers. These tests also include continuity checking of each fiber.

    a. For horizontal cabling system using multi-mode optical fiber, attenuation shall be measured in one direction at either 850 nanometer (nm) or 1300 nm using an LED light source and power meter.
    b. Backbone multi-mode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for single-mode) in one direction.
    c. Test set-up and performance shall be conducted in accordance with ANSI/TIA/EIA-526-14A Standard, Method B for multi-mode and ANSI/TIA/EIA-526-7 Standard, Method A.1 for single mode fiber optic cable.
    d. Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. ONLY BASIC LINK TEST IS REQUIRED. The Contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.
    e. Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.
    f. Provide OTDR testing of all OSP fiber optic cable and submit test results with closeout documentation. Provide backbone testing at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss. Test in one direction using a launch cable between the OTDR and first link connection and after the last link connection. If only one launch cable is available, test in both directions for strands over 300' in length. Test windows for multimode shall be 850 and 1300nm and single mode shall be 1310 and 1550nm.

2. CATV performance:

    a. Provide between 3dBm V and 10dBm V on all channels up to 750 MHz.
    b. Align and balance by adjusting gain and sensitivity of the amplifiers.
    c. Test for distortion, signal uniformity, signal-to-noise ratio, signal ingress, and Hum modulation.

3.16 SYSTEM DOCUMENTATION

A. Upon completion of the installation, the Telecommunications Contractor shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.

B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within thirty (30) working days of the completion of each testing phase. At the request of the Engineer, the Telecommunications Contractor shall provide copies of the original test results.

C. The Engineer may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Telecommunications Contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

D. Test Results documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation," the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version, and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

E. Printouts generated for each cable or fiber by the test instrument shall be submitted as part of the documentation package. Alternately, the Telecommunications Contractor may furnish this information in electronic form CD. These discs shall contain the actual test result report and viewing software for the tester utilized as defined by the bid specification.

F. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

G. The as-built drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Telecommunications Contractor shall provide paper and electronic (DWG, AutoCAD) formats of as-built construction information. Contractor to submit a copy to Owner and Engineer.

H. The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic AutoCAD 2000 format.

END OF SECTION

SECTION 311000

SITE CLEARING

(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 1-B – School Bid Depository Conditions and Regulations

1.02 SUMMARY

A. This Section includes the following:

1. Protecting existing trees shrubs groundcovers plants and grass to remain.

2. Removing existing trees shrubs groundcovers plants and grass.

3. Clearing, stumping and grubbing.

4. Stripping and stockpiling topsoil.

5. Removing above and below-grade site improvements.

6. Disconnecting, capping or sealing, abandoning site utilities in place and removing site utilities.

7. Protecting existing site utilities.

8. Removal of non-hazardous debris and trash on-site.

B. Related Sections include the following:

1. Section 024116 "Demolition" for partial or complete demolition of buildings or structures undergoing alterations.

2. Section 312500 “Erosion and Sedimentation Control” for temporary erosion and sedimentation control measures.

3. Section 312000 "Earthwork" for soil materials, excavating, backfilling, and site grading.

4. Section 329300 “Landscape Work” for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.03 DEFINITIONS

A. Topsoil: Natural or cultivated loam surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than

underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials. Topsoil shall conform either naturally or by addition of amendments provided by the Contractor to the requirements of Section 329300 “Landscape work”.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.04 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.05 SUBMITTALS

A. Photographs, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.06 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.07 PROJECT CONDITIONS

A. Prior to excavation, verify the underground utilities, pipes, structures, and facilities. Maine Dig-Safe law requires at least the following minimum measures:

1. Pre-mark the boundaries of your planned excavation with white paint, flags or stakes, so utility crews know where to mark their lines.

2. Call Dig Safe, at 1-888-DIGSAFE, at least three business days - but no more than 30 calendar days - before starting work. Don’t assume someone else will make the call.

3. If blasting, notify Dig Safe at least one business day in advance.

4. Wait three business days for lines to be located and marked with color-coded paint, flags or stakes. Note the color of the marks and the type of utilities they indicate. Transfer these marks to the As-Built drawings.

5. Contact the landowner and other non-member@ utilities (water, sewer, gas, etc.), for them to mark the locations of their underground facilities. Transfer these marks to the As-Built drawings.

6. Re-notify Dig Safe and the non-member utilities if the digging, drilling or blasting does not occur within 30 calendar days, or if the marks are lost due to weather conditions, site work activity or any other reason.

7. Hand dig within 18 inches in any direction of any underground line until the line is exposed. Mechanical methods may be used for initial site penetration, such as removal of pavement or rock.

8. Dig Safe requirements are in addition to town, city and/or state DOT street opening permit requirements.

9. For complete Dig Safe requirements, call the PUC or visit their website.

10. If you damage, dislocate or disturb any underground utility line, immediately notify the affected utility. If damage creates safety concerns, call the fire department and take immediate steps to safeguard health and property.

11. Any time an underground line is damaged or disturbed, or if lines are improperly marked, you must file an Incident Report with the PUC. For an Incident Report form visit www.state.me.us/mpuc or call the PUC at 800-452-4699.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Owner.

D. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

E. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

F. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31200 "Earthwork."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated. Obtain approval from Owner before clearing operations begin.

C. Protect existing site improvements on adjoining properties and on Owner's property to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within protection area.

2. Do not permit vehicles, equipment, or foot traffic within protection area.

3. Maintain protection area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.

2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.

3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.

4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.

2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Engineer.

3.03 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.

C. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet outside footprint indicated for new building construction. Abandon utilities outside this area.

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

3.04 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

3. Stumps shall be completely removed and the stump hole backfilled with suitable material.

4. Use only hand methods for grubbing within tree protection zone.

5. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.05 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.

D. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile topsoil in storage piles in areas shown, or where directed.

2. Do not stockpile topsoil within tree protection zones.

3. Dispose of excess topsoil as specified for waste material disposal.

E. Peat Soils shall be striped and stockpiled for future reuse in dressing playing field areas. Stockpiles shall be protected to reduce fugitive transportation offsite. Upon completion of dressing playing fields, surplus peat soils shall be removed from the site and properly disposed of.

3.06 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

2. Dispose of excavated pavement at a recycling facility.

3. Paint cut ends of epoxy coated steel reinforcement in concrete, to remain, to prevent corrosion.

3.07 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

Dispose in accordance with Maine Solid Waste Management Regulations and submit written substantiating documentation.

1. Burning will not be permitted.
2. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

SECTION 312000

EARTHWORK

(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. American Society for Testing and Materials (ASTM) Standards:

1. ASTM C136 - Method of sieve analysis of fine and coarse aggregates.
2. ASTM C117 - Standard test method for materials finer than No. 200 sieve in mineral aggregate washing.
3. ASTM D422 - Standard test method for particle size analysis of soils.
4. ASTM D1140 - Test for amount of material in soils finer than the No. 200 sieve.
5. ASTM D1556 - Test method for density of soil in place by the sand cone method.
6. ASTM D1557 - Test methods for moisture-density relations of soils and soil aggregate mixtures using 10 lb. hammer and 18 inch drop. AASHTO Standard T-180 may be substituted for ASTM D1557.
7. ASTM D2922 - Test methods for density of soil and soil-aggregate in place by nuclear methods (shallow depth).
8. ASTM D4318 - Test method for liquid limit, plastic limit and plasticity index of soils.

C. State of Maine Department of Transportation Standard Specifications, November 2014 Edition.

D. Refer to the Geotechnical Report titled Explorations and Geotechnical Engineering Services, Proposed Sanford High School and Regional Technical Center, Main Street and Old Mill Road, Sanford, Maine, as prepared by S.W. Cole Engineering Inc., dated October 14, 2015 for recommendations. Geotechnical reports takes precedence.

E. Section 1-B – School Bid Depository Conditions and Regulations

1.02 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walkways, pavements, turf and grasses and plants.
2. Excavating and backfilling for buildings, site walls and other structures.
3. Subbase course and base course for concrete walks and pavements.
4. Subbase course and base course for asphalt paving.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling for utility trenches within the building excavation limits.

7. Excavation and backfilling for site utility trenches.
8. Excavation and off-site disposal of all unsuitable and excess materials and stockpiling of all suitable onsite materials required for reuse.
9. Provision, transportation and placement of all required fill and backfill materials.
10. Drainage and dewatering required to perform work in the dry.

B. Related Work Specified in Other Sections:
1. Section 312500 “Erosion and Sedimentation Control”
2. Section 315000 “Excavation Support and Protection”

1.03 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Division 01 Section "Unit Prices."

B. Quantity allowances for earth moving are included in Division 01 Section "Allowances."

C. Rock Measurement: Volume of rock actually removed, measured in original position. See Section 3.04.A.2 for rock pay limits. Unit prices for rock excavation include replacement with approved materials. Unit prices for rock are included in Division 01 Section "Unit Prices."

1.04 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by geotechnical engineer and the owner’s agent. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by geotechnical engineer and the owner’s agent. Unauthorized excavation, as well as remedial work directed by geotechnical engineer and the owner’s agent, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 2 cu. yd. for bulk excavation or 1 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface within the building limits.

I. Subbase Course: Aggregate layer placed between the subgrade and base course.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.05 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextile separation fabric.
2. Warning tapes.
3. Subsurface geotextile filter fabric.

B. Samples for Verification: For the following products, in sizes indicated below:
1. 12 by 12-inch sample of drainage geotextile with specification analysis.

C. Qualification Data: For qualified testing agency.

D. Earth Material Samples: Contractor shall be responsible for obtaining samples (50 lb. minimum) of earthwork materials proposed to be used and transporting them to the site seven calendar days in advance of the time planned for incorporating them into the work. Use of proposed materials by the Contractor prior to testing and approval or rejection shall be at the Contractor's risk. The following information shall be submitted with the samples.

1. Location of borrow source site.
2. Present and past usage of the source site and material.

3. Any previously existing report(s) associated with an assessment of the source site, as relates to the presence of oil or hazardous material.
4. Location within the source site from which the material will be obtained.

E. Up to three test series (gradation and laboratory compaction) will be completed by the geotechnical engineer or owner's agent for off-site borrow sources for each category of earth materials defined in Part 2 of this Section at the owner's cost. Testing of additional samples or sources shall be at the Contractor's cost. Retesting of failed results as noted above shall be at the Contractor's cost.

1. Sieve analysis to be based on washed sieve analysis in accordance with appropriate ASTM Standard.

F. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 1557.
3. Report of actual unconfined compressive strength and/or results of bearing tests of each stratum tested.

G. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

H. Flowable Fill Mix Design: Submit mix design with admixture information for review and approval a minimum of 15 days prior to start of Work.

1.06 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Earthwork Observation and Testing:

1. The owner and/or owner's agent will retain a qualified geotechnical engineer and/or testing agency to perform onsite observation and testing during work under this and related sections and as indicated in the "Schedule of Special Inspections." The services of the geotechnical engineer/testing agency may include, but not be limited to, the following:

a. Observation during excavation, subgrade preparation and backfill for footings, slabs-on-grade, and subsurface drainage construction, etc.
b. Determination of requirements for additional excavation to remove unsuitable materials.
c. Observation and testing during placement and compaction of fill and backfill.
d. Laboratory testing and analysis of fill materials specified.
e. Review of submittals.

2. During the course of construction the geotechnical engineer/testing agency shall advise the owner's agent, in writing, with a copy to the Architect and Contractor, if at any time, in his opinion, the work is not in substantial conformity with the plans and specifications. The geotechnical engineer's and/or testing agency's presence does not include supervision of

direction of the actual work by the Contractor, his employees, subcontractors or agents. Neither the presence of the geotechnical engineer and/or testing agency, nor any observations and testing performed by him shall excuse the Contractor from defects discovered in his work.

3. Testing equipment will be provided by and testing performed by the geotechnical engineer and/or testing agency, except as otherwise provided by contract. Upon request by the owner's agent, the Contractor shall provide such auxiliary personnel and services as needed to accomplish testing work and to repair damage caused thereby to permanent work.
4. References herein to observations, testing and determinations by the "Engineer" include services to be provided by the geotechnical engineer and/or testing agency when appropriate and when so authorized by the engineer or owner.

C. Pre-excavation Conference: Conduct conference at Project site.

1. Before commencing earthwork, meet with representatives of the governing authorities, owner, architect, engineer, consultants, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least three working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

1.07 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Existing Utilities:

1. Notify utility locator service for area where project is located before site clearing or excavating. Contact Dig Safe not less than 3 business days before starting the work. Dig Safe requirements are in addition to local and/or State DOT street opening permit requirements
2. Hire private utility markout service for areas not marked by utility companies. See the "General Conditions" of the construction contract.
3. Before starting excavation, establish location and extent of any underground utilities occurring in work area. Make arrangements with appropriate utility company for removal and relocation of lines which are in the way of excavation. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
4. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility owner immediately for direction. Cooperate with owner, owner's agent, and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
5. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped. The location of such utilities shall be noted on record drawings and reported in writing to owner's agent. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff services if lines are active.

6. Do not interrupt existing utilities serving facilities occupied and used by owner or others, during occupied hours, except when permitted in writing by owner's agency and then only after arranging to provided acceptable temporary utility services. Provide minimum of 48 hours notice to owner's agent and receive written notice to proceed before interrupting any utility. Do not proceed with utility interruptions without owner's written permission.
7. When in the course of the work it is necessary to connect a utility to a main in a public way, all the requirements of both the authorities governing the utility and those governing the public way shall be met. Pavement shall be temporarily and permanently replaced as directed by these authorities at no additional cost to the owner.

C. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

D. Site Information:

1. Information in the contract plans and in the specifications relating to subsurface conditions, existing utilities and structures is from the best sources presently available. Such information is furnished only for the information and convenience of the Contractor, and the accuracy and completeness of this information is not guaranteed.
2. Refer to the Geotechnical Report titled "Geotechnical report, titled Report, Explorations and Geotechnical Engineering Services, Proposed Sanford High School and Regional Technical Center, Main Street and Old Mill Road, Sanford, Maine, prepared for Sanford School Department, revision October 14, 2015 for available subsurface data. A copy of this report is included in Appendix A attached to this section. This report is not part of the Contract Documents and is furnished only for the information and convenience of the contractor. The exploration logs and related information included in the report depict subsurface conditions at specific locations and dates indicated. Conditions at other locations at the site may differ from the conditions encountered in the exploration. The Contractor may, at his own expense and upon application to the owner, conduct additional subsurface explorations and testing. The contractor shall be assumed to have familiarized himself or herself with the nature of the subsurface and groundwater conditions to their own satisfaction. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of the subsoil conditions, tests and results of analyses conducted by the geotechnical engineer. The owner will not be responsible for interpretations or conclusions drawn from this data by the Contractor.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. All rock and soil materials furnished for use as fill or backfill shall be free of grease, soil, solvents, pesticides, herbicides or other hazardous or deleterious materials and/or contaminants. All rock and soil materials specified in this Section shall also be free from ice, snow, trash, debris, stumps, roots and organic material.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups symbols shall not be used as fill or backfill except where impervious fill is specified or detailed Satisfactory soils which have been rendered excessively wet, such that the Contractor cannot establish a stable soil mass compacted as specified in this Section, also shall not be used as fill or backfill.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

2. Unsuitable Materials also include material containing excessive plastic clay, vegetation, organic matter, debris, pavement, stones or boulders over 6 inches in greatest dimension, and frozen material. Material which, in the opinion of the Geotechnical Engineer, will not provide a suitable foundation or subgrade

D. Backfill and Fill: Satisfactory soil materials.

E. Unless indicated otherwise, materials shall conform to the "Standard Specification for Highways and Bridges" revision of December 2014, Maine Department of Transportation (abbreviated as MDOT "Standard Specification").

F. Reservoir Stone: Stone for permeable pavers base shall conform to ASTM #2 open-graded stone standards.

SQUARE MESH SIEVES	**PERCENT FINER BY WEIGHT**
Pass 3 Inch	100
Pass 2½ Inch	90 - 100
Pass 2 Inch	35 - 70
Pass 1½ Inch	0 – 15
Pass ¾ Inch	0 - 5

G. No. 9 Stone: Stone for permeable pavers openings shall conform to ASTM #9 stone for joints/voids.

SQUARE MESH SIEVES	**PERCENT FINER BY WEIGHT**

Pass 3 Inch	100
Pass 2½ Inch	85 - 100
Pass 2 Inch	10 - 40
Pass 1½ Inch	0 – 10
Pass ¾ Inch	0 - 5

H. 3/4 Inch Crushed Stone: Crushed stone shall be a quarry product ¾ inch or washed gravel stone obtained from offsite sources for use as detailed on the drawings. Crushed stone shall consist of durable crushed rock or gravel stone essentially free of silt, clay, loam or other deleterious materials and shall conform to the following gradation requirements for the nominal size indicated.

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 1 Inch	100
Pass 3/4 Inch	90 - 100
Pass 1/2 Inch	20 - 55
Pass 3/8 Inch	0 - 15
Pass No. 4	0 - 5

I. Sand-Gravel Fill: Naturally or artificially graded non-plastic mixture of durable, sound coarse and fine aggregate and obtained from suitable excavated onsite soils or offsite sources. Mixture to be free of debris, waste, frozen materials, and organics, and shall be well graded within the following limits:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 2-1/4 Inch	100
Pass 2 Inch	95 - 100
Pass 3/4 Inch	50 - 75
Pass 1/4 Inch	25 - 45
Pass No. 40	5 - 20
Pass No. 100	2 - 12

J. Bedding Material: Sand or sandy soil free of debris, waste, frozen materials and organics with 100 percent passing a 3/8-inch sieve and not more than 10 percent passing a No. 200 sieve.

K. Granular Borrow: Granular borrow shall be obtained from suitable excavated onsite soil or offsite borrow sources for use as fill and backfill below and interior to building areas except where other materials are specified or detailed, and as detailed on the drawings. Granular fill shall consist of non-plastic naturally or artificially graded mixture of sound coarse and fine aggregates free of debris, waste, frozen materials and organics and conforming to the following gradation:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 3 Inch	100
Pass No. 4	30 – 90
Pass No. 40	10- 50
Pass No. 200	0 – 8

L. 1-1/2” Crushed Stone: Crushed stone shall be a quarry product or washed gravel stone obtained from offsite sources for use as detailed on the drawings. Crushed stone shall consist of durable crushed rock or gravel stone essentially free of silt, clay, loam or other deleterious materials and shall conform to the following gradation requirements for the nominal size indicated.

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 2 Inch	100
Pass 1-1/2 Inch	95-100
Pass 3/4 Inch	35-70

Pass 3/8 Inch	10-30
Pass No. 4	0-5

M. General Fill: Clean, sound mixture of material free of debris, waste, frozen materials and organics with 5 inch maximum size aggregate and not more than 12 percent passing the No. 200 sieve.

N. Sand: ASTM C 33; fine aggregate.

O. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

P. Flowable Fill: Mixture of cement, GranCem, sand, water and admixtures to produce a flowable fill with a 100 psi minimum, 28 day minimum compressive strength.

Q. Aggregate Base Materials: Shall meet the requirements of MDOT Standard Specifications Section 703.06(a), Type A, Section 703.06(a), Type B or Section 703.06(a), Type C.

R. Aggregate Subbase Material: Shall meet the requirements of Maine Department of Transportation Standard Specifications Section 703.06(b), Type D. Underdrain Filter Sand: Granular material for underdrain shall be free from organic matter and shall conform to the MDOT "Standard Specifications" Section 703.22 for Underdrain Type B

2.02 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Grab Tensile Strength: 157 lbf (minimum); ASTM D 4632.
2. Sewn Seam Strength: 142 lbf (minimum); ASTM D 4632.
3. Tear Strength: 56 lbf (minimum); ASTM D 4533.
4. Puncture Strength: 56 lbf (minimum); ASTM D 4833.
5. Apparent Opening Size: No. 70 sieve, maximum; ASTM D 4751.
6. Permittivity: 0.5 per second, minimum; ASTM D 4491.
7. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.03 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Underslab and Footing Drainage Pipe: Perforated and solid pipe for subsurface drains shall be heavy-duty corrugated polyethylene tubing conforming to ASTM F 405. Pipe and fittings shall be made of polyethylene compounds that meet or exceed the requirements of Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM D 1248. The pipe and fittings shall be free of foreign inclusions, cracks, creases, unpigmented or nonuniformly pigmented areas, or other visible defects. Fittings and/or couplings shall be split and/or screw-on with corrugations to match the pipe corrugations. Fittings supplied by manufacturers other than the manufacturer of the pipe shall not be used.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

D. Provide protective construction fence around all landscaping in work area to remain.

E. Paved surfaces: Do not operate equipment on paved surfaces that will damage surface.

F. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades and foundation soils from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. The Contractor shall grade and ditch the site as necessary to direct surface runoff away from open excavations. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to keep all excavations and work sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction product or procedures nor cause excessive disturbance of underlying natural ground or footing and slab subgrades. Contractor shall similarly control water entering the excavation as a result of construction operations, such as washing of concrete equipment and tools and the like.
3. Water from trenches and excavations shall be disposed of in such a manner as will not cause injury to public health, nor damage to public or private property, existing work, or work in progress, nor to the surface of roads, walks and streets, nor cause any undue interference with the use of the same by the public. The Contractor shall comply with all applicable environmental protection and/or sediment/erosion control regulations.
4. Under no circumstances place concrete or fill, or lay piping or install appurtenances in excavations containing free water. Keep utility trenches free from water until pipe joint material has hardened.

3.03 EXPLOSIVES

A. Explosives: Explosives may be utilized for rock excavation. Use shall be conducted by a licensed, qualified contractor and governed by all Federal, State, County, and Local codes and laws.

3.04 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not disintegrate or excavate rock until it has been classified and cross sectioned by the geotechnical engineer and/or owner's agent. The Contract Sum will be adjusted for rock excavation according to contract provisions for changes in the Work. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and replacement with approved materials. Excavated rock shall be reused on-site, when in compliance with this specification. This may include on-site crushing.
    a. Contractor shall uncover and expose all rock surfaces to be removed.
    b. Contractor shall notify owner in writing prior to proceeding with rock removal.

c. The Owner shall engage such professionals to determine the quantity of rock for payment, measurements for payment will be based on in place cubic yards to rock remove to paylines, as defined:

1) For Walls or Piers with Footings: The measurements will be taken horizontally parallel to and 24 inches outside of the edges of the concrete footings and vertically 24 inches below bottom of footing elevation as indicated in the Contract Documents.
2) For Walls or Piers without Footings: The measurements will be taken horizontally parallel to and 24 inches outside of the edges of the concrete limits and vertically 24 inches below bottom of concrete elevation as indicated in the Contract Documents.
3) For Slabs-on-Grade: The measurement will be taken vertically 60 inches below slab subgrade elevation as indicated in the Contract Documents.
4) Paved and Landscaped Areas: The measurement will be taken vertically 24 inches below finished surface elevation as indicated in the Contract Documents.
5) For Utility Trenches: The measurement will be taken vertically 6 inches below bottom of pipe and horizontally 24 inches wider than the nominal diameter of pipe/conduit as indicated in the Contract Documents.
6) For Tanks, Vaults, Manholes, Pits, Etc.: The measurement will be taken horizontally 24 inches greater in both length and width or diameter than the actual exterior dimensions of the structures and vertically 12 inches below the bottom elevation of structure as indicated in the Contract Documents.

d. Owner and Contractor shall agree on quantity of rock removal based on the above paylimits prior to mass rock removal.
e. No payment will be made for overblasted rock and/or shattered layers below paylimits, associated removal and replacement with suitable fill material.

B. Dimensions:

1. Excavate to elevations and dimensions indicated on the drawings or as otherwise required for the work. Do all necessary excavation, including but not limited to, excavation for structures, footings, foundations, grade beams, walls and slabs below grade, paving, utility lines, mechanical work, mechanical and drainage structures, drains, and other below grade work. Excavate sufficient material so as to allow ample space for construction operations including placing and removal of forms, installation of waterproofing, dampproofing or utilities and inspection of excavated areas.
2. Side forms will be required for all concrete work unless omission of forms is requested by the Contractor, in writing, to the engineer. Where omission of forms is requested by the Contractor, and accepted by the engineer, the Contractor shall bear the cost of any additional concrete volume required beyond the minimum profiles and dimensions of the footing, wall, pier as detailed.
3. Remove and dispose of pavements and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, and other materials encountered that are not classified as unauthorized excavation.
4. All previous construction, including foundations, walls, floor slabs and abandoned utilities, be removed from within the limits of the building be replaced with compacted structural fill.

5. All previous construction below parking, roadways and landscaped areas should be removed to a minimum of 2 feet below the bottom of pavement section and replaced with compacted structural fill.
6. Excavation in Paved Areas: Saw cut pavement prior to excavation to provide a clean, uniform edge. Minimize disturbance of remaining pavement. Cut and remove the minimum amount of pavement required to do the work. Use shoring and bracing where sides of excavation will not stand without undermining pavement.

C. Disposition of Excavated Material:

1. Sort and stockpile excavated material according to its suitability for reuse and job requirements. Onsite stockpile room will be limited and the contractor shall plan his operations to facilitate prompt reuse of excavated material or provide off-site stockpile locations as required.
2. Stockpile soil materials without intermixing. Place, grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
4. Offsite Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash and debris and legally dispose of it off owner's property.

D. Unauthorized Excavation: Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the engineer or owner's agent. Unauthorized excavation, as well as remedial work specified by the engineer, shall be at the Contractor's expense.

1. In areas below structures, pavements and walks, backfill unauthorized excavation with granular fill placed and compacted in accordance with this Section, unless otherwise directed by the engineer.
2. Elsewhere, backfill and compact unauthorized excavations with general fill, compacted to the requirements of this Section.
3. Where the excavation of otherwise suitable materials is required due to these materials being rendered unsuitable due to disturbance, construction activity, freezing or lack of protection from the elements, the Contractor shall excavate these materials and provide remedial work as specified above at no additional cost to the owner.

E. Authorized Additional Excavation: In the case that unsuitable materials, as determined by the engineer, are encountered at the specified subgrade elevation, the engineer may direct the removal of the unsuitable material and refill with granular fill placed and compacted in accordance with the requirements of this Section.

1. Several Test Borings and Probes indicate seams of peat bog and organic soils. Where proposed construction will overlie these areas, organic and peat soils shall be completely removed from beneath proposed improvement s until native soils free from peat and organics are encountered. The removal of peat and organics shall extend horizontally outward from the edge 1-foot for every 1 foot of vertical depth. Backfill for peat and organic removal shall consist of compacted suitable fill, as directed by the Geotechnical Report.

F. Backfilling Prior to Acceptance of Work Installed:

1. Do not allow or cause the work performed or installed to be covered up or enclosed by work of this Section prior to all required inspections, tests and acceptances.
2. Should any of the work be so enclosed or covered up before it has been accepted, uncover all such work at no additional cost to the owner.
3. After the work has been completed, tested, inspected and accepted, make all repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, all at no additional cost to the owner.

G. Sheeting, Shoring and Bracing:

1. Provide sheeting, shoring and/or bracing at excavations as required to assure safety against collapse of earth or rock at sides of excavations; as required for support of adjacent structures, streets or utilities; or as required to comply with federal, state or local regulations, codes or ordinances.
2. Provide materials for sheeting, shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down sheeting, shoring and bracing as excavation progresses.
3. All sheeting and bracing not ordered left in place shall be carefully removed in such a manner as not to endanger the construction of other structures, utilities or property whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand and rammed with tools especially adapted to that purpose or otherwise compacted as directed to achieve the required density.
4. Wood sheeting shall not be completely withdrawn if driven below mid-diameter of any pipe, and under no circumstances shall any wood sheeting be cut off at a level lower than one foot above the top of pipe.
5. Refer to the *Related Requirements* in Section 315000 "Excavation Support and Protection."

H. Dust and Erosion Control:

1. The Contractor shall take all necessary measures and provide equipment and/or materials to minimize dust from rising and blowing across the site and also to control surface water throughout the operation so that it does not run onto paved ways without being filtered. In addition, the Contractor shall control all dust created by construction operations and movement of construction vehicles, both on the site and on paved ways.
2. Thoroughly moisten all surfaces as required to prevent dust from being a nuisance to the public, neighbors and performance of other work on the site.
3. Repair any broken or damaged sections of hay bales or other erosion and siltation control measures damaged during excavation and grading operations and install any additional sections necessary for proper control.

I. Frost Protection and Snow Removal:

1. The Contractor shall, at his own expense, keep the operations under this contract clear and free of accumulations of snow or as required to carry out the Work.
2. Do not excavate to full indicated depth when freezing temperatures may be expected, unless footings or slabs can be cast immediately after excavation has been completed. Protect the excavation from frost if placing of concrete is delayed. Do not cast concrete on frozen ground.

3. Completed foundations which have not been backfilled or which have less than 60 inches of earth cover above the bottom of the foundation shall be protected from freezing by temporary additional earth cover, insulating blankets, heaters or other methods.

J. Protection of Persons and Property:

1. The Work shall be executed in such a manner as to prevent any damage to adjacent property and any other property and existing improvements, such as but not limited to, streets, curbs, paving, service utility lines, structures, monuments, bench marks and other public and private property. Protect existing improvements from damage caused by settlement, lateral movements, undermining, washout, vibration and other hazards created by earthwork operations.
2. In the case of any damage or injury caused in the performance of the Work, the Contractor shall, at his own expense, make good such damage or injury to the satisfaction of and without cost to the owner. Existing roads, sidewalks and curbs damaged during the project work shall be repaired or replaced to their original condition at the commencement of operations. The Contractor shall replace, at his own expense, existing bench marks, monuments and other reference points which are disturbed or destroyed.
3. Barricade open excavations occurring as part of this Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and otherwise as required.
4. Buried structures, utility lines, etc., including those which project less than 18 inches above grade, which are subject to damage from construction equipment shall be clearly marked to indicate the hazard.
5. Provide protective construction fence around all landscaping in work area to remain.

3.05 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. General: Do not disturb bottom of excavation. Footing bearing surfaces shall be over excavated by 6 inches and refilled to bearing level with ¾” crushed stone placed on non-woven geotextile separation fabric Trim bottoms to required lines and grades to leave solid base to receive other work.

B. Preparation of Building Area for Foundations:

1. The Contractor’s bid is to include the costs to excavate and legally dispose of from the site all materials within the building footprint to the subgrade elevations indicated on the drawings, including stripping of topsoil. The Contractor’s bid is also to include all excavation of the area of proposed footings plus 2 feet horizontally (minimum) beyond the area of all footings as well as excavation of necessary transitional slopes per OSHA requirements, and backfill with compacted granular fill. The Contractor’s bid is to include the removal of all previous construction including foundations, walls, slabs and abandoned utilities from within the limits of the proposed building. Additionally the Contractor’s bid is to include the costs to furnish and place compacted granular fill and base materials to the slab subgrade elevations indicated on the drawings.
2. Excavation of Unsuitable Material within the Influence of the Building Foundations: Additional excavation to remove existing fill or other unsuitable material from within the areas of influence of the foundations and below slabs-on-grade shall be conducted when so directed by the

geotechnical engineer. The horizontal limits of excavation below footing level shall be one foot beyond the outside perimeter of the footing plus an additional one foot for every foot of depth below the footing, unless otherwise directed by the engineer.

C. Spread Footing Subgrades:

1. Spread footing foundations shall bear on natural inorganic soil or compacted granular fill overlying natural inorganic soils. The compacted granular fill shall extend at least one foot horizontally beyond the limits of the footing.
2. Footing subgrades shall be prepared by excavating all existing material to the specified bottom of the footing elevation, 5 feet below existing grades, or as indicated on the Contract Documents, whichever is lower. Allow the geotechnical engineer to view the excavated subgrade at this level. The geotechnical engineer shall determine whether authorized additional excavation is required to remove unsuitable material. Remove and replace such unsuitable material in accordance with paragraph 3.05 B.2 of this section or as otherwise directed by the engineer.
3. The Contractor shall take every precaution to minimize the disturbance of excavated subgrades in the natural soils. Such precautions shall include, but not be limited to, using excavation buckets without teeth and/or accomplishing excavation to final subgrade with hand tools. All materials disturbed during excavation shall be removed to undisturbed natural soils or re-compacted as directed by the engineer.
4. Refill excavation to the specified bottom of the footing elevation with granular fill placed and compacted in accordance with the requirements of this Section.
5. Proof compact the final footing subgrade with at least two passes of a vibratory plate compactor immediately prior to placing forms and reinforcing.

D. Subgrade for Slabs-on-Grade:

1. Slabs-on-grade shall be supported on subbase/base course(s) as indicated on the drawings.
2. Remove and replace excessively wet, disturbed or unstable material and proof compact the subgrade for the slab subbase/base course with at least six passes of a vibratory plate or vibratory roller compactor immediately prior to placement of slab base course material unless otherwise directed.
3. The final surface of the subgrade for the moisture retarder membrane and/or slabs-on-grade shall be proof rolled with at least four passes of an approved vibratory plate or vibratory drum compactor immediately prior to placing the membrane, reinforcing or concrete (as may be applicable).

3.06 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe, conduit or ductbank. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe, conduit or ductbank unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit unless otherwise indicated.

C. Trench Bottoms: Excavate trenches 6 inches deeper than bottom of pipe and conduit elevation, unless otherwise indicated on Construction Documents, to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.07 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Saw cut pavement prior to excavation to provide a clean, uniform edge. Minimize disturbance of remaining pavement. Cut and remove the minimum amount of pavement required to do the work.

C. Use shoring and bracing where sides of excavation will not stand without undermining pavement.

3.08 SUBGRADE INSPECTION

A. Notify Architect, geotechnical engineer and owner's agent when excavations have reached required subgrade.

B. If geotechnical engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed and in accordance with paragraph 3.05 B.2 of this section.

C. Proof-roll subgrade as directed by the geotechnical engineer and /or owner's agent.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by geotechnical engineer, without additional compensation.

3.09 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 PLACEMENT AND COMPACTION OF FILL AND BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.

3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Unless otherwise specified or indicated on the drawings, the products specified in Part 2 of this Section shall be employed in the various fill and backfill applications indicated in that part. Place and compact fill material in layers to required elevations as follows:
1. Under steps and ramps, use granular fill material.
2. Under building slabs-on-grade, use granular fill, crushed stone and sand-gravel material. See Contract Documents for additional information.
3. Under footings and foundations, use granular fill.
4. Against the interior face of foundation walls, use granular fill material. Use granular fill material to 3'-0" beyond the outside face of foundation walls. Use general fill beyond the 3 feet of granular fill.
5. Against the interior face (retained soil side) of site retaining walls use granular fill material. Use granular fill material to 3’-0” beyond the inside (retained soil side) of site retaining walls. Use general fill beyond the 3 feet of granular fill.
6. Under utilities, use either bedding material or crushed stone (see drawings).
7. Under equipment pads, use crushed stone.
8. Under grass and planted areas, use general fill
9. Under walks and pavements, use base and subbase material

D. All vegetation, peat, organic topsoil or subsoil, trash, debris, roots, stumps, and any compressible or otherwise deleterious materials shall be stripped from the existing ground surface and removed from excavations prior to placement of fill or backfill.

E. All fill and backfill materials shall be placed in horizontal layers. Each layer shall be spread evenly and thoroughly mixed during spreading to ensure uniformity of material in each layer. Layer thickness shall not exceed that specified in paragraph 3.09 L of this Section.

F. Where horizontal fill layers meet a natural or excavated slope, the layer shall be keyed into the slope by cutting a bench. The surface of benches shall be compacted to the same requirements as apply to the area being filled.

G. In no instance place fill over materials that were permitted to freeze prior to compaction or over ice or snow. Removal of such materials will be required as directed by the engineer. In no case will frozen material be allowed for use in fill or backfill.

H. No fill shall be placed or compacted during unfavorable weather conditions. When work is interrupted by heavy rains or snow, fill operations shall not be resumed until the moisture content and density of previously placed fill are as specified hereinafter.

I. Allow the geotechnical engineer sufficient time to make necessary observations and tests. The degree of compaction shall be based on a maximum dry density as determined by ASTM Standard D1557 or AASHTO Standard T180. All fill and backfill placed in various areas shall be compacted in individual layers to minimum dry densities as follows:

1. Under Structures, within Building Foundation Backfill Limits, Equipment Pads, Building Slabs, Steps and Pavements: 95 percent.
2. Beside site retaining walls: 95 percent
3. Top 2 feet under pavement: 95 percent
4. Below top 2 feet under pavement: 92 percent
5. Trenches through paved areas, top 2 feet:: 95 percent
6. Trenches through paved areas, below top 2 feet: 92 percent
7. Trenches through unpaved areas: 92 percent
8. Grass and mulch areas: 90 percent
9. Uniformly graded crushed stone materials which are not suited to field density testing shall be compacted in accordance with the minimum compactive effort indicated in paragraph 3.10 L of this Section.

J. The term "under," as applied to building, structures and paved areas, shall be construed to include all materials immediately below the plan area of the building, as well as those materials within a line sloping at one vertical to one horizontal drawn downward and outward from the exterior of building foundation, structure foundation or paved area.

K. Compaction shall be by mechanical means designed specifically for compaction and approved by the engineer. The engineer reserves the right to disapprove any device or inadequate capacity or of type unsuited to the character of the material being compacted. In areas which are too restricted to permit the use of mechanical compactors, fill may be placed in 3 inch layers and compacted by hand rammer or pneumatic tools.

L. In addition to the stated degree of compaction, all fill and backfill shall receive at least the compactive effort given in the following table. Lift thickness shall not exceed that shown for the compaction method selected, except that the first lift of fill or backfill placed over natural ground in wet conditions may be as much as 12 inches thick. Application of the minimum compactive effort does not relieve the contractor from his requirement to achieve the specified degree of compaction.

Compaction Method	Maximum Stone Size	Maximum Loose Lift Thickness		Minimum Number of Passes	
		Below Structures and Pavement	Less Critical Areas	Below Structures and Pavement	Less Critical Areas
Hand-operated vibratory plate or light roller in confined areas	3"	6"	8"	6	4
Hand-operated vibratory drum rollers weighting at least 1,000#	6"	8"	10"	6	4
Light vibratory drum roller, minimum dynamic force 3,000# per ft. of drum width	6"	8”	14"	6	4
Medium vibratory drum roller, minimum dynamic force 5,000# per ft. of drum width	6"	8”	18"	6	4
Large vibratory drum roller, minimum dynamic force 8,000# per ft. of drum width	6"	8”	24"	6	4

M. Moisture Control:

1. Water shall be added to fill material which does not contain sufficient moisture to be compacted to the specified densities. Fill and backfill material containing excess moisture shall be required to dry prior to or during compaction to a moisture content not greater than two percentage points above optimum except that material which displays pronounced elasticity or deformation underfoot or under load shall be required to dry to optimum moisture content before it is placed and compacted, if that is required to achieve specified compaction. At the Contractor's option, material which is too wet may be removed and replaced with satisfactory material at no additional cost to the owner.
2. The Contractor is alerted to the potential silty nature of the onsite soil which renders them sensitive to moisture. Onsite silty soils are difficult to handle and compact and are easily disturbed when wet. The Contractor shall plan and conduct his excavation and filling operations considering the nature of the onsite materials.

N. Where the engineer determines that fill or backfill does not conform to the compacted density specified, or did not receive the minimum compactive effort specified, such fill shall be removed and replaced with conforming materials at the Contractor's own cost.

O. Backfilling of Walls:

1. Do not backfill against walls until completion of slabs-on-grade, structural framing and suspended slabs which provide lateral support to these walls. In placing backfill, take special care to prevent any wedge action, eccentric loading or overloading by equipment used in backfilling and compaction. See Contract Documents for additional requirements.
2. Do not use equipment weighing more than 5,000 lbs. within 10 feet of all walls. Equipment weighing more than 5,000 lbs. shall not be used adjacent to walls, except as expressly approved by the engineer.
3. Backfill shall be placed concurrently on all sides of shafts, tunnel, and freestanding walls, each lift being compacted on all sides before successive lifts are placed. See Contract Documents for additional requirements.
4. Prevent damage to wall waterproofing or dampproofing when backfilling.

3.11 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION

A. The Contractor shall take the necessary steps to avoid disturbance of subgrade during excavation and filling operations. Methods of excavation and filling shall be revised as necessary to avoid disturbance of the subgrade, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials, dewatering and other acceptable control measures. The Contractor shall cooperate with the engineer to modify his operations as necessary to mitigate disturbance and protect bearing soils, based on the engineer's observations.

B. All excavated or filled areas disturbed during construction; damaged by freezing temperatures, frost, rain, accumulated water, or construction activities; all loose or saturated soil, and other areas that do not meet compaction requirements as specified herein shall be removed and replaced with the compacted fill materials specified. Costs of removal of disturbed material and refill with compacted fill shall be borne by the Contractor.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits and ductbanks.

C. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete shall comply with requirements specified in Division 3 Section "Cast-in-Place Concrete."

E. Backfill under all existing utility pipes crossed during construction operations with ¾-inch crushed stone. Crushed stone backfill shall extend continuously from the bedding of new utility pipes to the utility pipe crossed, including a 6-inch thick envelope of crushed stone all around the existing utility pipes. Crushed

stone backfill shall stand at its own angle of repose. No “haunching” or “forming” with common fill will be allowed.

F. Place and compact initial backfill of gravel fill, free of particles larger than 1 inch in any dimension, to the building slab subgrade elevation.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Coordinate backfilling with utilities testing.

I. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

C. Site Grading Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1/2 inch.

3. Pavements: Plus or minus 1/2 inch.

3.14 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified above.

B. Subsurface Drain: Drainage pipe to be surrounded by stone and wrapped with filter fabric as shown on the Construction Documents.

C. Drainage Backfill for site retaining walls: Place and compact granular fill material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each granular fill material layer to specified compaction of soil backfills and fills requirements.

2. Place and compact impervious fill over drainage backfill in 6-inch thick compacted layers to final subgrade.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.

2. Shape subbase and base course to required crown elevations and cross-slope grades.

3. Place subbase and base course 6 inches or less in compacted thickness in a single layer.

4. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

5. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than the specified compaction of soil backfills and fills requirements.

3.16 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, each soil stratum will be verified by a geotechnical engineer to confirm subgrade preparation and ability to support design bearing capacities.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.

1. Field in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.
2. When field in-place density tests are performed using nuclear methods, make calibration checks for both density and moisture gages at the beginning of work, on each different type of material encountered and at intervals as directed by the engineer.
3. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
4. Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests along a wall face.
5. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
6. Pavement areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by geotechnical engineer and/or owner’s agent; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

ATTACHMENTS

Attachment A – Geotechnical Report

END OF SECTION

ATTACHMENT A

Geotechnical Report titled Explorations and Geotechnical Engineering Services, Proposed Sanford High School and Regional Technical Center, Main Street and Old Mill Road, Sanford, Maine, as prepared by S.W. Cole Engineering Inc., dated October 14, 2015

R E P O R T

October 14, 2015
12-0471 S

Explorations and Geotechnical Engineering Services

Proposed Sanford High School & Regional Technical Center
Main Street and Old Mill Road
Sanford, Maine

PREPARED FOR:
Sanford School Department
Attention: David Theoharides, Superintendent of Schools
917 Main Street – Suite 200
Sanford, Maine 04073

PREPARED BY:
S. W. Cole Engineering, Inc.
286 Portland Road
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S.W.COLE
ENGINEERING, INC.

- *Geotechnical Engineering*
- *Construction Materials Testing and Special Inspections*
- *GeoEnvironmental Services*
- *Test Boring Explorations*

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12-0471 S

October 14, 2015

Sanford School Department
Attention: David Theoharides, Superintendent of Schools
917 Main Street – Suite 200
Sanford, Maine 04073

Subject: Explorations and Geotechnical Engineering Services
Proposed Sanford High School & Regional Technical Center
Main Street and Old Mill Road
Sanford, Maine

Dear Superintendent:

In accordance with our Agreement, dated March 5, 2015, we have performed subsurface explorations for the subject project in Sanford, Maine. This report summarizes our findings and geotechnical engineering recommendations relative to foundations, earthwork and pavements associated with the proposed construction. The contents of this report are subject to the limitations set forth in Attachment A.

1.0 INTRODUCTION

1.1 Scope and Purpose

The purpose of our services was to obtain subsurface information at the site in order to provide geotechnical recommendations for foundations, earthwork and pavement associated with the proposed construction. Our scope of services included: test boring, rod probe and test pit explorations; soils laboratory testing; geotechnical analyses of the subsurface findings; geotechnical review of civil and foundation plans and preparation of this report.

1.2 Proposed Construction

Based on the plans provided and our discussions with you, we understand a former sand and gravel pit east of the intersection of Old Mill Road and Route 109 in South Sanford is proposed for construction of the new Sanford High School and Regional

Technical Center campus. We understand the proposed building will be a 1 and 2-story steel-framed structure with on-grade floor slabs situated in the northern portion of the site with paved parking to the south of the building and athletic fields south, west, and southwest of the building. A new access road will enter the site from Route 109 and exit to Route 4 to the south.

We understand the building is proposed at a Finished Floor Elevation of 254.0 feet (project datum) and a partial mechanical basement is planned with a finished floor elevation of about 242 feet. Proposed and existing site features are illustrated on the "Exploration Location Plan" attached as Sheet 1.

2.0 EXPLORATION AND TESTING

2.1 Explorations

Several phases of subsurface explorations have been performed at the site, including preliminary explorations for previous proposed site concepts and recent explorations for the current proposed site layout. Subsurface explorations made at the site include:

- Twenty-two test pits (TP-101 through TP-106 and TP-201 through TP-216) made on January 6 and 7, 2014 for preliminary phase investigation of the original site layout;

- Six test borings (B-1 through B-5 and B-8) and one rod probe (P-1) made on January 7 and 8, 2014 for preliminary phase investigation of the original site layout;

- Eleven test borings (B-101 through B-111) made on May 6 through 8, 2014 for preliminary phase investigation of the current site layout;

- Twenty-six test borings (B-201 through B-228 and B-301 through B-306, excluding B-203, B-211 through B-213, B-221, B-223, B-225, and B-226) made between March 23 and April 3, 2015 for design phase engineering of the current site layout. The excluded borings were proposed for future building expansion areas, but were not deleted from our scope as requested by others;

- Thirty-two test pits (TP-301 through TP-332) made on March 19 and 20, 2015 for design phase engineering of the current site layout;

- Three hand pushed tile probes (P-101 through P-103) made on April 9, 2015 for design investigation of the current site layout.

The explorations were made by drilling and excavation companies working under subcontract to S. W. Cole Engineering, Inc. (S.W.COLE). The hand pushed tile probes were made by S.W.COLE. The exploration locations were selected in collaboration with the design team and Maine Department of Education. S.W.COLE established in exploration locations in the field using a survey grade Trimble GPS. The approximate exploration locations are shown on the "Exploration Location Plan" attached as Sheet 1. Logs of the explorations and a key to the notes and symbols used on the logs are attached as Appendix A.

2.2 Testing

The borings were performed using a combination of hollow-stem auger, solid-stem auger, cased wash-boring, rock coring, and rod probing techniques. The soils in the test borings were sampled at 2 to 5 foot intervals using a split spoon sampler and Standard Penetration Test (SPT) methods. SPT blow counts are shown on the logs. The test pits were made using a tracked excavator with bulk samples obtained using a hand shovel.

Soil samples obtained from the explorations were returned to our laboratory for further classification and testing. Laboratory testing included grain size analyses, soil moisture content, and organic content. Moisture content and organic content test results are noted on the logs. Grain size analyses are attached as Appendix B.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Surficial and Historical

The site is located in the Mousam River Valley northwest of the intersection of Route 109 and Route 4 in South Sanford, Maine. Surface relief across the site is generally characterized by terraces and ridges with wetland troughs between and approximately parallel to the Mousam River. A flood plain bench exists along the edge of the current

Mousam River channel along the east side of the site. We understand portions of the site were historically used as a sand and gravel borrow source. As a result, several access roads and pathways existing across the site.

Based on available historical mapping, we understand that the Mousam River was dammed downstream from the site as early as the 1940's. The dam resulted in an impoundment known as Jagger Pond which appears to have inundated portions of the site. The dam and Jagger Pond apparently were removed in favor of the current wastewater treatment plant. Historical topographic mapping is attached as Appendix C.

3.2 Soil and Bedrock

According to the Maine Geologic Survey, Surficial Soils Map, the surficial soils generally consist of glacio-fluvial outwash deposits of sand and gravel overlying bedrock within the high elevation terraces and ridges and wetland soils in the lower elevation troughs. Similarly, alluvial deposits of sand, silt, gravel and organics are generally mapped within the flood plain immediately adjacent to the current channel of the Mousam River. We understand the terrace and ridge areas of the site were previously mined for sand and gravel. A surficial soils map of the site is attached as Appendix D.

The explorations encountered subsurface conditions similar to the soil deposits mapped on the Maine Geologic Survey Surficial Soils map. In general,

- The explorations performed in the higher terrace and ridge areas of the site encountered sand and gravel overlying glacial till and bedrock.

- The explorations performed in the wetland trough over the western portion the site for the original site layout encountered organic peat soils overlying sand and gravel deposits.

- The explorations performed in the flood plain immediately adjacent to the Mousam River encountered sand and gravel overlying glacial till overlying bedrock. Organic peat soils were encountered at borings B-4 and B-111, and B-301. The peat appears to exist as discontinuous and erratic seams within the alluvial sand and gravel soils which is typical of the Mousam River Valley.

- Layers of uncontrolled fills, likely remnant from previous site usage, were encountered at some explorations erratically across the site, including within the southern portion of the proposed school building and athletic field footprints.

- Shallow bedrock was generally encountered in the central ridge of the site generally defined by borings B-224 to B-6. Bedrock outcrops were observed at B-6 and TP-105. Shallow bedrock is also present along a portion of the proposed access road alignment along the west edge of the site. A map of bedrock geology of the site is attached in Appendix D. Some readily visible bedrock outcrops were located using GPS and are displayed on the "Exploration Location Plan" attached as Sheet 1.

For more detailed subsurface information at the exploration locations, please refer to the attached logs.

3.3 Groundwater

Groundwater was generally at the ground surface within the wetland in the western portion of the site. In the explorations around the wetland and in the flood plain along the river, groundwater was generally 1 to 8 feet below the ground surface. In the higher terrace in the northwest portion of the site, groundwater was not observed within the 5 to 10 foot depth explored.

Groundwater likely becomes perched on relatively shallow bedrock encountered beneath higher elevation terrace and ridge areas of the site. Long-term groundwater levels are likely influenced by the level of the Mousam River. It should be anticipated that seasonal groundwater levels will fluctuate, especially during periods of snowmelt and precipitation.

3.4 Frost and Seismic

The 100-year Air Freezing Index for the Sanford, Maine area is about 1,407-Farenheit degree-days, which corresponds to a frost penetration depth on the order of 4.5 feet. Based on the subsurface findings, we interpret the site soils to correspond to Seismic Soil Site Class D, according to 2009 International Building Code.

4.0 EVALUATION AND RECOMMENDATIONS

4.1 General Findings

Based on the subsurface findings, the proposed construction appears feasible from a geotechnical standpoint. The principle geotechnical considerations include:

- The proposed building footprint is generally underlain by sand and gravel deposits overlying glacial till and bedrock. Alluvial soils with seams of organic peat and layers of uncontrolled fill were encountered at explorations in the central and southern portions of the proposed footprint. Rammed aggregate piers (RAPs) are recommended to improve foundation bearing surfaces beneath these portions of the building footprint. Uncontrolled fills should be densified with a vibratory roller compactor prior to placing Granular Borrow to raise building area grades.

- Following densification of uncontrolled fills and ground improvement using RAPs, conventional spread footing foundations and on-grade floor slabs appears suitable for the proposed structures.

- The terrace and ridge areas of the site contain sand and gravel deposits overlying relatively shallow bedrock. These areas are generally higher in elevation and are anticipated to be cut to establish finished grades. The sand and gravel provide a borrow source for granular fill for reuse on-site. The bedrock will require blasting and may be blended with on-site sands to create premium gravels for building and pavement construction.

- Explorations performed at the wetland area in the western portion of the site encountered 3 to 14 feet of organic peat overlying sand and gravel deposits. The peat soils appeared generally thinnest around the edge of the wetland and thickest in the center. This wetland area may represent a prior stream braid or channel of the Mousam River that was likely in-filled with the current wetland. Construction over this wetland is not considered feasible, in our opinion; however, the roads and athletic fields proposed around the edges of the wetland may feasibly be built provided the organic soils are completely removed prior to constructing fills, utilities and surface improvements. Removal of the organic soils will be difficult and will require careful excavation and dewatering.

- Groundwater was encountered at relatively shallow depths in lower elevations across the site, including within the proposed building footprint. Open cut excavations shallower than about 5 feet may be feasible with sump and pump dewatering techniques. Deeper excavations, such as for utilities, may require sheetpiling and well-point dewatering systems.

- Imported Granular Borrow, Structural Fill, and Crushed Stone will be needed for construction.

4.2 Site and Subgrade Preparation

We recommend that site preparation begin with the construction of an erosion control system to protect adjacent drainage ways and areas outside the construction limits. Surficial organics, roots and topsoil should be completely removed from areas of proposed fill and construction. As much vegetation as possible should remain outside the construction areas to lessen the potential for erosion and site disturbance. We recommend the existing water impoundments be drained and organics removed before filling.

Proposed Building: Following site grubbing, exposed granular soils and uncontrolled fills should be proof-rolled with 3 to 5 passes of a vibratory roller having a static weight of at least 10 tons. Areas which become soft and yielding should be overexcavated and replaced with compacted Granular Borrow. Granular Borrow should be placed and compacted to raise grades below the proposed structures.

As discussed, organic peat seams are present in the native alluvial soils below portions of the building. As such, ground improvement by RAPs will be needed beneath load bearing walls and columns after filling to 2 feet below finished floor elevation has been achieved. The approximate limits of RAP improvement are shown on Sheet 1, attached.

Footings supported on RAP improved ground should be underlain with 6 inches of compacted Structural Fill. Footings outside the RAP treatment area should be underlain with 6 inches of compacted Structural Fill overlying compacted Granular Borrow or stable native, non-organic soils. Final cuts to subgrade elevation in native soils should be completed using a smooth-edged bucket to reduce disturbance of the bearing soils. Footings founded on bedrock should be underlain with 6 inches of crushed stone to remove hard points below the footings. At least 6-inches of compacted Crushed Stone

wrapped in non-woven geotextile, such as Mirafi 160N or equivalent, should be installed below basement footings. At least 12-inches of geotextile wrapped Crushed Stone should be provided below the basement floor slab. Blasted bedrock subgrades, if encountered, should be thoroughly choked with crushed stone prior to placing new fills. Loose and overblasted bedrock should be removed and replaced with compacted Granular Borrow.

Proposed Grandstand, Bleacher and Concessions Structures: Following site grubbing, all uncontrolled fill should be removed and replaced with compacted Granular Borrow beneath the bleacher and concessions structures. Footings for the grandstands and pressbox must extend through uncontrolled fills to undisturbed native sands. The approximate limits of uncontrolled fill removal and extension of footings through uncontrolled fill for these structures is shown on Sheet 1, attached.

Proposed Athletic Track, Fields and Courts: Following site grubbing, all uncontrolled fill beneath the synthetic turf field should be proof-rolled with 3 to 5 passes of a vibratory smooth drum roller having a static weight of at least 10 tons. Areas that become soft or yielding after proof-rolling should be removed and replaced with compacted Granular Borrow.

We recommend the athletic track, pole vault and long jump running surfaces, as well as tennis courts, be underlain with non-frost susceptible material to frost depth (4.5 feet below finished grade) to help reduce the potential for frost heaves. These areas should also be provided with MaineDOT Type B Underdrains routed to gravity outlets.

It appears that portions of the athletic fields and track will overlie wetland and peat bog areas. All peat and organics must be completely removed from beneath the proposed athletic field and track areas until granular soils, free from peat and organics, are encountered. The removal of peat and organics should extend horizontally outward from the edge 1-foot for every 1 foot of vertical depth (1H:1V bearing splay). Backfill for peat and organic removal should consist of compacted MaineDOT Granular Borrow.

Paved Areas: Following site grubbing, exposed granular subgrade soils should be proof rolled with 3 to 5 passes of a vibratory roller having a static weight of at least 10 tons. Areas that become soft and yielding during proof-rolling should be overexcavated and replaced with Granular Borrow. Areas of organic and peat soils should be completely

removed to expose underlying stable native non-organic soils, then backfilled with compacted Gravel Borrow, Rock Borrow or Granular Borrow. The removal of the peat and organics should extend horizontally outward from the edge 1-foot for every 1 foot of vertical depth (1H:1V bearing splay). Blasted bedrock subgrades below paved areas should be thoroughly choked with Crushed Stone prior to placing fills.

4.3 Excavation, Blasting and Dewatering

Excavation work will generally encounter native sand and gravel, glacial till, bedrock, peat and organics. Areas of uncontrolled fills associated with past site usage will be encountered across the site. Saturated soils and groundwater will be encountered at lower elevations across the site. Care must be exercised during construction to limit disturbance of the bearing soils. Earthwork and grading activities should occur during drier Summer and Fall seasons. Final cuts to subgrade should be performed with a smooth-edged bucket to help minimize soil disturbance.

Extensive removal of peat and organics will be required where paved areas and athletic fields are proposed over the existing wetland area. The peat extended to depths as great as 8 feet at the explorations performed near the proposed construction. Free water is present at the ground surface in the wetland area. Careful excavation and dewatering will be needed for peat removal, likely including sheetpile cofferdams and heavy pumping.

Bedrock encountered at the site will require blasting. We recommend removing bedrock in mass to a depth of at least 5 feet below finished floor elevation in the building and 2 feet in proposed paved and landscape areas. Deeper bedrock removal will likely be needed for installation of underground utilities and landscaping. The blasted bedrock may remain on-site and be crushed and blended with sand to create pavement base and subbase aggregates. Alternatively, the blasted bedrock may be reused as Rock Borrow to backfill areas of peat removal. We recommend that blasting be performed by a licensed, qualified contractor and that pre-blast surveys should be performed on surrounding structures and wells within at least 500 feet of the blast area.

Open excavations in sand and gravel shallower than about 5 feet appear feasible with conventional sump and pump dewatering techniques. Deeper excavations, such as for utilities, may require braced excavations and sheetpiling with well-point dewatering systems for groundwater control. Excavations to remove organic peat soils may also

require the installation of cofferdams, stabilizing berms and dewatering methods to limit the impact to wetlands and help reduce the volume of materials excavated. Controlling the water levels to at least one foot below planned excavation depths will help stabilize subgrades during construction.

Excavations must be properly shored or sloped in accordance with OSHA regulations to prevent sloughing and caving of the sidewalls during construction. Care must be taken to preclude undermining adjacent structures, utilities and roadways. The design, planning and construction of excavations, excavation support and dewatering are the responsibility of the contractor. We recommend the contract documents require engineered shop drawings of shoring and dewatering plans for excavations below groundwater and excavations to remove peat and organics.

4.4 Foundations and Walls

The building may be supported on spread footings founded on properly prepared subgrades. As discussed, we recommend that ground improvement using Rammed Aggregate Piers (RAP) be performed below footings in portions of the school building where peat seams were encountered in the native alluvial soils and uncontrolled fills are present. We recommend removing and replacing uncontrolled fills below spread footings supporting the bleachers, stadium lighting and ancillary structures.

4.4.1 Spread Footings and Basement Walls

For spread footings supported on properly prepared subgrades, including areas recommended for RAP ground improvement, we recommend the following geotechnical parameters for foundation and RAP design consideration:

Geotechnical Parameters for Spread Footings and Basement Walls	
Design Frost Depth	4.5 feet
Net Allowable Soil Bearing Pressure	3.0 ksf or less
Base Friction Factor	0.35
Total Unit Weight of Backfill	130 pcf (compacted Structural Fill)
At-Rest Lateral Earth Pressure Coefficient	0.5 (compacted Structural Fill)
Internal Friction Angle of Backfill	32° (compacted Structural Fill)
Total Post-Construction Settlement	1 inch of less
Differential Post-Construction Settlement	½ inch or less

4.4.2 Rammed Aggregate Piers

We recommend that ground improvement using Rammed Aggregate Piers (RAP) be installed to a tip elevation of 234 feet below load bearing foundations (columns and walls) in Areas A1, A3, B, E, F1 and F2 of the building where peat seams and uncontrolled fills where encountered in the explorations. Additionally, we recommend RAPs be installed below basement footings to improve bearing capacity for the shallow groundwater conditions anticipated in basement area. We recommend a groundwater elevation of 240 feet be assumed for RAP design.

We recommend displacement RAPs as they densify the ground surrounding the aggregate pier elements. Displacement RAP's are a ground improvement technique which is designed and installed by a specialty geotechnical contractor. RAP installation consists of systematically inserting a hollow steel mandrel through the weak or organic soils and into suitable bearing soils, and then repeatedly extracting and ramming while feeding aggregate into the mandrel. The result is a series of stiff, compacted aggregate columns in a matrix of densified in-situ soils. The approximate limits of RAP improvement below the building (load bearing footings only) are illustrated on Sheet 1.

We recommend the contract documents require an engineered submittal for RAPs to improve ground conditions to meet or exceed the geotechnical parameters for bearing capacity and settlement as recommended herein. The RAP submittal should be prepared and sealed by a Professional Engineer licensed in the State of Maine and endorsed by the RAP Installer and Geopier Foundation Company.

4.4.3 Segmental Retaining Walls

We anticipate exterior segmental retaining walls (SRW), such as Redi-Scape, will be needed. We recommend the facing blocks be founded on a minimum 6-inch thick leveling course of compacted Crushed Stone overlying properly prepared native soil or bedrock subgrades, or properly compacted new fill overlying properly prepared subgrades.

Based on the site soils and our understanding of the proposed construction, we provide the following soil parameters for use by a wall design engineer in their design of the segmental retaining wall:

Geotechnical Parameters of Segmental Block Retaining Wall			
Wall Segment	**Friction Angle**	**Cohesion**	**Unit Weight**
Retained Soil (Granular Borrow)	30 degrees	0 psf	125 pcf
Reinforced Backfill (Structural Fill)	32 degrees	0 psf	130 pcf
Foundation Soil (Sandy Soils)	30 degrees	0 psf	125 pcf
Net Allowable Bearing Capacity	3 ksf (properly prepared subgrade)		
Anticipated Settlement	up to 1 inch (post-construction)		
Seismic Soil Site Class	D (IBC 2009)		

Design of the retaining wall and evaluation of base sliding, overturning and internal stability of the wall are the responsibility of the wall design engineer. The wall designer must account for construction surcharge loads and future live load conditions. S.W.COLE is available to provide SRW design. S.W.COLE should be retained to perform a global stability analysis of the SRW and to review the SRW submittal if designed by others.

4.4.4 Seismic Considerations

Based on the subsurface findings, we interpret the site soils to correspond to Seismic Soil Site Class D according to IBC 2009/ASCE 7-05. We recommend the following seismic design parameters for the 2,500-year design earthquake:

RECOMMENDED SEISMIC DESIGN PARAMETERS (2,500-year Design Earthquake)		
Peak Ground Acceleration (PGA)	0.2-second Spectral Acceleration (S_s)	1-second Spectral Acceleration (S_1)
0.203 g	0.356 g	0.08 g

NOTE: Seismic design parameters from USGS accessed May 21, 2015.

Liquefiable soils typically consist of loose, fine sands and non-plastic silts below the groundwater table. Based on the subsurface findings, it is our opinion the soils at the site are not susceptible to liquefaction during a seismic event and therefore the risk of lateral spread and seismic induced settlement are negligible.

4.5 Foundation Drainage

We recommend an underdrain system be installed along the outside edge of perimeter footings. Except for the basement footings, we recommend a 4-inch diameter smooth-bore, slotted HDPE pipe enveloped in 12 inches of Underdrain Sand. For the basement, we recommend a 4-inch diameter, perforated SDR-35 foundation drain pipe bedded in the layer of geotextile wrapped Crushed Stone below the basement footings. The underdrain

pipes must have a positive gravity outlet protected from freezing, clogging and backflow. Surface grades should be sloped away from the building for positive surface water drainage. General underdrain details are illustrated on Sheet 2.

4.6 Slab-On-Grade Floors

On-grade floor slabs in heated areas may be designed using a subgrade reaction modulus of 120 pci provided the slab is underlain by at least 12-inches of compacted Structural Fill, or 12-inches of compacted Crushed Stone in basement areas, placed over properly prepared subgrades. The structural engineer or concrete consultant must design steel reinforcing and joint spacing appropriate to slab thickness and function.

We recommend installation of a subslab radon venting system. We also recommend a sub-slab vapor retarder particularly in areas of the building where the concrete slab will be covered with an impermeable surface treatment or floor covering that may be sensitive to moisture vapors. The vapor retarder must have a permeance that is less than the floor cover or surface treatment that is applied to the slab. The vapor retarder must have sufficient durability to withstand direct contact with the sub-slab base material and construction activity. Additionally, the vapor retarder may be underlain with a shim layer of stone dust over structural fill or non-woven geotextile fabric over crushed stone. The vapor retarder material should be placed according to the manufacturer's recommended method, including the taping and lapping of all joints and wall connections. The architect and/or flooring consultant should select the vapor retarder products compatible with flooring and adhesive materials.

The floor slab should be appropriately cured using moisture retention methods after casting. Typical floor slab curing methods should be used for at least 7 days. The architect or flooring consultant should assign curing methods consistent with current applicable American Concrete Institute (ACI) procedures with consideration of curing method compatibility to proposed surface treatments, flooring and adhesive materials.

4.7 Entrance Slabs and Sidewalks

Entrance slabs and sidewalks adjacent to the building must be designed to reduce the effects of differential frost action between adjacent pavement, doorways, and entrances. We recommend that non-frost susceptible Structural Fill be provided to a depth of at least 4.5 feet below the top of entrance slabs. This thickness of Structural Fill should extend the full width of the entrance slab and outward at least 4.5 feet, thereafter

transitioning up to the bottom of the adjacent sidewalk or pavement gravels at a 3H:1V or flatter slope. General details of this frost transition zone are attached as Sheet 2.

4.8 Backfill and Compaction

We recommend the following fill and backfill materials for construction:

Granular Borrow: Fill to raise grades in building, athletic field and paved areas should be sand or silty sand meeting the requirements for 2014 Standard Specification MaineDOT 703.19 Granular Borrow. Fills over wet subgrades may require MaineDOT 703.19 Granular Borrow of Underwater Backfill.

Gravel Borrow: Backfill for areas of peat removal may be sand and gravel meeting the requirements for 2014 MaineDOT Standard Specification 703.20 Gravel Borrow.

Rock Borrow: Backfill for areas of peat removal may be blasted bedrock meeting the requirements for 2014 MaineDOT Standard Specification 703.21 Rock Borrow and should be placed according the MaineDOT Standard Specification requirements.

Structural Fill: Fill to repair soft areas, backfill for foundations, slab base material and material below exterior entrances and sidewalks should be clean, non-frost susceptible sand and gravel meeting the gradation requirements for Structural Fill as given below:

Structural Fill	
Sieve Size	**Percent Finer by Weight**
4 inch	100
3 inch	90 to 100
¼ inch	25 to 90
#40	0 to 30
#200	0 to 5

Crushed Stone: Crushed Stone, used beneath foundations and for underdrain aggregate, should meet the requirements of 2014 MaineDOT Standard Specification 703.13 Crushed Stone ¾-Inch.

Underdrain Sand: Clean, free-draining sand around perimeter foundation drains meeting the requirement of 2014 MaineDOT 703.22 Type B Underdrain Backfill Material.

Reuse of Site Soils: The terrace and ridge areas of the site contain sand and gravel deposits overlying relatively shallow bedrock. These areas are generally higher in elevation and are anticipated to be cut to establish finished grades. The sand and gravel provide a borrow source for granular fill for reuse on-site. The bedrock will require blasting and may be blended with on-site sands to create premium gravels for building and pavement construction.

Placement and Compaction: Fill should be placed in horizontal lifts and compacted such that the desired density is achieved throughout the lift thickness with 3 to 5 passes of the compaction equipment. Loose lift thicknesses for grading, fill and backfill activities should not exceed 12 inches. Thicker lifts of fill are permissible for Rock Borrow.

We recommend that fill and backfill in building and paved areas be compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557. We recommend that fill and backfill in landscape and playfield areas be compacted to at least 92 percent of its maximum dry density as determined by ASTM D-1557. Crushed Stone should be compacted with 3 to 5 passes of a vibratory plate compactor having a static weight of at least 500 pounds.

4.9 Weather Considerations

Construction activity should be limited during wet and freezing weather and the site soils may require drying before construction activities may continue. The contractor should anticipate the need for water to temper fills in order to facilitate compaction during dry weather. If construction takes place during cold weather, subgrades, foundations and floor slabs must be protected during freezing conditions. Concrete and fill must not be placed on frozen soil; and once placed, the concrete and soil beneath the structure must be protected from freezing.

4.10 Paved Areas

We anticipate paved areas will be subjected primarily to passenger vehicle and light delivery truck traffic with occasional heavy delivery truck traffic. Considering the site soils, and proposed usage, we offer the following pavement section for consideration. Materials are based on MaineDOT Standard Specifications.

FLEXIBLE (HMA) PAVEMENT SECTION	
Pavement Layer	**Material Thickness**
MaineDOT 9.5 mm Hot Mix Asphalt (50 Gyration Design)	1 ¼ inches
MaineDOT 19.0 mm Hot Mix Asphalt (50 Gyration Design)	2 ¼ inches
MaineDOT 703.06 Aggregate Base Type A	6 inches
MaineDOT 703.06 Aggregate Subbase Type D	12 inches

Hot mix asphalt pavement should be compacted to 92 to 97 percent of its theoretical maximum density as determined by ASTM D-2041. A tack coat should be used between successive lifts of bituminous pavement.

RIGID (CONCRETE) PAVEMENT SECTION	
Pavement Layer	**Material Thickness**
Concrete – 4,500 psi compressive, 500 psi flexural, 1 ½ inch aggregate, with 6 ±1% air entrainment	7 inches
MaineDOT 703.06 Aggregate Subbase Type D, Crushed	12 inches

The base and subbase materials should be compacted to at least 95 percent of their maximum dry density as determined by ASTM D-1557. It should be understood that frost penetration can be on the order of 4.5 feet in this area. In the absence of full depth excavation of frost susceptible soils below paved areas and subsequent replacement with non-frost susceptible compacted fill, frost penetration into the subgrade will occur and some heaving and distress of pavement must be anticipated.

4.11 Design Review and Construction Testing

S.W.COLE should review the construction documents prior to bidding to determine that our earthwork, foundation and pavement recommendations have been properly interpreted and implemented.

A testing and special inspections program should be implemented during construction to observe compliance with the construction documents. S.W.COLE should be retained to provide geotechnical observations during earthwork, RAP, foundation and paving construction activities, as well as providing testing and special inspection services for soils, concrete, masonry, steel, and spray-applied fireproofing.

5.0 CLOSURE

It has been a pleasure to be of assistance to you with this phase of your project. We look forward to working with you during the construction phase of the project.

Sincerely,

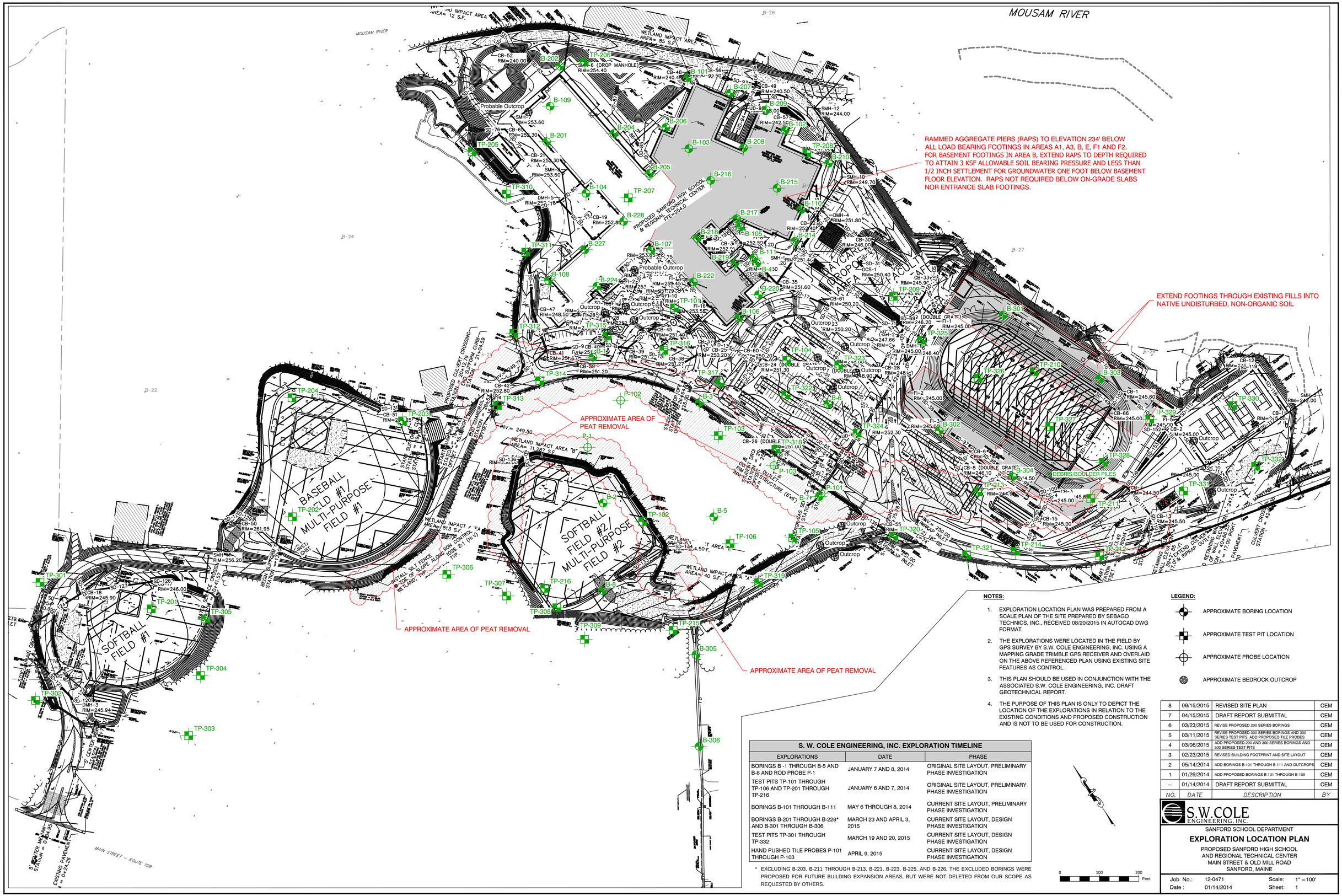
S. W. Cole Engineering, Inc.

Evan M. Walker, P.E.
Geotechnical Engineer

Timothy J. Boyce, P.E.
Senior Geotechnical Engineer

STATE OF MAINE
TIMOTHY J.
BOYCE
No. 9263
LICENSED
PROFESSIONAL ENGINEER

EMW:tjb



NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A SCALE PLAN OF THE SITE PREPARED BY SEBAGO TECHNICS, INC., RECEIVED 08/20/2015 IN AUTOCAD DWG FORMAT.
2. THE EXPLORATIONS WERE LOCATED IN THE FIELD BY GPS SURVEY BY S.W. COLE ENGINEERING, INC. USING A MAPPING GRADE TRIMBLE GPS RECEIVER AND OVERLAID ON THE ABOVE REFERENCED PLAN USING EXISTING SITE FEATURES AS CONTROL.
3. THIS PLAN SHOULD BE USED IN CONJUNCTION WITH THE ASSOCIATED S.W. COLE ENGINEERING, INC. DRAFT GEOTECHNICAL REPORT.
4. THE PURPOSE OF THIS PLAN IS ONLY TO DEPICT THE LOCATION OF THE EXPLORATIONS IN RELATION TO THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION AND IS NOT TO BE USED FOR CONSTRUCTION.

LEGEND:

- APPROXIMATE BORING LOCATION
- APPROXIMATE TEST PIT LOCATION
- APPROXIMATE PROBE LOCATION
- APPROXIMATE BEDROCK OUTCROP

S. W. COLE ENGINEERING, INC. EXPLORATION TIMELINE

EXPLORATIONS	DATE	PHASE
BORINGS B -1 THROUGH B-5 AND B-8 AND ROD PROBE P-1	JANUARY 7 AND 8, 2014	ORIGINAL SITE LAYOUT, PRELIMINARY PHASE INVESTIGATION
TEST PITS TP-101 THROUGH TP-106 AND TP-201 THROUGH TP-216	JANUARY 6 AND 7, 2014	ORIGINAL SITE LAYOUT, PRELIMINARY PHASE INVESTIGATION
BORINGS B-101 THROUGH B-111	MAY 6 THROUGH 8, 2014	CURRENT SITE LAYOUT, PRELIMINARY PHASE INVESTIGATION
BORINGS B-201 THROUGH B-228* AND B-301 THROUGH B-306	MARCH 23 AND APRIL 3, 2015	CURRENT SITE LAYOUT, DESIGN PHASE INVESTIGATION
TEST PITS TP-301 THROUGH TP-332	MARCH 19 AND 20, 2015	CURRENT SITE LAYOUT, DESIGN PHASE INVESTIGATION
HAND PUSHED TILE PROBES P-101 THROUGH P-103	APRIL 9, 2015	CURRENT SITE LAYOUT, DESIGN PHASE INVESTIGATION

* EXCLUDING B-203, B-211 THROUGH B-213, B-221, B-223, B-225, AND B-226. THE EXCLUDED BORINGS WERE PROPOSED FOR FUTURE BUILDING EXPANSION AREAS, BUT WERE NOT DELETED FROM OUR SCOPE AS REQUESTED BY OTHERS.

0 100 200 Feet

NO.	DATE	DESCRIPTION	BY
8	09/15/2015	REVISED SITE PLAN	CEM
7	04/15/2015	DRAFT REPORT SUBMITTAL	CEM
6	03/23/2015	REVISE PROPOSED 200 SERIES BORINGS	CEM
5	03/11/2015	REVISE PROPOSED 300 SERIES BORINGS AND 300 SERIES TEST PITS, ADD PROPOSED TILE PROBES	CEM
4	03/06/2015	ADD PROPOSED 200 AND 300 SERIES BORINGS AND 300 SERIES TEST PITS	CEM
3	02/23/2015	REVISED BUILDING FOOTPRINT AND SITE LAYOUT	CEM
2	05/14/2014	ADD BORINGS B-101 THROUGH B-111 AND OUTCROPS	CEM
1	01/29/2014	ADD PROPOSED BORINGS B-101 THROUGH B-109	CEM
--	01/14/2014	DRAFT REPORT SUBMITTAL	CEM

S.W.COLE ENGINEERING, INC.

SANFORD SCHOOL DEPARTMENT

EXPLORATION LOCATION PLAN

PROPOSED SANFORD HIGH SCHOOL
AND REGIONAL TECHNICAL CENTER
MAIN STREET & OLD MILL ROAD
SANFORD, MAINE

Job No.: 12-0471 Scale: 1" =100'
Date : 01/14/2014 Sheet: 1

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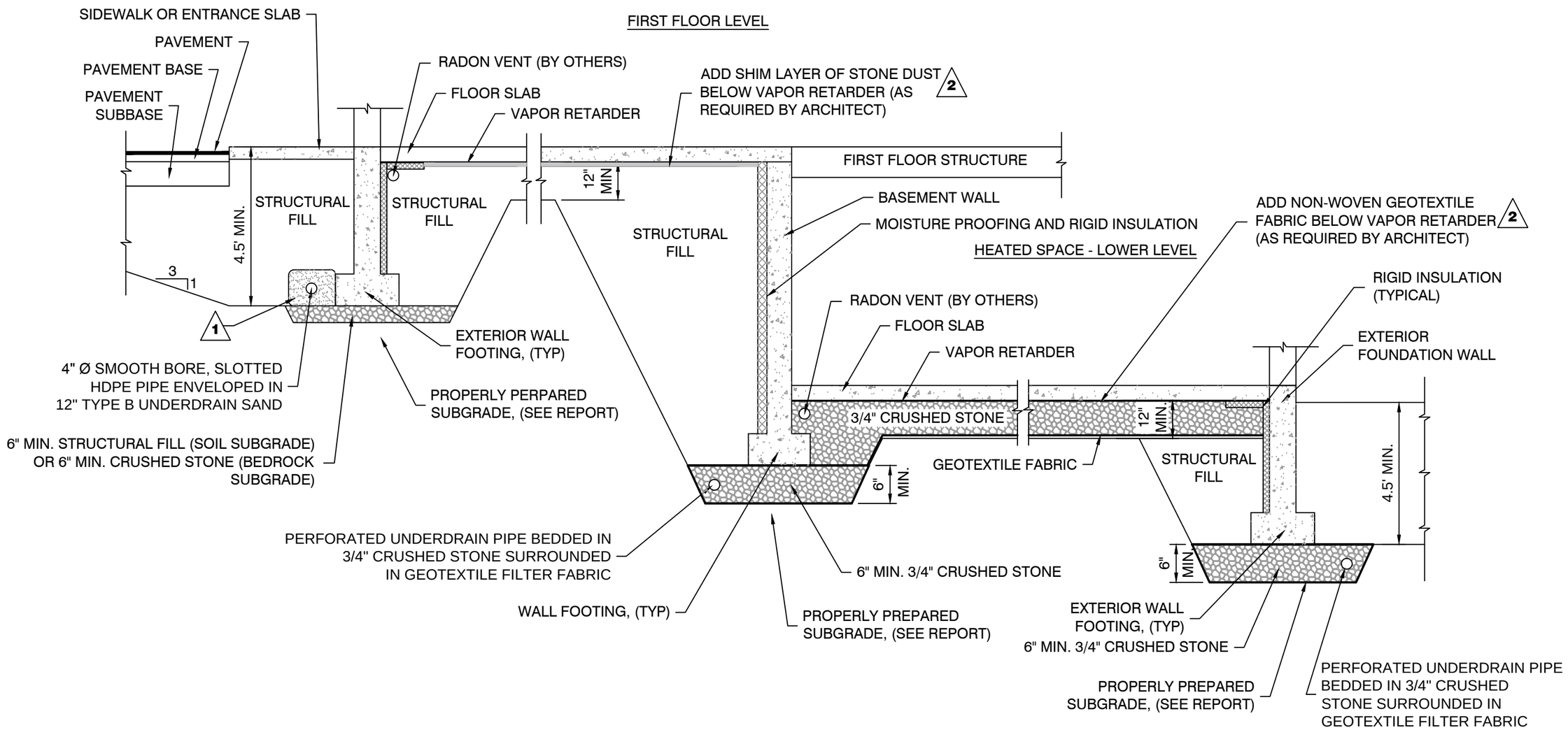

NOTE:

1. UNDERDRAIN INSTALLATION AND MATERIAL GRADATION RECOMMENDATIONS ARE CONTAINED WITHIN THIS REPORT.

2. DETAIL IS PROVIDED FOR ILLUSTRATIVE PURPOSES ONLY, NOT FOR CONSTRUCTION.

NO.	DATE	DESCRIPTION	BY
2	10/14/15	ADD STONE DUST AND NON-WOVEN GEOTEXTILE FABRIC	CEM
1	09/15/15	REVISE UNDERDRAIN	CEM
0	04/15/2015	REPORT SUBMISSION	CEM

S.W.COLE ENGINEERING, INC.

SANFORD SCHOOL DEPARTMENT

UNDERDRAIN DETAIL

PROPOSED SANFORD HIGH SCHOOL
AND REGIONAL TECHNICAL CENTER
MAIN STREET & OLD MILL ROAD
SANFORD, MAINE

Job No.:	12-0471	Scale:	Not to Scale
Date :	04/15/2015	Sheet:	2

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APPENDIX A

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-1**
SHEET:	OF
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
WET @ 5.5' / GROUNDWATER @ 7.0'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF AND TOPSOIL
	1D	24"	2"	7.0'	5	5	5	52		BROWN GRAVELLY SAND SOME SILT WITH COBBLES & BOULDERS ~ MEDIUM DENSE TO DENSE ~
	2D	6"	5"	10.5'	50/6"				11.2'	….WITH BEDROCK FRAGMENTS
										REFUSAL @ 11.2 FEET (PROBABLE BEDROCK)

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-1**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-2**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ 4.0'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF & TOPSOIL
	1D	24"	3"	4.0'	5	5	5	6		BROWN SAND WITH GRAVEL ~ LOOSE TO MEDIUM DENSE ~
	2D	24"	6"	6.0'	11	12	14	19	9.5'	
										REFUSAL @ 9.5' (PROBABLE BEDROCK)

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-2**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-3**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
	1D	24"	1"	2.0'	WOH	WOH	WOH	WOH		BROWN FIBROUS PEAT ~ VERY SOFT ~
	2D	24"	2"	4.0'	WOH	WOH	WOH	WOH	4.0'	
	3D	24"	9"	6.0'	3	7	16	20	6.0'	BROWN SAND SOME GRAVEL WITH ORGANICS ~ MEDIUM DENSE ~
	4D	24"	7"	8.0'	11	16	18	20	9' +/-	GRAY-BROWN SAND SOME GRAVEL SOME SILT ~ DENSE ~
	5D	24"	24"	12.0'	5	6	5	6		BROWN SAND SOME GRAVEL TRACE SILT ~ LOOSE TO MEDIUM DENSE ~ 2' OF SAND HEAVE IN AUGERS AT 15'...AUGERS ADVANCED WITHOUT SAMPLING ...GRAVELLY LAYER 17' TO 19' PROBABLE SAND
										BOTTOM OF EXPLORATION @ 30.0

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-3**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-4**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ 5.5'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF & TOPSOIL
	1D	24"	7"	7.0'	3	6	9	12	8' +/-	BROWN GRAVELLY SAND TRACE SILT ~ LOOSE TO MEDIUM DENSE ~
	2D	24"	14"	12.0'	3	5	6	10	15.0'	BROWN SAND WITH 2" PEAT SEAM IN SAMPLER ~ LOOSE TO MEDIUM DENSE ~
										2' OF SAND HEAVE IN AUGERS AT 15'...ABANDONED BOREHOLE BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-4**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-5**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/8/2014
DATE FINISH:	1/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	140 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
	1D	24"	1"	2.0'	WOH		1-18"			
	2D	24"	6"	4.0'	WOH - 12"		1-12"			
	3D	24"	6"	7.0'	WOH-24"					DARK BROWN PEAT
	4D	24"	16"	9.0'	WOH-24"					~ VERY LOOSE / SOFT ~
	5D	24"	14"	11.0'	WOH-24"					w = 897.5% O = 62.6%
	6D	24"	6"	13.0'	WOH-24"					
									14.0'	
	7D	24"	6"	15.0'	WOH-12"		1	4	14.5'	ORANGE-BROWN SAND, TRACE SILT ~ LOOSE ~
	8D	24"	8"	17.0'	3	2	3	4	17.0'	GRAY-BROWN SAND TRACE SILT, TRACE GRAVEL ~ LOOSE ~
	9D	24"	8"	22.0'	9	12	16	9		BROWN GRAVELLY SAND TRACE SILT ~ MEDIUM DENSE ~
									24.8'	...WITH COBBLES
	10D	24"	8"	27.0'	16	20	13	17		GRAY-BROWN GRAVELLY SILTY SAND ~ DENSE ~
									30.5'	
	11D	24"	8"	32.0'	10	5	4	5		GRAY SILTY SAND TRACE GRAVEL ~ LOOSE TO MEDIUM DENSE ~
									35.0'	
										BOTTOM OF EXPLORATION @ 35.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-5**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-6**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										BEDROCK OUTCROP @ GROUND SURFACE

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-6**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-7**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	
DATE FINISH:	
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										NOT DRILLED DUE TO ACCESS

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-7**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-8**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION

GROUNDWATER @ 5.5'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF & TOPSOIL
	1D	24"	4"	4.0'	3	5	6	8		BROWN GRAVELLY SAND SOME SILT ...WITH BEDROCK FRAGMENTS
	2D	24"	3"	6.0'	6	20	20	27		
										REFUSAL @ 7.5' (PROBABLE BEDROCK)

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-8**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**P-1**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/8/2014
DATE FINISH:	1/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PROBABLE PEAT
									4.9'	HYDRAULIC PUSH ROD PROBE - STRATA CHANGE @ 4.9' - PROBABLE SAND
										BOTTOM OF EXPLORATION @ 4.9'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
DRILLER - VISUALLY
SOIL TECH. - VISUALLY
LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-1**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-101**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 7' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.8'	FOREST DUFF / BROWN SAND, SOME SILT, WITH ORGANICS
	1D	24"	16"	2.0'	1	1	2	2	2.0'	ORANGE-BROWN SAND, TRACE SILT, WITH ROOTLETS
									6.0'	BROWN SAND, SOME SILT ~ DENSE ~
	2D	24"	18"	7.0'	15	18	21	21		
	3D	24"	16"	9.0'	16	23	19	23		w = 9.5% BROWN SAND AND GRAVEL, SOME SILT, WITH COBBLES
	4D	24"	14"	12.0'	21	33	18	18		~ DENSE ~
									15.0'	ORANGE-BROWN SILTY GRAVEL AND SAND
	5D	24"	12"	17.0'	9	12	16	30	16.7'	~ MEDIUM DENSE ~
	6D	2"	2"	17.2'	50-2"				17.2'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
										REFUSAL @ 17.2' PROBABLE BOULDER OR BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
X	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-101**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-102**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/8/2014
DATE FINISH:	5/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 7.5' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN AND BLACK SILTY SAND WITH ORGANICS
	1D	24"	16"	16.0'	1	1	3	3	2.0'	ORANGE-BROWN SAND, SOME GRAVEL, SOME SILT, WITH ROOTLETS
	2D	10"	10"	6.3'	4	50-4"			8.0'	BROWN GRAVELLY SAND, SOME SILT, WITH FREQUENT COBBLES ~ DENSE ~ COBBLE 5' - 5.5' +/-
	3D	24"	20"	10.0'	21	44	34	26		GRAY-BROWN SILTY SAND SOME GRAVEL WITH COBBLES (GLACIAL TILL) w = 11.7% ~ DENSE TO VERY DENSE ~
	4D	24"	18"	12.0'	15	23	20	19		
									15.0'	
	5D	23"	23"	16.9'	11	26	36	50-5"	16.9'	GRAY-BROWN SILTY GRAVEL AND SAND WITH COBBLES (GLACIAL TILL) ~ VERY DENSE ~
									17.2'	PROBABLE WEATHERED BEDROCK - ADVANCE BY AUGER
										REFUSAL @ 17.2' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
X	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-102**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-103**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/8/2014
DATE FINISH:	5/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	2.0'	1	1	1	2		BROWN SAND, TRACE SILT, TRACE FINE GRAVEL
										~ LOOSE ~
	2D	24"	18"	4.0'	1	3	3	3	3.8'	
									4.5'	BROWN FINE TO MEDIUM SAND, SOME SILT ~ LOOSE ~
										BROWN SAND AND GRAVEL, SOME SILT
	3D	24"	16"	7.0'	10	21	21	18	7.0'	~ DENSE ~
									8.0'	BROWN SAND, TRACE SILT ~ DENSE ~
	4D	24"	16"	9.0'	26	21	24	41		
										BROWN SANDY GRAVEL, TRACE SILT
									11.0'	~ DENSE ~
	5D	24"	18"	12.0'	17	19	11	12		BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)
									12.9'	~ MEDIUM DENSE ~
										REFUSAL @ 12.9'
										PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-103**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-104**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
NO FREE WATER OBSERVED

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.8'	FOREST DUFF
	1D	24"	12"	2.0'	2	6	11	18	2.0'	BROWN GRAVELLY SAND, SOME SILT, TRACE ROOTLETS
										REFUSAL @ 2.0'
										PROBABLE BEDROCK
										NOTE:
										MOVED 5' TO NE: REFUSAL @ 2.1'
										MOVED 10' TO NE: REFUSAL @ 2.5'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-104**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-105**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2.5'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF
	1D	24"	14"	2.0'	1	5	6	3		BROWN GRAVELLY SAND, SOME SILT, WITH TRACE ROOTLETS
										BROWN GRAVELLY MEDIUM TO COARSE SAND, TRACE SILT ~ MEDIUM DENSE ~ w = 15.8%
	2D	24"	18"	7.0'	2	8	9	18	7.0'	
	3D	24"	18"	9.0'	9	12	20	20	10.0'	BROWN GRAVELLY SAND, TRACE SILT WITH OCCASIONAL GRAY-BROWN SILT SEAMS, WITH FREQUENT COBBLES ~ MEDIUM DENSE TO DENSE ~
	4D	24"	16"	12.0'	10	14	21	25	12.0'	ORANGE-BROWN GRAVELLY SILTY SAND WITH COBBLES (GLACIAL TILL) ~ DENSE ~
	5D	24"	16"	14.0'	14	18	22	22	20.0'	BROWN GRAVELLY SILTY SAND WITH FREQUENT COBBLES AND BOULDERS (GLACIAL TILL) ~ DENSE ~ ~ NO SAMPLING BELOW 5D, ADVANCE BY ROLLER CONE ~
										BOTTOM OF EXPLORATION @ 20.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
X	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-105**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-106**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 8' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF
	1D	24"	16"	2.0'	1	3	4	6		BROWN GRAVELLY SAND, SOME SILT WITH TRACE COAL AND ROOTLETS (FILL)
	2D	24"	14"	7.0'	4	4	4	4		~ LOOSE ~
									8.0'	
	3D	24"	16"	9.0'	4	4	2	2		BROWN MEDIUM TO COARSE SAND, TRACE SILT, TRACE GRAVEL
									10.0'	~ LOOSE ~
	4D	24"	16"	12.0'	3	6	9	17		BROWN SANDY GRAVEL, SOME SILT
	5D	24"	16"	14.0'	14	24	14	8		~ MEDIUM DENSE TO DENSE ~
									15.0'	
	6D	24"	18"	17.0'	3	7	7	9	17.0'	ORANGE-BROWN WITH BLACK LAYERS FINE SAND, SOME SILT, WITH TRACE ROOTLETS ~ MEDIUM DENSE ~
									18.0'	ORANGE-BROWN SILTY FINE TO MEDIUM SAND ~ DENSE ~
	7D	24"	20"	19.0'	10	18	18	17		GRAY-BROWN GRAVELLY SILT AND SAND (GLACIAL TILL)
	8D	24"		22.0'	7	12	20	22		~ DENSE ~
									25.0'	
									26.0'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
	9D	24"	20"	27.0'	17	13	17	44	27.0'	GRAY SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 27.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-106**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-107**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURAED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
	1D	10"	8"	0.8'	1	50-4"			0.5'	FOREST DUFF
									4.0'	BROWN SILTY SAND SOME GRAVEL WITH FREQUENT COBBLES AND BOULDERS, WITH ORGANICS (FILL) ~ MEDIUM DENSE ~
									6.0'	DARK BROWN SILTY SAND, SOME GRAVEL (FILL) ~ MEDIUM DENSE ~
	2D	24"	16"	7.0'	5	8	11	8	7.0'	BROWN SILTY SAND, SOME GRAVEL ~ MEDIUM DENSE ~
	3D	24"	14"	9.0'	10	9	9	8		BROWN SILT AND SAND, TRACE GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	24"	18"	12.0'	3	5	8	8	12.0'	
	5D	10"	10"	12.8'	10	50-4"			12.8'	BROWN GRAVELLY SILTY SAND WITH BEDROCK FRAGMENTS (GLACIAL TILL)
									14.5'	PROBABLE BEDROCK - ADVANCE BY ROLLER CONE
										REFUSAL @ 14.5' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-107**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-108**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	1	2	5	5	2.0'	ORANGE-BROWN SAND, SOME GRAVEL, TRACE SILT, WITH ROOTLETS
									5.0'	BROWN SAND, SOME GRAVEL, TRACE SILT ~ MEDIUM DENSE ~
										REFUSAL @ 5.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-108**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-109**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:	NQ	2"		

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 3' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS
	1D	24"	16"	2.0'	2	4	4	5	2.0'	BROWN SAND, TRACE SILT
										BROWN GRAVELLY SAND, SOME SILT, WITH COBBLES ~ MEDIUM DENSE ~
	2D	1"	1"	5.1'	50-1"				5.1'	
										BEDROCK - ADVANCE BY ROLLER CONE TO 6.0' - BEGIN CORE LIGHT GRAY GRANITE GRADING TO DARK GRAY GRAYWACKE AT 10.5' HARD; FINE TO COARSE GRAINED SLIGHTLY WEATHERED, IRON OXIDE STAINING ON FRACTURE SURFACES
	R1	5.0'	4.8'	11.0'	RQD = 65%, FAIR				11.0'	FRACTURE ANGLES AT 5, 20, 40 & 60 DEGREES FROM HORIZONTAL
										BOTTOM OF EXPLORATION @ 11.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-109**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-110**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/8/2014
DATE FINISH:	5/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET AT GROUND SURFACE
SOILS SATURATED BELOW 1' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.8'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	2.0'	1	2	2	2	2.0'	ORANGE-BROWN SAND, SOME SILT, WITH ROOTLETS
									4.5'	BROWN SAND, SOME SILT, TRACE GRAVEL ~ MEDIUM DENSE ~
									6.0'	BROWN GRAVELLY SAND, TRACE SILT, WITH COBBLES ~ VERY DENSE ~
	2D	24"	18"	7.0'	30	31	30	20	10.0'	GRAY-BROWN SILTY SAND, SOME GRAVEL, WITH COBBLES (GLACIAL TILL) ~ VERY DENSE ~
	3D	24"	16"	12.0'	5	7	5	7	15.0'	GRAY-BROWN SAND, SOME SILT, SOME GRAVEL, WITH COBBLES (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	5"	5"	15.4'	50-5"				16.4'	GRAY-BROWN GRAVELLY SILTY SAND WITH FREQUENT COBBLES (GLACIAL TILL) ~ MEDIUM DENSE ~
										REFUSAL @ 16.4' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-110**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-111**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF
	1D	24"		2.0'	2	2	1-12"			DARK BROWN SILTY SAND WITH ORGANICS AND PEAT SEAMS ~ VERY LOOSE ~
	2D	24"	14"	4.0'	WOH - 24"				4.0'	
	3D	24"	10"	7.0'	18	26	40	48	8.0'	BROWN SAND AND GRAVEL, SOME SILT ~ VERY DENSE ~
	4D	24"	14"	12.0'	7	7	8	20	11.5'	DARK BROWN WITH BLACK STAINING SAND, SOME SILT ~ MEDIUM DENSE ~
									15.0'	BROWN GRAVELLY SAND, SOME SILT ~ DENSE ~
										REFUSAL @ 15.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-111**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-201**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/25/2015
DATE FINISH:	3/25/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	5	7	9	7	4.0'	BROWN GRAVEL AND SAND, SOME SILT ~ MEDIUM DENSE ~
	2D	24"	16"	6.0'	4	4	6	7	5.5'	BROWN GRAVELLY MEDIUM TO COARSE SAND, TRACE SILT ~ MEDIUM DENSE ~
									8.0'	RUST BROWN TO GRAY SILT AND SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
	3D	24"	18"	10.0'	4	5	10	14	12.0'	GRAY-BROWN GRAVELLY SILTY SAND (GLACIAL TILL) ~ MEDIUM DENSE ~
										REFUSAL @ 12.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-201**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-202**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.0'	ORANGE-BROWN SILTY FINE SAND WITH ROOTS
	1D	24"	16"	4.0'	2	4	4	5		LIGHT BROWN SILTY FINE SAND WITH OCCASIONAL SILT PARTINGS
	2D	24"	18"	6.0'	5	8	7	9	7.0'	~ LOOSE TO MEDIUM DENSE ~
	3D	24"	14"	11.0'	10	8	10	8	14.0'	BROWN SANDY GRAVEL SOME SILT ~ MEDIUM DENSE ~
	4D	24"	20"	16.0'	6	7	7	10	17.0'	GRAY-BROWN SILTY SAND, TRACE GRAVEL ~ MEDIUM DENSE ~
	5D	4"	4"	19.3'	65-4"				19.3'	BROWN TO ORANGE-BROWN GRAVELLY SILTY SAND ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 19.3'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-202**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-204**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 1' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	10	20	18	8	4.2'	DARK BROWN SANDY GRAVEL, SOME SILT (POSSIBLE FILL) ~ DENSE ~
	2D	24"	8"	6.0'	3	2	3	4	6.5'	BROWN FINE TO MEDIUM SAND, TRACE SILT ~ LOOSE ~
	3D	24"	14"	8.0'	5	7	17	15		ORANGE-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
	4D	2"	2"	9.2'	50-2"				9.2'	
										REFUSAL @ 9.2' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-204**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-205**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/25/2015
DATE FINISH:	3/25/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	NW	3"	140 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
										COBBLES IN TOP 2'
	1D	24"	6"	4.0'	12	12	10	8		BROWN SAND AND GRAVEL, SOME SILT
	2D	24"	3"	6.0'	13	12	9	10		~ MEDIUM DENSE ~
	3D	24"	14"	8.0'	10	9	10	10		<RUNNING SANDS/SAND HEAVE BELOW 8'>
									9.0'	
									9.5'	BROWN SILTY SAND AND GRAVEL ~ VERY DENSE ~
	4D	24"	8"	11.0'	35	31	17	18		GRAY-BROWN TO LIGHT BROWN SILTY GRAVELLY SAND (GLACIAL TILL)
										~ VERY DENSE ~
	5D	11"	8"	14.9'	17	50-5"			14.9'	
									15.8'	PROBABLE WEATHERED BEDROCK - ADVANCE BY ROLLER CONE
										REFUSAL @ 15.8'
										PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-205**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-206**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	16"	4.0'	4	5	6	7		BROWN FINE TO MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~
	2D	24"	18"	6.0'	8	7	12	14		
									8.0'	
	3D	24"	18"	10.0'	5	6	9	14	10.0'	LIGHT BROWN SILTY FINE SAND ~ MEDIUM DENSE ~
	4D	24"	16"	15.0'	8	9	10	13		BROWN SAND AND GRAVEL, SOME SILT WITH OCCASIONAL COBBLES ~ MEDIUM DENSE ~
									18.0'	
									19.0'	BROWN MEDIUM TO COARSE SAND, TRACE SILT ~ MEDIUM DENSE ~
	5D	24"	20"	20.0'	6	10	24	33	20.0'	BROWN TO GRAY GRAVELLY SILTY SAND (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 20.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-206**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-207**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST FROM GROUND SURFACE
SOILS SATURATED BELOW 5' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
										ROOTS EXTEND TO 3' +/-
	1D	24"	18"	4.0'	3	3	4	5		BROWN SAND, TRACE SILT
									4.5'	~ LOOSE ~
	2D	24"	16"	6.0'	6	9	15	19		BROWN SILTY FINE SAND
									7.0'	~ MEDIUM DENSE ~
	3D	24"	18"	8.0'	8	10	10	14	8.0'	BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
	4D	24"	12"	10.0'	5	14	17	13		BROWN SILTY SAND AND GRAVEL
										~ MEDIUM DENSE TO DENSE ~
									13.0'	
									13.5'	BROWN FINE SAND, TRACE SILT ~ MEDIUM DENSE ~
	5D	24"	6"	15.0'	14	9	8	19		BROWN GRAVELLY SAND, SOME SILT
										~ MEDIUM DENSE ~
									18.0'	
									19.0'	BROWN MEDIUM TO COARSE SAND, TRACE SILT ~ DENSE ~
	6D	23"	20"	19.9'	11	30	50	50-5"	19.9'	GRAY GRAVELLY SILTY SAND (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 19.9'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-207**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-208**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST FROM GROUND SURFACE,
WET BELOW 4' +/-, SATURATED BELOW 7' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.5'	LIGHT BROWN FINE SAND, TRACE SILT ~ MEDIUM DENSE ~
	1D	24"	16"	4.0'	3	15	28	25	4.0'	BROWN GRAVELLY SAND, SOME SILT ~ DENSE ~
	2D	24"	12"	5.3'	24	67	50-4"		7.0'	BROWN SILTY SAND AND GRAVEL WITH FREQUENT COBBLES ~ VERY DENSE ~
	3D	24"	16"	10.0'	13	11	14	19		GRAY-BROWN GRAVELLY SILTY SAND (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	24"	12"	15.0'	10	11	11	16	15.0'	
										BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-208**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-209**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.0'	BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
									3.0'	BROWN MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~
	1D	24"	16"	4.0'	6	14	21	23		BROWN SANDY GRAVEL, SOME SILT, WITH FREQUENT COBBLES
	2D	24"	16"	6.0'	22	34	42	50		~ VERY DENSE ~
									8.0'	
									8.5'	BROWN SILTY SAND AND GRAVEL ~ DENSE ~
	3D	24"	16"	10.0'	13	17	23	22		BLACK CEMENTED OXIDE SEAM @ 8.5'
										ORANGE-BROWN SILTY GRAVEL AND SAND
	4D	11"	8"	13.9'	17	50-5"			13.9'	~ DENSE TO VERY DENSE ~
										BOTTOM OF EXPLORATION @ 13.9'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-209**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-210**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS MOIST BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	12"	4.0'	7	14	21	27	4.5'	BROWN SILTY GRAVEL AND SAND WITH COBBLES ~ DENSE TO VERY DENSE ~
	2D	24"	14"	6.0'	25	23	17	13	8.1'	BROWN SILTY SAND, SOME GRAVEL ~ DENSE ~
										REFUSAL @ 8.1' PROBABLE BOULDER OR BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-210**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-214**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS SATURATED BELOW 8' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									3.0'	ORANGE WITH DARK BROWN LAYERS SILTY SAND WITH ORGANICS ~ VERY LOOSE ~
	1D	24"	14"	4.0'	1-12"		1	1		
	2D	24"	16"	6.0'	2	4	6	7	6.0'	LIGHT BROWN FINE SAND, SOME SILT ~ MEDIUM DENSE ~
	3D	24"	18"	8.0'	5	5	7	8	8.0'	LIGHT BROWN FINE TO MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~
	4D	24"	16"	10.0'	4	6	5	6	10.0'	BROWN SAND, TRACE SILT WITH SILTY FINE SAND SEAMS ~ MEDIUM DENSE ~
	5D	24"	20"	12.0'	5	6	7	6	14.0'	BROWN MEDIUM TO COARSE SAND, TRACE SILT WITH SILTY FINE SAND SEAMS ~ MEDIUM DENSE ~ <RUNNING SANDS / SAND HEAVE IN AUGERS BELOW 8' +/->
	6D	24"	20"	15.0'	8	10	23	20		BROWN GRAVELLY SILTY SAND WITH OCCASIONAL COBBLES (GLACIAL TILL) ~ MEDIUM DENSE TO DENSE ~
	7D	24"	2"	20.0'	5	8	9	9		
	8D	7"	4"	23.6'	47	50-1"			23.6'	<PUSHING GRAVEL/COBBLE AT 7D & 8D>
										BOTTOM OF EXPLORATION @ 23.6'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-214**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-215**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/25/2015
DATE FINISH:	3/25/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	NW	3"	140 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 3' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	6.0'	20	22	17	19	9.0'	BROWN GRAVELLY SAND, SOME SILT ~ DENSE ~
									9.5'	ORANGE-BROWN GRAVELLY SILTY SAND ~ VERY DENSE ~
	2D	24"	12"	11.0'	35	32	17	13	11.4'	GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
									11.7'	PROBABLE WEATHERED BEDROCK - ADVANCE BY ROLLER CONE REFUSAL @ 11.7' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-215**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-216**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 4' +/-
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	4.0'	2	4	4	5	5.0'	BROWN SAND, TRACE SILT, TRACE FINE GRAVEL ~ LOOSE ~
	2D	24"	16"	6.0'	5	6	8	16	8.0'	LIGHT BROWN SILTY FINE SAND ~ MEDIUM DENSE ~
	3D	24"	8"	10.0'	11	12	14	11		GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	24"	8"	15.0'	8	8	14	14	15.0'	
										BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-216**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-217**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 2' +/-
FREE WATER IN BOREHOLE @ 3'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	4.0'	3	5	6	8	4.5'	LAYERED BROWN MEDIUM SAND, TRACE SILT AND BROWN SILTY FINE SAND ~ MEDIUM DENSE ~
	2D	24"	16"	6.0'	4	14	14	13	4.6'	DARK BROWN SILTY SAND ~ MEDIUM DENSE ~
									6.0'	ORANGE-BROWN GRAVELLY SILTY SAND ~ MEDIUM DENSE ~
	3D	24"	14"	8.0'	6	6	9	10	9.0'	BROWN SILTY SAND, SOME GRAVEL, WITH COBBLES ~ MEDIUM DENSE ~
	4D	24"	8"	11.0'	15	19	25	23	14.0'	BROWN MEDIUM TO COARSE SAND SAND, SOME GRAVEL, SOME SILT WITH COBBLES ~ DENSE ~
	5D	15"	6"	15.2'	14	25	50-3"		15.2'	BROWN GRAVELLY SILTY SAND ~ DENSE ~
										REFUSAL @ 15.2' PROBABLE BOULDER OR BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-217**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-218**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST AT GROUND SURFACE
SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	4	24	11	12	2.0'	BROWN FINE TO MEDIUM SAND, TRACE SILT ~ DENSE ~
	2D	24"	16"	4.0'	17	26	23	23		BROWN TO ORANGE-BROWN GRAVEL AND SAND, SOME SILT
	3D	24"	8"	6.0'	14	20	20	21		~ DENSE TO VERY DENSE ~
	4D	24"	4"	8.0'	15	24	30	27		
									9.0'	
	5D	24"	16"	11.0'	7	26	19	13	10.5'	ORANGE-BROWN MEDIUM TO COARSE SAND, TRACE SILT, TRACE GRAVEL ~ DENSE ~
									14.0'	ORANGE-BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
	6D	24"	18"	16.0'	4	5	8	8		<6" SAND HEAVE IN SAMPLER @ 6D>
									19.0'	ORANGE-BROWN SAND, SOME SILT, TRACE GRAVEL WITH SILTY SAND AND GRAVELLY SAND SEAMS ~ MEDIUM DENSE ~
										BOTTOM OF EXPLORATION @ 19.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-218**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-219**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	14	16	14	13	4.0'	BROWN SAND AND GRAVEL, SOME SILT ~ MEDIUM DENSE ~
	2D	24"	10"	6.0'	13	19	16	11	6.0'	BROWN TO ORANGE-BROWN SILTY SAND AND GRAVEL ~ DENSE ~
	3D	24"	14"	8.0'	7	10	10	8		BROWN TO ORANGE-BROWN FINE TO MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~ <RUNNING SANDS / SAND HEAVE @ 4D >
	4D	24"	16"	10.0'	2	3	10	6	9.8'	TURNS DARK RUST-BROWN @ 8', WITH BLACK OXIDE LAYER 9' - 9.1'
									19.0'	GRAY SANDY SILT TRACE GRAVEL (PROBABLE GLACIAL TILL) <ATTEMPTED SAMPLE @ 15' - RUNNING SANDS / SAND HEAVE IN AUGERS>
	5D	24"	14"	21.0'	58	34	36	52	21.0'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 21.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-219**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-220**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST FROM GROUND SURFACE
SOILS SATURATED BELOW 9' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	3	9	9	10	4.0'	BROWN SILTY SAND, SOME GRAVEL, WITH PLASTIC (FILL) ~ MEDIUM DENSE ~
	2D	24"	12"	6.0'	13	14	17	12	6.0'	BROWN GRAVELLY SAND, SOME SILT, WITH ASPHALT (FILL) ~ DENSE ~
	3D	24"	6"	8.0'	11	18	13	13		DARK BROWN GRAVELLY SAND, SOME SILT, WITH ORGANICS (FILL) ~ MEDIUM DENSE TO DENSE ~
	4D	24"	4"	10.0'	6	8	16	22	10.0'	< SPOON BOUNCING @ 4D - PROBABLE WOOD IN FILL >
	5D	24"	10"	12.0'	11	13	10	12		BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
	6D	24"	14"	14.0'	7	8	4	4	13.5'	
	7D	24"	14"	16.0'	4	4	4	4		BROWN FINE SAND, TRACE SILT ~ LOOSE ~
										TURNS DARK RUST BROWN/BLACK TO ORANGE BELOW 19'
	8D	24"	14"	21.0'	3	4	4	7		< RUNNING SANDS/ SAND HEAVE IN AUGERS >
									24.0'	
	9D	16"	6"	25.3'	18	50	50-4"		25.3'	BROWN GRAVELLY SILTY SAND ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 25.3'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-220**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-222**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST BELOW 2' +/-
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	3	5	7	10		BROWN TO DARK BROWN SILTY GRAVELLY SAND WITH COBBLES, BOULDERS AND ORGANICS (FILL)
	2D	24"	16"	4.0'	6	8	12	17		
	3D	24"	10"	6.0'	6	7	9	10		~ MEDIUM DENSE ~
	4D	24"	16"	8.0'	21	29	17	12	8.0'	
										REFUSAL @ 8.0' PROBABLE BOULDER OR BEDROCK NOTE: MOVED SOUTHEAST 5' AND ADVANCED AUGERS - REFUSAL @ 7'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-222**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-224**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
ALL SOILS MOIST

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.3'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	16"	2.0'	1	1	3	13	0.8'	BROWN SAND, SOME SILT ~ LOOSE ~
									3.0'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
										REFUSAL @ 3.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-224**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-227**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	4.0'	3	7	17	12		BROWN WITH ORANGE STAINING SILTY SAND, SOME GRAVEL (GLACIAL TILL)
	2D	24"	16"	6.0'	3	7	7	6		~ MEDIUM DENSE ~
	3D	24"	18"	11.0'	11	29	38	46	10.8'	
										PROBABLE WEATHERED BEDROCK
									12.5	
										REFUSAL @ 12.5' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-227**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-228**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.5'	BROWN GRAVELLY SAND, TRACE SILT ~ MEDIUM DENSE ~
	1D	24"	14"	4.0'	6	11	14	12		BROWN GRAVELLY SILTY SAND (GLACIAL TILL) ~ MEDIUM DENSE ~
	2D	24"	14"	6.0'	7	12	9	16	6.1'	
										REFUSAL @ 6.1' PROBABLE BEDROCK
										NOTE: MOVED NE 6' AND ADVANCED AUGERS - REFUSAL @ 6.5'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-228**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-301**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET FROM GROUND SURFACE
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	2	1	2	2	3.0'	BROWN FINE TO MEDIUM SAND, TRACE SILT ~ LOOSE ~
	2D	24"	20"	4.0'	2	4	5	5		2" DARK BROWN FIBROUS PEAT SEAM @ 5'
	3D	24"	20"	6.0'	3	5	6	6		BROWN SILTY FINE SAND
	4D	24"	24"	8.0'	6	7	9	11		~ MEDIUM DENSE ~
									10.0'	<RUNNING SANDS IN AUGERS BELOW 5'>
	5D	24"	8"	11.0'	3	6	34	22		BROWN GRAVELLY SAND, SOME SILT
										~ VERY DENSE ~
	6D	18"	3"	15.5'	20	50	106		15.5'	<SAMPLER PUSHING GRAVEL OR COBBLE A@ 6D>
										BOTTOM OF EXPLORATION @ 15.5'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-301**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-302**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	4.0'	12	11	21	24	3.5'	BROWN SANDY GRAVEL, SOME SILT ~ MEDIUM DENSE ~
	2D	24"	16"	6.0'	6	14	14	28	6.0'	GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE TO DENSE ~
									7.0'	PROBABLE WEATHERED BEDROCK - ADVANCE BY AUGER
										REFUSAL @ 7.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-302**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-303**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	4.0'	3	4	4	4		LIGHT BROWN TO BROWN SAND, SOME SILT
	2D	24"	18"	6.0'	5	7	7	10		~ LOOSE TO MEDIUM DENSE ~
	3D	24"	16"	8.0'	6	4	4	5		WITH ORANGE STAINING @ 9'-10' +/-
	4D	24"	16"	11.0'	3	5	8	9		
	5D	24"	20"	16.0'	4	7	8	7	15.5'	
										BROWN GRAVELLY SAND, TRACE SILT ~ MEDIUM DENSE TO VERY DENSE ~
	6D	24"	6"	21.0'	16	30	29	26	21.0'	<SAMPLER PUSHING GRAVEL @ 6D>
										BOTTOM OF EXPLORATION @ 21.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-303**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-304**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 1' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									2.3'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS (PROBABLE FILL) ~ LOOSE TO MEDIUM DENSE ~
	1D	24"	18"	4.0'	1	4	11	12		ORANGE-BROWN TO BROWN SAND, TRACE SILT (PROBABLE FILL) ~ MEDIUM DENSE ~
	2D	9"	9"	4.8'	14	50-3"				
									6.0'	BOULDERS AND COBBLES TO 4.8' - 6' +/- (PROBABLE FILL)
	3D	24"	18"	8.0'	6	13	16	19		GRAY-BROWN GRAVELLY SILT AND SAND (GLACIAL TILL) ~ MEDIUM DENSE TO DENSE ~
	4D	24"	18"	10.0'	12	14	16	23	10.0'	
	5D	24"	16"	15.0'	17	18	17	15	15.0'	GRAY GRAVELLY SILTY SAND WITH OCCASIONAL COBBLES (GLACIAL TILL) ~ DENSE ~
										BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-304**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-305**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED FROM SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										FOREST DUFF AND TOPSOIL OVERLYING BROWN SAND, SOME SILT
									10.0'	BOTTOM OF EXPLORATION @ 10.0' NOTE: NO SAMPLING - AUGER PROBE

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-305**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-306**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED FROM SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										FOREST DUFF / TOPSOIL OVERLYING BROWN SILTY FINE TO MEDIUM SAND BECOMES GRAVELLY BELOW 5'
									10.0'	BOTTOM OF EXPLORATION @ 10.0' NOTE: NO SAMPLING - AUGER PROBE

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-306**

S.W.COLE ENGINEERING, INC.

PROBE LOG

BORING NO.:	**P-101**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/9/2015
DATE FINISH:	4/9/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: DRILLER:

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
FREE WATER AT GROUND SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PEAT AND ORGANICS <HAND PUSH STEEL TILE PROBE TO REFUSAL>
									3.5'	GRANULAR SOILS @ 3.5'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-101**

S.W.COLE ENGINEERING, INC.

PROBE LOG

BORING NO.:	**P-102**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/9/2015
DATE FINISH:	4/9/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: DRILLER:

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
FREE WATER AT GROUND SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PEAT AND ORGANICS <HAND PUSH STEEL TILE PROBE TO REFUSAL>
									8.1'	GRANULAR SOILS @ 8.1'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-102**

S.W.COLE ENGINEERING, INC.

PROBE LOG

BORING NO.:	**P-103**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/9/2015
DATE FINISH:	4/9/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: DRILLER:

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
FREE WATER AT GROUND SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PEAT AND ORGANICS <HAND PUSH STEEL TILE PROBE TO REFUSAL>
									4.2'	GRANULAR SOILS @ 4.2'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-103**

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-101

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS	
		2.5	BROWN GRAVELLY SILTY SAND WITH COBBLES (GLACIAL TILL)	
			REFUSAL @ 2.5' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 2.5' REFUSAL DEPTH TO WATER: NO FREE WATER OBSERVED

TEST PIT TP-102

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS	
S-1	4-5'		BROWN GRAVEL AND SAND, SOME SILT SIDEWALLS CAVING @ 4.5'	
			BOTTOM OF EXPLORATION @ 6.5'	

COMPLETION DEPTH: 6.5' DEPTH TO WATER: HEAVY SEEPAGE @ 4.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-103

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF	
		4.5	DARK BROWN FIBROUS PEAT TRACE SAND, TRACE GRAVEL	w = 487.5% O = 79.5%
			GRAY-BROWN SAND, SOME SILT, TRACE GRAVEL	
			BOTTOM OF EXPLORATION @ 5.5'	

COMPLETION DEPTH: 5.5' DEPTH TO WATER: GROUNDWATER AT SURFACE TEST PIT FILLED W/ WATER

TEST PIT TP-104

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		2.0	FOREST DUFF / BROWN SILTY SAND WITH ROOTS AND ORGANICS	
		8.0	BROWN GRAVELLY SAND SOME SILT WITH COBBLES BECOMES SILTY BELOW 6' +/-	
			BROWN SILTY SAND SOME GRAVELY WITH COBBLES (GLACIAL TILL)	
			BOTTOM OF EXPLORATION @ 9.0'	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-105

DATE: _____ SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			BEDROCK OUTCROP AT GROUND SURFACE	

COMPLETION DEPTH: _____ DEPTH TO WATER: _____

TEST PIT TP-106

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / VEGETATION	
		3.0	DARK BROWN FIBROUS PEAT TRACE SAND, TRACE GRAVEL	
			BROWN SAND AND GRAVEL, TRACE TO SOME SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 8.5'	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: GROUNDWATER AT SURFACE

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-201

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	DISTURBED BROWN SILTY SAND WITH ORGANICS PLASTIC DEBRIS AND RUBBER HOSE AT GROUND SURFACE	
		6.8	SAND, SOME SILT, TRACE GRAVEL ORANGE STAINING @ 4.5'	w = 7.9%
			REFUSAL @ 6.8' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 6.8' REFUSAL DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-202

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5'	FOREST DUFF / BROWN SILTY SAND WITH ROOTS AND ORGANICS	
		8.0'	BROWN GRAVELLY SAND, TRACE SILT	w = 3.4%
			REFUSAL @ 8.0' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 8.0' REFUSAL DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-203

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SAND, SOME SILT WITH ROOTS AND ORGANICS	
		2.0		
			BROWN AND ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL	
		5.2		
		5.4	WEATHERED BEDROCK	
			REFUSAL @ 5.4' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 5.4' REFUSAL DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-204

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		2.0	ORANGE-BROWN SAND, TRACE SILT, TRACE GRAVEL WITH ROOTS	
			BROWN SAND, TRACE SILT, TRACE GRAVEL WITH GRAVELLY LAYERS	
			BOTTOM OF EXPLORATION @ 10.5'	

COMPLETION DEPTH: 10.5' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-205

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SAND SOME SILT WITH ORGANICS	
		0.8		
		2.0	BROWN SAND SOME SILT	
			BROWN SAND, SOME SILT, SOME GRAVEL WITH COBBLES AND BOULDERS WITH SILTY LAYERS BELOW 3.5'	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: PERCHED SEEPAGE @ 3.5'

TEST PIT TP-206

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		1.2		
			ORANGE-BROWN TO BROWN SILTY FINE TO MEDIUM SAND WITH ROOTS TO 3.5'	
		4.0		
			BROWN SAND AND GRAVEL, TRACE SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: MODERATE SEEPAGE @ 7'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-207

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		1.0	BROWN SAND AND GRAVEL, TRACE SILT WITH COBBLES	
		5.0	GRAY-BROWN SILTY GRAVELLY SAND WITH COBBLES	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: HEAVY SEEPAGE @ 5'

TEST PIT TP-208

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		0.8	ORANGE-BROWN SILTY SAND, TRACE GRAVEL, WITH COBBLES AND ROOTS	
		2.5	BROWN GRAVELLY SILTY SAND WITH COBBLES AND BOULDERS	
		6.0	GRAY-BROWN SILTY GRAVELLY SAND WITH COBBLES ~ DENSER DIGGING ~	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 9.2' DEPTH TO WATER: MODERATE SEEPAGE @ 7'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-209

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF	
		4.6	DARK BROWN TO BROWN SILTY SAND, SOME GRAVEL WITH COBBLES, BOULDERS, ROOTS, ORGANICS (FILL)	
		5.1	DARK BROWN SILTY SAND WITH ORGANICS (RELIC TOPSOIL)	
			LIGHT BROWN SAND, TRACE SILT	
			BOTTOM OF EXPLORATION @ 9.0'	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS DAMP TO MOIST

TEST PIT TP-210

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		3.8	BROWN GRAVELLY SAND, SOME SILT WITH BOULDERS, COBBLES, ROOTS, ORGANICS (FILL)	
		6.0	DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS (RELIC TOPSOIL / FILL)	
		8.0'	BROWN GRAVELLY SAND, SOME SILT WITH COBBLES	
			BROWN GRAVEL AND SAND, TRACE SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 9.0'	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-211

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF	
		1.0		
			DARK BROWN GRAVELLY SILTY SAND WITH BOULDERS, COBBLES. ORGANICS, STUMPS, ROOTS (FILL)	
		5.0		
			GRAY-BROWN GRAVELLY MEDIUM TO COARSE SAND, TRACE SILT	
			BOTTOM OF EXPLORATION @ 7.0'	

COMPLETION DEPTH: 7.0' DEPTH TO WATER: HEAVY SEEPAGE @ 5'

TEST PIT TP-212

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		0.8		
			BROWN SILTY SAND, SOME GRAVEL WITH ROOTS (FILL)	
		3.5		
			BROWN GRAVELLY SAND, TRACE SILT	
			BOTTOM OF EXPLORATION @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: HEAVY SEEPAGE @ 3.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-213

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / ORGANICS	
		2.5	DARK BROWN GRAVELLY SILTY SAND WITH BOULDERS, ORGANICS, STUMPS (FILL)	
		3.5	DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS (RELIC TOPSOIL)	
		6.0	BROWN GRAVELLY SAND, SOME SILT WITH COBBLES	
			GRAY-BROWN SANDY GRAVEL, TRACE SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: HEAVY SEEPAGE @ 3.5'

TEST PIT TP-214

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		3.0	BROWN SILTY SAND SOME GRAVEL WITH COBBLES, BOULDERS, ROOTS, ORGANICS (FILL)	
		3.8	DARK BROWN SILTY SAND WITH ORGANICS (RELIC TOPSOIL)	
			BROWN MEDIUM TO COARSE SAND AND GRAVEL, TRACE SILT	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: HEAVY SEEPAGE @ 6.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-215

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		0.8	ORANGE-BROWN SILTY SAND WITH ROOTS	
		2.5	BROWN SAND, TRACE TO SOME SILT, TRACE GRAVEL	
			BOTTOM OF EXPLORATION @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: ALL SOILS DAMP TO MOIST

TEST PIT TP-216

DATE: _____ SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		1.5	DARK BROWN TO ORANGE-BROWN SILTY SAND WITH ROOTS	
		7.1	BROWN SAND, TRACE SILT, TRACE GRAVEL	
			REFUSAL @ 7.1' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 7.1' DEPTH TO WATER: ALL SOILS DAMP TO MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-301

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.5	ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL, WITH ROOTS	
		8.5	BROWN GRAVELLY SAND, TRACE SILT	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: HEAVY SEEPAGE @ 7.5'

TEST PIT TP-302

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		3.5	DARK BROWN TO BROWN SILTY SAND, SOME GRAVEL WITH ORGANICS CONCRETE SLAB PIECES (FILL)	
		3.8	DARK BROWN SILTY SAND WITH ORGANICS (RELIC TOPSOIL)	
		8.5	BROWN TO ORANGE-BROWN SAND, TRACE SILT, TRACE FINE GRAVEL ORANGE-BROWN OXIDE CEMENTED LAYER @ 6.5'	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: HEAVY SEEPAGE @ 7'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-303

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		5.0	ROOTS EXTEND TO 3' +/- BROWN SAND, SOME GRAVEL, SOME SILT WITH FREQUENT COBBLES AND BOULDERS	
		6.5	BROWN SILTY SAND, SOME GRAVEL WITH FREQUENT COBBLES AND BOULDERS	

COMPLETION DEPTH: 6.5' DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-304

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.5	ORANGE-BROWN SAND, SOME SILT, WITH ROOTS	
		9.0	LIGHT BROWN FINE TO MEDIUM SAND, TRACE TO SOME SILT WITH SOME GRAVEL @ 7.5	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-305

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.2	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		8.0	BROWN SAND, SOME GRAVEL, TRACE SILT WITH GRAVELLY SEAMS	
		8.7	LIGHT BROWN FINE TO MEDIUM SAND, TRACE SILT	

COMPLETION DEPTH: 8.7' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-306

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
			PROBABLE BEDROCK @ 0.5' NOTE: PEAT AND ORGANICS OBSERVED WEST OF TEST PIT LOCATION	

COMPLETION DEPTH: 0.5' (REFUSAL) DEPTH TO WATER: ALL SOILS SATURATED

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-307

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		0.9	ROOTS EXTEND TO 2' +/- ORANGE-BROWN TO BROWN MEDIUM TO COARSE SAND, SOME GRAVEL, TRACE SILT WITH OCCASIONAL GRAVELLY LAYERS	
		8.5		

COMPLETION DEPTH: 8.5' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-308

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		0.7	ROOTS EXTEND TO 2.5' +/- ORANGE-BROWN TO BROWN MEDIUM SAND, TRACE GRAVEL, TRACE SILT TURNS LIGHT BROWN WITH DEPTH	
		7.5		

COMPLETION DEPTH: 7.5' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-309

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SAND, SOME SILT WITH ORGANICS	
		0.8	ROOTS EXTEND TO 2' +/- ORANGE-BROWN TO LIGHT BROWN MEDIUM TO COARSE SAND, TRACE GRAVEL, TRACE SILT WITH OCCASIONAL LAYERS OF FINE SAND, SOME SILT	
		7.5		

COMPLETION DEPTH: 7.5' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-310

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		0.8	ORANGE-BROWN TO BROWN SAND, SOME SILT	
		6.0	GRAY GRAVELLY SILTY SAND WITH OCCASIONAL COBBLES (GLACIAL TILL)	
		8.0	NOTE: HEAVY SIDEWALL CAVING AND SEEPAGE BELOW 3.5'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: FREE WATER @ 3.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-311

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		6.5	ORANGE-BROWN TO LIGHT BROWN SILTY SAND, SOME GRAVEL WITH OCCASIONAL COBBLES AND BOULDERS DIFFICULT EXCAVATION BELOW 5.5' DUE TO FREQUENT COBBLES AND BOULDERS	

COMPLETION DEPTH: 6.5' DEPTH TO WATER: SEEPAGE @ 2' +/-

TEST PIT TP-312

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		7.5	ORANGE-BROWN GRAVEL AND SAND, TRACE TO SOME SILT WITH FREQUENT COBBLES ~ DENSE EXCAVATING ~	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: SOILS SATURATED BELOW 5.5' +/- SEEPAGE @ 6' +/-

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-313

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		4 +/-	FOREST DUFF OVERLYING BROWN FIBROUS PEAT	
		6.5 +/-	BROWN TO ORANGE-BROWN MEDIUM TO COARSE SAND, TRACE GRAVEL, TRACE SILT	
			NOTE: SHALLOW WATER OBSCURED TEST PIT OBSERVATIONS	

COMPLETION DEPTH: 6.5' +/- DEPTH TO WATER: FREE WATER BELOW 0.5'

TEST PIT TP-314

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		6 +/-	FOREST DUFF OVERLYING BROWN FIBROUS PEAT	
		7 +/-	BROWN MEDIUM SAND, TRACE SILT	
			NOTE: SHALLOW WATER OBSCURED TEST PIT OBSERVATIONS	

COMPLETION DEPTH: 7' +/- DEPTH TO WATER: FREE WATER BELOW 0.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-315

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.3	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.5	BROWN GRAVELLY SAND, SOME SILT, WITH FREQUENT COBBLES	
			BEDROCK @ 1.5'	

COMPLETION DEPTH: 1.5' (REFUSAL) DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-316

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		6.0	ROOTS EXTEND TO 2' +/- BROWN GRAVEL AND SAND, SOME SILT WITH FREQUENT COBBLES AND OCCASIONAL BOULDERS	
		7.5	ORANGE-BROWN MEDIUM SAND, TRACE SILT, TRACE GRAVEL	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-317

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.7	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		8.5	ROOTS EXTEND TO 2.5' +/- BROWN GRAVELLY SAND, TRACE TO SOME SILT, WITH FREQUENT COBBLES	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-318

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		3 +/-	FOREST DUFF OVERLYING BROWN FIBROUS PEAT	
		4+/-	BROWN MEDIUM TO COARSE SAND, SOME FINE GRAVEL, TRACE SILT	
			NOTE: SHALLOW WATER OBSCURED TEST PIT OBSERVATIONS	

COMPLETION DEPTH: 4' +/- DEPTH TO WATER: FREE WATER @ GROUND SURFACE

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-319

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.5	DARK BROWN SILTY SAND, TRACE GRAVEL, WITH ROOTS AND ORGANICS (FILL)	
		4.0	LIGHT BROWN SAND, SOME SILT, WITH ROOTS (PROBABLE FILL)	
		9.5	ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL WITH OCCASIONAL LAYERS OF GRAVELLY MEDIUM TO COARSE SAND	

COMPLETION DEPTH: 9.5' DEPTH TO WATER: HEAVY SEEPAGE @ 8.5'

TEST PIT TP-320

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.0	BROWN FINE TO MEDIUM SAND, SOME GRAVEL, TRACE SILT WITH FREQUENT COBBLES AND BOULDERS	
		10.0	FRACTURED BEDROCK WITH SEAMS OF BROWN SILTY SAND	
			SOUND BEDROCK @ 10.0' NOTE: SLOPING BEDROCK - REFUSAL AS SHALLOW AS 2.5' ON SOUTH SIDE	

COMPLETION DEPTH: 2.5' TO 10' (REFUSAL) DEPTH TO WATER: SEEPAGE @ TOP OF SOUND BEDROCK

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-321

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.0	ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL, WITH ROOTS	
		5.0	BROWN SAND, SOME GRAVEL, SOME SILT WITH FREQUENT COBBLES	
		6.0	BROWN FINE TO MEDIUM SAND, SOME SILT	
		10.0	BROWN SAND, SOME GRAVEL, SOME SILT WITH FREQUENT COBBLES	

COMPLETION DEPTH: 10.0' DEPTH TO WATER: SEEPAGE @ 9'

TEST PIT TP-322

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.5	ORANGE-BROWN GRAVELLY SAND, SOME SILT, WITH ROOTS	
		5.6	LIGHT BROWN SILTY SAND, SOME GRAVEL, WITH OCCASIONAL COBBLES AND BOULDERS (GLACIAL TILL)	
			PROBABLE BEDROCK @ 5.6'	

COMPLETION DEPTH: 5.6' (REFUSAL) DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-323

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
			BROWN GRAVELLY SAND, TRACE SILT	
		4.7	PROBABLE BEDROCK @ 4.7'	

COMPLETION DEPTH: 4.7' (REFUSAL) DEPTH TO WATER: ALL SOILS DAMP SEEPAGE @ 4.6'

TEST PIT TP-324

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
			ROOTS EXTEND TO 2' +/- ORANGE-BROWN TO BROWN GRAVELLY SAND, SOME SILT WITH FREQUENT COBBLES AND OCCASIONAL BOULDERS	
		6.0	BROWN SILTY GRAVELLY SAND WITH FREQUENT COBBLES	
		7.5		
		8.0	WEATHERED BEDROCK	
			BEDROCK @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-325

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.0	DARK BROWN GRAVELLY SAND, SOME SILT, WITH ROOTS AND ORGANICS (FILL)	
		6.0	BROWN GRAVEL AND SAND, SOME SILT WITH FREQUENT COBBLES WITH OCCASIONAL SILTY SAND LAYERS	
		7.0	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)	
			PROBABLE BEDROCK @ 7.0'	

COMPLETION DEPTH: 7.0' (REFUSAL) DEPTH TO WATER: SEEPAGE @ 6.9'

TEST PIT TP-326

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.2	BROWN GRAVEL, SOME SAND, SOME SILT, WITH FREQUENT COBBLES (FILL)	
		7.8	BROWN SILTY GRAVELLY SAND WITH FREQUEN COBBLES (GLACIAL TILL)	
			PROBABLE BEDROCK @ 7.8' NOTE: REFSUAL SURFACE SLOPES UPWARD TO 2.5' DEPTH ON NORTH SIDE	

COMPLETION DEPTH: 2.6' - 7.8' (REFUSAL) DEPTH TO WATER: SEEPAGE @ TOP OF REFUSAL SURFACE

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-327

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.5	BROWN SILTY SAND, SOME GRAVEL, WITH ROOTS AND ORGANICS	
		5.0	BROWN MEDIUM TO COARSE SAND AND GRAVEL WITH FREQUENT COBBLES	
		9.0	BROWN SILTY SAND, SOME GRAVEL WITH OCCASIONAL COBBLES AND BOULDERS (GLACIAL TILL)	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-328

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.8	ORANGE-BROWN GRAVELLY SAND, TRACE SILT ROOTS/ROOTLETS EXTEND TO 4.8'	
		5.2	BLACK CEMENTED OXIDE SAND, TRACE SILT	
		8.5	GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: SEEPAGE @ 4.8'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-329

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.0	BROWN GRAVELLY SILTY SAND WITH BOULDERS, COBBLES, ROCK SLABS, ASPHALT, PLASTIC (FILL)	
		9.0	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)	

COMPLETION DEPTH: 9.0'
DEPTH TO WATER: WATER PERCHED IN FILLS HEAVY SEEPAGE @ 4'

TEST PIT TP-330

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		3.0	LIGHT BROWN SILTY FINE SAND	
		6.8	ORANGE-BROWN FINE SAND, SOME SILT	
		7.0	BROWN GRAVELLY SAND, SOME SILT	

COMPLETION DEPTH: 7.0'
DEPTH TO WATER: SEEPAGE @ 2.8'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-331

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.0	ORANGE-BROWN GRAVELLY SAND, SOME SILT WITH FREQUENT COBBLES AND BOULDERS	
		10.0	LIGHT BROWN SILTY GAVELLY SAND WITH FREQUENT COBBLES AND BOULDERS (GLACIAL TILL)	

COMPLETION DEPTH: 10.0'

DEPTH TO WATER: SOILS DAMP FROM GROUND SURFACE SATURATED BELOW 7' +/-

TEST PIT TP-332

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		8.0	ROOTS EXTEND TO 3' +/- ORANGE-BROWN TO BROWN GRAVELLY SAND, SOME SILT WITH LAYERS OF MEDIUM TO COARSE SAND AND GRAVEL	
		9.0	LIGHT BROWN SILTY FINE SAND	
			BOULDERS OR BEDROCK @ 9.0'	

COMPLETION DEPTH: 9.0' (REFUSAL)

DEPTH TO WATER: HEAVY SEEPAGE @ 8'

KEY TO THE NOTES & SYMBOLS
Test Boring and Test Pit Explorations

All stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Key to Symbols Used:

w	-	water content, percent (dry weight basis)
q_u	-	unconfined compressive strength, kips/sq. ft. - laboratory test
S_v	-	field vane shear strength, kips/sq. ft.
L_v	-	lab vane shear strength, kips/sq. ft.
q_p	-	unconfined compressive strength, kips/sq. ft. – pocket penetrometer test
O	-	organic content, percent (dry weight basis)
W_L	-	liquid limit - Atterberg test
W_P	-	plastic limit - Atterberg test
WOH	-	advance by weight of hammer
WOM	-	advance by weight of man
WOR	-	advance by weight of rods
HYD	-	advance by force of hydraulic piston on drill
RQD	-	Rock Quality Designator - an index of the quality of a rock mass.
γ_T	-	total soil weight
γ_B	-	buoyant soil weight

Description of Proportions:

Trace:	0 to 5%
Some:	5 to 12%
"Y"	12 to 35%
And	35+%

Description of Stratified Soils

Parting:	0 to 1/16" thickness
Seam:	1/16" to ½" thickness
Layer:	½" to 12" thickness
Varved:	Alternating seams or layers
Occasional:	one or less per foot of thickness
Frequent:	more than one per foot of thickness

REFUSAL: **Test Boring Explorations** - Refusal depth indicates that depth at which, in the drill foreman's opinion, sufficient resistance to the advance of the casing, auger, probe rod or sampler was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

REFUSAL: **Test Pit Explorations** - Refusal depth indicates that depth at which sufficient resistance to the advance of the backhoe bucket was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

Although refusal may indicate the encountering of the bedrock surface, it may indicate the striking of large cobbles, boulders, very dense or cemented soil, or other buried natural or man-made objects or it may indicate the encountering of a harder zone after penetrating a considerable depth through a weathered or disintegrated zone of the bedrock.

APPENDIX B

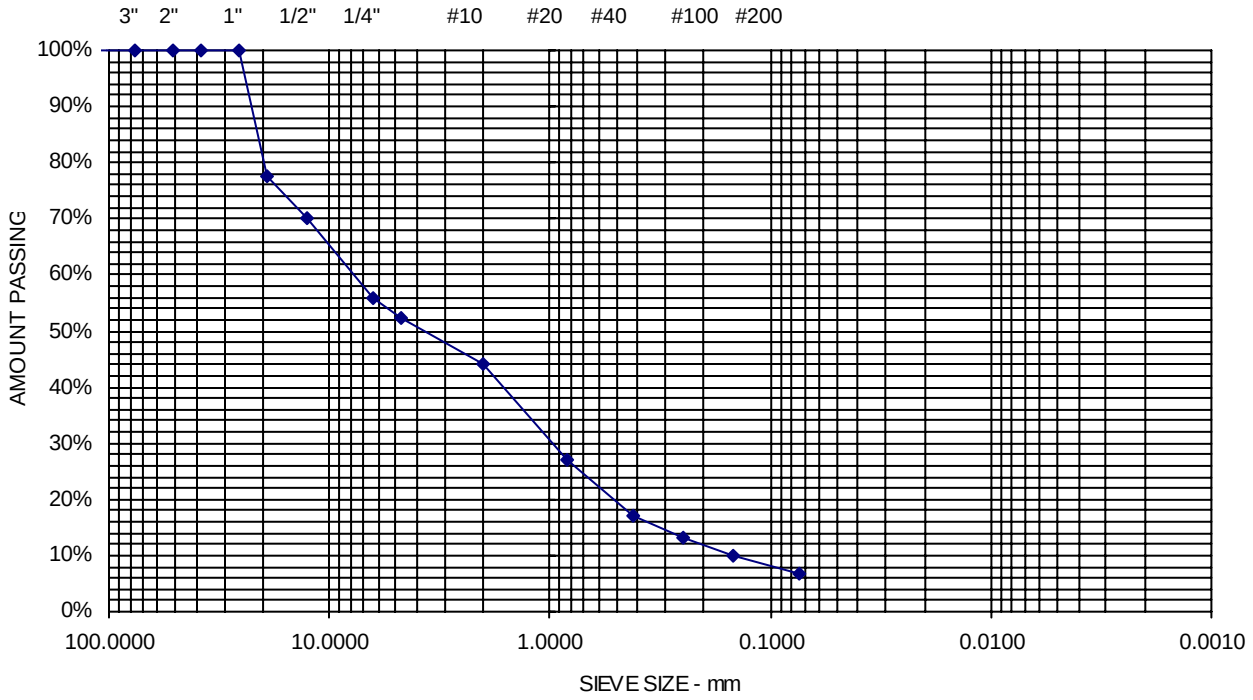
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	18199G
		Date Received	5/20/2014
		Date Completed	5/22/2014
Material Source	**B-101 3D 7-9**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**78**	
12.5 mm	**1/2"**	**70**	
6.3 mm	**1/4"**	**56**	
4.75 mm	**No. 4**	**52**	47.5% Gravel
2.00 mm	**No. 10**	**44**	
850 um	**No. 20**	**27**	
425 um	**No. 40**	**17**	45.6% Sand
250 um	**No. 60**	**13**	
150 um	**No. 100**	**10**	
75 um	**No. 200**	**6.9**	6.9% Fines



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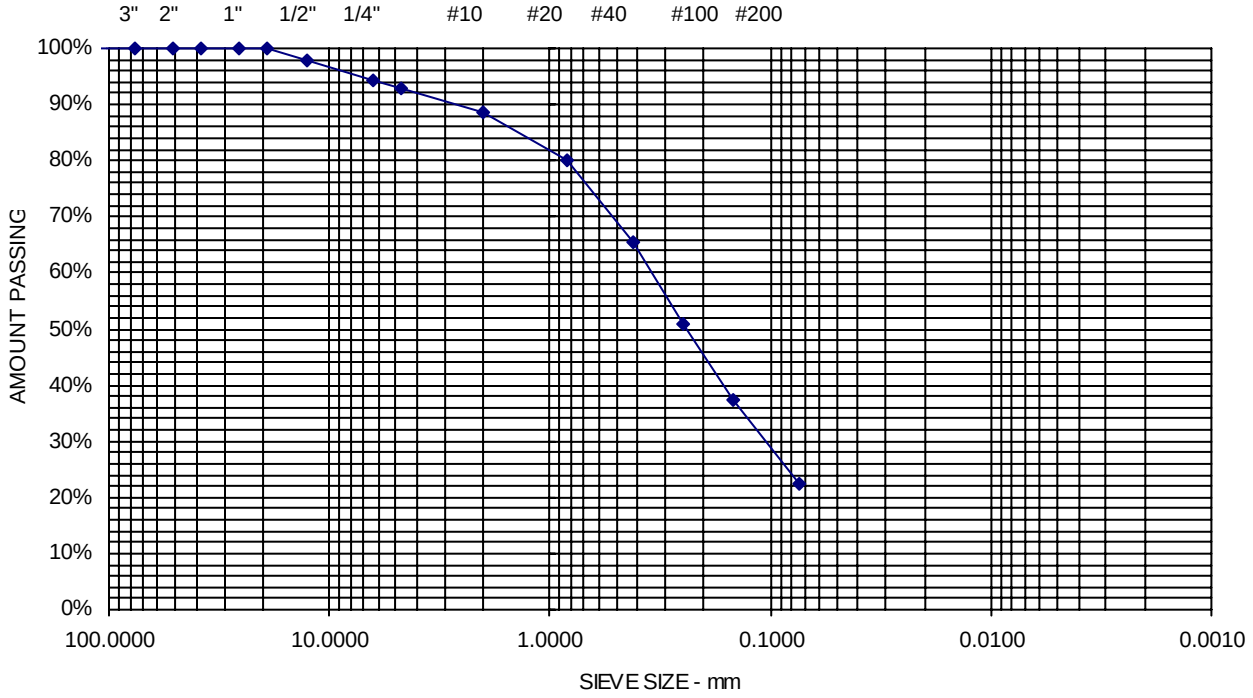
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	18200G
		Date Received	5/20/2014
		Date Completed	5/22/2014
Material Source	**B-102 4D 10-12**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**100**	
12.5 mm	**1/2"**	**98**	
6.3 mm	**1/4"**	**94**	
4.75 mm	**No. 4**	**93**	7% Gravel
2.00 mm	**No. 10**	**89**	
850 um	**No. 20**	**80**	
425 um	**No. 40**	**66**	70.5% Sand
250 um	**No. 60**	**51**	
150 um	**No. 100**	**37**	
75 um	**No. 200**	**22.6**	22.6% Fines



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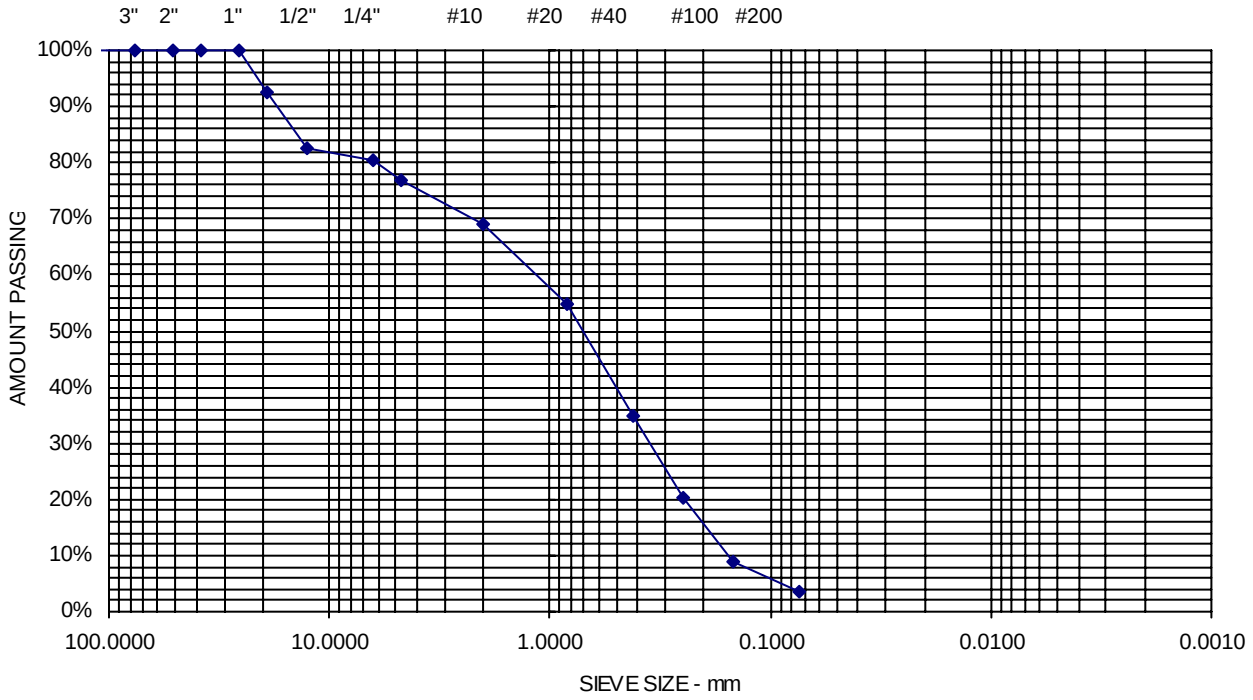
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	18198G
		Date Received	5/20/2014
		Date Completed	5/22/2014
Material Source	**B-105 2D 5-7**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**93**	
12.5 mm	**1/2"**	**83**	
6.3 mm	**1/4"**	**80**	
4.75 mm	**No. 4**	**77**	23.3% Gravel
2.00 mm	**No. 10**	**69**	
850 um	**No. 20**	**55**	
425 um	**No. 40**	**35**	73% Sand
250 um	**No. 60**	**20**	
150 um	**No. 100**	**9**	
75 um	**No. 200**	**3.7**	3.7% Fines



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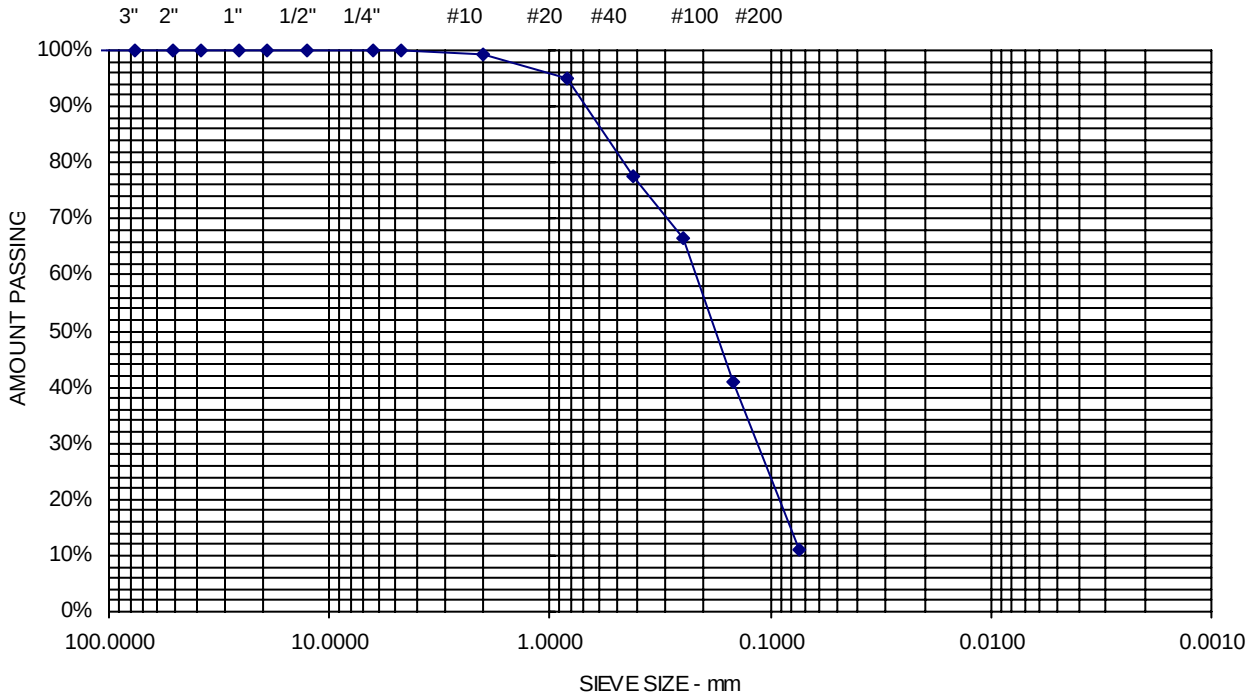
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	17805G
		Date Received	1/9/2014
		Date Completed	1/13/2014
Material Source	**TP-201 3-4**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**100**	
12.5 mm	**1/2"**	**100**	
6.3 mm	**1/4"**	**100**	
4.75 mm	**No. 4**	**100**	0.1% Gravel
2.00 mm	**No. 10**	**99**	
850 um	**No. 20**	**95**	
425 um	**No. 40**	**78**	88.8% Sand
250 um	**No. 60**	**66**	
150 um	**No. 100**	**41**	
75 um	**No. 200**	**11.1**	11.1% Fines



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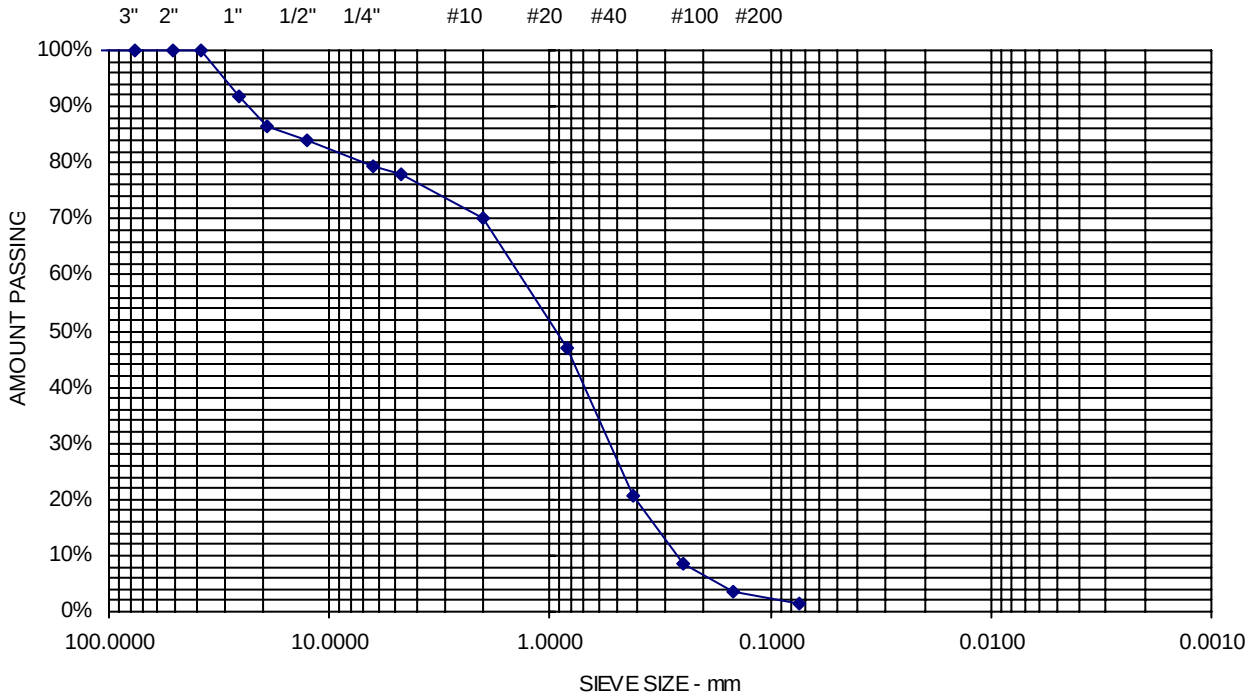
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	17806G
		Date Received	1/9/2014
		Date Completed	1/14/2014
Material Source	**TP-202 2-3**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**92**	
19.0 mm	**3/4"**	**86**	
12.5 mm	**1/2"**	**84**	
6.3 mm	**1/4"**	**79**	
4.75 mm	**No. 4**	**78**	22% Gravel
2.00 mm	**No. 10**	**70**	
850 um	**No. 20**	**47**	
425 um	**No. 40**	**21**	76.4% Sand
250 um	**No. 60**	**9**	
150 um	**No. 100**	**3**	
75 um	**No. 200**	**1.6**	1.6% Fines



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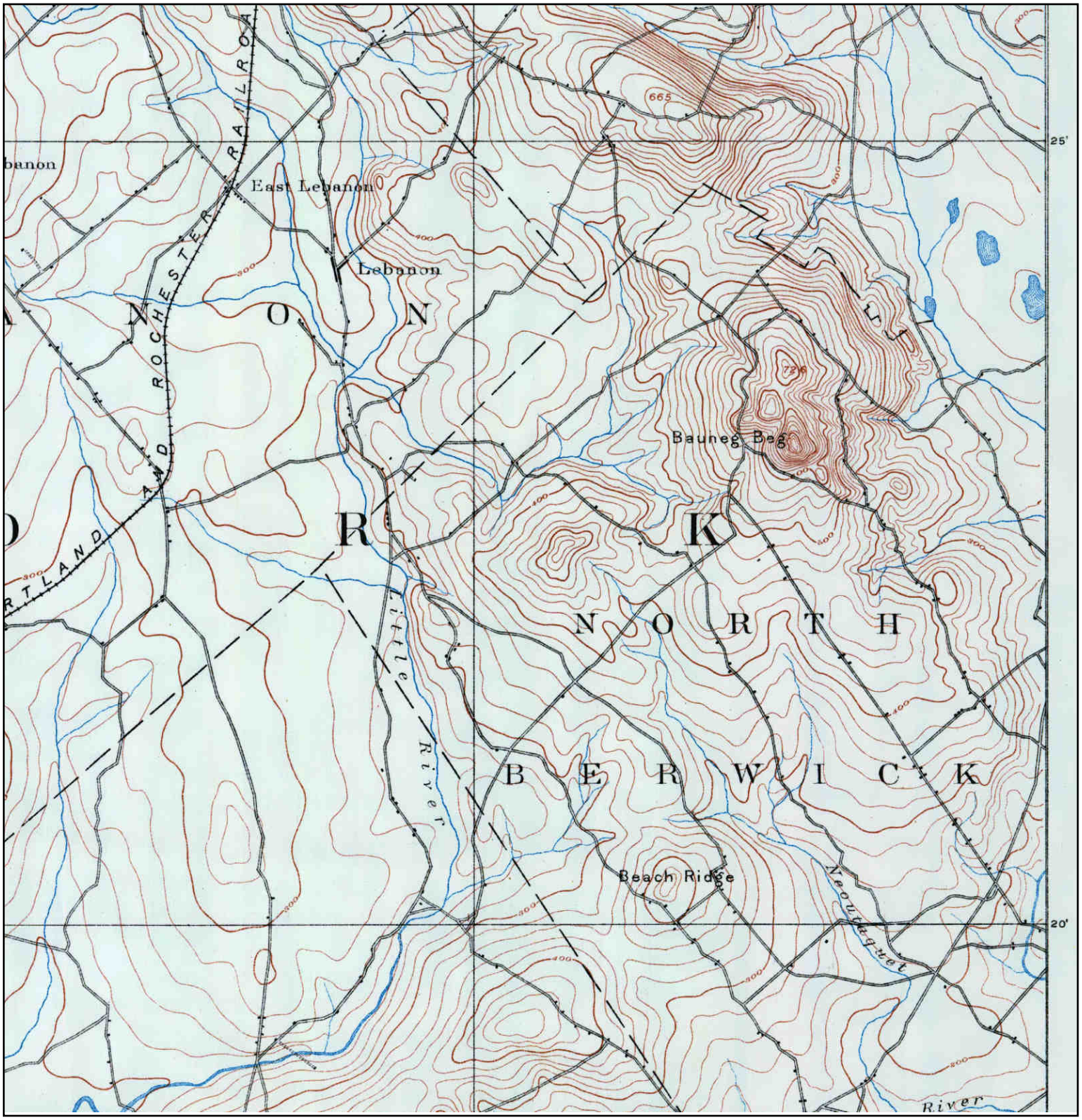
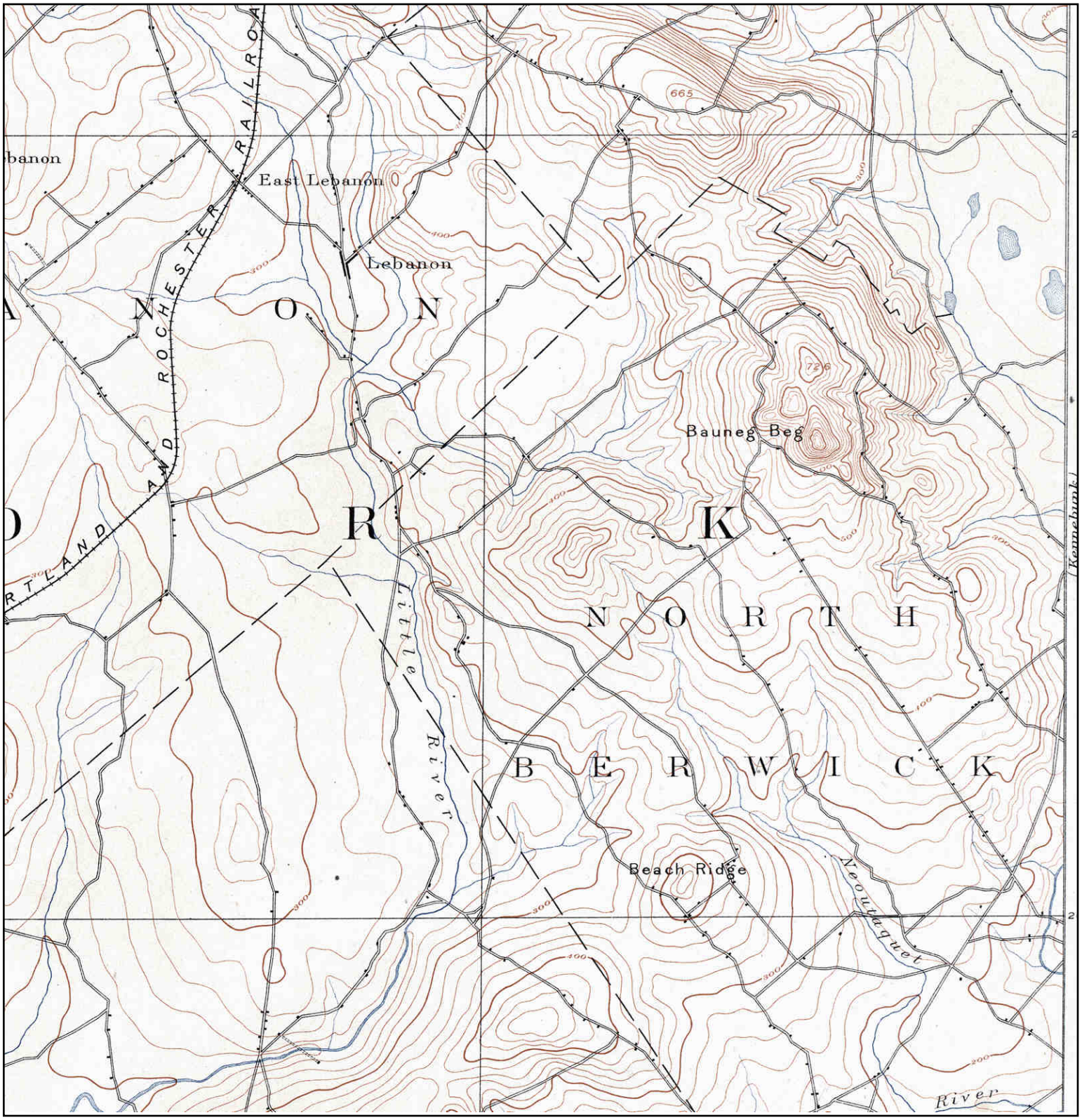
APPENDIX C

Historical Topographic Map



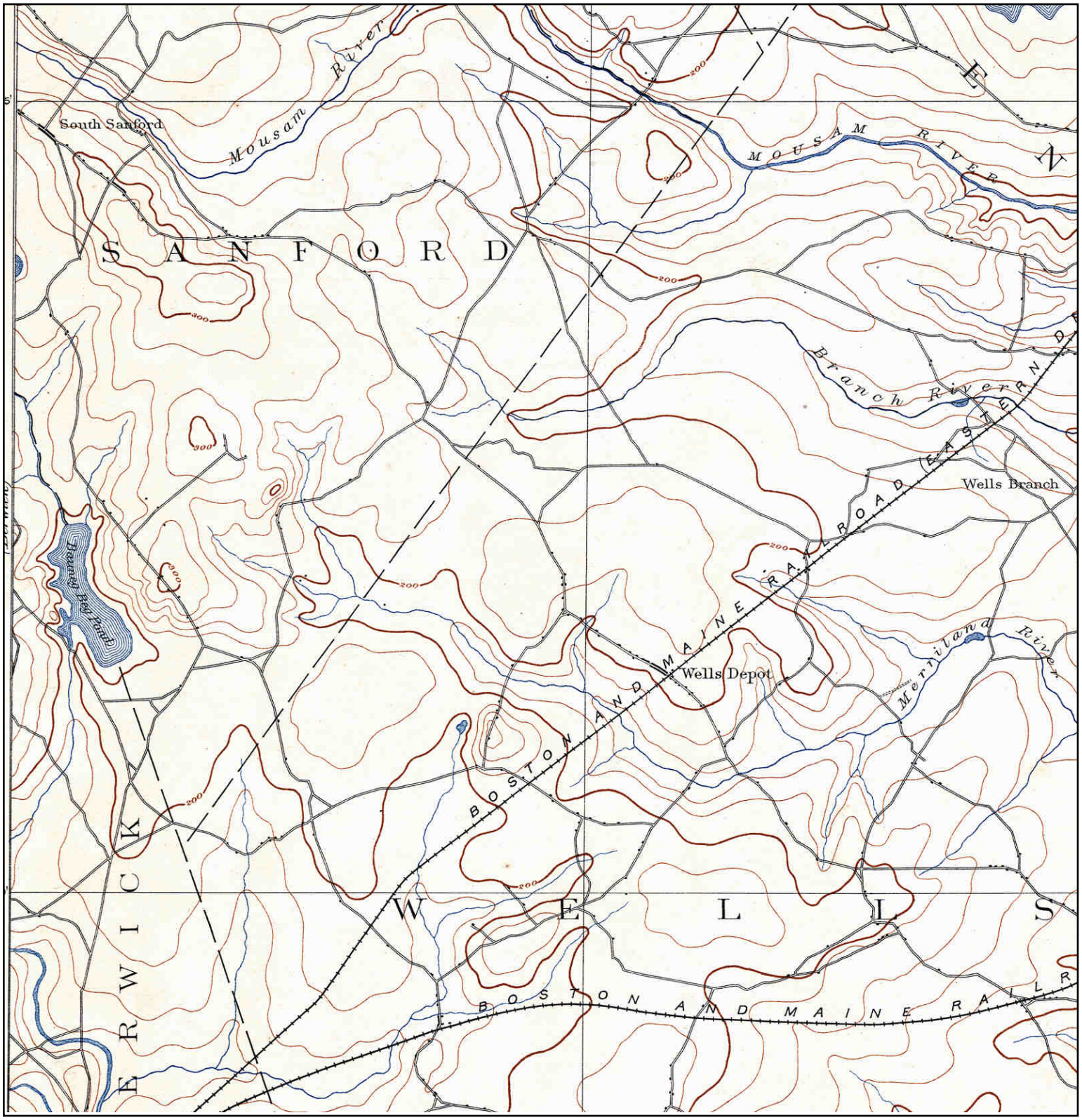
N	TARGET QUAD NAME: BERWICK MAP YEAR: 1891 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map



N	TARGET QUAD NAME: BERWICK MAP YEAR: 1893 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map



N	TARGET QUAD NAME: KENNEBUNK MAP YEAR: 1898 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map

N	TARGET QUAD NAME: KENNEBUNK MAP YEAR: 1944 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

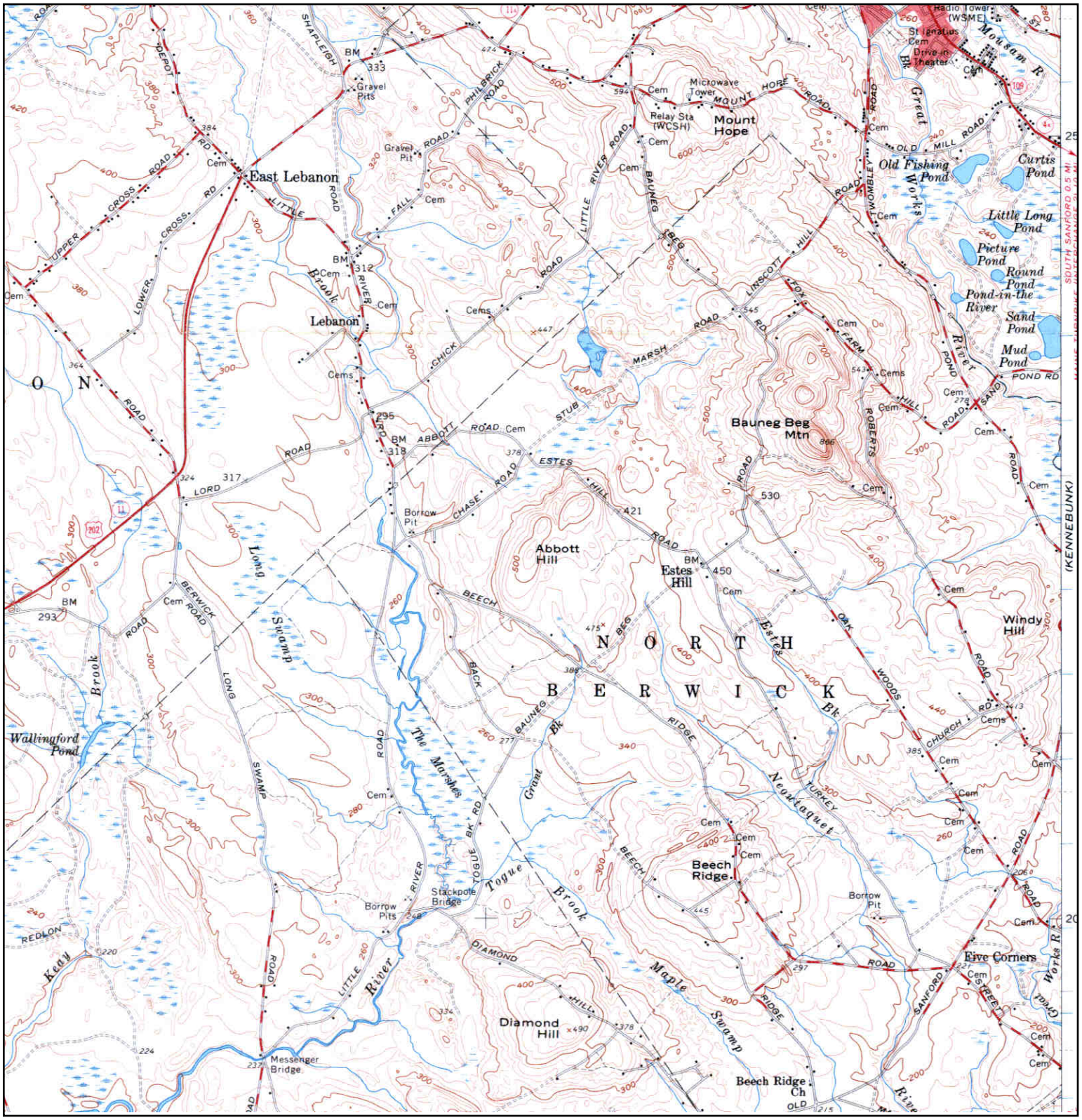
Historical Topographic Map

N	TARGET QUAD NAME: BERWICK MAP YEAR: 1944 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map

N	TARGET QUAD NAME: KENNEBUNK MAP YEAR: 1956 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map



N	TARGET QUAD NAME: BERWICK MAP YEAR: 1958 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

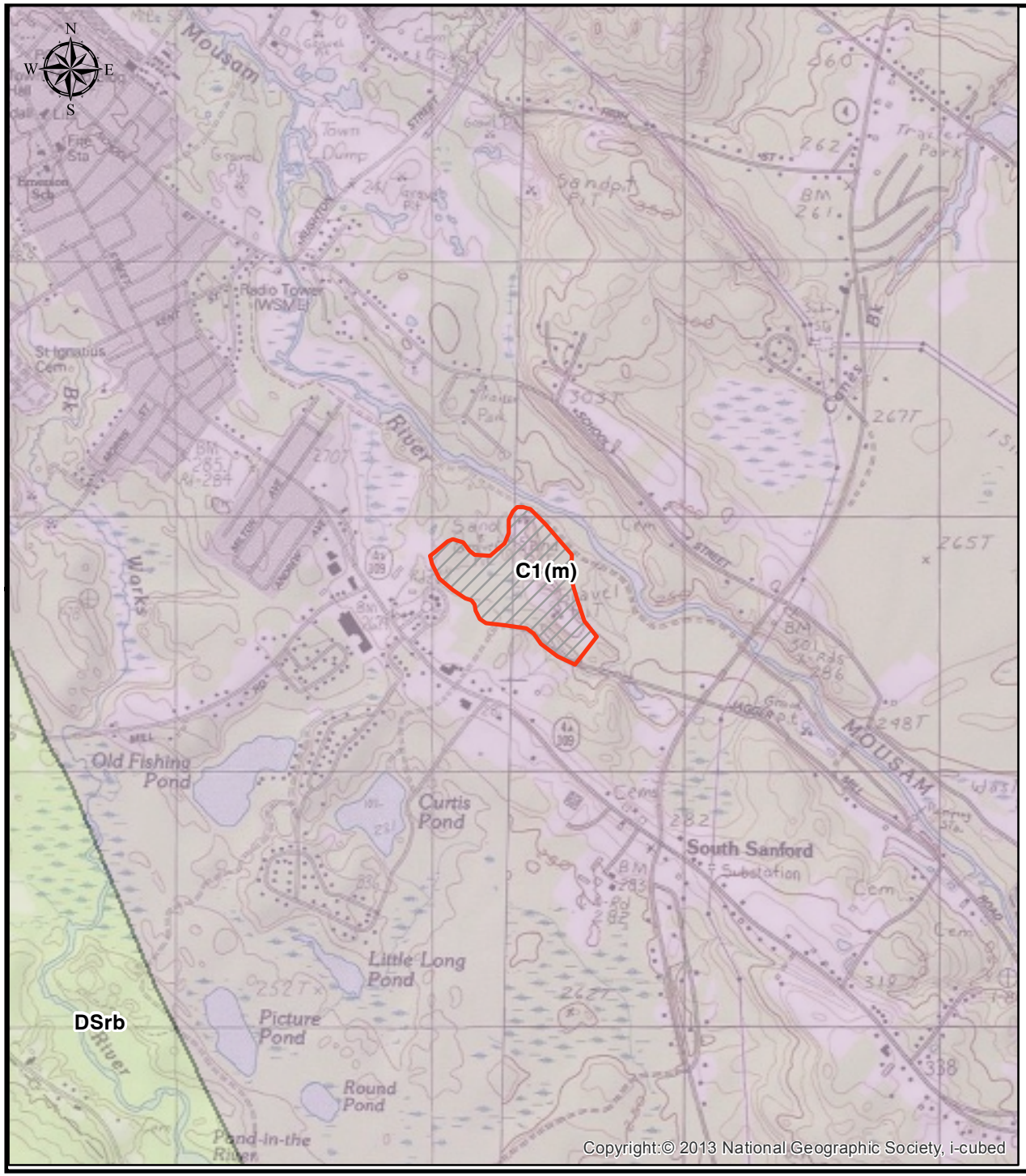
Historical Topographic Map

N	**TARGET QUAD** NAME: SANFORD MAP YEAR: 1983 PROVISIONAL SERIES: 7.5 SCALE: 1:24000	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map

N	TARGET QUAD NAME: ALFRED MAP YEAR: 1983 PROVISIONAL SERIES: 7.5 SCALE: 1:24000	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

APPENDIX D



S.W.COLE ENGINEERING, INC.

BEDROCK GEOLOGY

DATA REFERENCE

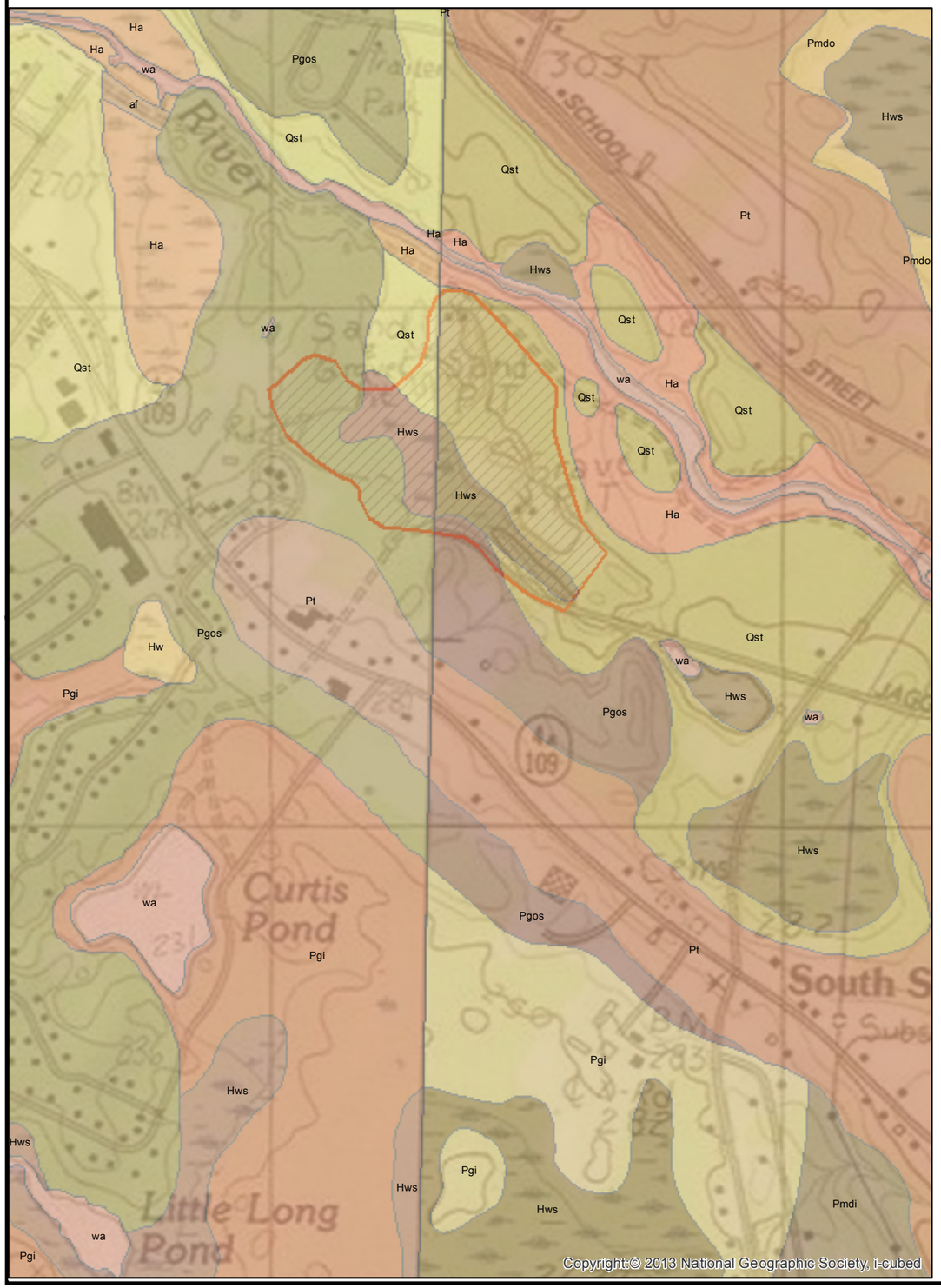
BEDROCK GEOLOGY FROM MAINE DEPARTMENT OF CONSERVATION (MEDOC), MAINE GEOLOGICAL SURVEY (MGS)

Approx_Site

SANFORD, MAINE

1,000 0 1,000 2,000 3,000 4,000

Scale in Feet



SANFORD

- Ha|Stream alluvium - Sand, silt, gravel, and organic material. Deposited on flood plains of modern rivers and streams.
- Hwm|Wetland deposits - marsh
- Hws|Wetland deposits - wooded swamps
- Hw|Wetland deposits - Undifferentiated. Peat, muck, and fine-grained inorganic sediments. Deposited in poorly drained areas.
- Pge|Esker deposits - Sand and gravel deposited by meltwater streams in glacial tunnels. Chevrons indicate inferred direction of glacial stream flow.
- Pgi|Ice-contact deposits - Undifferentiated sand and gravel deposits formed in contact with melting glacial ice.
- Pgos|Sanford outwash plain deposits - Glaciofluvial sand and gravel deposited as an extensive outwash plain in the Mousam and Great Works River valleys.
- Pgo|Glacial outwash - Undifferentiated glaciofluvial sand and gravel deposited in the Little and upper Mousam River valleys.
- Phm|Hummocky moraine - Glacial till with hummocky topography. Usually contains many boulders. Lenses of sand, gravel, and silt are locally abundant.
- Plf|Lacustrine fan deposits - Deltaic sand and gravel deposited into glacial lakes in the Middle Branch Mousam River and Stub Marsh valleys.
- Plmd1|Lacustrine delta deposit - Deltaic sand and gravel deposited into glacial Lake Mousam. Corresponds to Plmd1 of Boothroyd (1997) and Meglioli and Thompson (1997).
- Pmdi|Marine delta - Ice-contact, glaciomarine delta deposited in the Mousam and Great Works River valleys.
- Pt|Till - Loose to very compact, poorly sorted, mostly non-stratified mixture of sand, silt, and gravel deposited by glacial ice. Locally contains lenses of water-laid sediment.
- Qst|Stream terrace deposits - Sand and gravel deposited on erosional terraces at elevations between the original Sanford outwash plain surface and the modern flood plain.
- af|Artificial fill - Man-made unit. May be composed of any material. Commonly seen as highway and railroad embankments, and landfills.
- wa|Water

ALFRED

- Ha|Stream alluvium - Gray to brown fine sand and silt with some gravel. Comprises flood plains along present streams and rivers. Extent of alluvium approximates areas of potential flooding.
- Hws|Wooded swamps - Muck, peat, silt, and sand. Poorly drained areas, often with standing water.
- Hw|Wetland - Muck, peat, silt, and sand. Poorly drained areas, often with standing water. Hws - wooded swamps; Hw - undifferentiated.
- Pemc|End moraine - May occur as a series or complex of moraines (Pemc).
- Pem|End moraine - Coarse gravel and sand, some till and silt. Generally occur within glacial marine sediments (Pp, Pps), and are complexly interstratified with them. Formed at or near the ice front during retreat of marine-based glacier.
- Pge|Esker - Coarse gravel and sand comprising distinct linear ridge forms, mostly in major valleys. Generally surrounded by Pgi deposits, and terminating in ice-contact deltas (Pmdi). May be more than 10 m thick.
- Pgi|Ice-contact deposits (undifferentiated) - Coarse gravel and sand in areas not mapped as deltas or Pge. Primarily kettled glacial stream deposits in the immediate vicinity of eskers (Pge). Average thickness probably between 10 and 15 m.
- Pgos|Sanford outwash plain deposits - Glaciofluvial sand and gravel deposited as an extensive outwash plain in the Mousam and Great Works River Valleys.
- Pgo|Outwash - Sand, gravel, and minor silt deposited by glacial streams in a proglacial (away from ice) setting. Generally confined to major river valley. Sometimes terraced. Average thickness probably between 5 and 10 m.
- Pmdi|Marine delta - Heads of deltas are commonly kettled (Pmdi) and mark ice frontal positions.
- Pmdo|Marine delta - Sediments in distal portions of deltas (Pmdo) commonly grade into glacial marine sediments (Pp, Pmrs).
- Pmd|Marine delta - Coarse sand and gravel grading to sand and silt. Flat to gently sloping constructional surface formed by glacial streams discharging into late-glacial sea.
- Pp|Presumpscot Formation - Massive to laminated gray and blue gray (weathering brown) silt and silty clay. Locally may contain boulders, sand, and gravel. Variable thickness. Deposited during late glacial marine submergence.
- Pt|Till - Gray to gray brown poorly sorted mixture of silt, sand, pebbles, cobbles, and boulders. Forms a blanket deposit over bedrock, and is inferred to underlie younger sediments where not exposed at surface.
- Qst|Stream terrace deposits - Sand and gravel deposited on erosional terraces at elevations between the original Sanford outwash plain surface and the modern flood plain.
- wa|Water
- Approx_Site

N
W E
S

DATA REFERENCE
SURFICIAL GEOLOGY FROM MAINE GEOLOGICAL SURVEY (MGS)

1,000 0 1,000
Scale in Feet

SURFICIAL GEOLOGY

SECTION 31 23 15
BUILDING PAD EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide all labor, materials, equipment and services, etc. and perform all operations necessary for building pad earthwork required for the execution of all construction as indicated on the Drawings, Specified herein, or otherwise required for a complete and proper job.

B. The building pad area is defined as the building area to ten (10) feet outside of the proposed building footprint, including attached walkways, canopies, sidewalks, loading docks, retaining walls, and any other such appurtenances that are necessary for construction of the building.

C. Only fill materials defined herein and in the Geotechnical Engineering Report prepared for the Project by S.W. Cole Engineering Inc., titled; Proposed Sanford High School & Regional Technical Center, Main Street and Old Mill Road, Sanford Maine shall be used for fill within the building pad and backfill for foundations. The required fill material shall extend to the lateral limits defined as 1 foot horizontally and then 1 foot horizontal and 1 vertical line sloped down and outward from the bottom outside edge of foundations and floor slabs supported by fill (Zone of Stress Influence).

D. Subsurface investigations and reports have been executed, and the results are available for the Contractor's general information only. The Architect and Owner assume no responsibility for their completeness, accuracy, or correctness.

E. Excavations shall be undertaken by the Contractor until the naturally occurring undisturbed, non-organic soils or bedrock are encountered below the bottom of footings. The Geotechnical Engineer shall determine the acceptability of bearing surface and determine requirements for ground improvement by rammed aggregate piers or removal and replacement of unsuitable soils.

F. Dewatering will be required. Dewatering techniques will vary depending upon location and depth of required excavations. Techniques may vary from conventional sump and pump dewatering to deeper braced excavations and sheetpiling with well-point dewatering systems for groundwater control. Maintain water levels a minimum of one (1) foot below the lowest excavated depth.

1.02 RELATED REQUIREMENTS

A. Section 01 22 00 - Unit Prices: Unit costs for sitework.

B. Section 02 32 10 – Subsurface Explorations.

C. Division 31 - Earthwork.

D. Division 32 - Exterior Improvements.

E. Division 33 - Utilities.

F. Section 33 46 00 – Subdrainage: Perimeter drainage system.

G. Section 33 46 10 – Soil Gas Depressurization System: Sub-grade vapor barrier, venting crushed stone base and vent piping system below building slabs-on-grade.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product data on all manufactured products including filter fabric and aggregate products (sieve analyses).

C. Manufacturer's Certificate: Certify that products meet specified requirements.

D. If dewatering is required, the Contractor shall submit their proposed dewatering methods to the Geotechnical Engineer at least two (2) weeks prior to implementation.

E. The Contractor shall submit their engineered ground improvement plans and calculations for rammed aggregate piers to the Geotechnical Engineer at least two (2) week prior to mobilization.

1.04 TESTING AND INSPECTIONS

A. See Section 01 40 00 – Quality Requirements.

B. Testing Agency Services provided by the Owner: Testing and inspections shall be performed as required by the building code, the Construction Documents, or as otherwise directed by the Architect. The Owner shall employ the Geotechnical Engineer of Record for the purpose of testing and inspecting existing site soil conditions, fill materials, fill placement, and load-bearing surfaces and ground improvements.
   1. Owner's testing and inspection services shall be paid from the Testing Allowance. See Section 01 21 00 - Allowances.

C. The following testing and inspections shall be conducted prior to field compaction:
   1. During and following excavation, the Geotechnical Engineer of Record shall verify the suitability of existing soils, verify design bearing capacity, and promptly notify the Owner, Contractor, and Architect of any variances.
   2. During placement and compaction activities, compliance with the recommendations of the Geotechnical Report for fill materials and maximum lift thickness shall be verified.
   3. At least one week prior to compaction, at least one test shall be made on a representative sample of each borrow material that will be incorporated in compacted earthwork to confirm gradation, per ASTM D422 and moisture density characteristics per ASTM D1557.

D. The following testing and inspections shall be conducted after field compaction to determine the actual in-place densities being attained.
   1. Perform field in-place density tests in accordance with ASTM D2922 (nuclear method).
   2. Verification and approval of footing and slab subgrades shall be performed by the Geotechnical Engineer of Record prior to the placement of any required fill material or foundation forms.
   3. Building slab areas shall be tested at each compacted fill and backfill layer, with at least one in-place density test for every 2,000 sq. ft., but in no case fewer than three (3) tests.
   4. Foundation wall backfill shall be tested at each compacted backfill layer with at least one in-place density test for each 100 feet or less of wall length, but no fewer than two (2) tests along a wall face.

E. Testing and Inspections of Rammed Aggregate Pier ground improvements shall be made as specified per Section 31 51 00.

F. When fills, or backfills do not meet specifications, corrections shall be made, and all re-tests shall be at the expense of the Contractor.

G. Such inspections and tests shall not relieve the Contractor of responsibility for providing his own inspections, quality control and materials and fabrication procedures in compliance with specified requirements. Any non-compliant materials shall be removed and replaced at the Contractor’s expense.

H. The Contractor shall cooperate with and facilitate testing and inspection by Geotechnical Engineer of Record and/or Testing Agency. The Contractor shall, at his own expense, furnish the Testing Agency, upon request, with the following:
   1. Representative samples for testing.
   2. Assistance for testing materials and proper facilities for inspection of the Work.
   3. Access to the material source for Testing Agency inspection and testing, if required.

I. The Contractor shall arrange and coordinate all testing and inspections and shall give the Testing Agency at least 24 hour advance notice.

J. Testing Agency Services provided by the Contractor: The Contractor shall provide and pay for certification and submittal testing, including but not limited to gradation analysis, for all imported fill materials submitted to the Architect for approval.

1. The Contractor shall notify the Architect at least seven (7) working days in advance of intention to import material.
2. If materials change in composition from that originally submitted by the Contractor, new gradation tests and moisture/density testing shall be conducted on soil samples. The cost of such re-testing shall be the responsibility of the Contractor.

K. Do not allow or cause any of the Work performed or installed to be covered up or enclosed by Work of this Section prior to all required inspections, tests, and approvals. Should any of the Work be so enclosed or covered up before it has been approved, the Contractor shall uncover all such Work at no additional cost to the Owner. After the Work has been completely tested, inspected and approved, make all repairs and replacements necessary to restore the Work to the condition in which it was found at the time of uncovering, all at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Structural Fill: Consisting of sand and gravel, free of organic materials, snow, ice or other unsuitable materials, non-frost susceptible and graded within limits as follows:

Sieve Size:	Percent Passing by Weight:
4 inch	100 %
3 inch	90 - 100 %
1/4 inch	25 - 90%
No. 40	0 - 30%
No. 200	0 - 5 %

1. Application: Fill to repair soft areas, backfill for foundations, slab base material and material below exterior entrances and sidewalks.

B. Granular Borrow: Fill to raise grades in building, athletic field and paved areas shall be sand or silty sand meeting the requirements for 2014 Standard Specification Maine DOT 703.19 Granular Borrow. Fills over wet subgrades may require Maine DOT 703.19 Granular Borrow of Underwater Backfill, as directed by the Geotechnical Engineer.

C. Gravel Borrow: Backfill for areas of peat removal may be sand and gravel meeting the requirements for 2014 Maine DOT Standard Specification 703.20 Gravel Borrow.

D. Rock Borrow: Backfill for areas of peat removal may be blasted bedrock meeting the requirements for 2014 Maine DOT Standard Specification 703.21 Rock Borrow and shall be placed according the Maine DOT Standard Specification requirements.

E. Crushed Stone: Crushed Stone, used beneath foundations and for underdrain aggregate, shall meet the requirements of 2014 Maine DOT Standard Specification 703.13 Crushed Stone ¾-Inch.

F. Underdrain Sand: Clean, free-draining sand around perimeter foundation drains meeting the requirement of 2014 Maine DOT 703.22 Type B Underdrain Backfill Material.

G. Stone Dust: Stone dust setting bed materials and joint filler shall consist of hard, durable, uncoated particles of soil or rock, free from lumps of clay and all deleterious substances graded within limits as follows:

Sieve Size:	Percent Passing by Weight:
1/4 inch	100 %
No. 10	50 - 85 %
No. 40	20 - 45 %
No. 200	3 - 10 %

1. Application: For (1) one inch setting bed over structural fill below surface slab on grade (Main Floor Level).

H. Venting Crushed Stone Fill: For slab-on-grade base with soil gas ventilation system as specified in Section 33 46 10 – Soil Gas Depressurization System.

I. Reuse of Site Soils: The existing sand and gravel deposits overlaying bedrock may provide a borrow source for granular fill for reuse on-site. The bedrock will require blasting and may be blended with on-site sands to create fill and backfill materials for building and site improvement. On-site sands meeting the above criteria may generally be used as Granular Borrow at locations as determined by the Geotechnical Engineer of Record, subject to placement conditions. The Contractor shall mechanically screen or process on-site soils to remove over-sized and deleterious materials prior to reuse as required or directed by the Geotechnical Engineer.

J. Geotextile (Filter Fabric): Six ounce/sq yd minimum, needle-punched, non-woven, synthetic, chemically resistant non-biodegradable fabric. Geotextile shall be used to prevent fine-grained soils from migrating into coarse grain materials as judged necessary by the Engineer, at subsurface basement level slab atop crushed stone as a protective barrier between the crushed stone base and vapor barrier, and at the locations shown on the Drawings or indicated in the Specifications. Geotextile Fabric.
   1. Product: 160N by Mirafi.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.01 GENERAL

A. Familiarization: Prior to all Work of this Section, the Contractor shall become thoroughly familiar with the site conditions, the building and site improvements, and all portions of the Work covered by this Section. The Contractor shall satisfy himself, by actual examination of the site of the Work, as to the existing conditions, contours and elevations and the amount of Work required under this Section.

B. Conditions: The Contractor acknowledges that he has satisfied himself as to the nature and location of the Work, the general and local conditions, particularly those bearing upon site access and transportation, disposal, handling, and storage of materials, availability of labor, water, electric power, roads and uncertainties of weather, ground water table or similar physical character of equipment and facilities needed prior to and during the prosecution of the Work and all other matters which can in any way affect the Work or the cost thereof under this Contract. Any failure by the Contractor to acquaint himself with all available information concerning these conditions will not relieve him from responsibility for estimating properly the difficulty and cost of successfully performing the Work.

C. Coordinate the building pad earthwork in accordance with the Drawings, Geotechnical Report, field measurements, manufacturer's data, trade practices, and as specified herein.

D. Remove all trees, shrubs, saplings, brush, vines, stumps and other debris as required.

E. Stripping of Unsuitable or Surplus Materials: All topsoil, peat, organic materials, debris, frozen or saturated soils, muck, loose or disturbed soils, pre-existing fills, any other fills that cannot be compacted properly or other unsuitable or surplus materials shall be stripped to their entire depths from building pad area. All excavations shall be performed in a manner to minimize the disturbance of underlying natural ground to remain.

F. All excavations whether cut, general excavation, or trenching shall conform to the following provisions as applicable:
   1. Extent: Excavation shall be performed to elevations and dimensions indicated or implied, plus sufficient space to permit erection of forms, shoring, drains, construction of structures, and the inspection of the Work. Excavations shall extend beyond the indicated or implied limits if necessary to remove all traces of loam, peat, waste, or other unsuitable materials. Excavation shall include all trenching required for the installation of items where the trenching is not specifically described on the Drawings or in other Sections of these Specifications.

G. Cold Weather Excavation: Do not excavate to full indicated depth when freezing temperatures may be expected, unless fill materials, footings or slabs can be placed immediately after the

excavation has been completed. Protect the excavation from frost if placing of concrete or additional fill for compaction is delayed.

1. Where footings and slabs are exposed to freezing temperatures, they shall be protected to prevent frost penetration into the subbase and subgrade beneath the concrete.
2. Fill shall not be placed over frozen sub base or subgrade material. Soil that is frozen shall be removed prior to placement of compacted fill. Remove all frozen uncompacted fill prior to placing additional fill for compaction. Placement of compacted fills shall not be conducted when air temperatures are 30 degrees F, or below, to prevent moisture in the fill from freezing before placement.

H. Maintain a dewatered and stable subgrade during construction. Efforts shall be made to prevent surface water run-off from collecting in excavations. Subgrade fills that become unstable shall be removed and replaced with granular fill or as recommended by the Geotechnical Engineer.

1. Perimeter foundation and underslab drains are required. Refer to Section 33 46 00 Subdrainage, 02 32 10 - Subsurface Investigations and the Drawings.
2. Foundation waterproofing shall be provided under Section 07 14 00 – Fluid Applied Waterproofing.

I. Dewatering:

1. Dewatering is expected to be required to permit construction in the dry. The groundwater level shall be lowered prior to excavation to a minimum of two (2) feet below the anticipated excavation depth. The proposed dewatering system shall be reviewed by the Geotechnical Engineer prior to implementation by the Contractor.
2. Provide and maintain at all times during construction, ample means and devices with which to promptly remove and dispose of all water from every source entering the excavations or other parts of the Work. Dewater by means that will ensure dry and stable excavations, the preservation of the final lines and grades of bottoms of excavations, and minimize disturbance of underlying natural ground. Provide adequate pumping equipment, including standby equipment.
3. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
   a. Do not place, spread, or roll any fill material during unfavorable weather conditions. Do not resume operations until moisture content and fill density are satisfactory to the Architect.
   b. Provide berms or channels to prevent water from entering excavations, ponding on prepared subgrades, and flooding Project site and surrounding area. Promptly remove all water collecting in depressions.
   c. If the excavation to subgrade has been softened or damaged by erosion, flooding, placement during unfavorable weather or other causes, remove all disturbed and saturated soils, re-fill and re-compact as specified. Following the Geotechnical Engineer's approval, crushed stone, approximately 3/4” average size, completely wrapped in filter fabric may be used to stabilize subgrade soils. Perform work to repair the subgrade prior to proceeding with the normal course of the Work on the subgrade.
4. The engineering, construction, maintenance and removal of all berms, cofferdams and all other systems required for excess water control and diversion shall be the sole responsibility of the Contractor.
5. Dispose of water pumped or drained from construction site in a legal and suitable manner to avoid public nuisance, injury to public health, damage to public and private property, and damage to the Work completed or in progress.
   a. The drainage of all water resulting from pumping shall be recharged into the ground in a nearby excavation, to the extent feasible. Discharge to municipal storm drain systems shall be performed only with approval of the Architect and in accordance with all regulations and required permits.

b. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey runoff and water removed from excavations to collecting areas. Do not use trench excavations as temporary drainage ditches.
c. Water shall pass through a sediment trap prior to discharge.

3.02 STABILITY OF EXCAVATIONS

A. The Contractor is solely responsible for the protection of the excavations.

B. Provide shoring, sheeting, and/or bracing of excavations as required to assure complete safety against collapse of earth at sides of excavations. Alternatively, lay back excavations to a stable slope.

C. Comply with local, and State safety regulations and with the provisions of the Occupational Safety and Health Act (OSHA).

D. The design, planning and construction of excavations, excavation support and dewatering are the responsibility of the contractor. These construction documents require engineered shop drawings of shoring and dewatering plans for excavations below groundwater and excavations to remove peat and organics. Qualified and experienced engineer licensed in the State of Maine.

3.03 INSPECTION OF SUBGRADES

A. Inspection of Subgrades: Notify the Geotechnical Engineer of Record and Architect when excavations have reached required subgrade prior to the placement of any fill material or concrete formwork. The Geotechnical Engineer shall assess foundation excavation and preparation efforts to determine compliance with recommendations of the geotechnical report. Do not cover subgrades until accepted by the Geotechnical Engineer. Should bearing materials at subgrade be determined to be unsuitable, continue excavation until suitable bearing materials are encountered, as determined by the Geotechnical Engineer. Replace excavated material with compacted Granular Borrow as directed by the Geotechnical Engineer. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities as directed by the Geotechnical Engineer, at no cost to the Owner.

3.04 PREPARATION OF SUBGRADES FOR STRUCTURES

A. Footings and Slabs:
1. Over-excavation may be required to remove locally weak, disturbed or otherwise unacceptable bearing soils. Fills within the building limits and the Zone of Stress Influence for footings shall be compacted Granular Borrow. Final excavations of bearing surfaces shall be made by smooth bladed equipment to minimize soil disturbance.
2. Following site grubbing, exposed granular soils and uncontrolled fills shall be proof-rolled with 3 to 5 pass of a vibratory roller having a static weight of 10 tons, minimum. Areas which become soft and yielding shall be overexcavated and replaced with compacted Granular Borrow. Granular Borrow shall be placed and compacted to raise grades below the proposed structures.
3. Footings outside the RAP treatment area shall be underlain with 6 inches of compacted Structural Fill overlying compacted Granular Borrow or stable native, non-organic soils. Footings founded on bedrock shall be underlain with 6 inches of crushed stone to remove hard points below the footings. At least 6-inches of compacted Crushed Stone wrapped in non-woven geotextile, such as Mirafi 160N or equivalent, shall be installed below basement footings. At least 12-inches of geotextile wrapped Crushed Stone shall be provided below the basement floor slab. Blasted bedrock subgrades, if encountered, shall be thoroughly choked with crushed stone prior to placing new fills. Loose and overblasted bedrock shall be removed and replaced with compacted Granular Borrow.
4. Fill shall be placed in horizontal lifts and compacted such that the desired density is achieved throughout the lift thickness with 3 to 5 passes f a 10-ton vibratory roller, or equivalent effort. Footing trench bases shall be proofrolled using at least six (6) passes of a 700 pound vibratory plate compactor. Crushed Stone shall be compacted with 3 to 5 passes of a vibratory plate compactor having a static weight of at least 500 pounds. Loose lift thicknesses for grading, fill and backfill activities shall not exceed 12 inches. Thicker

lifts of fill are permissible for Rock Borrow per direction of the Geotechnical Engineer. Remove and replace soils that become unstable as a result of proofrolling.

5. Fill and backfill in building and paved areas shall be compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557. Fill and backfill in landscape and playfield areas be compacted to at least 92 percent of its maximum dry density as determined by ASTM D-1557.
6. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and for inspection.
7. Excavation for Underground Tanks, Basins, Mechanical or Electrical Items: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot. Do not disturb bottom of excavations intended for bearing surface.

B. Floor Slabs:
1. As part of the scope of the Soil Gas Depressurization System, a sub-grade vapor barrier shall be installed continuously at least 12 inches below slabs-on-grade, and may be installed below sub-slab plumbing piping. The sub-grade vapor barrier shall extend from the perimeter foundation wall horizontally inward at least 25 feet and in no case shall extend less than 20 feet beyond the inner extents of crushed stone placed for foundation bearing. This vapor barrier shall be sealed air-tight with tape to all penetrating pipes.
2. Basement Slab Area: On top of minimum 6 oz per square yard non-woven geotextile fabric, place a minimum (12) twelve inch thick layer of clean Soil Gas Crushed Stone, below the bottom of the slab.
3. Surface Level Slab Area (Main Level): Place a minimum (8) eight inch thick layer of Structural Fill with a minimum (8) eight inch thick layer of clean Venting Crush Stone directly below floor slab. See Section 33 46 10 for Soil Gas Venting System to be installed below all building slabs-on-grade.
4. A slab vapor retarder shall be installed over all slabs in accordance with Section 07 21 00 and 33 46 10.

C. Protection of Bearing Surfaces: The native soils are expected to be susceptible to disturbance by water and worker traffic. Care shall be taken to prevent surface water from collecting on exposed bearing surfaces. Traffic over bearing surfaces shall be minimized. Additional stabilization of bearing surfaces will be likely at the ground floor level, including over excavation, placement of geotextile fabric and crushed stone. Stabilization techniques shall be determined by the Geotechnical Engineer on a case-by-case basis.

D. Filling and Compaction:
1. To the extent practicable, each layer of fill shall be compacted to the specified density the same day it is placed. Fill that is too wet for proper compaction shall be dried to the proper moisture content, or removed and replaced.
2. Fill shall be placed systematically in horizontal layers not to exceed twelve (12) inches thick. Compaction equipment in open areas shall be large self-propelled vibratory rollers with a minimum compactive energy of 25,000 lbs. In confined areas, hand operated vibratory plate compaction equipment or a walk behind vibratory roller shall be used with a maximum placed layer of six (6) inches.
3. All Fill placed within the building pad to the bottom of slab elevation shall be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557.
4. Structural Fill shall be used to backfill excavations below the bottom of footings. Structural Fill shall extend to the lateral limits defined as 1 foot horizontally and then 1 horizontal and 1 vertical line sloped down and outward from the bottom outside edges of foundations supported by fill (Zone of Stress Influence).
5. Compaction Around Structures: No heavy machinery shall be allowed within five (5) feet of the structure during placing. Unbalanced wall backfill shall not be placed until slabs have been poured and set and the structure can satisfactorily withstand the loads imposed by fill and backfill. Backfills at structures shall be brought up evenly on all sides to avoid damage to the structure by uneven loading. Each lift shall be properly compacted.

a. Use extra care when compacting adjacent to walls. Where walls are buried on both sides, backfill and compaction shall proceed on both sides of the wall so that the difference, in top of fill level on either side of the wall shall not exceed two (2) feet at any stage of construction. Where backfill of buried wall is only on one side, only a hand-operated roller or plate compactor shall be used within a lateral distance of five (5) feet of back wall for walls less than fifteen (15) feet high and within ten (10) feet of back of wall for walls more than fifteen (15) feet high.

6. Backfill excavations, promptly, but not before completing the following:
   a. Acceptance of construction below finish grade including waterproofing, foundation drains, perimeter insulation, sealing of all perimeter foundation penetrations and sub-grade vapor barrier.
   b. Surveying locations of underground utilities for record documents.
   c. Testing, inspecting, and approval of underground utilities.
   d. Concrete formwork removal.
   e. Removal of trash and debris from the excavation.
   f. Removal of temporary shoring and bracing, and sheeting.
   g. Installing permanent or temporary horizontal bracing on horizontal supported walls.
7. Frozen materials shall not be placed in the backfill nor shall materials be placed upon frozen materials. Previous frozen materials shall be removed or shall be otherwise treated as required before new backfill is placed.
8. Any Fill material that is placed below or around the building foundations or below pavement areas that the does meet the requirements as stated herein or within the Geotechnical Engineering Report and Soil Gas Depressurization System, without prior approval from the Geotechnical Engineer and Architect, becomes unstable during compaction efforts, or becomes unstable due to saturation shall be removed and replaced as directed by the Geotechnical Engineer at no cost to the Owner.

E. **OFF-SITE DISPOSTION OF EXCESS EXCAVATED SOILS**

1. The Contractor shall manage and legally dispose off-site all excess or unsuitable materials that cannot be reused on-site. Excess or unsuitable materials shall be removed from the site and transported to appropriate facilities or locations in accordance with all local, state, federal regulations, the RCMP, and the requirements herein. All excavated excess or unsuitable materials will become the property of the Contractor. Materials excavated from the site shall not be transported or used at schools, public parks, residential properties, day care facilities or other environmentally-sensitive site. Prior to removal of excavated materials from the site, the Contractor shall notify the Owner of the proposed disposal site(s) and receive approval from the Owner prior to removal and disposal of the materials. All excavated materials proposed for off-site disposal or reuse shall be tested in accordance with the requirements of the receiving facility at the Contractor's expense. If off-site reuse or disposal is proposed at a location other than a licensed treatment or disposal facility, soil shall be tested in accordance with requirements set by the Engineer.
2. The Contractor shall coordinate and contract with applicable receiving facilities and complete all associated paperwork. Copies of all associated paperwork shall be provided to the Owner within seven (7) days of removal of the material from the site.
3. Excavated soils and materials removed from the site shall be loaded within the site limits. All trucks leaving the site shall be covered and cleaned of debris that might fall from the trucks during transport.
4. The Contractor shall take measures to prevent debris or water from being spilled from trucks or tracked from the site onto local streets. The Contractor shall sweep off-site streets as necessary or as directed by the Owner.

END OF SECTION

SECTION 312500

EROSION AND SEDIMENTATION CONTROL

(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this Section.

B. Erosion and Sedimentation Control Plan: Refer to the contract documents for the erosion and sedimentation control plan.

C. Inspection, Maintenance, and Housekeeping Plan: Refer to the inspection and maintenance procedures below.

D. Section 1-b – School Bid Depository Conditions and Regulations

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: Section 312000

B. Contract Drawings

1.03 DESCRIPTION OF WORK

A. The Contractor shall provide all materials, equipment, and labor necessary for the diversion of surface water from the construction area and make provisions for temporary and permanent erosion and sedimentation control structures and measures as shown on the plans and/or set forth in these Specifications.

B. Erosion and sedimentation controls shall be provided in accordance with these Specifications for all areas within the limits of this Contract where existing earth, vegetation and waterways will be disturbed by construction.

1.04 EROSION AND SEDIMENTATION CONTROL GUIDELINES

A. Installation of erosion control measures shall generally conform to procedures in the Maine Department of Environmental Protection publication dated March 2003 (or latest revision), "Maine Erosion and Sediment Control Best Management Practices".

1.05 CONFORMANCE WITH ENVIRONMENTAL LICENSING REQUIREMENTS

A. All construction under this project shall be subject to review and/or inspection by local, State, and Federal agencies for the adequacy of erosion and sedimentation control measures. The Contractor shall conform to the conditions of environmental permits or licenses, which are applicable to the project.

1.06 SUBMITTALS

A. For information only, the Contractor shall submit five copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including silt fencing, stormdrain inlet protection, erosion control blankets, and others as requested by the Engineer.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - MATERIALS

2.01 Seed, fertilizer and lime shall be as specified under Erosion Control Notes provided on Contract Drawings.

2.02 MULCH

A. Organic mulches including hay and straw need to be air-dried, free of undesirable seeds and coarse materials. Application rate shall be 2 bales (70-90 lbs) per 1000 square feet or 1.5 to 2 tons (90-100 bales) per acre. This type of mulch must be anchored with a tackifier amendment and/or via physical means (i.e. vehicle tracking, jute netting, etc…) to avoid displacement by wind or water.

2.03 STORMDRAIN INLET PROTECTION

A. Inlet protection shall be "Siltsack-Regular Flow" as distributed by ACF Environmental, Inc. or approved equal.

2.04 SILTATION FENCE

A. Siltation Fence: Fencing shall be "Envirofence" as manufactured by Tencate Mirafi or approved equal.

B. Support Fence: Siltation fabric shall be attached to metal or wooden posts. Fence with an integral support mesh and posts may be used.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Prior to grubbing, stripping, excavation, placement of fill, temporary or permanent placement of excavated materials, or other earthwork within the limits of this Contract, the Contractor shall implement erosion and sedimentation control measures as specified in the Erosion and Sedimentation Control Plan and/or as shown on the drawings.

B. Temporary measures for controlling erosion and sedimentation may include, but are not limited to, the following:

1. Siltation fencing around the downslope periphery of areas to be disturbed by construction.
2. Temporary seeding and mulching of soil stockpiles or disturbed areas.
3. Inlet Protection of the tributary stormdrain system
4. Stabilized construction entrance and egress locations
5. Other temporary practices as approved by the Engineer.

C. Permanent measures for controlling erosion and sedimentation shall be provided as shown on the plans or required by these Specifications.

D. Where disturbed areas cannot be permanently stabilized within 7 days of exposure of the soil, the areas shall be temporarily seeded and mulched as specified in the Erosion and Sedimentation Control Plan, or otherwise stabilized as approved by the Engineer.

E. Permanent soil stabilization measures for all slopes, channels, ditches, or any disturbed land areas adjacent to a protected natural resource shall be completed within 48 hours after final grading has been completed. Where such permanent erosion control measures are not possible or practical to implement, and upon approval by the Engineer, temporary stabilization practices shall be applied as in 3.01.D above.

F. All temporary and permanent control measures shall be periodically inspected and maintained by the Contractor for the duration of the construction and warranty period of this Contract, as outlined in the "Inspection, Maintenance and Housekeeping Plan." Sediment collection devices shall be cleaned periodically as required, and the removed material reused or disposed of at an approved disposal area.

3.02 DIVERTING SURFACE WATER

A. Build, maintain, and operate all cofferdams, channels, flumes, sumps, and other temporary diversion and protection works needed to divert surface water through or around the construction site and away from the construction work while construction is in progress.

B. Outlet diverted stormwater to sedimentation trap or basin or other approved sedimentation control measure.

3.03 SILTATION FENCE

A. Construct siltation fences at the locations and to the dimensions shown on the Drawings, and as required to meet specified criteria.

B. Prior to removal of the silt fence, all retained soil or other material shall be removed and disposed of at an approved disposal area.

3.04 INSPECTION AND MAINTENACE PROCEDURES

A. The following plan inspection and maintenance procedures are anticipated for the erosion and sedimentation control measures as well as stormwater management facilities for the project. These procedures also outline several housekeeping requirements that shall be followed during and after

construction. These procedures shall be followed in order to ensure the intended function of the designed measures and to prevent unreasonably adverse impacts to the surrounding environment.

B. The procedures outlined are provided as an overview of the anticipated practices to be used on this site. In some instances, additional measures may be required due to unexpected conditions. For additional detail on any of the erosion and sedimentation control measures or stormwater management devices to be utilized on this project, refer to the most recently revised edition of the "Maine Erosion and Sedimentation Control BMP" manual and/or the "Stormwater Management for Maine: Best Management Practices" manual as published by the Maine Department of Environmental Protection (MDEP).

C. Inspection: During the construction process, it is the Contractor's responsibility to comply with the inspection and maintenance procedures outlined in this section and the erosion and sedimentation control plan for the project. These responsibilities include inspecting disturbed and impervious areas, erosion control measures, materials storage areas that are exposed to precipitation, and locations where vehicles enter or exit the site. These areas shall be inspected at least once a week as well as before and after a storm event, and prior to completing permanent stabilization measures. A person with knowledge of erosion and stormwater control, including the standards and conditions in any applicable permits, shall conduct the inspections.

D. Maintenance: All measures shall be maintained in an effective operating condition until areas are permanently stabilized. If Best Management Practices (BMPs) need to be maintained or modified, additional BMPs are necessary, or other corrective action is needed, implementation must be completed within 7 calendar days and prior to any storm event (rainfall).

E. Documentation: A log summarizing the inspections and any corrective action taken must be maintained on-site. Correction action shall be performed in general conformance with the Maine Construction General Permit and Maine DEP Chapter 500 Stormwater standards. The log must include the name(s) and qualifications of the person making the inspections, the date(s) of the inspections, and major observations about the operation and maintenance of erosion and sedimentation controls, material storage areas, and vehicle access points to the site. Major observations must include BMPs that need maintenance, BMPs that failed to operate as designed or proved inadequate for a particular location, and locations where additional BMPs are needed. For each BMP requiring maintenance, BMP needing replacement, and location needing additional BMPs, note in the log the corrective action taken and when it was taken. The log must be made accessible to the appropriate regulatory agency upon request. The permittee shall retain a copy of the log for a period of at least three years from the completion of permanent stabilization.

F. Specific Inspection and Maintenance Tasks: The following is a list of erosion control and stormwater management measures and the specific inspection and maintenance tasks to be performed during construction.

1. Filter Berms:
   a. Hay bale barriers, silt fences, and filter berms shall be inspected immediately after each rainfall and at least daily during prolonged rainfall.
   b. If the fabric on a silt fence or filter barrier should decompose or become ineffective prior to the end of the expected usable life and the barrier is still necessary, it shall be replaced.
   c. Sediment deposits should be removed after each storm event. They must be removed before deposits reach approximately one-half the height of the barrier.
   d. Filter berms shall be reshaped as needed.
   e. Any sediment deposits remaining in place after the silt fence or filter barrier is no

longer required should be dressed to conform to the existing grade, prepared, and seeded.

1. Stone Check Dams:
   a. Inspect the center of the dam to make sure it is lower than the edges. Erosion caused by high flows around the edges of the dam must be corrected.
   b. Sediment accumulation shall be removed prior to reaching half of the original design height.
   c. Areas beneath stone check dams must be seeded and mulched upon removal.
2. Riprap Materials:
   a. Once a riprap installation has been completed, it should require very little maintenance. It shall, however, be inspected periodically to determine if high flows have caused scour beneath the riprap or dislodged any of the stone.
3. Erosion Control Blankets:
   a. Inspect these reinforced areas semi-annually and after significant rainfall events for slumping, sliding, seepage, and scour. Pay close attention to unreinforced areas adjacent to the erosion control blankets, which may experience accelerated erosion.
   b. Review all applicable inspection and maintenance procedures recommended by the specific blanket manufacturer. These tasks shall be included in addition to the requirements of this plan.
4. Stabilized Construction Entrances/Exits:
   a. The exit shall be maintained in a condition that will prevent tracking of sediment onto public rights-of-way.
   b. When the control pad becomes ineffective, the stone shall be removed along with the collected soil material. The entrance should then be reconstructed.
   c. Areas that have received mud-tracking or sediment deposits shall be swept or washed. Washing shall be done on an area stabilized with aggregate, which drains into an approved sediment-trapping device (not into storm drains, ditches, or waterways).
5. Temporary Seed and Mulch:
   a. Mulched areas should be inspected after rain events to check for rill erosion.
   b. If less than 90% of the soil surface is covered by mulch, additional mulch shall be applied in bare areas.
   c. In applications where seeding and mulch have been applied in conjunction with erosion control blankets, the blankets must be inspected after rain events for dislocation or undercutting.
   d. Mulch shall continue to be reapplied until 95% of the soil surface has established temporary vegetative cover.
6. Stabilized Temporary Drainage Swales:
   a. Sediment accumulation in the swale shall be removed once the cross section of the swale is reduced by 25%.
   b. The swales shall be inspected after rainfall events. Any evidence of sloughing of the side slopes or channel erosion shall be repaired and corrective action should be taken to prevent reoccurrence of the problem.
   c. In addition to the stabilized lining of the channel (i.e. erosion control blankets), stone check dams may be needed to further reduce channel velocity.

G. Housekeeping: The following general performance standards apply to the proposed project.

1. Spill prevention: Controls must be used to prevent pollutants from being discharged from materials on-site, including storage practices to minimize exposure of the materials to stormwater, and appropriate spill prevention, containment, and response planning

and implementation. A Spill, Prevention, Control and Countermeasures Plan is created for the project and is to be kept onsite at all times.

2. Groundwater protection: During construction, liquid petroleum products and other hazardous materials with the potential to contaminate groundwater may not be stored or handled in areas of the site draining to an infiltration area. An "infiltration area" is any area of the site that by design or as a result of soils, topography and other relevant factors, accumulates runoff that infiltrates into the soil. Dikes, berms, sumps, and other forms of secondary containment that prevent discharge to groundwater may be used to isolate portions of the site for the purposes of storage and handling of these materials.
3. Fugitive sediment and dust: Actions must be taken to insure that activities do not result in noticeable erosion of soils or fugitive dust emissions during or after construction. Oil may not be used for dust control.

4. Debris and other materials: Litter, construction debris, and chemicals exposed to stormwater must be prevented from becoming a pollutant source.
5. Trench or foundation dewatering: Trench dewatering is the removal of water from trenches, foundations, cofferdams, ponds, and other areas within the construction area that retain water after excavation. In most cases, the collected water is heavily silted and hinders correct and safe construction practices. The collected water must be removed from the ponded area, either through gravity or pumping, and must be spread through natural wooded buffers or removed to areas that are specifically designed to collect the maximum amount of sediment possible, like a cofferdam sedimentation basin. Avoid allowing the water to flow over disturbed areas of the site. Equivalent measures may be taken if approved.

3.04 REMOVAL OF TEMPORARY WORKS

A. Temporary measures shall be removed and the ground surface shall be leveled smooth and graded to the extent required to present a sightly appearance and to prevent any obstruction of the flow of water or any other interference with the operation of or access to the permanent works.

END OF SECTION

SECTION 315000

EXCAVATION SUPPORT AND PROTECTION

(Trade Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 1-B – School Bid Depository Conditions and Regulations

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
3. Division 31 Section "Dewatering" for dewatering system for excavations.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of Maine, using performance requirements and design criteria indicated.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Monitor vibrations, settlements, and movements.

1.4 SUBMITTALS

A. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Other Informational Submittals:

1. Photographs: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.

2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

a. Note locations and capping depth of wells, if applicable.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at project site.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect/Engineer and Owner no fewer than five days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Architect/Engineer's or Owner's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
2. The geotechnical report is included elsewhere in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect/Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

1.7 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

G. Tiebacks: Steel bars, ASTM A 722/A 722M.

H. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on shop drawings and secure to soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

B. The installation and removal of sheeting shall be done with minimum vibrations to the ground. The work shall be controlled so that peak particle velocities, measured at adjacent structures, shall not exceed the “safe” limits recommended by the U.S. Bureau of Mines in Appendix B of BUMINES RI 8507. Vibration monitoring shall be performed by the Contractor and will be reviewed by the Architect/Engineer

3.4 TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect/Engineer.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
3. Repair or replace, as approved by Architect/Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION

SECTION 31 51 00

RAMMED AGGREGATE PIER® FOUNDATION SYSTEMS

PART 1: GENERAL REQUIREMENTS

1.01 Description

Work shall consist of designing, furnishing and installing Rammed Aggregate Pier foundations to the lines and grades designated on the project foundation plan and as specified herein. The aggregate piers shall be constructed by driving a hollow mandrel to the design depth and vertically ramming lifts of aggregate using a specially designed tamper head and high-energy impact densification equipment to create a compacted aggregate pier. The Rammed Aggregate Pier elements shall be in a columnar-type configuration and shall be used to improve ground conditions for support of foundation loads.

1.02 Work Included

A. Provision of all equipment, material, labor, and supervision to design and install Rammed Aggregate Pier elements. Design shall rely on subsurface information presented in the project geotechnical report. All work incidental to installation of Rammed Aggregate Pier elements shall be included, except footing excavation and subgrade preparation following aggregate pier installation which shall be provided by the General Contractor.

B. The Rammed Aggregate Pier design and installation shall adhere to all methods and standards described in this Specification.

C. Drawings and General Provisions of the Contract, including General and Supplemental Conditions, and Division 1 Specifications, apply to the work in this specification.

1.03 Approved Installers

A. The Rammed Aggregate Pier Installer (the Installer) shall be approved by the Geotechnical Engineer of Record (Owner's Engineer) prior to bid opening.

B. Installers of Rammed Aggregate Pier foundation systems shall have a minimum of 5 years of experience with the installation of Rammed Aggregate Pier systems and shall have completed at least 50 projects.

C. Installers licensed by the Geopier Foundation Company, Inc. (www.geopier.com) will be accepted as approved Installers.

1.04 Reference Standards

A. Design

1. "Control of Settlement and Uplift of Structures Using Short Aggregate Piers," by Evert C. Lawton (Assoc. Prof., Dept. of Civil Eng., Univ. of Utah), Nathaniel S. Fox (President, Geopier Foundation Co., Inc.), and Richard L. Handy (Distinguished Prof. Emeritus, Iowa State Univ., Dept. of Civil Eng.), reprinted from *IN-SITU DEEP SOIL IMPROVEMENT, Proceedings of sessions sponsored by the Geotechnical Engineering Division/ASCE in conjunction with the ASCE National Convention held October 9-13, 1994, Atlanta, Georgia*.

2. "Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers," by Evert C. Lawton and Nathaniel S. Fox. *Geotechnical Special Publication No. 40: Vertical and Horizontal Deformations of Foundations and Embankments,* ASCE, 2, 962-974.

3. "Behavior of Geopier®-Supported Foundation Systems during Seismic Events," by Kord Wissmann, Evert C. Lawton, and Tom Farrell. Geopier Foundation Company, Inc. Blacksburg, VA ©1999.

B. Modulus Testing

1. ASTM D 1143 - Pile Load Test Procedures
2. ASTM D 1194 - Spread Footing Load Test

C. Materials and Inspection

1. ASTM D 1241 - Aggregate Quality
2. ASTM D 422 - Gradation of Soils

D. Where specifications and reference documents conflict, the Rammed Aggregate Pier Designer shall make the final determination of the applicable document.

1.05 Certifications and Submittals

A. Design Calculations - The Installer shall submit detailed design calculations and construction drawings for review and approval by the Owner and Owner's Engineer. All plans shall be sealed by a Professional Engineer licensed in the State of Maine.

B. Professional Liability Insurance - The Installer shall have Errors and Omissions design insurance providing a minimum coverage of $5 million per occurrence.

C. Modulus Test Reports – A modulus test(s) shall be performed on a non-production Rammed Aggregate Pier element to verify the design assumptions. The Installer shall furnish the General Contractor a description of the installation equipment, installation records, complete test data, analysis of the test data and verification of the design parameter values based on the modulus test results. The report shall be prepared under direction of a Professional Engineer licensed in the State of Maine.

D. Daily Rammed Aggregate Pier Progress Reports – The Installer shall furnish a complete and accurate record of Rammed Aggregate Pier installation to the General Contractor. The record shall indicate the pier location, length, volume of aggregate used or number of lifts, densification forces during installation, and final elevations or depths of the base and top of piers. The record shall also indicate the type and size of the installation equipment used, and the type of aggregate used. The Installer shall immediately report any unusual conditions encountered during installation to the General Contractor, Owner's Engineer and Owner's Testing Agency, with written notification within 24 hours.

E. Material Submittals: Installer shall submit aggregate materials to Owner's Engineer for approval prior to use on-site.

PART 2: MATERIALS

2.01 Aggregate

A. Aggregate used by the Rammed Aggregate Pier Installer for pier construction shall be pre-approved by the Owner's Engineer and shall demonstrate suitable performance during modulus testing. Typical aggregate consists of Type 1 Grade B in accordance with ASTM D-1241-68, No. 57 stone, recycled concrete or other graded aggregate approved by the Owner's Engineer.

B. Potable water or other suitable source shall be used to increase aggregate moisture content where required. The General Contractor shall provide such water to the Installer.

PART 3: DESIGN REQUIREMENTS

3.01 Rammed Aggregate Pier Design

A. The design of the Rammed Aggregate Pier system shall be based on the service load bearing pressure and the allowable total and differential settlement criteria of all footings indicated by the design team for support by the Rammed Aggregate Pier system. The Rammed Aggregate Pier system shall be designed in accordance with generally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design life of the structure shall be 100 years.

B. The design shall meet the following criteria.

Maximum Allowable Bearing Pressure for Footings supported by Rammed Aggregate Pier Reinforced Soils	3,000 psf
Estimated Total Long-Term Settlement for Footings:	≤ 1-inch
Estimated Long-Term Differential Settlement of Adjacent Footings:	≤ ½-inch
Minimum Tip Elevation (project datum)	Elev 234 feet

C. The Rammed Aggregate Pier elements shall be designed using a Rammed Aggregate Pier stiffness modulus to be verified by the results of the modulus test described in Section 5.02 of these specifications.

3.02 Design Submittal

The Installer shall submit detailed design calculations, construction drawings, and shop drawings, (the Design Submittal), for approval at least 2 week(s) prior to mobilization. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal. Additionally, the quality control test program for Aggregate Pier system, meeting these design requirements, shall be submitted. All computer-generated calculations and drawings shall be prepared and sealed by a Professional Engineer, licensed in the State of Maine. Submittals will be submitted electronically unless otherwise required by specific submittal instructions.

PART 4: EXECUTION

4.01 Approved Installation Procedures

The following sections provide general criteria for the construction of the Rammed Aggregate Pier elements. Unless otherwise approved by the Owner's Engineer, the installation method used for Rammed Aggregate Pier construction shall be that as used in the construction of the successful modulus test.

A. Displacement Rammed Aggregate Pier systems shall be constructed by advancing a specially designed mandrel with a minimum 15 ton static force augmented by dynamic vertical ramming energy to the full design depth. The hollow-shaft mandrel, filled with aggregate, is incrementally raised, permitting the aggregate to be released into the cavity, and then lowered by vertically advancing and/or ramming to densify the aggregate and force it laterally into the adjacent soil. The cycle of raising and lowering the mandrel is repeated to the top of pier elevation. The cycle distance shall be stated in the Design Submittal.

B. Special high-energy impact densification apparatus shall be employed to vertically densify the Rammed Aggregate Pier elements during installation of each constructed lift of aggregate.

C. Densification shall be performed using a mandrel/tamper. The mandrel/tamper foot is required to adequately increase the lateral earth pressure in the matrix soil during installation.

D. Downward crowd pressure shall be applied to the mandrel during installation.

E. Alternative installation methods shall be approved by the Owner's Engineer prior to bidding.

4.02 Plan Location and Elevation of Rammed Aggregate Pier Elements

The as-built center of each pier shall be within 3 inches of the locations indicated on the plans. Piers installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Owner.

4.03 Rejected Rammed Aggregate Pier Elements

Rammed Aggregate Pier elements installed beyond the maximum allowable tolerances shall be abandoned and replaced with new piers, unless the Installer provides other remedial measures. All material and labor required to replace rejected piers shall be provided at no additional cost to the Owner, unless the cause of rejection is due to an obstruction.

PART 5: QUALITY CONTROL

5.01 Control Technician

The Installer shall have a full-time, on-site Control Technician to verify and report all installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Owner's Engineer, the General Contractor, and to the Owner's Testing Agency.

5.02 Rammed Aggregate Pier Modulus Test

At least two (2) Rammed Aggregate Pier Modulus Tests will be performed at locations agreed upon by the Owner's Engineer, Owner and General Contractor to verify or modify Rammed

Aggregate Pier designs. Modulus Test Procedures shall utilize appropriate portions of ASTM D 1143 and ASTM D 1194, as outlined in the Rammed Aggregate Pier design submittal.

5.03 Bottom Stabilization Testing (BSTs) / Crowd Stabilization Testing (CSTs)

Bottom stabilization testing (BSTs) or Crowd stabilization testing (CSTs) shall be performed by the Control Technician during the installation of the modulus test pier. Additional testing shall be performed on at least 10% of production Rammed Aggregate Pier elements, at locations agreed upon by the Owner's Engineer and Installer, to compare results with the modulus test pier.

PART 6: QUALITY ASSURANCE AND QUALITY CONTROL

6.01 Installer's QC and Owner's QA

The Rammed Aggregate Pier Installer shall provide full-time Quality Control monitoring of Rammed Aggregate Pier construction activities. The Owner shall retain Geotechnical Engineer of Record to serve as Owner's Testing Agency to provide Quality Assurance services during Rammed Aggregate Pier installation and load testing.

6.02 Responsibilities of Owner's Testing Agency

A. The Owner's Testing Agency shall monitor the modulus test pier installation and testing. The Installer shall provide and install all dial indicators and other measuring devices.

B. The Owner's Testing Agency shall monitor the installation of Rammed Aggregate Pier elements to verify that the production installation practices are similar to those used during the installation of the modulus test elements.

C. The Owner's Testing Agency shall report any discrepancies to the Installer, General Contractor and Owner's Engineer, immediately and in-writing within 24 hours.

D. The Owner's Testing Agency shall observe the excavation, compaction and preparation of foundation bearing surfaces as described in Section 7.05.

PART 7: RESPONSIBILITIES OF THE GENERAL CONTRACTOR

7.01 Site Preparation and Protection

A. The General Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the Rammed Aggregate Pier elements.

B. Site grades for Rammed Aggregate Pier installation shall be within 1 foot of the bottom of footing elevation or within 2 feet of finished floor elevation to minimize Rammed Aggregate Pier installation depths. Ground elevations and bottom of footing elevations shall be provided to the Rammed Aggregate Pier Installer in sufficient detail to estimate installation depth elevations to within 3 inches.

C. The General Contractor will provide site access to the Installer, after earthwork in the area has been completed. A working surface shall be established and maintained by the General Contractor to provide wet weather protection of the subgrade and to provide access for efficient operation of the Rammed Aggregate Pier installation.

D. Prior to, during and following Rammed Aggregate Pier installation, the General Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.

E. Remove excavation spoils from the Rammed Aggregate Pier work area in a timely manner to prevent interruption of Rammed Aggregate Pier installation.

7.02 Rammed Aggregate Pier Layout

The location of Rammed Aggregate Pier-supported foundations for this project, including layout of individual Rammed Aggregate Pier elements, shall be marked in the field by the General Contractor using survey stakes/wiskers or similar means at locations shown on the drawings.

7.03 Contractor's / Owner's Independent Testing Agency (Owner's Quality Assurance)

Owner is responsible for engaging Owner's Testing Agency to provide Quality Assurance services as described in this specification. The Aggregate Pier Installer will provide Quality Control services as described in this specification.

7.04 Excavation of Obstructions

A. Should any obstruction be encountered during Rammed Aggregate Pier installation, the General Contractor shall be responsible for promptly removing such obstruction, or the pier shall be relocated or abandoned. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., which shall prevent placing the piers to the required depth, or shall cause the pier to drift from the required location.

B. Dense natural rock or weathered rock layers shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials.

C. Compacted Fill shall not be deemed obstructions and the Rammed Aggregate Pier Installer shall pre-drill or spud as necessary to install piers.

7.05 Utility Excavations

The General Contractor shall coordinate all excavations made subsequent to Rammed Aggregate Pier installations so that excavations do not encroach on the piers as shown in the Rammed Aggregate Pier construction drawings. Protection of completed Rammed Aggregate Pier elements is the responsibility of the General Contractor. In the event that excavations are required in close proximity to the installed Rammed Aggregate Pier elements, the General Contractor shall contact the Rammed Aggregate Pier Designer immediately to develop construction solutions to minimize impacts on the installed Aggregate Pier elements.

7.06 Footing Bottoms

A. Excavation and surface compaction of all footings shall be the responsibility of the General Contractor.

B. Foundation excavations to expose the tops of Rammed Aggregate Pier elements shall be made in a workman-like manner, and shall be protected until concrete placement, with procedures and equipment best suited to (1) avoid exposure to water, (2) prevent softening of the matrix soil between and around the Rammed Aggregate Pier elements before pouring structural concrete, and (3) achieve direct and firm contact between the dense, undisturbed Rammed Aggregate Pier elements and the concrete footing.

C. All excavations for footing bottoms supported by Rammed Aggregate Pier foundations shall be prepared in the following manner by the General Contractor. Recommended procedures for achieving these goals are to:

1. Limit over-excavation below the bottom of the footing to 6-inches using a smooth edged bucket and install 6-inches of Crushed Stone or Structural Fill in accordance with the project geotechnical report.
2. Compaction of crushed stone and top of Rammed Aggregate Pier elements shall be prepared using a motorized impact compactor ("Wacker Packer," "Jumping Jack," or similar). Sled-type tamping devices shall only be used in granular soils and when approved by the designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed, respectively. The surface of the aggregate pier shall be recompacted prior to completing footing bottom preparation.
3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on moisture-sensitive soils. If same day placement of footing concrete is not possible, open excavations shall be protected from surface water accumulation.

D. The following criteria shall apply, and a written inspection report sealed by the Owner's Testing Agency shall be furnished to the Installer to confirm:

1. That water (which may soften the unconfined matrix soil between and around the Rammed Aggregate Pier elements, and may have detrimental effects on the supporting capability of the Rammed Aggregate Pier reinforced subgrade) has not been allowed to pond in the footing excavation at any time.
2. That all Rammed Aggregate Pier elements designed for each footing have been exposed in the footing excavation.
3. That immediately before footing construction, the tops of Rammed Aggregate Pier elements exposed in each footing excavation have been inspected and recompacted as necessary with mechanical compaction equipment.
4. That no excavations (elevator, etc) have been made after installation of Aggregate Pier elements within the excavation limits described in the Rammed Aggregate Pier construction drawings, without the written approval of the Installer or Designer.

E. Failure to provide the above inspection and certification by the Testing Agency, which is beyond the responsibility of the Rammed Aggregate Pier Installer, may void any written or implied warranty on the performance of the Rammed Aggregate Pier system.

PART 8: PAYMENT

8.01 Method of Measurement

A. Measurement of the aggregate piers is on a lump sum basis.

B. Payment shall cover design, supply and installation of the aggregate pier foundation system. Excavation of unsuitable materials or obstructions, as documented and approved by the Owner or Owner's Engineer, shall be paid for under separate pay items.

8.02 Basis of Payment

A. The quantities of piers accepted in the Installer's Design Submittal will be paid in lump sum fee per approval of in-place aggregate-pier. Payment will be made under:

Pay Item:	Pay Unit:
Preparation of plans and specifications, mobilization and all labor, equipment, materials and supplied to install rammed aggregate pier elements	$_____ Lump Sum

B. Unit prices shall be provided for the following additional work as approved by the Owner:

Additional Installed Piers	$____ Each
Additional Mobilization	$____ Each
Additional Modulus or Uplift Load Tests	$____ Each

SECTION 321216

ASPHALT PAVING
(Trade Bid Required)

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes hot-mix asphalt paving, patching and overlay.

1.02 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations

1.03 REFERENCE STANDARDS

A. Maine Department of Transportation (MDOT) 2014 Edition

1. Standard Specifications, Revision of November 2014 (and as amended)

B. American Association of State Highway and Transportation Officials (AASHTO)

1. M140 - Standard Specification for Emulsified Asphalt Nineteenth Edition; Revised Per Interim Specifications - Specifications - 1999 R(1998)
2. M226 -Standard Specification for Viscosity Graded Asphalt Cement Nineteenth Edition R(1996)
3. T245 - Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus Nineteenth Edition; ASTM D1559-76

C. American Society for Testing and Materials (ASTM)

1. D1559 – Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
2. D2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
3. D2171 – Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer (RAP Asphalt Mixes)

D. Asphalt Institute (AI)

1. MS-2 – Mix Design Method for Asphalt Concrete and Other Hot Mix Types
2. MS-22 – Principles of Construction of Hot-Mix Asphalt Pavement, Addendum

1.04 SUBMITTALS

A. Job Mix Designs: Contractor shall submit a mix design using either the “Marshall Stability” or “Superpave” Mix Design Submittal Forms, included in this specification, for each pavement course proposed for construction for the Owner’s review and approval 45 days prior to schedule production and placement of the mix.

B. "Marshall Stability" design mix submittals shall include type/name of mix, gradation analysis, grade of asphalt cement, Marshall Stability in pounds flow, effective asphalt content in percent (%), and corresponding copies of the Maine Department of Transportation (MDOT) material specifications.

C. "Superpave" design mix submittals may be submitted in lieu of a "Marshall Stability" design mix, meeting the specifications of the Maine Department of Transportation.

D. Material Certificates: Contractor shall submit certificates stating that asphalt mix to be supplied complies with the specifications of the Maine Department of Transportation, as well as copies the regulatory specifications corresponding to the asphalt mix formula and material. The certificates shall be signed by the asphalt mix producer and the Contractor.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction and the MDOT.

B. Regulatory Requirements: Comply with applicable standards and requirements of the regulatory authority having jurisdiction and MDOT for asphalt paving work.

C. Asphalt-Paving Publication: Comply with Asphalt Institute Manual MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

D. Paving Contractor: Paving contractor shall be listed in the MDOT prequalified contractor list for for paving projects and shall be valid at time of paving operations.

1.06 PROJECT CONDITIONS

A. Environmental/Weather Limitations: Do not apply or produce asphalt materials if the underlying course is wet or excessively damp, the subgrade or base course is frozen, during rainy weather, or if the air temperature, measured in the shade away from artificial heat at the location of the paving operations, does not meet the following requirements:

1. Tack Coat and Prime Coat: Minimum ambient temperature in the shade is 40 degree F and rising, immediately prior to application;
2. Asphalt Base Course: Minimum surface temperature of 40 degree F and rising at time of placement;
3. Asphalt Binder (Intermediate) Course: Minimum surface temperature of 40 degree F and rising at the time of placement; and,
4. Asphalt Surface Course: Minimum surface temperature is above 50 degree F at time of placement.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 ASPHALT MATERIALS

A. Asphalt Cement – The type and grade of asphalt cement for the paving mixture shall comply with the applicable requirements of AASHTO Specification M226, Table 2, and meet MDOT specifications.

B. Prime Coat - emulsified asphalt applications shall meet the requirements of AASHTO M140, and the MDOT specifications.

C. Tack Coat - emulsified asphalt applications shall meet the requirements of AASHTO M140 and meet MDOT specifications.

D. Hot Mix Asphalt – Per MDOT approved mix.

PART 3 - EXECUTION

3.01 COLD MILLING

A. Milling of existing asphalt pavement shall be at the depth and location as indicated on the Construction Drawings or as directed by the Owner.

B. The milled surface shall be reasonably smooth and free of excessive scarification marks, gouges, ridges, continuous grooves, or other damage. The milled pavement surface shall be thoroughly cleaned of all loose aggregate particles, dust, and other objectionable material by the use of power brooms, power blowers, power vacuums or other means.

C. The Contractor shall coordinate the adjustment of manholes, meter boxes, drainage inlets, and valve boxes with the milling operation.

D. All milled material shall become the property of the Contractor and shall be disposed of off-site or used in conformance with Section 312000, Earthwork, or for utilization as Reclaimed Asphalt Pavement, in conformance with the specification provided above, as approved by the Owner.

3.02 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated or directed by the Owner. Re-compact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 gal/sy. For patching where base or intermediate pavement is present, provide horizontal tack coat.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix, and while it is still hot, compact flush with adjacent surface.

3.03 SURFACE PREPARATION

A. Proofroll crushed aggregate base in conformance with Section 312000 Earthwork, immediately prior to paving.

B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared substrate surface is ready to receive paving. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 gal./sy.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving; and,

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3. Adequate traffic control shall be provided to prohibit traffic from traversing applied area.

4. Any foreign matter on tack coat is to be removed and area re-tacked before applying pavement.

D. Prime Coat: Apply uniformly to non-asphalt surfaces when specified on the drawings at a rate of .20 Gal/Sy.

3.04 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

B. Spread mix at minimum temperature of 275°F and maximum temperature of 325°F.

C. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

D. Place paving in consecutive strips not less than 10 feet wide unless infill or edge strips of a lesser width are required. Joint patterns shall be constructed parallel to traffic flow.

E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.05 COMPACTION

A. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct lay-down and rolling operations to comply with requirements.

B. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density.

C. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

D. Protection: After final rolling, erect barricades to protect paving from traffic until pavement has cooled and hardened.

E. Density: Compare density of in-place material against laboratory specimen of same mixture, subjected to 50 blows of a Standard Marshall hammer on each side of specimen. Minimum acceptable density of in-place material shall be:

1. Density: 95% of reference maximum theoretical density according to ASTM D2041 for binder (intermediate) and surface courses.
2. Density: 95% ± 2.5% of reference maximum theoretical density according to ASTM D2041 for base courses.

3.06 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: ±1/4 inch;
2. Binder (Intermediate) Course: ±1/4 inch; and,
3. Surface Course: ± 1/4 inch.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch;
2. Binder (Intermediate) Course: 1/4 inch; and,
3. Surface Course: 1/4 inch.

C. Contractor's duties relating to testing include:

1. Notify Owner 72 hours prior to asphalt paving;
2. Notifying laboratory of conditions requiring testing; and
3. Coordinate with laboratory for field testing.

3.07 DISPOSAL

A. Except for material indicated to be recycled, remove excavated or milled materials from Project site and legally dispose of them in an EPA-approved landfill.

3.08 QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests, inspections, and to prepare test reports. Testing agency shall be paid by the Owner.

B. The Owner shall pay for and have testing agency take two 4-inch diameter cores per 10,000 sq. yds. of intermediate course, at locations selected by Owner, for thickness tests. Contractor shall repair holes resulting from coring to match existing paving. The Owner reserves the right to take

additional testing and should these tests show insufficient thickness, all areas shall be remediated as prescribed by the Owner.

C. The Owner shall provide on-site density testing at random locations during paving operations for all proposed asphalt courses.

D. The Contractor may be required to remove and replace hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements, at not cost to the Owner.

END OF SECTION

SECTION 321217

ASPHALT TREATED PERMEABLE BASE
(Maine DOT Special Provision Section 404)
(Trade Bid Required)

PART 1 – GENERAL

1.1 DESCRIPTION

A. The Contractor shall furnish and place one or more courses of Asphalt Treated Permeable Base (ATPB) on an approved base in accordance with the contract documents and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the plans.

1.2 RELATED DOCUMENTS

A. School Bid Depository Conditions and Regulations

1.3 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Materials shall meet the following requirements from Maine DOT Standard Specification November 2014 Edition:

Performance Graded Asphalt Binder and Section 702.01	**PGAB 76-28, modified with SBS polymer**
Aggregates for ATPB	Table 2 of this Special Provision

2.2 COMPOSTION OF MIXTURES

A. The Contractor shall compose the Asphalt Treated Permeable Base with aggregate, Performance Graded Asphalt Binder (PGAB), and mineral filler if required. The Contractor shall size, uniformly grade, and combine the aggregate fractions in proportions that provide a mixture meeting the grading requirements specified, and the requirements in Table 1.

B. The Contractor shall submit for review and approval, a Job Mix Formula (JMF) that has been reviewed and approved by the MaineDOT Central Laboratory in Bangor. The JMF shall state the original source, gradation, and percentage to be used of each portion of the aggregate. It shall also state the proposed PGAB content, proposed mixing and compaction temperatures, the name and location of the refiner, the

supplier, the source of PGAB submitted for approval, the type of PGAB modification if applicable, and the location of the terminal if applicable. The Department shall then have 15 calendar days in which to process the design before approval. At the time of JMF submittal, the Contractor shall identify and make available the stockpiles of all proposed aggregates at the plant site. There must be a minimum of 135 Mg [150 ton] for stone stockpiles before the Department will sample. The Department shall obtain samples for laboratory testing. The Contractor shall also make available to the Department the PGAB proposed for use in the mix in sufficient quantity to test the properties of the asphalt and to produce samples for testing of the mixture.

C. Performance Graded Asphalt Binder Unless otherwise noted in Special Provision 403 - Hot Bituminous Pavement, PGAB shall be 76 – 28, modified with SBS polymer. The PGAB shall meet the applicable requirements of AASHTO M320 - Standard Specification for PGAB. The Contractor shall provide the Department with an approved copy of the Quality Control Plan for PGAB in accordance with AASHTO R 26-01 Certifying Suppliers of PGAB. The Contractor shall request approval from the Department for a change in PGAB supplier or source by submitting documentation stating the new supplier or source a minimum of 24 hours prior to the change. In the event that the PGAB supplier or source is changed, the Contractor shall make efforts to minimize the occurrence of PGAB co-mingling.

Sufficient PGAB shall be used in the mixture such that at least 95 percent of the aggregate particles are completely coated with binder as determined by AASHTO T 195. In addition, when compacted in a gyratory compactor for 35 gyrations, the resulting specimen shall be stable and must not fall apart under its own weight.

Table 1 – ASPHALT TREATED PERMEABLE BASE DESIGN CRITERIA

PGAB content	2.0 percent minimum
Mixing temperature range	290°F – 350°F Or as per PGAB supplier
PGAB Grade	PG 76-28

Table 2: AGGREGATE REQUIREMENTS

GRADATION REQUIREMENTS	
Sieve Designation	Percentage by Weight Passing Square Mesh Sieves (Combined Aggregate)
37.5 mm	100
25 mm	95 – 100
19 mm	80 – 95
12.5 mm	35 – 70
4.75 mm	2 – 10
2.36 mm	0 – 5
0.075 mm	0 – 2.0

AGGREGATE QUALITIES	
AASHTO T 327 Micro-Deval	18.0 maximum
ASTM D5821 Coarse Aggregate Angularity (Minimum)	85/80
ASTM D4791 (8.4) Flat and Elongated Particles (Maximum)	10

ASTM D5821 - "85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two fractured faces.

ASTM 4791 - Criteria are presented as maximum percent by weight of flat and elongated particles (5:1 ratio).

PART 3 – EXECUTION

3.1 EQUIPMENT

A. Permeable Base shall be produced and placed with equipment meeting the following requirements of Maine DOT Standard Specification November 2014 Edition, Section 401 of the Special Provisions:

Hot Mix Asphalt Plant	401.07
Hauling Equipment	401.08
Pavers	401.09
Rollers	401.10

3.2 WEATHER LIMITATIONS

A. Permeable Base shall only be placed between the dates of May 1st and the Saturday following October 1st provided that the air temperature as determined by an approved thermometer (placed in the shade at the paving location) is 10°C [50°F] or higher and the base to paved upon is 60°F or higher..

3.3 CONSTRUCTION REQUIREMENTS

A. A test strip shall be constructed prior to the placement of ATPB on the project. The test strip will be constructed offsite to establish the proper mix design, production, placement, and compaction procedures for this contract prior to full plant production and placement on the project site.

1. The test strip shall consist of a 20 ton minimum quantity. The Contractor shall work cooperatively with the Department to develop the mix gradation and asphalt content, and shall notify the Department within 48 hours prior to their intent to construct the test strip. The Contractor shall provide the Department with two mix samples from the test strip produced material for mix verification. The samples shall be tested for conformance to the contract requirements before further production. In addition to the mix samples, a minimum of three cores will be sampled from the test strip, and shall be evaluated for density, porosity, and asphalt coating.

2. The mix samples, when compacted in a gyratory compactor for 35 gyrations, shall result in a specimen that is porous, and stable, and not fall apart under its own weight when removed from the

gyratory compactor. Sufficient PGAB shall be used in the mixture such that at least 95 percent of the aggregate particles are completely coated with binder as determined by AASHTO T 195. In the event that the cores or gyratory compacted samples do not meet the requirements set forth in this specification, mixture gradation and asphalt contents will be adjusted and new test strips will be required until the requirements are met. Any modifications to the mixture shall be submitted as a change to the JMF by contract modification.

There will be no separate payment for material placed in a offsite test strip, but shall be considered incidental to the 404.30 - Asphalt Treated Permeable Base item.

ATPB mix production will not resume unless the Department is confident material meeting the contract requirements can be produced.

B. PREPARATION OF EXISTING SURFACE

1. The Contractor shall thoroughly clean the surface upon which Asphalt Treated Permeable Base is to be placed of all objectionable material. When the surface of the existing base is irregular, the Contractor shall bring it to uniform grade and cross section.

C. PREPARATION OF AGGREGATES

1. The Contractor shall dry and heat the aggregates for the ATPB to the required temperature. The Contractor shall properly adjust flames to avoid physical damage to the aggregate and to avoid depositing soot on the aggregate.

D. MIXING

1. The Contractor shall combine the dried aggregate in the mixer in the amount of each fraction of aggregate required to meet the JMF. The Contractor shall measure the amount of PGAB and introduce it into the mixer in the amount specified by the JMF. The Contractor shall produce the ATPB at the temperature established by the JMF. Once mixed, the ATPB must be placed as soon as possible. Storage of Asphalt Treated Permeable Base in surge hoppers or storage silos for a period exceeding 2 hours will not be allowed.

E. SPREADING AND FINISHING

1. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the Contractor shall spread, rake, and lute the ATPB with hand tools to provide the required compacted thickness. Solvent based agents developed to strip asphalts from aggregates will not be allowed as release agents.

2. On roadways with adjoining lanes carrying traffic, the Contractor shall place each course over the full width of the traveled way section being paved that day, unless otherwise directed by the Department.

3. Joints shall be fully coated with PGAB 64-28 just prior to the placement of the adjoining course. Areas that become contaminated or stripped of asphalt coating will be retreated with asphalt prior to placement of the adjoining course.

F. COMPACTION

1. The actual methods and equipment utilized to compact the ATPB will be determined during the placement and compaction of the offsite test strip.

2. Immediately after the Asphalt Treated Permeable Base has been spread, struck off, and any surface irregularities adjusted, the Contractor shall thoroughly and uniformly compact the ATPB by rolling. The ATPB shall be compacted by a minimum of three complete passes of a steel roller having a minimum weight of 12 tons operated in static mode, or 10 tons if equipped with oscillatory compaction and operated in low frequency, low amplitude mode, unless otherwise directed by the Department. When allowed by the Owner's representative, a light application of water may be applied to the ATPB during compaction. Pneumatic rollers will not be used to compact the ATPB.

3. The Contractor shall roll the surface when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, or shoving. The Contractor shall prevent adhesion of the ATPB to the rollers or vibrating compactors without the use of fuel oil or other petroleum, or solvent based release agents. Solvents designed to strip asphalt binders from aggregates will not be permitted as release agents on equipment, tools or ATPB surfaces. The Contractor shall immediately correct any displacement occurring as a result of the reversing of the direction of a roller or from other causes to the satisfaction of the Department. Any operation that results in breakdown of the aggregate shall be discontinued.

G. TRAFFIC

1. After a 24 hour curing period of the ATPB, limited traffic may be routed over the ATPB surface. Unless otherwise authorized by the Department, construction equipment, and traffic shall be prohibited from traveling over the ATPB surface until the entire pavement structure is in place, including the surface course. Damage to the ATPB layer caused by construction equipment or traffic shall be remedied by complete removal replacement of the damaged area to the limits determined by the Department. There will be no additional payment for repairs, or associated work.

Table 3. ACCEPTANCE LIMITS

Gradation	Table 2 Limits
PGAB content	JMF Target +/- 0.5 %

Part 4: TESTING AND ACCEPTANCE

4.1 ACCEPTANCE

A. The quantity of ATPB placed on the project shall be evaluated by Quality Level Analysis as described in Section 106 of the Standard Specifications, Revision of December 2002, using the gradation limits established in Table 3. A Lot shall consist of the entire quantity placed, and will be divided into four equal sublots. The Department will obtain samples of ATPB in conformance with AASHTO T168 Sampling Bituminous Paving Mixtures, and the MDOT/ ACM Sampling Policy, which will then be transported by the contractor in approved transport containers to the designated acceptance laboratory within 48 hours.

The Department will take two (2) full sample boxes randomly within each sublot. At this time, the contractor may obtain splits of the sample for testing. The mix will be tested for gradation and PGAB content. Disputes will be allowed for PGAB content only, as provided for in Section 401 of the Standard Specifications or special Provision 400. If the Percent within Limits for PGAB Content and percent passing the nominal maximum, 12.5 mm, 4.75 mm and 0.075 mm sieves are equal to or greater than a 90 PWL, the Department will pay 100% of the contract price. If any of these properties are less than 90 Percent within the limits, the following deductions shall apply to the Lot.

Nominal max., 12.5 mm, and 4.75 mm sieves	- 1 % each
0.075 mm sieve	- 2 %
PGAB content	- 2 %

Open Graded Friction Course
(Maine DOT Special Provision Section 404)

Part 1: General

1.1 DESCRIPTION

A. The Contractor shall furnish and place one or more courses of open-graded friction course (OGFC) on an approved base in accordance with the contract documents and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the plans. The Department will accept this work under Quality Assurance provisions, in accordance with the requirements of Section 106 – Quality, Section 401 – Hot Mix Asphalt Pavement, and this Special Provision.

PART 2: PRODUCTS

2.1 MATERIALS

A. Materials shall meet the following requirements from Maine DOT Standard Specification November 2014 Edition:

Performance graded asphalt binder	702.01
Aggregates for HMA Pavement	703.07, except as noted in Table 1.

B. Mineral Filler

1. Mineral filler shall consist of finely divided mineral matter such as rock or limestone dust or other suitable material. At the time of use it shall be sufficiently dry to flow freely and essentially free from agglomerations. Filler shall be free from organic impurities and have a plasticity index not greater than 4. Filler material for the mix shall meet AASHTO M17, except that the gradation requirements of M17 shall not apply.

C. Stabilizing additive

1. Stabilizing additive shall consist of a fiber stabilizer, either cellulose or mineral fiber. The dosage rate for cellulose shall be approximately 0.3 percent by total mixture mass and sufficient to prevent draindown. Cellulose fibers shall conform to the properties outlined in Table 2. For mineral fibers, the dosage rate shall be approximately 0.4 percent by total mixture mass and sufficient to prevent draindown. Mineral fibers shall conform to the properties of Table 3.

TABLE 1 - AGGREGATE REQUIREMENTS

Criteria	Test Method	Specified Minimum	Specified Maximum
Micro-Deval	AASHTO TP 58-99	-	18.0
Flat and Elongated, % 3 to 1			
	ASTM D4791	-	20

5 to 1	ASTM D4791	-	5
Fractured Faces, %			
One face	ASTM D5821	100	-
Two faces		90	-
Sand equivalent	AASHTO T176	50	-
Uncompacd Void Content of Fine Aggregate	AASHTO T304	45	-

TABLE 2 – Cellulose Fiber Properties

Property	Requirements
Method A - Alpine Sieve[1] Analysis Fiber Length Passing 0.150mm (No. 100) sieve	
	6 mm (0.25 in.) maximum
	70 ± 10%
Ash Content[2]	18 ± 5% non-volatiles
PH[3]	7.5 ± 1.0
Oil Absorbtion[4]	5.0 ± 1.0 (times fiber mass)
Moisture Content[5]	Less than 5.0% (by mass)

1 Alpine Sieve Analysis. This test is performed using an Alpine Air Jet Sieve (Type 200 LS). A representative five gram sample of fiber is sieved for 14 minutes at a controlled vacuum of 75 kPa (11 psi). The portion remaining on the screen is weighed.

2 Ash Content. A representative 2-3 gram sample of fiber is placed in a tared crucible and heated between 595° and 650°C (1100° and 1200° F) for not less than two hours. The crucible and ash are cooled in a desiccator and reweighed.

3 pH Test. Five grams of fiber is added to 100 ml of distilled water, stirred and let sit for 30 minutes. The pH is determined with a probe calibrated with pH 7.0 buffer.

4 Oil Absorption Test. Five grams of fiber is accurately weighed and suspended in an excess of mineral spirits for not less than five minutes to ensure total saturation. It is then placed in a screen mesh strainer (approximately 0.5 square millimeter hole size) and shaken on a wrist action shaker for ten minutes (approximately 1-¼ inch motion at 240 shakes/minute). The shaken mass is then transferred without touching, to a tared container and weighed. Results are reported as the amount (number of times it's own weight) the fibers are able to absorb.

[5] Moisture Content. Ten grams of fiber are weighed and placed in a 121° C (250 °F) forced air oven for two hours. The sample is then reweighed immediately upon removal from the oven.

TABLE 3 – Mineral Fiber Properties Mineral fibers[1]

	Sieve Analysis
Fiber Length[2]	6 mm (0.25in.) maximum mean test value
Thickness[3]	0.050 mm (0.0002 in.) maximum mean test value
	Shot Content[4]
0.250 mm (No. 60) Sieve	90 ± 5% passing
0.063 mm (No. 230) Sieve	70 ± 10% passing

[1] Fiber Thickness Fiber Length opean experience and development of the above criteria are based on the use of basalt mineral fibers.

[2] The fiber length is determined according to the Bauer McNett fractionation.

[3] The fiber thickness is determined by measuring at least 200 fibers in a phase contrast microscope.

[4] Shot content is a measure of non-fibrous material. The shot content is determined on vibrating sieves. Two sieves, the 0.250 mm (No. 60) and the 0.063 mm (No. 230) are typically utilized. For additional information, see ASTM C612.

2.2 COMPOSITION OF MIXTURES

A. The Contractor shall compose the open-graded friction course with aggregate, Performance Graded Asphalt Binder (PGAB), stabilizing fibers and mineral filler if required. OGFC shall be designed and tested according to AASHTO R35 and the requirements listed in Tables 4 and 5. The Contractor shall size, uniformly grade, and combine the aggregate fractions in proportions that provide a mixture meeting the grading requirements of the Job Mix Formula (JMF).

B. The Contractor shall submit for Department approval a JMF to the Central Laboratory in Bangor for each mixture to be supplied. The Department shall then have 15 calendar days in which to process a new design before approval. The JMF shall establish a single percentage of aggregate passing each required sieve size within the limits shown in Table 4. The general composition limits given in Table 4 indicate the control points of mixtures permissible under this specification. The JMF shall state the source, gradation, and percentage to be used of each portion of the aggregate and mineral filler if required. It shall also state the proposed PGAB content, the name and location of the refiner, the supplier, the source of PGAB submitted for approval, the type of PGAB modification if applicable, and the location of the terminal if applicable.

C. In addition, the Contractor shall provide the following information with the proposed JMF:

1. Properly completed JMF indicating all mix properties (Gmm, VMA, VFB, etc.)
2. Stockpile Gradation Summary
3. Design Aggregate Structure Consensus Property Summary
4. Design Aggregate Structure Trial Blend Gradation Plots (0.45 power chart)
5. Trial Blend Test Results for at least three different asphalt contents
6. Design Aggregate Structure for at least three trial blends

7. Test results for the selected aggregate blend at a minimum of three binder contents
8. Specific Gravity and temperature/viscosity charts for the PGAB to be used
9. Recommended mixing and compaction temperatures from the PGAB supplier
10. Material Safety Data Sheets (MSDS) For PGAB Asphalt Content vs. Air Voids trial blend curve
11. Test report for Contractor's Verification sample
12. Test reports for PG binder content and gradation of RAP when used in the JMF
13. Supplier's recommended mixing and compaction temperatures for PGAB

TABLE 4. Aggregate Gradation Control Points

Sieve Designation	Nominal Maximum Aggregate Size---Control Points - Percentage by Weight Passing Square Mesh Sieves (Combined Aggregate)	
	12.5 mm OGFC	9.5 mm OGFC
19 mm	100	
12.5 mm	85 – 100	100
9.5 mm	55 – 75	85 – 100
4.75 mm	10 – 25	20 – 40
2.36 mm	5 – 10	5 – 10
0.075 mm	2.0 – 4.0	2.0 – 4.0

D. At the time of JMF submittal, the Contractor shall identify and make available the stockpiles of all proposed aggregates at the plant site. There must be a minimum of 135 Mg [150 ton] for stone stockpiles, 70 Mg [75 ton] for sand stockpiles, and 45 Mg [50 ton] of blend sand before the Department will sample. The Department shall obtain samples for laboratory testing. The Contractor shall also make available to the Department the PGAB and stabilizing fibers proposed for use in the mix in sufficient quantity to test the properties of the asphalt and to produce samples for testing of the mixture. Before the start of paving, the Contractor and the Department shall split a production sample for evaluation. The Contractor shall test its split of the sample and determine if the results meet the requirements of the Department's written policy for mix design verification (See Maine DOT Policies and Procedures for HMA Sampling and Testing available at the Central Laboratory in Bangor). If the results are found to be acceptable, the Contractor will forward their results to the Department's Lab, which will test the Department's split of the sample. The results of the two split samples will be compared and shared between the Department and the Contractor. If the Department finds the mixture acceptable, an approved JMF will be forwarded to the Contractor and paving may commence. The first day's production shall be monitored, and the approval may be withdrawn if the mixture exhibits undesirable characteristics such as checking, shoving or displacement. The Contractor shall be allowed to submit aim changes within 24 hours of receipt of the first Acceptance test result. Adjustments will be allowed of up to 2% on the percent passing the 2.36 mm sieve through the 0.075 mm and 3% on the percent passing the 4.75 mm or larger sieves. Adjustments will be allowed on the %PGAB of up to 0.2%. Adjustments will be allowed on GMM of up to 0.010.

E. The Contractor shall submit a new JMF for approval each time a change in material source or materials properties is proposed. The same approval process shall be followed. The cold feed percentage of any aggregate may be adjusted up to 10 percentage points from the amount listed on the JMF, however no aggregate listed on the JMF shall be eliminated.

TABLE 5: VOLUMETRIC DESIGN CRITERIA

Air Voids @ N_{Design}	20.0 percent
Binder Content	6.0 percent minimum
VCA_{mix}	Less than VCA_{DRC}
Draindown	0.3 percent maximum (AASHTO T 305)
Gyrations @ N_{Design}	50

F. Temperature Requirements: After the JMF is established, the temperature of the mixture shall conform to the PGAB supplier's recommended mixing sand compaction temperature, with the following tolerances:

In the truck at the mixing plant +/- 25°F
At the Paver +/- 25°F

The JMF and the mix subsequently produced shall meet the requirements of Tables 1, 4 and 5. Under no circumstances will the Department accept HMA (unless the binder has been modified) that has been heated to temperatures over 179°C [340°F].

G. Performance Graded Asphalt Binder: Unless otherwise noted in Special Provision 403 - Hot Bituminous Pavement, PGAB shall be 76 – 28, modified with SBS polymer. The PGAB shall meet the applicable requirements of AASHTO M320 - Standard Specification for PGAB. The Contractor shall provide an approved copy of the Quality Control Plan for PGAB in accordance with AASHTO R 26-01 Certifying Suppliers of PGAB. The Contractor shall request approval for a change in PGAB supplier or source by submitting documentation stating the new supplier or source a minimum of 24 hours prior to the change. In the event that the PGAB supplier or source is changed, the Contractor shall make efforts to minimize the occurrence of PGAB co-mingling.

Part 3: EXECUTION

3.1 EQUIPMENT

A. Open graded friction coarse shall be produced and placed with equipment meeting the following requirements of Maine DOT Standard Specification November 2014 Edition, Section 401 of the Special Provisions:

Weather and Seasonal Limiations	401.06
Hot Mix Asphalt Plant	401.07
Hauling Equipment	401.08
Pavers	401.09
Rollers	401.10
Surface Tolerances	401.101
Prepartion of Existing Surface	401.11
Hot Mix Asphalt Documentation	401.12
Preparation of Aggregates	401.13
Mixing	401.14
Spreading and Mixing	401.15
Compaction	401.16
Joints	401.17
Quality Control Method A, B & C	401.18

Quality Control Method D 401.19

B. Weather and Seasonal Limitations **Section** 401.06 shall apply, with the following change: The atmospheric temperature must be 16°C [60°F] or higher for placement of OGFC.

C. Rollers Section 401.10 shall apply, with the following exceptions: Pneumatic rollers will not be required. Steel wheel rollers shall have a minimum weight of 10 tons.

D. Preparation of Existing Surface Section 401.11 shall apply, with the following requirements:

1. The surface where the OGFC is to be placed shall be cleaned of all foreign and loose material.

2. Immediately before beginning paving operations, ensure that the surface is dry. Do not place tack coat unless the weather restrictions are met. When precipitation has occurred within 24 hours before application, the Department will determine when the surface is completely dry.

3. Apply a tack coat of PGAB 64-28 to curbs, gutters, manholes, and other similar structures. Clean the exposed surfaces of these structures and apply a uniform coating to contact surfaces before paving.

4. In areas inaccessible to distributor spray bars, use hand spraying equipment for tack coat. Do not allow traffic or construction vehicles on tack coated surfaces.

5. Only apply tack coat that can be paved over in the same day. Apply a tack coat of PGAB 64-28 at a rate of 0.10 to 0.14 gallons per square yard and at a spraying temperature of 325 °F. Adjust the spraying temperature and application rate to produce a uniform coating, with no excess material.

E. Compaction Section - 401.16 shall apply, with the following exceptions: Pneumatic rollers will not be used to compact the OGFC. The OGFC shall be compacted by a minimum of three complete passes of a steel roller operated in static mode, unless otherwise directed by the Department. If the OGFC is unstable during compaction, it may be allowed to cool until rolling can be completed without excessive displacement. Following compaction, no traffic will be allowed on the OGFC for a period of 24 hours.

F. Quality Control Method A, B & C Section 401.18 shall apply, with the following exceptions:

1. Quality Control Plan, Item M: Maximum silo storage time shall be two hours.

2. Reasons for the Contractor to cease paving, Item d. Revise to read, “The Fractured Faces value falls below the requirements of Special Provision 404, Table 1 - Aggregate Requirements.”

3. Reasons for the Contractor to cease paving, Item f. Revise to read, “The Flat and Elongated value exceeds the requirements of Special Provision 404, Table 1- Aggregate Requirements”

Part 4: TESTING AND ACCEPTANCE

4.1 Acceptance Sections - 401.201, 401.202 and 401.203 of Maine DOT Standard Specification November 2014 Edition shall apply, with the following exceptions:

A. Replace Table 5 - Method a Acceptance Limits with the following:

TABLE 6 - METHOD A ACCEPTANCE LIMITS

Property	USL and LSL
Passing 4.75 mm [No. 4] and larger sieves	Target +/-7%
Passing 2.36 mm [No. 8] to 1.18 mm [No. 16] sieves	Target +/-4%
Passing 0.60 mm [No. 30]	Target +/-3%
Passing 0.30 mm [No. 50] to 0.075 mm [No. 200] sieve	Target +/-2%
PGAB Content	Target +/-0.4%
Air Voids	20.0 % +/- 2.0 %

B. Replace Table 6 - Method B Acceptance Limits with the following:

TABLE 7: METHOD B ACCEPTANCE LIMITS

Property	USL and LSL
Percent Passing 4.75 mm and larger sieves	Target +/-7
Percent Passing 2.36 mm to 1.18 mm sieves	Target +/-5
Percent Passing 0.60 mm	Target +/-4
Percent Passing 0.30 mm to 0.075 mm sieve	Target +/-3
PGAB Content	Target +/-0.5
Air Voids	20.0 % +/-2.5

C. Replace Table 7 - Method C Acceptance Limits with the following:

Table 8: METHOD C ACCEPTANCE LIMITS

Property	USL and LSL
Passing 4.75 mm and larger sieves	Target +/-7%
Passing 2.36 mm to 1.18 mm sieves	Target +/-5%
Passing 0.60 mm	Target +/-4%
Passing 0.30 mm to 0.075 mm sieve	Target +/-2%
PGAB Content	Target +/-0.4%
Air Voids	20.0% +/-2.0%

SECTION 321218

POLYRESIN TRACK SYSTEM APPLICATION FOR TRACK ASPHALT SURFACES
(Trade Bid Required)

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submit product literature that includes information on the performance and operation of the polyresin track system, materials of construction, limitations, and physical properties.

B. Provide shop drawings that clearly identify the materials of construction and dimensions.

C. Provide list of installations in the New England Area within the last five (5) years.

1.2 QUALITY ASSURANCE

A. Manufacturer

1. Supplier shall have ten years (10) experience in the manufacture of polyresin track system.

2. Manufacturer shall have designed, fabricated and have at least five (5) current installations of polyresin track system in the New England area.

3. All liquid products shall be supplied by one manufacturer.

B. Installer

1. Installer shall have five years (5) experience in the installation of polyresin track system, and shall be a certified installer of surface system.

2. Installer shall have designed, fabricated and have at least five (5) current installations of polyresin track system in the New England area.

1.3 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations

1.4 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 – PRODUCTS

A. Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   1. Plexitrac Lighting Polyresin Track System, 3/8", as manufactured by Plexipave, 150 Dascomb Road, Andover, Massachusetts 01810, www.plexipave.com. See material cut sheets and specifications.

   2. Approved equal.

PART 3 – EXECUTION

3.1 Installation

A. New asphalt pavement shall cure for 14 days prior to application of any surfacing materials.

B. Contractors must notify the Engineer of all applications, 48 hours prior to installation. The surface to be coated shall be inspected and made sure to be free of grease, oil, dust, dirt and other foreign matter before starting work.

C. Prior to the application of surfacing materials, the entire surface should be flooded and checked for minor depressions or irregularities. Any puddled area covering a nickel shall be marked and repaired per the manufacturer. After patching, the asphalt surface shall not vary more than 1/8" in 10 feet measured in any direction.

D. The polyresin track system shall be installed in accordance with manufacturer's written installation specifications.

E. Repairs and adjustments shall be performed per the manufacturer's recommendations.

F. Paint lines in accordance with manufacturer's recommendations.

END SECTION

SECTION 321219

COMBINATION SURFACE SYSTEM FOR TENNIS ASPHALT SURFACES
(Trade Bid Required)

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submit product literature that includes information on the performance and operation of the combination surface system, materials of construction, limitations, and physical properties.

B. Provide shop drawings that clearly identify the materials of construction and dimensions.

C. Provide list of installations in the New England Area within the last five (5) years.

1.2 QUALITY ASSURANCE

A. Manufacturer

1. Supplier shall have ten (10) years experience in the manufacture of combination surface system.

2. Manufacturer shall have designed, fabricated and have at least five (5) current installations of combination surface system in the New England area.

3. All liquid products shall be supplied by one manufacturer.

B. Installer

1. Installer shall have five (5) years experience in the installation of combination surface system, and shall be a certified installer of surface system.

2. Installer shall have designed, fabricated and have at least five (5) current installations of combination surface system in the New England area.

1.3 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository and Regulations

1.4 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 – PRODUCTS

A. Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   1. Novacrylic Combination Surface System® for new hot mix asphalt, as manufactured by Nova Sports U.S.A., 6 Industrial Rd., Bldg. #2., Milford, MA 01757. 800-USA-NOVA. See material cut sheets and specifications.

   2. Approved equal.

B. All coatings shall be pure acrylic, containing no asphaltic or tar emulsions, nor any vinyl, alkyd or non-acrylic resins. The color system shall be factory-mixed compounds requiring only the addition of water at the jobsite except for the addition of sand. All materials shall be delivered to the jobsite in sealed containers with the manufacturer's label affixed

PART 3 – EXECUTION

3.1 Installation

A. New asphalt pavement shall cure for 14 days prior to application of any surfacing materials.

B. Contractors must notify the Engineer of all applications, 48 hours prior to installation. The surface to be coated shall be inspected and made sure to be free of grease, oil, dust, dirt and other foreign matter before starting work.

C. The surface shall be flooded. Any ponding water remaining that is deep enough to cover the thickness of a five-cent piece shall be corrected using a patch mix, 50-mesh sand and Portland cement, as per manufacturer's directions. Depressions must be primed per the manufacturer prior to patching.

D. Tennis courts shall be cleaned using a stiff bristle broom and gas powered blower or water based pressure spray unit capable of generating 2500 psi at the nozzle tip, to remove all dirt and debris.

E. The combination surface system shall be installed in accordance with manufacturer's written installation specifications.

F. Repairs and adjustments shall be performed per the manufacturer's recommendations.

G. Paint lines in accordance with manufacturer's recommendations.

SECTION 321293

ARTIFICIAL TURF FIELD

(Trade Bid Required)

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Artificial Turf
2. Infill Material
   a. Base Bid Infill – Crumb Rubber
   b. Bid Alternate Infill – Organic Infill

B. Related Documents
1. Section 1-B – School Bid Depository Conditions and Regulations

1.2 SUBMITTALS

A. Submit shop drawings and submittals in accordance with manufacturer's specifications.

1.3 QUALITY ASSURANCE

A. In accordance with manufacturer's specifications

1.4 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 – PRODUCTS

2.1 ARTIFICIAL TURF

A. FieldTurf USA, Inc
175 N. Industrial Blvd
Calhoun, GA 30701
800-724-2969

1. Model: Field Turf XT-65

B. Greenfields USA
4910 Jonesboro Rd
Union City, GA 30291
855-773-6668

1. Greenfields XP 50

2.2 INFILL MATERIAL

A. Base Bid

1. Crumb Rubber Infill per turf Manufacturer's Specification

B. Bid Alternate

1. Greenplay Organics, LLC
212-904-1223

a. Organic Infill to meet requirements per turf manufacturer's specification. This includes any additional padding or stabilizing materials.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's specifications.

END OF SECTION

ATTACHMENT A

Field Turf XT-65 Specification

SECTION 32 12 93.10

ARTIFICIAL GRASS FIELDTURF
XT-65

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, tools and equipment necessary to install slit-film artificial grass FieldTurf as indicated on the plans and as specified herein; including components and accessories required for a complete installation. including but not limited to
   1. Acceptance of prepared sub-base.
   2. Coordination with related trades to ensure a complete, integrated, and timely installation: Aggregate base course, sub-base material (tested for permeability), grading and compacting, piping and drain components (when required); as provided under its respective trade section.

1.2 REFERENCE STANDARDS

A. FM Factory Mutual
   1. P7825 - Approval Guide; Factory Mutual Research Corporation; current edition

B. ASTM – American Society for Testing and Materials.
   1. D1577 - Standard Test Method for Linear Density of Textile Fiber
   2. D5848 - Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
   3. D1338 - Standard Test Method for Tuft Bind of Pile Yarn Floor Covering
   4. D1682 - Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
   5. D5034 - Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
   6. F1015 - Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces
   7. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
   8. D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
   9. F355 - Standard Test Method for Shock-Absorbing Properties of Playing Surfaces.
   10. F1936 - Standard Test Method for Shock-Absorbing Properties of North American Football Field Playing Systems as Measured in the Field
   11. D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

1.3 SUBMITTALS

A. Substitutions: Other products are acceptable if in compliance with all requirements of these specifications. Submit alternate products to Architect for approval prior to bidding in accordance Section 01 25 13, Product Substitution Procedures.
   1. Provide substantiation that proposed system does not violate any other

manufacturer's patents, patents allowed or patents pending.

2. Provide a sample copy of insured, non-prorated warranty and insurance policy information.

B. Comply with Section 01 33 00, Submittals Procedures. Submit for approval prior to fabrication.

C. Shop Drawings:
   1. Indicate field layout; field marking plan and details for the specified sports; i.e., NCAA Football; roll/seaming layout; methods of attachment, field openings and perimeter conditions.
   2. Show installation methods and construction indicating field verified conditions, clearances, measurements, terminations, drainage.
   3. Provide joint submission with related trades when requested by Architect.

D. Product Data:
   1. Submit manufacturer's catalog cuts, material safety data sheets (MSDS), brochures, specifications; preparation and installation instructions and recommendations; storage, handling requirements and recommendations.
   2. Submit fiber manufacturer's name, type of fiber and composition of fiber.
   3. Submit data in sufficient detail to indicate compliance with the contract documents.
   4. Submit manufacturer's instructions for installation.
   5. Submit manufacturer's instructions for maintenance for the proper care and preventative maintenance of the synthetic turf system, including painting and markings.

E. Samples: Submit samples, 6 x 6 inches, illustrating details of finished product in amounts as required by General Requirements, or as requested by Architect.

F. Product Certification:
   1. Submit manufacturer’s certification that products and materials comply with requirements of the specifications.
   2. Submit test results indicating compliance with Reference Standards.

G. Project Record Documents: Record actual locations of seams, drains and other pertinent information in accordance with Division 1 Specifications Series, General Requirements.

H. List of existing installations: Submit list including respective Owner’s representative and telephone number.

I. Warranties: Submit warranty and ensure that forms have been completed in Owner's name and registered with approved manufacturer.

J. Testing data to the Owner to substantiate that the finished field meets the required shock attenuation, as per ASTM F1936.

K. Submit Bills of Lading/Material Delivery Receipts for synthetic turf infill materials. Bills of lading shall bear the name of the project/delivery address, quantity of materials delivered, source/location of origin of infill materials and/or manufacturer, and date of delivery.

L. Testing Certification: Submit certified copies of independent (third-party) laboratory reports on ASTM testing:
   1. Pile Height, Face Weight & Total Fabric Weight, ASTM D5848.

2. Primary & Secondary Backing Weights, ASTM D5848.
3. Tuft Bind, ASTM D1335.
4. Grab Tear Strength, ASTM D1682 or D5034.
5. Shock Attenuation, ASTM F1936.
6. Water Permeability, ASTM D4491

1.4 QUALITY ASSURANCE

A. Comply with Section 01 43 00, Quality Assurance.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section. The turf contractor and/or the turf manufacturer:
   1. Shall be experienced in the manufacture and installation of specified type of infilled slit-film synthetic grass system for a minimum of three years. This includes a slit-film fiber, backing, the backing coating, and the installation method.
   2. Shall have 500 slit-film fields in play for at least two years. Fields shall be 65,000 ft^2 or more
   3. Shall have a minimum of 500 fields that are at least 8 years old, which is equal to the respective warranty period, with the same infill system.
   4. The manufacturer must have ISO 9001, ISO 14001 and OHSAS 18001 certifications demonstrating its manufacturing efficiency with regards to quality, environment and safety management systems.
   5. The manufacturer must be a FIFA Preferred Producer and a FIFA Licensee
   6. The manufacturer must be licensed by all of the following major international governing bodies: FIFA, International Rugby Board (IRB), International Hockey Federation (FIH), Australian Football League (AFL).
   7. Shall have a minimum of 5 installations in the State/Province of Maine and at least 25 installations in New England.
   8. Shall have a minimum of 1 FIFA 2-Star recommended field in North America.
   9. Shall have a minimum of 5 NFL game and/or practice fields in play for the previous year
   10. Shall have minimum 25 NCAA Division 1 game and/or practice fields installed.
   11. Shall have a minimum of 1000 installations in North America, each of 65,000 ft^2 or more. Fields shall be 65,000 ft^2 or more of the specified material, including infill material and a slit-film fiber.
   12. Shall provide third party certification confirming minimum requirement of 9 lbs tuft bind.

C. Installer: Company shall specialize in performing the work of this section. The Contractor shall provide competent workmen skilled in this specific type of synthetic grass installation.
   1. The designated Supervisory Personnel on the project shall be certified, in writing by the turf manufacturer, as competent in the installation of slit-film material, including sewing seams and proper installation of the infill mixture.
   2. Installer shall be certified by the manufacturer and licensed.
   3. The installer supervisor shall have a minimum of 5 years experience as either a construction manager or a supervisor of synthetic turf installations

D. Pre-Installation Conference: Conduct conference at project site at time to be determined by

Architect. Review methods and procedures related to installation including, but not limited to, the following:

1. Inspect and discuss existing conditions and preparatory work performed under other contracts.
2. In addition to the Contractor and the installer, arrange for the attendance of installers affected by the Work, The Owner's representative, and the Architect.

E. The Contractor shall verify special conditions required for the installation of the system.

F. The Contractor shall notify the Architect of any discrepancies.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, Product Requirements.

B. Prevent contact with materials that may cause dysfunction.

C. Deliver and store components with labels intact and legible.

D. Store materials/components in a safe place, under cover, and elevated above grade.

E. Protect from damage during delivery, storage, handling and installation. Protect from damage by other trades.

F. Inspect all delivered materials and products to ensure they are undamaged and in good condition.

G. Comply with manufacturer's recommendations.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the Work with installation of work of related trades as the Work proceeds.

B. Sequence the Work in order to prevent deterioration of installed system.

1.7 WARRANTY AND GUARANTEE

A. See Section 01780 - Closeout Submittals, For Additional Warranty Requirements.

B. The Contractor shall provide a warranty to the Owner that covers defects in materials and workmanship of the turf for a period of eight (8) years from the date of substantial completion. The turf manufacturer must verify that their representative has inspected the installation and that the work conforms to the manufacturer's requirements. The manufacturer's warranty shall include general wear and damage caused from UV degradation. The warranty shall specifically exclude vandalism, and acts of God beyond the control of the Owner or the manufacturer. The warranty shall be fully third party insured; pre paid for the entire 8 year term and be non-prorated. The Contractor shall provide a warranty to the Owner that covers defects in the installation workmanship, and further warrant that the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's representative. Prior to final payment for the synthetic turf, the Contractor shall submit to owner notification in writing that the field is officially added to the annual policy coverage, guaranteeing the warranty to the Owner. The insurance policy must be underwritten by an "AM Best" A rated carrier and must reflect the following values:

- Pre-Paid 8-year insured warranty.
- Insured Warranty Coverage must be provided in the form of 1 single policy
- Maximum per claim coverage amount of $32,000,000.
- Minimum of thirty-two million dollar ($32,000,000) annual aggregate
- Must cover full 100% replacement value of total square footage installed, minimum of $7.00 per sq ft. (in case of complete product failure, which will include removal and disposal of the existing surface)
- Policies that include self insurance or self retention clauses shall not be considered.
- Policy cannot include any form of deductible amount.
- Sample policy must be provided at time of bid to prove that policy is in force. A letter from an agent or a sample Certificate of Insurance will not be acceptable.

C. The artificial grass system must maintain a G-max of less than 200 for the life of the Warranty as per ASTM F1936.

1.8 MAINTENANCE SERVICE

A. Contractor shall train the Owner's facility maintenance staff in the use of the turf manufacturer's recommended maintenance equipment.

B. Manufacturer must provide maintenance guidelines and a maintenance video to the facility maintenance staff.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Approved manufacturers are as follows:

1. FieldTurf USA Inc.
   175 N. Industrial Blvd
   Calhoun, GA 30701
   P: 800-724-2969

Model: FieldTurf XT-65

2.2 MATERIALS AND PRODUCTS

A. Artificial grass FieldTurf system materials shall consist of the following:
   1. Carpet made of slit-film polyethylene fibers tufted into a fibrous, perforated backing.
   2. Infill: Controlled mixture of graded sand and cryogenic rubber crumb that partially covers the carpet.
   3. Glue, thread, paint, seaming fabric and other materials used to install and mark the

artificial grass slit-film FieldTurf.

B. The installed artificial grass slit-film FieldTurf shall have the following properties:

Standard	Property	Specification
ASTM D1577	Fiber Denier	10,000
ASTM D2256	Yarn Breaking Strength	18 lbs
ASTM D3218	Tape Thickness	100 Microns
ASTM D5823	Pile Height	2 1/2”
ASTM D5793	Stitch Gauge	3/4”
ASTM D5848	Pile Weight	40oz/square yard
ASTM D5848	Primary Backing	7+oz/square yard
ASTM D5848	Secondary Backing	16+oz/square yard
ASTM D5848	Total Weight	59+oz/square yard
ASTM D1335	Tuft Bind (Without Infill)	8+ lbs
ASTM D5034	Grab Tear (Width)	200 lbs/force
ASTM D5034	Grab Tear (Length)	200 lbs/force
ASTM D4491	Carpet Permeability	>40 inches/hour
ASTM F355/F1936	Impact Attenuation (Gmax)	<200
	Infill Material Depth	1.75 inches
	Sand Infill Component	4lbs/square foot
	SBR Rubber Infill Component	3.5lbs/square foot
	Total Product Weight	1139oz/square yard

C. Carpet shall consist of slit-film fibers tufted into a primary backing with a secondary backing.

D. Carpet Rolls shall be 15’ wide rolls.
   1. Rolls shall be long enough to go from field sideline to sideline.
   2. Where the playing field is for football, the perimeter white line shall be tufted into the individual sideline rolls.

E. Backing:
   1. Primary backing shall be a double-layered polypropylene fabric treated with UV inhibitors.
   2. Secondary backing shall consist of an application of porous, heat-activated urethane to permanently lock the fiber tufts in place.
   3. Perforated (with punched holes), backed carpet are acceptable.

F. Fiber shall be 10,000 denier, low friction, and UV-resistant fiber measuring not less than 2 ½ inches high.
   1. Systems with less than a 2 ½ inch fibers are unacceptable.

G. Infill materials shall be approved by the manufacturer.
   1. Infill shall consist of a resilient layered granular system, comprising selected and graded sand and SBR rubber crumb.
   2. The sand component of the infill must represent a minimum of 51% or more of the total infill, by weight.
   3. Infill should be no less than 6 pounds per sq. ft. Infill systems with less than 6 pounds will be required to have a pad under the turf system.

H. Non-tufted or inlaid lines and markings shall be painted with paint approved by the synthetic turf manufacturer.

I. Thread for sewing seams of turf shall be as recommended by the synthetic turf manufacturer.

J. Glue and seaming fabric for inlaying lines and markings shall be as recommended by the synthetic turf manufacturer.

2.3 QUALITY CONTROL IN MANUFACTURING

A. The manufacturer shall own and operate its own manufacturing plant in North America. Both tufting of the field fibers into the backing materials and coating of the turf system must be done in-house by the turf manufacturer. Outsourcing of either is unacceptable.

B. The manufacturer shall have full-time certified in-house inspectors at their manufacturing plant that are experts with industry standards.

C. The manufacturer's full-time in-house certified inspectors shall perform pre-tufting fiber testing on tensile strength, elongation, tenacity, denier, shrinkage, and twist i.e., turns per inch, upon receipt of fiber spools from fiber manufacturer.

D. Primary backing shall be inspected by the manufacturer's full-time certified in-house inspectors before tufting begins.

E. The manufacturer's full-time in-house certified inspectors shall verify "pick count", yarn density in relation to the backing, to ensure the accurate amount of face yarn per square inch.

F. The manufacturer's full-time, in-house, certified inspectors shall perform turf inspections at all levels of production including during the tufting process and at the final stages before the turf is loaded onto the truck for delivery.

G. The manufacturer shall have its own, in-house laboratory where samples of turf are retained and analyzed, based on standard industry tests, performed by full-time, in-house, certified inspectors.

H. The manufacturer must have ISO 9001, ISO 14001 and OHSAS 18001 certifications demonstrating its manufacturing efficiency with regards to quality, environment and safety management systems.

2.4 FIELD GROOMER & SWEEPER

A. Supply field groomer as part of the work.
   1. Field Groomer shall include a towing attachment compatible with a field utility vehicle.
   2. Field Groomer shall be a FieldTurf GroomRight
   3. Field Sweeper shall include a towing attachment compatible with a field utility vehicle.
   4. Field Sweeper shall be a FieldTurf SweepRight

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that all sub-base leveling is complete prior to installation.

B. Installer shall examine the surface to receive the synthetic turf and accept the sub-base planarity in writing prior to the beginning of installation.
   1. Acceptance is dependent upon the Owner's test results indicating compaction and planarity are in compliance with manufacturer's specifications.
   2. The surface shall be accepted by Installer as "clean" as installation commences and shall be maintained in that condition throughout the process.

C. Compaction of the aggregate base shall be 95%, in accordance with ASTM D1557 (Modified Proctor procedure); and the surface tolerance shall not exceed 0-1/4 inch over 10 feet and 0-½" from design grade.

D. Correct conditions detrimental to timely and proper completion of Work.

E. Do not proceed until unsatisfactory conditions are corrected.

F. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Prior to the beginning of installation, inspect the sub-base for tolerance to grade.

B. Sub-base acceptance shall be subject to receipt of test results (by others) for compaction and planarity that sub-base is in compliance with manufacturer's specifications and recommendations.

C. Dimensions of the field and locations for markings shall be measured by a registered surveyor to verify conformity to the specifications and applicable standards. A record of the finished field as-built measurements shall be made.

D. When requested by Architect, installed sub-base shall be tested for porosity prior to the installation of the slit-film turf. A sub base that drains poorly is an unacceptable substrate

3.3 INSTALLATION - GENERAL

A. The installation shall be performed in full compliance with approved Shop Drawings.

B. Only trained technicians, skilled in the installation of athletic caliber synthetic turf systems working under the direct supervision of the approved installer supervisors, shall undertake any cutting, sewing, gluing, shearing, topdressing or brushing operations.

C. The designated Supervisory personnel on the project must be certified, in writing by the turf manufacturer, as competent in the installation of this material, including sewing seams and proper installation of the Infill mixture.

D. Designs, markings, layouts, and materials shall conform to all currently applicable National Collegiate Athletic Association rules, NFHS rules, and/or other rules or standards that may apply to this type of synthetic grass installation. Designs, markings and layouts shall first be approved by the Architect or Owner in the form of final shop drawings. All markings will be in full compliance with final shop drawings.

3.4 INSTALLATION

A. Install at location(s) indicated, to comply with final shop drawings, manufacturers'/installer's instructions.

B. The Contractor shall strictly adhere to specified procedures. Any variance from these requirements shall be provided in writing, by the manufacturer's on-site representative, and submitted to the Architect and/or Owner, verifying that the changes do not in any way affect the Warranty. Infill materials shall be approved by the manufacturer and installed in accordance with the manufacturer's standard procedures.

C. Carpet rolls shall be installed directly over the properly prepared aggregate base. Extreme care shall be taken to avoid disturbing the aggregate base, both in regard to compaction and planarity.

1. Repair and properly compact any disturbed areas of the aggregate base as recommended by manufacturer

D. Full width rolls shall be laid out across the field.

1. Turf shall be of sufficient length to permit full cross-field installation from sideline to sideline.
2. No cross seams will be allowed in the main playing area between the sidelines.
3. Each roll shall be attached to the next roll utilizing standard state-of-the- art sewing procedures.
4. When all of the rolls of the playing surface have been installed, the sideline areas shall be installed at right angles to the playing surface.

E. Artificial turf panel seams shall be sewn along the selvedge edging flap of the turf roll. Seams secured by other means including gluing are unacceptable. Installation shall be 99% sewn.

1. Minimum gluing will only be permitted to repair problem areas, corner completions, and to cut in any logos or inlaid lines as required by the specifications.
2. Seams shall be flat, tight, and permanent with no separation or fraying.
3. In the case of all lines and logos, turf carpet must be field fibers must be sheared to the backing (do not cut the backing) and adhered using hot melt adhesives.

F. Infill Materials:

1. Infill materials shall be applied in numerous thin lifts. The turf shall be brushed as the mixture is applied. The infill material shall be installed to a depth determined by the manufacturer.
2. Two-layered infill shall be installed in a systematic order.
3. Infill materials shall be installed to fill the voids between the fibers and allow the fibers to remain vertical and non-directional. The Infill installation consists of a base layer of sand followed by SBR rubber. The Infill shall be installed to the depth of 1 ¾". Infill density shall consist of 4 pounds of sand and 3.5 pounds of rubber per square foot. The Infill shall be placed so that there is a void of ¾" to the top of the fibers. Infill system will not be less than 6 pounds per sq. ft.

G. Non-tufted or inlaid lines and markings shall be painted in accordance with turf and paint manufacturers' recommendations. Number of applications will be dependent upon installation and field conditions.

H. Synthetic turf shall be attached to the perimeter edge detail in accordance with the manufacturer's standard procedures.

I. Upon completion of installation, the finished field shall be inspected by the installation crew and an installation supervisor.

3.5 FIELD MARKINGS

A. Field markings shall be installed in accordance with approved shop drawings. If football is designated as the primary sport, all five yard lines will be tufted-in.

B. Balance of sports markings will be inlaid or painted in accordance with the Drawings.

C. Center field logo shall be either painted or inlaid according to artwork indicated on Drawings and in accordance with manufacturer's standard palette of turf colors.

D. End-zone letters and logos shall be either painted or inlaid according to artwork and fonts indicated on the Drawings, and in accordance with manufacturer's standard palette of turf colors.

3.6 ADJUSTMENT AND CLEANING

A. Do not permit traffic over unprotected surface.

B. Contractor shall provide the labor, supplies, and equipment as necessary for final cleaning of surfaces and installed items.

C. All usable remnants of new material shall become the property of the Owner.

D. The Contractor shall keep the area clean throughout the project and clear of debris.

E. Surfaces, recesses, enclosures, and related spaces shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

3.7 PROTECTION

A. Protect installation throughout construction process until date of final completion.

ATTACHMENT B

Greenfields XP 50 Specification

Greenfields XP 50 Synthetic Turf System

1. 0 GENERAL REQUIREMENTS

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this section.

1.2 Scope of Work

Furnish all labor, materials, tools, and equipment necessary to install, in place, all synthetic turf material as indicated on the plans and as specified herein. The installation of all new materials shall be performed in strict accordance with the Manufacturer's written installation instructions, and in accordance with all approved shop drawings.

A. Prior to order of materials, the Synthetic Turf Contractor shall submit the following:
    1. Product data, including Independent Laboratory Test Results
    2. 50,000 Lisport cycle test results
    3. FIFA Preferred Producer verification information
    4. Installation details
    5. Product Samples
    6. Sample Warranty
    7. Field layout and striping plans
    8. Details on construction, especially any details that may deviate from plans and specifications.

B. Prior to the beginning of installation, the Synthetic Turf Contractor shall verify the base for planarity. Upon written confirmation from the base contractor that compaction/planarity and drainage/permeability specifications have been achieved, the installation of synthetic turf will proceed as arranged. Prior to Final Acceptance, the Synthetic Turf Contractor shall verify payment to sub-contractors and suppliers and submit to the Owner three (3) copies of Executed Warranty Documents and Maintenance Manuals, which will include necessary instructions for the proper care and preventative maintenance of the synthetic turf system, including painting and striping (if applicable).

1.3 Shop Drawings

1. Shop drawings shall be prepared at the scale of the construction documents and contain all pertinent information regarding installation. These drawings shall be submitted to the Owner or Owner's representative for approval prior to the manufacturing and shipment of materials.

2. Submit drawings for:
    1. Installation details, edge detail, goal post detail, other inserts, and covers, etc., as required by contract.
    2. Striping plan showing any field lines, markings and boundaries, and field logos per project drawings.

1.4 Quality Assurance

A. Synthetic Turf Contractor's Experience:
    1. The Synthetic Turf Contractor shall have the experience of at least fifty (50) acceptable installations of full-size football or soccer fields (minimum 70,000 sq. ft.) globally within the past five (5) years of tufted, polyethylene, grass-like fabrics that are filled with either all rubber or a mixture of SBR rubber and sand. Submit a list of (10) applicable installations with the bid.

2. The Synthetic Turf Contractor shall be a FIFA Preferred Producer or qualified Distributor thereof
3. The Synthetic Turf Contractor shall have a representative of the Synthetic Turf Manufacturing perform a quality assurance check at completion

B. Synthetic Turf Manufacturer's Qualifications

1. Shall be experienced in the manufacturing and installation of specified type of infilled slit-film synthetic grass systems for a minimum of eight years. This includes a slit-film fiber, backing, the backing coating, and the installation method.
2. The manufacturer must be a FIFA Preferred Producer
3. Shall have minimum 250 FIFA certified fields worldwide.
4. The manufacturer must be licensed by all of the following major international governing bodies: FIFA, International Rugby Board (IRB), International Hockey Federation (FIH).

C. Quality Control in Manufacturing

1. The manufacturer shall own and operate its own manufacturing plant in North America.
2. The manufacturer shall have full-time certified in-house inspectors at their manufacturing plant that are experts with industry standards.
3. The manufacturer's full-time in-house certified inspectors shall perform pre-tufting fiber testing on tensile strength, elongation, tenacity, denier, shrinkage, and twist i.e., turns per inch, upon receipt of fiber spools from fiber manufacturer.
4. Primary backing shall be inspected by the manufacturer's full-time certified in-house inspectors before tufting begins.
5. The manufacturer's full-time in-house certified inspectors shall verify "pick count", yarn density in relation to the backing, to ensure the accurate amount of face yarn per square inch.

6. The manufacturer shall have its own, in-house laboratory where samples of turf are retained and analyzed, based on standard industry tests, performed by full-time, in-house, certified inspectors.

D. The system shall be tufted on a 5/8" gauge at a stitch rate of approximately 4 stitches per inch. The pile height shall be approximately 2.0 inches (+/- 1/8").

E. The Primary Backing shall consist of two layers of woven fabric, as manufactured by TenCate.

F. The Secondary Backing of high-grade polyurethane shall be applied to the Primary Backing at 20 oz/yd^2. Secondary Backing adds resistance to water degradation and strengthens grip on fibers.

G. The entire backing shall be coated with holes perforated throughout the backing at the Synthetic Turf Manufacturer's recommended interval to allow for drainage. Partially coated backings or latex coating materials shall not be acceptable.

H. Warranty: The Synthetic Turf Contractor shall submit their Manufacturer's Warranty, which guarantees the usability and playability of the synthetic turf system for its intended uses for an eight (8) year period commencing with the date of Substantial Completion.

1. The warranty submitted must have the following characteristics:
    a) Must provide full-field coverage for eight (8) years from date of Substantial Completion
    b) Must warrant materials and workmanship
    c) Must warrant that the materials installed meet or exceed the product specifications within manufacturing tolerances

d) Must have a provision to either repair or replace such portion of the installed materials that are no longer serviceable to maintain a serviceable and playable surface

e) Must be a Manufacturer's warranty from a single source covering workmanship and all self-manufactured or procured materials

1.5 Existing Conditions

A. If the surface on which the new synthetic turf is to be installed is an existing asphaltic/concrete base, the Synthetic Turf Contractor will be responsible for any damage due to negligence to the concrete during removal/installation of the synthetic turf system provided there are no failures below the surface which contribute to the damage. The football goal posts, if any, are to be removed and reinstalled by the Owner or Prime Contractor to facilitate the installation of the new synthetic turf system.

B. If the surface on which the new synthetic turf to be installed is a new asphaltic/concrete base or a new base of compacted, porous aggregate, the Synthetic Turf Contractor will be responsible for any damage to the base during removal/installation of the synthetic turf system after the deficiencies (if any) have been corrected by the base contractor with respect to planarity, compaction, and drainage/permeability. New football goal posts (if any) and/or infield dirt mix backfill within the contiguous synthetic turf limits or immediately adjacent thereto are not to be installed by the Owner or Prime Contractor until after the new synthetic turf system has been completed. Damage to the synthetic turf system during the installation of such materials is not the responsibility of the Synthetic Turf Contactor.

1.6 Schedule

A. The Synthetic Turf Contractor shall complete all work on the synthetic turf system in accordance with the published project schedule, and in compliance with manufacturing procurement times as mutually agreed upon and identified in final contract negotiations.

B. The Synthetic Turf Contractor will require unencumbered use of an area within thirty (30) feet of the synthetic turf area(s) being installed in order to complete his work. The Synthetic Turf Contractor shall also be afforded unencumbered access through the construction site to reach the synthetic turf field area being installed.

1.7 Surface Area

A. The Synthetic Turf Contractor is to verify all measurements.

B. Base acceptance will be based on planarity of ¼" tolerance over a 10ft straight edge. Deviations from this tolerance are to be corrected by the Prime Contractor or a subcontractor associated with the base installation.

C. The Synthetic Turf Contractor shall provide G-max testing at completion of the installation. Test results will verify that the field does not exceed an average G-max of 125 at completion. The Synthetic Turf Contractor will warrant the field to not exceed a G-max of 165 for the 8 year warranty period.

1.8 Utilities

A. Owner or Prime Contractor will supply necessary water, adequate lighting, and electricity for installation. Owner or Prime Contractor shall permit use of toilet and wash up facilities.

2.0 PRODUCTS

2.1 Materials

A. Fiber Requirements

1. Fiber shall be slit-film, parallel fibrillated polyethylene fibers. The fibers shall be tufted in a grass-like fashion to a finished pile height of approximately 2.0" and coated with a secondary backing of high-grade polyurethane. Turf product shall have shown no fiber splitting wear after completion of 75,000 Lisport cycles.

B. Infill shall consist of ambiently processed SBR rubber and silica sand. The synthetic turf fabric shall be filled with 100% SBR rubber.

C. All components and their installation method shall be designed and manufactured for use on outdoor athletic fields. The materials as hereinafter specified should be able to withstand full climatic exposure in all climates, be resistant to insect infestation, rot, fungus, mildew, ultraviolet light and heat degradation, and shall have the basic characteristics of flow-through drainage, allowing free movement of surface runoff through the synthetic turf fabric where such water may flow to the existing base and into the field drainage system.

D. The finished playing surface shall appear as mowed grass with no irregularities and shall afford excellent traction for conventional athletic shoes of all types. The finished surface shall resist abrasion and cutting from normal use. The system shall be suitable for football, field hockey, soccer, lacrosse, baseball, softball, PE classes, intramurals, and recreational use.

E. The polyethylene slit-film yarn shall be a proven athletic caliber yarn designed specifically for outdoor use and stabilized to resist the effect of ultraviolet degradation, heat, foot

traffic, water, and airborne pollutants. The slit-film yarn shall be as manufactured by TenCate. There is no known equal. Substitutions will not be allowed.

The pile fiber shall possess the following physical characteristics:

	XP 50	METHOD
Yarn	Tencate XP Blade + Yarn	
Yarn Denier	10,000/1 ± 500	ASTM D 1577
Yarn Thickness / Width	100 microns	ASTM D 3218
Breaking Load	25 - 27 lb-f	ASTM D 2256
PE Pile Fiber Weight	40 ± 1 oz/yd2	ASTM D 5848

The Pile fabric shall possess the following physical characteristics:

	XP 50	METHOD
Finished Pile Height	2.0” (50mm) ± 2mm	ASTM D 5823
Product Weight (total)	67.8 ±3 oz/yd2	ASTM D 5848
Primary Backings	7.8 ± 1.5 oz/yd2	ASTM D 5848
Secondary Coating (polyurethane)	20 ± 2 oz/yd2	ASTM D 5848
Fabric Width	15’	ASTM D 5793
Tuft Gauge	5/8”	ASTM D 5793
Grab Tear Strength	> 200 lb-f	ASTM D 5034
Tuft Bind Strength	8 lb-f	ASTM D 1335

I. Approved product: Greenfields XP 50.

ATTACHMENT C

Greenplay Organic Infill Specification

Specification section for Greenplay™ organic infill

A. Organic Infill Greenplay™ is a product of Greenplay Organics, LLC (212) 904-1223

1. Organic infill: Infill system shall be comprised of a proven blend of a coconut fiber matrix blended with cork, brown in color, 100% organic, not chemically treated & pesticide free.

2. The plant-based organic infill must be mineral free to avoid abrasiveness and compaction, providing an Abrasion Index below 30%.

3. The purely organic infill must retain sufficient moisture to allow for an evaporative cycle to keep the synthetic turf cool under the heat of the sun so it maintains an average temperature to within 20˚F of natural grass.

4. The bulk density of the organic infill must be less than 12 lbs. per cubic foot or 0.160- 0.190 grams per cubic centimeter.

5. No more than 43% of the organic infill comprised of coconut fiber and cork shall pass through the #18 (1mm) sieve.

6. Durability and resistance to compaction:

   a. Must be able to retain no more than a 10% variance in gradation or bulk density after a thousand repeated impacts of a 20-pound missile.

7. Typical infill quantity varies with pile height and density:
   a. 2 lbs. per square foot for a 2 ½ inch pile height.
   b. 1 ¾ lbs. per square foot for a 2 inch pile height.
   c. 1 ½ lbs. per square foot for a 1 ¾ inch pile height.

8. Installation:
   a. Prepare the turf by first installing a uniform ballast layer of rounded or sub-rounded 20/40 silica sand at 3 pounds per square foot.
   b. Greenplay™ is to be installed in layers until reaching the desired infill depth based on the pile height as described above.
   c. Upon completion of filling, the field must be watered down to allow for settling of the infill.
   d. Allow the infill to dry and apply a final layer to top-off the installation, then wet the field once again before delivering to customer.
   e. Upon completion, free pile height shall be no more than ¾ inch.

9. System Performance Characteristics:
   a. Must pass FIFA 2 Performance criteria for synthetic turf.

4. End of Life Recyclability:
   a. The organic infill must be 100% organic and natural for utilization after removal from the turf as a top-dressing for natural grass or to be tilled into natural soil.
   b. The organic infill must be 100% organic and natural as to not contaminate the synthetic turf after its full life cycle with any inorganic components that would prevent it from re-purposing.

5. Maintenance Equipment:
   a. Field Grooming Equipment: Manufacturer recommended, purpose built Geo-Groom adjustable tine rake & brush, consisting of four rows of spring tines ahead of a six foot wide stiff brush. Tines and brush are height adjustable to be utilized independently or in tandem. The Geo-Groom can be dragged by small field equipment or attached to a tractor with a three-point hydraulic platform. The Geo-Groom is available from Greenplay Sports, Inc. (212) 904-1223
   b. Field Sweeping Equipment: The sweeper must be topical for the turf only and avoid any brushing action or equivalent so as not to disturb the organic infill below.

SECTION 321313

CONCRETE PAVING

(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 1-B – School Bid Depository Conditions and Regulations

1.02 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Driveways and roadways.
2. Walkways.
3. Unit paver base.

1.03 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.04 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 01 Specification Sections

B. Product Data: For each type of manufactured material and product indicated.

C. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Qualification Data: For manufacturer.

E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Dowels
4. Fiber reinforcement.
5. Admixtures.
6. Curing compounds.
7. Applied finish materials.
8. Bonding agent or epoxy adhesive.
9. Joint fillers.
10. Non shrink grout.
11. Seal coat.

G. Field quality-control test reports.

H. Minutes of preinstallation conference.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: The owner will retain an independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect fourteen days in advance of dates and times when mockups will be constructed.
3. Obtain Architect's approval of mockups before starting construction.
4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

1.06 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.07 NOTIFICATION OF RELATED TRADES

A. Notify all other trades responsible for installing inserts, sleeves, anchors, when ready for such installation, and for final checking immediately before concrete is placed. Cooperate with such trades to obtain proper installation.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

2. Forms shall be constructed to conform to shapes, lines and dimensions shown, plumb and straight and shall be maintained sufficiently rigid to prevent deformation under load. Forms shall be sufficiently tight to prevent the leakage of concrete. Securely brace and shore forms to prevent displacement and to safely support the construction loads

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

C. Form Removal:

1. Formwork may be removed as soon as concrete has hardened sufficiently to resist damage from removal operations, but must remain a minimum of 3 days after the placement of the concrete.

2. No live loads shall be allowed on slabs until the concrete has reached the specified 28 day strength, unless the slab is reshored.

2.02 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

C. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

H. Plain Steel Wire: ASTM A 82, galvanized.

I. Deformed-Steel Wire: ASTM A 496.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain.

K. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

O. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

P. Zinc Repair Material: ASTM A 780.

2.03 CONCRETE MATERIALS

A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I or II

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.04 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

1. Products subject to compliance with requirements:

2.05 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B. Subject to compliance with current USEPA Regulations for volatile organic compounds (VOC) emissions. Curing compound shall not impair bonding of any material to be applied directly to the concrete.

2.06 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

1. Expansion joint filler shall be Sonoflex by Sonneborn or engineer approved equal.

B. Joint Filler at Expansion Joints in Paved Areas: ½" thick polyethylene closed cell material.

1. Sonoflex F. by Sonneborn
2. Engineer approved equal.

C. Seal coat: Seal coat for all exposed concrete walk surfaces shall consist of two coats of Hydrozo Clear 15 as manufactured by Hydrozo Coatings Company, Lincoln, Nebraska or Architect approved equal.

D. Non-Shrink Grout: "Embeco Pre-Mixed Grout" by Master Builders, "P.I.W. Irontrox Grout" by Toch Brothers, Inc., "Por-Rok" Expanding Grout by Hallemite Manufacturing Company, or equal as approved by the Architect.

E. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

F. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

G. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types I and II, non-load bearing IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

H. Non-Shrink Grout - "Embeco Pre-Mixed Grout" by Master Builders, "P.I.W. Irontrox Grout" by Toch Brothers, Inc., "Por-Rok" Expanding Grout by Hallemite Manufacturing Company, or equal as approved by the Engineer.

I. Seal coat for all exposed concrete walk surfaces shall consist of two coats of Hydrozo Clear 15 as manufactured by Hydrozo Coatings Company, Lincoln, Nebraska or Engineer approved equal.

2.07 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi .
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.

3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 7 percent plus or minus 1 percent for 3/4-inch nominal maximum aggregate size

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 3.0 lb/cu. yd..

2.08 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.02 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable on supports spaced to minimize sagging. Lap adjoining pieces at least two full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction. Lace overlaps with wire.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.05 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Provide tie bars at sides of pavement strips where indicated.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints and Expansion Joints: Form isolation joints and expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
2. Align with existing joints where appropriate.
3. Extend joint fillers full width and depth of joint.
4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
5. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
6. Furnish joint fillers in one-piece lengths as long as practicable, for the full width being placed wherever possible. Where more than one length is required, lace or clip joint-filler sections together.
7. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
8. Apply resilient caulking material in accordance with manufacturer's direction.

D. Contraction Joints or Control Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch] radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between limits of construction joints until the placing of the panel or section is completed. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Maintain reinforcement in position during concrete placement operations.

I. Screed pavement surfaces with a straightedge and strike off.

J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

K. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen material.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
4. All temporary heat, from insulation, insulated blankets, coverings, or other equipment and materials necessary to protect the concrete work from physical damage caused by frost, freezing action, or low temperature shall be provided prior to start of placing operations. Prior to construction, proposed methods must be approved by the Engineer.
   a. When the air temperature has fallen to or is expected to fall below 40 deg. F, provide adequate means to maintain the temperature in the area where concrete is being placed between 50 and 70 deg. F. Temperature shall be maintained in this range for a minimum of 24 hours prior to concrete placement and 72 hours after concrete placement.

L. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.07 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Non-Slip Broom Finish (NSBrm-Fn): Apply non-slip broom finish to exterior concrete platforms, steps and ramps, and elsewhere as indicated.
      a. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

   2. Finishing Landing Slabs:
      a. After striking off and consolidating concrete, smooth the surface by screeding and floating. Use square nose shovels to consolidate along edges and corners. Use hand methods only where mechanical floating is not possible. Adjust the floating to compact the surface and produce a uniform texture.
      b. After floating, test surface for trueness with a 10' straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous, smooth finish.
      c. Work edges of exposed slabs with a 1/8 in. radius edging tool, unless otherwise shown.
         1) After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing as follows:
         2) Provide broom finish by drawing a fine-hair broom across the concrete surface, perpendicular to the line of traffic.
         3) Repeat operation if required to provide a fine line texture acceptable to the Architect.

3.08 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

   1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

      a. Water.
      b. Continuous water-fog spray.

c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener or with a covering material bonded to concrete such as concrete, waterproofing, damp-proofing, membrane roofing, flooring, painting and other coatings and finish materials, unless otherwise acceptable to Architect.
   b. No chemical curing, sealing, or parting agents of any kind shall be used without the written approval of the finish floor manufacturer.

3.09 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 50 cu. yd., 2000 sq. ft. or fraction thereof of each concrete mix placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days and one specimen held In reserve for later testing if required.

a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 321413

UNIT PAVING

(Trade Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this Section.

B. Section 1-B – School Bid Depository Conditions and Regulations

1.2 SUMMARY:

A. This section includes the following:

1. Provide labor, materials, and equipment necessary to complete the work of this Section, and without limiting the generality thereof, furnish and include the following:

a. Preparation of site.

b. Supply and place laying course.

c. Supply and install paver stones in quality, shape, thickness and color as specified.

B. Related Work Specified in Other Sections:

1. Earthwork: Section 312000

2. Asphalt Paving: Section 321216

3. Concrete Paving: Section 321313

1.3 SUBMITTALS:

A. Samples: Submit samples of following:

1. Each paver indicating full range of color and texture to be expected in completed work.

1.4 WEATHER LIMITATIONS:

A. Protect unit paver work against freezing when temperature is 40° F (4° C) and falling. Protect unit paver work in hot weather to prevent excessive evaporation of setting beds.

1.5 QUALITY ASSURANCE:

A. Manufacturer Qualifications:

1. Paver manufacturer shall be an Interlocking Concrete Pavement Institute Certified Producer.

2. Paver manufacturer shall be a member in good standing with the National Concrete Masonry Association.

3. Paver manufacturer shall provide systematic testing of concrete pavers during production by a National Concrete Masonry Association Certified Masonry Testing Technician.

4. Paver manufacturer shall provide independent quality assurance test results for concrete pavers manufactured and tested within a calendar year.

B. Paving Subcontractor Qualifications:

1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.

2. Utilize an installer holding a current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.

C. Mock-Ups:

1. Install a 7 ft x 7 ft paver area.

2. Use this area to determine surcharge of the bitumen-sand layer and adhesive, joint sizes, lines, laying pattern(s), color(s) and texture of the job.

3. This area will be used as the standard by which the work will be judged.

4. Subject to acceptance by owner, mock-up may be retained as part of finished work.

5. If mock-up is not retained, remove and properly dispose of mock-up.

1.7 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.1 UNIT PAVERS:

A. Detectable Warning Paver manufactured by Hanover Archictural Products

B. Size: 11 ¾” X 11 ¾” X 2”

C. Color: Tudor

B. Edge restraint will be bituminous pavement where pavers abut sidewalks

C. Edge Restraint where pavers abut landscaped areas shall be galvanized steel edging as recommended by paver manufacturer.

2.2 GRADED AGGREGATE BASE COURSE:

A. Aggregate subbase and base course as shown in the Contract Documents. See Section 312000, "Earthwork."

2.3 WET MORTAR BED:

A. Motar shall consist of 1 part Portland cement, 2 parts sand and sufficient water to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

B. Sand shall consist of clean, coarse, concrete sand or granite screening, not Mason sand, with the following gradation limits:

Sieve Size	% Passing
3/8"	100
4	95 - 100
8	70-95
16	45-80
50	10-30
200	0 - 5

PART 3 - EXECUTION

3.1 CONSTRUCTION OF THE AGGREGATE BASE COURSE:

A. The aggregate base course shall be constructed to the proper subgrade in accordance with specification Section 312000 "Earthwork."

3.2 WET MORTAR BED:

A. The mortar bed shall be spread evenly over the area to be paved and troweled/floated to a level that will produce the required 1-2" thickness when the unit pavers have been placed and compacted.

B. Once mortar bed has been prepared for paver installation, it shall not be disturbed in any way.

3.3 UNIT PAVER INSTALLATION:

A. After setting bed has been properly prepared, the unit pavers shall be placed as indicated within the Contract Documents. Joints between the pavers shall be no wider than that allowed by the natural texture of the paver itself, in no case wider than 1/8".

B. After the pavers are carefully set, they shall be pressed into the mortar bed to ensure adequate contact/adheasion between paver and mortar bed, resulting in a surface of the proper slope and grade.

Any divergence from line and grade is to be corrected by taking up and relaying the pavers. All surplus mortar between paver joints shall be removed.

END OF SECTION

SECTION 321443

POROUS UNIT PAVING

(Trade Bid Required)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Porous paving consisting of concrete pavers set in aggregate setting beds.

2. Edge restraints.

B. Related Documents:

1. Section 1-B – School Bid Depository Conditions and Regulations

1.2 SUBMITTALS

A. Manufacturer's drawing and details: Indicate perimeter conditions, junction with other materials, expansion and control joints, paver layout, patterns, color arrangement, installation and setting details. Indicate layout, pattern, and relationship of paving joints to fixtures and project formed details.

B. Minimum 3 lb. (2 kg) samples of subbase, base, and bedding aggregate materials.

C. Sieve analysis of aggregate in openings per ASTM C 136.

D. Permeable concrete pavers:

1. Manufacturer's product catalog sheets with specifications.

2. Full-size samples of each paver type, thickness, color, and finish. Submit samples indicating the range of color expected in the finished installation.

3. Accepted samples become the standard of acceptance for the work of this Section.

4. Laboratory test reports certifying compliance of the concrete pavers with ASTM C 936.

5. Manufacturer's material safety data sheets for the safe handling of the specified materials and products.

6. Manufacturer's written quality control procedures including representative samples of production record keeping that ensure conformance of paving products to the project specifications.

E. Paver Installation Subcontractor:

1. A copy of Subcontractor's current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.

2. Job references from projects of a similar size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

3. Written Method Statement and Quality Control Plan that describes material staging and flow, paving direction and installation procedures, including representative reporting forms that ensure conformance to the project specifications.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Paver manufacturer shall be an Interlocking Concrete Pavement Institute Certified Producer.

2. Paver manufacturer shall be a member in good standing with the National Concrete Masonry Association.

3. Paver manufacturer shall provide systematic testing of concrete pavers during production by a National Concrete Masonry Association Certified Masonry Testing Technician.

4. Paver manufacturer shall provide independent quality assurance test results for concrete pavers manufactured and tested within a calendar year.

B. Paver Installation Subcontractor Qualifications:

1. Utilize an installer having successfully completed concrete paver installation similar in design, material and extent indicated on this project.

2. Utilize an installer holding a current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.

C. Review the manufacturers' quality control plan, paver installation subcontractor's Method Statement and Quality Control Plan with pre-construction meeting of representatives from the manufacturer, paver installation subcontractor, general contractor, engineer and/or owner's representative.

D. Mock-Ups:

1. Install a 10 ft x 10 ft (3 x 3 m) paver area.

2. Use this area to determine surcharge of the bedding layer, joint sizes, lines, laying pattern(s), color(s) and texture of the job.

3. This area will be used as the standard by which the work will be judged.

4. Subject to acceptance by owner, mock-up may be retained as part of finished work.

5. If mock-up is not retained, remove and properly dispose of mock-up.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.1 CONCRETE UNIT PAVERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Genest Concrete Works, Inc. 36 Wilson Street, Sanford, Maine 04073, phone: 1-800-332-4773, fax: 1-207-490-5076, www.GenestConcrete.com, email: sales@genest-concrete.com.

2. Pavedrain, LLC, phone: 1-888-575-5339, www.pavedrain.com, email:info@pavedrain.com

3. Manufacturers not listed shall be approved per the requirements of this section.

B. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested to ASTM C 67, and made from normal weight aggregates.

C. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following Permeable Interlocking Concrete Paver Units:

1. Paver Type A: Genest Tidewater Stone or approved equal

   a. Color: Riverbed

   b. Pattern: Ashlar

2. Paver Type B: Genest Eastern Bay Stone or approved equal

   a. Color: Granite Blend

   b. Pattern: 90° Herringbone

3. Paver Type C: Genest Eastern Bay Stone or approved equal

   a. Color: Granite Blend

   b. Pattern: Soldier's Course

4. Paver Type D: Genest Stormwater Brick, Pave Drain Permeable Articulating Concrete Blocks/ Mats (P-ACBM), or approved equal.

   a. Material Standard: Comply with ASTM C 936.

   b. Color: Custom Charcoal color to match pavement color

   c. Color Pigment Material Standard: Comply with ASTM C 979.

   d. Pattern: Running Bond

e. Size: Genest Stormwater Brick - 4” x 8” x 3-1/8”, or approved equal.

2.2 ACCESSORIES

A. Plastic Edge Restraints: Triangular PVC extrusions, rigid type for straight edges and flexible type for curved edges, with pipe connectors and 3/8-inch- diameter by 12-inch- long steel spikes, or per manufacturer’s recommendations.

1. Products: Subject to compliance with requirements, products may be incorporated into the Work include, but are not limited to the following plastic edge restraints:

a. Gator Edge, manufactured by Alliance Designer Products Inc., Laval, Quebec. Phone number 866-212-1611.

b. Approved equal.

B. Aluminum Edge Restraints: Extruded-aluminum edging, with loops pressed from face to receive stakes at 12 inches o.c., and with aluminum stakes 12 inches long for each loop, or per manufacturer’s recommendations.

1. Products: Subject to compliance with requirements, products may be incorporated into the Work include, but are not limited to the following aluminum edge restraints:

a. Permaloc Geoedge Aluminum Green Building Edge by Permaloc Corporation.

b. Approved equal.

2.3 AGGREGATE MATERIALS

A. Graded Aggregate for Porous Paver Fill: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

1. Provide stone of color to match paver.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.

B. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

C. Tolerances:

1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch unit-to-unit offset from flush.

2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches and 1/4 inch in 10 feet or a maximum of 1/2 inch.

D. Provide edge restraints as indicated. Install edge restraints before placing unit pavers

3.2 SETTING BED INSTALLATION.

A. Setting bed consisting of underdrain backfill, aggregate subbase, reservoir stone and leveling stone shall be installed per Site Plans and Details prior to placement of concrete pavers.

3.2 PAVER INSTALLATION

A. Concrete pavers may have spacer bars on each unit. Spacer bars are recommended for mechanically installed pavers. Manually installed pavers may be installed with or without spacer bars. Verify with manufacturers that overall dimensions do not include spacer bars.

B. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- minimum and 1/8-inch- maximum joint width.

C. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz.

D. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.

E. Apply additional aggregate to the openings and joints, filling them completely. Remove excess aggregate by sweeping then compact the pavers. This will require at least two passes with the plate compactor.

F. Remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

G. The surface elevation of pavers shall be 1/8 to 1/4 in. (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

3.3 FIELD QUALITY CONTROL

A. After sweeping the surface clean, check final elevations for conformance to the drawings.

B. Lippage: No greater than 1/8 in. (3 mm) difference in height between adjacent pavers.

3.4 PROTECTION

A. After work in this section is complete, the General Contractor shall be responsible for protecting work from sediment deposition and damage due to subsequent construction activity on the site.

END OF SECTION

SECTION 321600

CURBING
(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Plans, General Conditions of the Contract, and Supplementary General Conditions, apply to the work specified in this Section.

B. Section 1-B – School Bid Depository Conditions and Regulations

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: Section 312000
B. Asphalt Paving: Section 321216
C. Concrete Paving: Section 321313

1.03 DESCRIPTION OF WORK

A. Provide all materials, equipment, and labor necessary for the placement of slipform concrete curbing or granite curbing as shown within the Contract Documents and as specified herein.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - MATERIALS

2.01 CONCRETE SLIPFORM CURBING

A. Concrete for slipform shall be Class A meeting the requirements of 502.05 of the MaineDOT Specifications and have a minimum compressive strength of 4,000 psi.

B. Apply salt guard penetrating sealant to all concrete curb.

C. Concrete shall include polyester fibers shall be uniformly incorporated into the dry mix at a rate of 0.25 percent of the total batch weight. Certification shall be provided from the supplier with each shipment meeting the following requirements:

Average Length 0.25 inches ± 0.005

Average Diameter 0.0008 inches ± 0.0001
Specific Gravity 1.32-1.40
Melting Temperature 480 °F Minimum

2.02 GRANITE CURBING

A. Quarried granite stone conforming to MDOT Section 712.04.

B. Circular granite curb shall be in reasonable close conformity with the shape and dimensions as shown in the Contract Documents and to the applicable material requirement.

C. Joint mortar shall be in accordance with MDOT Section 705.02.

PART 3 - INSTALLATION

3.01 PLACEMENT OF CURBING

A. Installation of Slipform Curb:

1. Set curb on a compacted HMA base paving.

2. Apply epoxy bonding agent.

3. Deposit, consolidate, and slip form the concrete to the required section.

4. Protect as specified for concrete pavement in Section 321313.

5. Concrete shall be placed with an approved slipform machine that will produce a finished product according to the design specified in the plans and will meet the same standards set for cast-in-place curbing. For cold weather slipforming, the outside temperature must be at least 36°F (2.2°C) and rising. The curb shall be placed on a firm, uniform bearing surface, shall conform to the section profile specified in the plans and shall match the appropriate grade. Proper curing shall be insured through the use of a curing compound spray that meets ASTM specifications. Expansion joints will be provided at ends of curve radii or wherever the curb meets rigid structures such as building foundations or fire hydrants. Contraction joints will be placed at 10 foot intervals using sawing methods, which cut 1-3" into the concrete. Joints shall be constructed perpendicular to the subgrade and match other joints in roadways, sidewalks or other structures when applicable.

6. Slipform curbing must be adequately protected after placement. The concrete shall be allowed to cure for at least 72 hours. During cold weather conditions, when temperatures drop below the required temperature of 36°F (2.2°C) after placement, curbing shall be protected by concrete blankets or a combination of plastic sheeting and straw. After any placement of slipform curbing, regardless of weather conditions, the placed curbing shall be adequately protected by traffic control devices and flagging as necessary.

7. Backfilling:

   a. Fill all remaining spaces under the curb with approved material and thoroughly hand tamped so the stones will have a firm uniform bearing on the foundation for the entire length and width.

   b. Fill any remaining excavated areas surrounding the curb to the required grade with approved materials. Place this material in layers not exceeding 8 inches in depth, loose measure and thoroughly tamped.

8. Protection:

   a. Protect the curb and keep in new condition.

   b. Slipform curbing must be adequately protected after placement. The concrete shall be allowed to cure for at least 72 hours. During cold weather conditions, when temperatures drop below the required temperature of 36°F (2.2°C) after placement, curbing shall be protected by concrete blankets or a combination of plastic sheeting and straw. After any placement of slipform curbing, regardless of weather conditions, the placed curbing shall be adequately protected by traffic control devices and flagging as necessary.

B. Installation of Granite Curb:

1. Set curb on a compacted foundation so that the front top arris line conforms to the lines and grades required.

2. Prepare the foundation in advance of setting the stone by grading the proper elevation and shaping to conform as closely as possible to the shape of the bottom of the stone. Compact foundation prior to setting stone so settlement does not occur.

3. Assure the required spacing between stones by the use of an approved spacing device to provide an open joint between stones of at least ¼ inch and no greater than 5/8 inch.

4. Backfilling:

   a. Fill all remaining spaces under the curb with approved material and thoroughly hand tamped so the stones will have a firm uniform bearing on the foundation for the entire length and width.

   b. Fill any remaining excavated areas surrounding the curb to the required grade with approved materials. Place this material in layers not exceeding 8 inches in depth, loose measure and thoroughly tamped.

   c. When backfill material infiltrates through the joints between the stones, place small amounts of joint mortar or other approved material in the back portion of the joint to prevent such infiltrating.

5. Protection:

   a. Protect the curb and keep in good condition.

b. Clean and restore all exposed surfaces smeared or discolored to a satisfactory condition or remove and replace the curbstone.

END OF SECTION

SECTION 321723

PAVEMENT MARKINGS
(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. The Contract Documents, General Conditions of the Contract, and Supplementary General Conditions, apply to the work specified in this Section.

B. Section 1-B – School Bid Depository Conditions and Regulations

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Asphalt Paving: Section 321216

1.03 DESCRIPTION OF WORK

A. Provide all materials, equipment, and labor necessary for marking of pavement, including parking lots, walks and roadways, as indicated on the drawings.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - MATERIALS

2.01 GENERAL: All materials conforming to M.D.O.T. specifications Section 708.03.

2.02 PAINT FOR PAVEMENT MARKING: White, meeting the requirements of AASHTO M248, Type N.

PART 3 - INSTALLATION

3.01 GENERAL: Comply with requirements of the Manual on Uniform Traffic Control Devices.

3.02 PREPARATION OF SURFACE: Immediately prior to applying pavement marking, clean the surface of dirt, grease, oil, water and other foreign matter. Dry the surface if necessary.

3.03 LAYOUT: Layout required markings with chalk prior to applying paint to ensure proper alignment. Use standard stencils for all directional arrows.

3.04 APPLICATION: Apply paint by hand or with striping machine to a minimum wet thickness of 16 mils.

3.05 PROTECTION: Place temporary barriers to keep traffic off paint throughout required drying time.

END OF SECTION

32 18 16 - Playground Protective Surfacing

Fibar®Bulk | Specifications

Part 1: GENERAL

To prevent displacement of the Fibar in high-use areas and reduce maintenance, FibarMat wear mats must be installed under all swings, tire swings, slide exits, and all other wear areas including sliding poles.This will help to ensure compliance with the Federal Accessibility Law of March 15, 2012.

1.1 Provide Fibar Bulk Engineered Wood Fiber in areas indicated on plans.

1.2 Provide this Safety Surface immediately after installing playground equipment.

1.3 Fibar Engineered Wood Fiber and FibarMat wear mats are available from your local Representative or directly from The Fibar Group, LLC, 80 Business Park Drive, Suite 300, Armonk, NY 10504-1705.
You can call ☎ 800-342-2721 ☎ 914-273-8770.

PART 2: MATERIALS

2.1 Provide Fibar® Engineered Wood Fiber to a compacted depth of approximately 8 inches.

2.2 The amount of Fibar Engineered Wood Fiber necessary to provide the approximate depth, after compaction, is as follows:
Quantities shown are for a 1,000 sq. ft. playground:

Depth	Quantity
8"	38 cubic yards
10”	42 cubic yards
11”	46 cubic yards
12”	50 cubic yards

2.3 Provide one (1) FibarMat Wear Mat (minimum size: 36” x 36” x 1.5”) with 2” beveled edge on all sides under each swing seat, tire swing, slide exit, and sliding pole. Double and triple slides may require multiple FibarMats. Total quantity required is one.

PART 3: QUALITY CONTROL

3.1 Surfacing shall be IPEMA-CERTIFIED Engineered Wood Fiber. Standard wood chips or bark mulch will not be acceptable.

3.2 Supplier must provide test results for Engineered Wood Fiber and FibarMats for impact attenuation in accordance with ASTM F 1292 *Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment.* Results must be provided for new and for 12-year-old Engineered Wood Fiber material.

3.3 Testing of Engineered Wood Fiber in accordance with **ASTM F 1292** must show G-max values of less than 155G for the 8” thick system, or 120G for the 12” system at 12’ drop heights, and HIC values of less than 1,000 for both new and 12-year-old material.

3.4 Supplier must provide test results for the Engineered Wood Fiber in accordance with **ASTM F 2075** *Specification for Engineered Wood Fiber For Use as a Playground Safety Surface Under and Around Playground Equipment.*

3.5 Testing of FibarMat wear mats in accordance with **ASTM F 1292** must show values of less than 200G and HIC values of less than 1,000 for a 3’ drop height.

3.6 Supplier must provide test results in accordance with **ASTM F 1951**, *Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.*

3.7 Supplier must certify that the surface meets the intent of the *Americans with Disabilities Act*(ADA).

3.8 Supplier must provide **$10 Million** product liability insurance certificate with project owner named as certificate holder, prior to delivery.

3.9 In Canada, supplier must meet CSA guidelines.

PART 4: INSTALLATION

4.1 Install the Fibar Engineered Wood Fiber, and FibarMat wear mats in accordance with manufacturer's instructions.

4.2 Avoid contamination of the Fibar Engineered Wood Fiber with sand, gravel, mud, or native soil.

PART 5: MAINTENANCE

5.1 Maintain the Fibar Engineered Wood Fiber in accordance with manufacturer's instructions.

SECTION 323113

CHAIN LINK FENCES AND GATES

(Trade Bid Required)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Chain-Link Fences: Commercial/Industrial .
2. Gates: swing.

B. Bid Alternate

1. Vinyl coating; contractor to provide Owner with submittal information on coating process and color range.

2. Additional fencing as directed by the Owner.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.

1.3 RELATED DOCUMENTS

A. Section 1-B – School Bid Depository Conditions and Regulations

1.4 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Height indicated on Drawings Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:

1. Steel Wire Fabric: Metallic coated wire with a diameter of 0.148 inch (9 gauge).

a. Mesh Size: 2 inches
Metallic (Zinc) Coating: ASTM A 392, Type II.

2. Selvage: Knuckled at both selvages.

2.2 INDUSTRIAL FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe, and the following:

1. Group: IA, round steel pipe, Schedule 40 standard weight pipe in Accordance with ASTM F 1083, 2.0 oz/ ft² (610 g/m²) hot dip galvanized zinc exterior and 2.0 oz/ft² hot dip galvanized zinc interior coating
2. Regular Grade: Minimum Yield Strength 30,000 psi
3. Line Post: 2-1/2” O.D. Galvanized Steel Pipe; minimum 3.65 lbs/ft ; 2.0 oz/ ft² hot dip galvanized zinc coating interior and exterior;.
4. End, Corner, Pull Post: 3” O.D. Galvanized Steel Pipe; minimum 5.79 lbs/ft ; 2.0 oz/ ft² hot dip galvanized zinc coating interior and exterior.
5. Top, brace, bottom and intermediate rails: 1-5/8” O.D.; minimum 2.27 lbs/ft; 2.0 oz/ ft² hot dip galvanized zinc coating interior and exterior.

B. Post Brace Assembly: Manufacturer's standard adjustable brace at end posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line posts with 0.375" diameter rod and adjustable tightener.

C. Post Tops: Weathertight closure cap (for tubular posts), one cap for each post. Furnish caps with openings to permit passage of top rail.

D. Stretcher Bars: One piece lengths equal to full height of fabric, with minimum cross-section of 1/4" x 3/4". Provide one stretcher bar for each end post, and 2 for each corner and pull post, except where fabric is integrally woven into post.

E. Stretcher Bar Bands: Space not over 15" o.c., to secure stretcher bars to end, corner and pull posts.

F. Wire Ties: For tying fabric to line posts, use wire ties spaced 12" o.c. For tying fabric to rails and braces, use wire ties spaced 18" o.c. For tying fabric to tension wire, use hog rings spaced 24" o.c. Manufacturer's standard procedure will be accepted if of equal strength and durability

2.3 TENSION WIRE

A. General: Provide horizontal tension wire at top and bottom of fence fabric.

B. Metallic-Coated Steel Wire: 0.177-inch diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824.

1. Metallic Coating: Type II Zinc Coated, ASTM A817 Class 5 – 2.0 oz/ft (610 g/m^2).

2.4 INDUSTRIAL SWING GATES

A. General: Comply with ASTM F 900 for single and double swing gate types.

1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1083 and ASTM F 1043 for materials and protective coatings.

B. Frames and Bracing: Fabricate members from round, galvanized steel tubing with outside dimension and weight according to ASTM F 900 and the following:

1. Gate Fabric Height: As indicated
2. Leaf Width: As indicated.
3. Frame Members:

a. Tubular Steel: 1.90 inches round.

C. Frame Corner Construction:

1. Welded or assembled with corner fittings and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider.

D. Hardware: Latches permitting operation from both sides of gate, hinges, center gate stops and keepers for each gate leaf more than 5 feet wide. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

2.5 POLYMER FINISHES

A. Supplemental Color Coating: In addition to specified metallic coatings for steel, provide fence components with polymer coating.

B. Metallic-Coated Steel Tension Wire: PVC-coated wire complying with ASTM F 1664, Class 2b.

C. Metallic-Coated Steel Framing and Fittings: Comply with ASTM F 626 and ASTM F 1043 for polymer coating applied to exterior surfaces and, except inside cap shapes, to exposed interior surfaces.

D. Color (Bid Alternate): As selected by Architect from manufacturer's full range, complying with ASTM F 934.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified. Do not begin installation or erection of fencing before final grading and paving is completed unless otherwise permitted.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter. Concrete fill shall have minimum compressive strength of 3,000 psi.

D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment.

E. Line Posts: Space line posts uniformly at a maximum 10 feet o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567. Install braces at end and gate posts and at both sides of corner and pull posts.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing.

H. Top Rail: Install according to ASTM F 567.

I. Bottom Rails: Install, spanning between posts.

J. Chain-Link Fabric: Apply fabric to outside or inside of enclosing framework as directed by the Architect. Fencing shall be inside enclosing framework at tennis courts, inside enclosing framework for site perimeter and security fencing location. Confirm with Architect prior to installation of fabric.
1. Leave 1 inch between finish grade or surface and bottom selvage at tennis courts or ball fields unless otherwise indicated.
2. Leave 2 inches between finish grade or surface and bottom selvage at other locations. Confirm with Architect prior to installation of fabric

K. Tie Wires: Attach wire per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

M. Tennis Court Fencing: Construct tennis court fence according to ASTM F 969.

3.2 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed

means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION

SECTION 323223

SEGMENTAL RETAINING WALLS

(Trade Bid Required)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes single- depth segmental retaining walls with soil reinforcement.

B. Related Sections:

1. Division 31 Section "Earth Moving" for excavation for segmental retaining walls.

2. Section 1-B – School Bid Depository Conditions and Regulations

1.2 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Performance: Engineering design shall be based on loads due to soil pressures resulting from grades indicated and be according to NCMA's "Design Manual for Segmental Retaining Walls.", local building codes or as provided by the Geotechnical Engineer

D. Seismic Performance: Engineering design shall be based on loads and factors due to soil pressures resulting from grades indicated and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual", local building codes or as presented in the Geotechnical Report.

1. Horizontal Peak Ground Acceleration (A) for Project: As Presented in the Geotechnical Report. .

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each color and texture of concrete unit required.

C. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and field quality-control reports for compliance of materials and construction with design.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, licensees of one of the following:
   a. Anchor Wall Systems, Inc.
   b. Genest Diamond Pro Stonecut 7”
   c. Approved equal.

2. Provide units that comply with requirements for freeze-thaw durability.
3. Provide units that interlock with courses above and below by means of integral lugs or lips.

B. Color: Earth Blend

C. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.

2.2 INSTALLATION MATERIALS

A. Pins and Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

C. Leveling Base: Comply with requirements in approved shop drawings and.

D. Drainage Fill: Comply with requirements in approved shop drawings.

E. Soil Fill: Comply with requirements in Division 31 Section "Earth Moving" for satisfactory soils.

F. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb ASTM D 4632.

G. Subdrainage Pipe and Filter Fabric: perforated or slotted PVC pipe manufactured in accordance with ASTM D 3034 or corrugated HDPE pipe manufactured in accordance with AASHTO M252. Or as required in the Contract Documents."

H. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as specified in the approved shop drawings.

PART 3 - EXECUTION

3.1 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in running bond.
2. Form corners and ends by using special units or cutting units with motor-driven saw.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

E. Cap Units: Place cap units and secure with cap adhesive.

3.2 FILL PLACEMENT

A. General: Comply with requirements in Division 31 Section "Earth Moving," NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

    a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.

3. Compact nonreinforced-soil fill to comply with Division 31 Section "Earth Moving."

D. Place a layer of drainage fill at least 12 inches wide behind wall to within 12 inches of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated.

F. Place impervious fill over top edge of drainage fill layer.

G. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Division 31 Section "Earth Moving" for field quality control.

1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 150 feet or less of segmental retaining wall length.

END OF SECTION

SECTION 32 84 00

IRRIGATION COMPONENTS AND/OR SYSTEMS
(Trade Bid Required)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Work to be performed under this Section shall consist of furnishing all labor and materials necessary to construct a complete working and tested sprinkler irrigation system as per all drawings and specifications.

B. Related Documents

a. Section 1-B – School Bid Depository Conditions and Regulations

1.2 REFERENCES

A. ANSI – American National Standards Institute
B. ASIC – American Society of Irrigation Consultants: ASIC Grounding Guideline.
C. ASSE – American Society of Sanitary Engineering: ASSE 1013, 1015: Backflow Preventers, Pressure Reducers.
D. ASTM – American Society of Testing and Materials
E. IA – The Irrigation Association: Main BMP Document.
F. NFPA – National Fire Protection Association: NFPA 70 National Electrical Code.
G. UL – Underwriters Laboratories: UL Wires and Cables.

1.3 DEFINITIONS

A. Water Supply: Municipal Piping and Components furnished and installed by others to provide irrigation water to the Project.
B. Point of Connection: Location where Contractor shall tie into water supply to provide irrigation water to the Project.
C. Mainline: Pressurized piping downstream of the Point of Connection to provide water to remote control valves and quick couplers. Normally under constant pressure.
D. Lateral Pipe: The system of pipes that provide water from the valves to the sprinkler heads or emitters.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions prior to ordering of any materials. Delivered material shall match approved submittals.
B. Certifications: All general laborers and workers shall be previously trained and familiar with sprinkler installation, and have a minimum of one-year experience.
C. As-Built Drawings: Submit red-lined plan layout and details illustrating field installed points of connection, controllers, mainline and lateral line locations, size, and assembly. Include type and coverage of heads, type of valves, controllers, fittings, emitters, and accessories.
D. Operation and Maintenance Data:

1. Submit instructions covering full operation, care, and maintenance of system (and controls) and manufacturer's parts catalog.
2. Include year-to-year schedule showing length of time each valve is to be open to provide determined amount of water, drain procedures, cleanout features, etc.
3. Instruct Owner's maintenance personnel on how to operate controller, adjust sprinkler heads and other equipment, and use special tools for adjustments.

E. Keys:
1. Manual Valve Key: Furnish two 3 foot long valve keys to fit each type of valve assembly.
2. Controller: Furnish two keys for each automatic controller.

F. Tools: Furnish two sets of special tools required for removing, disassembling, and adjusting each type of valve supplied on the Project.

1.5 PERFORMANCE REQUIREMENTS

A. All work to be performed to current standards of local governing municipality.
B. Location of Equipment: Design locations shown on plans are approximate.
1. Adjust as necessary to avoid obstructions.
2. The number of heads or valves cannot be less than that indicated on plans without approval by Owner.

C. PVC Pipe: Must be stamped with certified NFS.
D. Drain the system at the end of each work day if work continues after November 1, or resumes before April 15. Do not permit water to remain in pipe overnight during this window.
E. Verify and mark locations of all utilities and underground obstructions. Contractor shall contact local utility location services a minimum of 48 hours prior to the commencement of any construction.
F. Contractor shall be responsible to obtain all necessary permits and to comply with electrical company requirements.
G. No substitutions of materials are allowed unless approved by Owner.
H. Record Copy: Maintain at project site one copy of plans marked "Project Record Copy". Mark any deviation in material installation or design on this copy. Maintain and update at least weekly. Use this copy to produce As-Built Drawings upon project completion.
I. As-Built Drawings: Contractor shall record and submit an "As-Built" drawing which records actual installed conditions.
1. The As-Built Drawings shall be clearly and neatly drawn on a reproducible base of the original irrigation design. An electronic version is also acceptable.
2. Contractor shall submit As-Built Drawings to the Owner's Representative and Landscape Architect before work under this contract will be considered for Acceptance.
3. All components of the system shall be shown with dimensions to reference points, as indicated above under "Irrigation Design Drawing". Drawing shall be scaled no smaller than 1" = 30'-0". As-Built submittal, review, and approval by the Owner's Representative and Landscape Architect shall precede Application for Final Payment by the Contractor.

1.6 QUALITY ASSURANCE

A. Contractor shall have considerable experience and demonstrate ability in the installation of irrigation system(s) of specified type(s) in a neat, orderly, and responsible manner in accordance with recognized standards of workmanship.
   1. Contractor shall have a minimum of five years experience in the commercial irrigation industry constructing jobs of similar size and complexity to this one.
   2. Contractor must be a current Certified Irrigation Contractor in good standing as set forth by the Irrigation Association.
   3. Contractor must be licensed to perform landscape construction in the state of this project.

B. Contractor shall provide a list of five equivalent commercial irrigation system installations, performed in the last five years, providing the following information:
   1. Name and address of project
   2. Name and address of Owner
   3. Name and address of whom contract was with

C. All work shall be performed in accordance with the best standards of practice relating to the trade.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, unload, store, and handle materials, packaging, bundling, and products in dry, weatherproof, waterproof condition in a manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism.
B. Deliver in original unopened packaging containers prominently displaying manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law.
C. Remove and replace cracked, broken, or contaminated items or elements prematurely exposed to moisture, inclement weather, temperature extremes, fire, and/or jobsite damage.
D. Damaged materials attributed to Contractor shall be replaced with new materials at Contractor's expense.

1.8 JOB SITE CONDITIONS

A. Protection of Property: Preserve and protect all monuments, structures, existing improvements, and paved areas from damage due to work of this section. In the event damage does occur, completely repair or replace all damage to satisfaction of Owner at no additional cost to the Project or Owner.
B. Protection and Repair of Underground Lines: Request proper utility company to stake exact location (including depth) of all underground utilities. Take whatever precautions are necessary to protect these underground lines from damage, and, in the event damage does occur, repair all damages at no additional cost to the Project or Owner.
C. Replacement of Paving and Curbs: Where trenches and lines cross existing roadways, paths, curbing, etc., keep damage to a minimum and restore to original condition.

1.9 WARRANTY

A. Contractor shall provide a one year warranty that covers all material, workmanship, and labor.
   1. Shall include filling and/or repairing depressions or replacing turf or other plantings due to settlement of irrigation trenches or irrigation system elements.
   2. Shall include replacing turf or other plantings due to malfunctioning irrigation system.
   3. Valve boxes, sprinklers, or other components settled from original finish grade shall be restored to proper grade. Irrigation system shall be adjusted to provide proper, adequate coverage of irrigated areas.

1.10 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.
   1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS:

1. General Information
   a. Provide pipe and fittings as per the specification.
   b. Pipe and fittings shall be comprised of components as outlined in this specification in order to meet the demands of the irrigation zones they service.

2. Pipe and Fittings
   a. Material: PVC
   b. Pressure Pipe: Schedule 40.
   c. Lateral Pipe: Schedule 40.
   d. Fittings: Schedule 40, solvent welded or threaded.
   e. Risers: Schedule 80, threaded.
   f. Sleeves: Schedule 40, minimum 2”.

2.2 AUTOMATIC CONTROLLERS

1. Rain Bird™ ESP-LXD Irrigation Controller

   a. ESP-LXD Irrigation controller specifications include but are not limited to:
      1) The controller shall be of a hybrid type that is microelectronic circuitry capable of fully automatic or manual operation.
      2) The controller shall be housed in a wall-mountable, weather resistant plastic cabinet with a key-locking cabinet door suitable for indoor or outdoor installation.
      3) The controller shall be a two-wire path decoder based control system.

4) The controller shall have incorporated a base station ESPLXD-M50 Module capacity of 50 stations as well as two additional expansion slots capable of receiving ESPLXD-SM75 Modules to create a controller capacity of 200 stations.
5) All stations shall have the capability of independently obeying or ignoring the weather sensor as well as using or not using the master valve.
6) The weather sensors shall include but are not limited to the Rain Bird™ WR2 Rain/Freeze Sensor, the Rain Bird™ RSD Rain Sensor, and the Rain Bird™ Anemometer with Rain Bird™ PT3002 pulse monitor. The ESP-LXMEF shall be compatible with a Rain Bird™ ET Manager Cartridge (ETM-LX).
7) The controller shall have 4 separate and independent programs which can have different start time, start day cycles and station run times.
   i) Each program shall have up to 8 start times per day for a total of 32 possible start times per day.
   ii) The programs shall be allowed to overlap operations based on user-defined settings which control the number of simultaneous stations per program and total for the controller.
8) The controller shall come standard with SimulStations™ which allows the user to define up to five 24 VAC, 7VA solenoid valves to operate simultaneously.
9) The controller shall have a Cycle+Soak™ water management feature which is capable of operating each station for a maximum cycle time and a minimum soak time to reduce water run-off.
10) The controller shall incorporate a FloManager™ feature that shall provide real-time flow, power, and station management; a Flow Smart Module™ option; and a flow sensor module that includes FloWatch™ which learns the normal flow rate of each station.
11) The controller shall be compatible with the IQ v2.0 Central Control System utilizing IQ-NCC Network Communication Cartridges.
12) Shall include a 1-year trade warranty.
13) Shall be manufactured by Rain Bird® Corporation.

b. Use Rain Bird™ LXMM lockable powder-coated steel case suitable for wall mounting or free standing pedestal mounting.

c. Use Rain Bird™ LXMMPED powder-coated steel pedestal for pedestal mounting in conjunction with the Rain Bird™ LXMM case.

d. Irrigation decoder specifications include but are not limited to:
   1) Shall have five different field decoder options to allow the user to choose the precise amount of landscape irrigation control needed.
      i) Rain Bird™ FD101Turf field decoder interfacing signal line and valve.
      ii) Rain Bird™ FD102Turf field decoder interfacing signal line and valve or pair of valves.
      iii) Rain Bird™ FD202Turf field decoder interfacing signal line and 2 valves or 2 pair of valves.

iv) Rain Bird™ FD401Turf field decoder interfacing signal line and up to 4 individual valves.
v) Rain Bird™ FD601Turf field decoder interfacing signal line and up to 6 individual valves.

2.3 ET MANAGER

1. General Information

   a. Provide irrigation controller manager cartridge as per the specification.

   b. The Rainbird™ ET Manager™ Cartridge shall be comprised of components as outlined in this specification in order to meet the electrical demands and control requirements of the irrigation zones they service.

2. Rainbird™ ET Manager™ Cartridge

   a. Rainbird™ ET Manager™ Cartridge specifications include but are not limited to:
      1) The ET Manager™ Cartridge shall be used to upgrade any ESP-LX series controller to an ET/Weather based irrigation controller.
         i) The ET Manager™ Cartridge shall consist of a cartridge and a receiver device that receives hourly weather signals.
         ii) The ET Manager™ Cartridge shall snap into a dedicated bay on back of ESP-LX faceplate and shall be an integral part of the controller.
         iii) The ET Manager™ Cartridge shall include a setup wizard to assist in the setup of program essential settings.
      2) The ET Manager™ Cartridge shall use current weather conditions to calculate evapotranspiration (ET).
      3) The ET Manager™ Cartridge shall be programmable to the required Signal Provider Code in order to receive messages from the Weather Reach™ Signal Provider (WRSP) when the user interface of the irrigation controller dial is in the proper operating position.
      4) The ET Manager™ Cartridge shall interrupt the irrigation controller to allow irrigation only when the soil moisture balance reaches levels set by the user.
      5) The ET Manager™ Cartridge shall manage the soil moisture.
         i) The manager shall use a programmed irrigation amount, and ET minus effective rainfall to determine when watering is needed.
      6) The ET Manager™ Cartridge shall have the ability to maintain four separate moisture balances, one for each of the controller's four programs.
      7) The ET Manager™ Cartridge shall receive hourly weather data and adjust the soil moisture balance used to control the watering frequency.
      8) Shall include programmable delays for rain, temperature and wind allowing irrigation to be interrupted until adverse conditions change.
      9) Shall be able to receive signal to interrupt all irrigation for emergency management or drought restrictions.
      10) Shall have two independent ET-based irrigation schedules to accommodate differing plant types.

11) Shall have a user programmable 12-month historical ET database for backup in the unlikely event that the weather signal is interrupted.
12) The programmable irrigation amounts shall correspond to the irrigation controller settings and are linked to the soil moisture balance to allow watering once soil moisture settings are reached.
13) An optional tipping rain gauge (ETM-RG) can be used onsite to complement information from the weather station.
    i) Programmable effective rain settings, based on soil conditions, shall automatically limit the amount of rain used in the soil moisture balance.
14) Rain gauge sensor (ETM-RG) Voltage: 3.3 Volts DC
    i) Three year warranty
15) The ET Manager™ Cartridge shall include an antenna receiver unit.
16) The ET Manager™ Cartridge shall be capable of being programmed manually through the ESP-LX.
17) Shall be manufactured by Rain Bird® Corporation

2.4 CONTROL VALVES

1. The Rain Bird® 200-PESB-NP-HAN2-PRS-D electric remote control valve shall be comprised of components as outlined in this specification in order to meet the hydraulic demands and flow requirements of the irrigation zones they service.

2. Rain Bird® 100-PESB-PRS-D Electric Remote Control Valve

    a. Rain Bird® 100-PESB-PRS-D electric remote control valve specifications include but are not limited to:
        1) The valve body shall be constructed of heavy-duty glass-filled ultra-violet resistant nylon.
        2) Diaphragm shall be of nylon reinforced nitrile rubber.
        3) Shall be compatible with ESP-LXD-decoders.
        4) Shall contain a nylon scrubber which prevents debris build-up and clogging.
        5) Valve can accommodate a field-installed Rain Bird® PRS-D pressure regulating module.
        6) Shall include 1” (26/34) NPT female threaded (available with BSP threads) configuration.
        7) Operating pressure range of 20 to 200 psi (1.4 to 13.8 bar).
        8) Operating flow rate of 5 to 200 gpm (1.14 to 45.4 m^3/h; 19.2 to 757 l/m).
        9) Shall include a 5-year trade warranty.
        10) Shall be manufactured by Rain Bird® Corporation.

2.5 QUICK COUPLING VALVE

1. Rain Bird® 44-LRC quick-coupling valve
    a. Rain Bird® 44-LRC quick-coupling valve specifications include but are not limited to:
        1) Shall be constructed of rugged, red brass construction for long life and reliable performance.

2) Shall include a locking thermoplastic cover for durability and vandal resistance.
3) Operating pressure range of 5 to 125 psi (0.3 to 8.6 bar).
4) Operating flow rate of 10 to 125 gpm (2.27 to 28.38 m^3/h; 37.8 to 265 l/m).
5) Shall include a 3-year trade warranty.
6) Shall be manufactured by Rain Bird® Corporation.

2.6 BACKFLOW PREVENTER

1. Backflow Preventer
   a. Manufacturer's standard, to suit sprinkler system as follows:
      1) Reduced Pressure Principle Device (RP) or as approved by local jurisdiction.
      2) Capability of being tested and serviced without removing from line.
      3) Comply with local water district and State requirements for such.

2.7 ROTOR HEADS

1. Rain Bird® 5006-PL-PC/FC-SAM-R-SS rotor sprinkler for medium turf areas (25-47 feet (7.6-14.3 m) spacing), maximum 75 psi (5.2 bar).

   a. Rain Bird® 5006-PL-PC/FC-SAM-R-SS rotor sprinkler specifications include but are not limited to:
      1) Shall have adjustable arc rotation of 40 to 360 degrees (0.7 to 6.3 rad) and reversing full circle rotation.
      2) Shall have Stream Control™ Technology (SCT) with Flow Shut-off capabilities.
      3) Shall have a pressure-activated, multi-function wiper seal that protects internals from debris and assures positive pop-up and retraction.
      4) Shall contain additional o-rings and seals for extra protection in "gritty" water.
      5) Operating precipitation rate of 0.20 to 1.01 inches per hour (5 to 26 mm/h).
      6) Operating pressure range of 25 to 75 psi (1.7 to 5.2 bar).
      7) Operating flow rate of 0.73 to 8.31 gpm (0.17 to 1.85 m^3/h).
      8) The body, stem, nozzle, and screen shall be constructed of heavy-duty and ultra-violet resistant plastic.
      9) Shall include a 45 psi (3.1 bar) pressure regulating device to prevent high pressure misting to the nozzle stream.
      10) Shall include an internal Seal-A-Matic™ check valve to prevent low head drainage of up to 7 feet (2.1 m) to prevent puddling, run-off and erosion.
      11) Shall include a stainless steel riser to help deter vandalism on public turf areas.
      12) Shall include a set of twelve interchangeable Rain Curtain™ nozzles, 8 nozzles with 25 degree (0.4 rad) trajectory and 4 low-angle nozzles with 10 degree (0.2 rad) trajectory.
      13) Shall include a five-year trade warranty.
      14) Shall be manufactured by Rain Bird® Corporation.

2. Rain Bird® 8005-SS rotor sprinkler for large turf areas (57-81 feet (17.4-24.7 m) spacing), maximum 100 psi (6.9 bar).

   a. Rain Bird® 8005-SS rotor sprinkler specifications include but are not limited to:
      1) Full and part circle arc rotation in one unit to reduce inventory requirements with part circle adjustable arc rotation of 50 to 330 degrees (0.9 to 5.8 rad).
      2) Shall have vandal resistant features including Memory Arc™, a non-strippable drive mechanism, and a brass reinforcing shaft.
      3) Shall have a pressure-activated, multi-function wiper seal that protects internals from debris and assures positive pop-up and retraction.
      4) Operating precipitation rate of .66 to 1.23 inches per hour (17 to 31 mm/h).
      5) Operating pressure range of 50 to 100 psi (3.4 to 6.9 bar).
      6) Operating flow rate of 11.1 to 36.3 gpm (2.5 to 8.2 m^3/h).
      7) The body, stem, nozzle, and screen shall be constructed of heavy-duty and ultra-violet resistant plastic.
      8) Shall include an internal Seal-A-Matic™ check valve to prevent low head drainage of up to 10 feet (3.1 m) to prevent puddling, run-off and erosion.
      9) Shall include a stainless steel covered nozzle turret and riser stem to help deter vandalism.
      10) Shall include a set of eight interchangeable color-coded Rain Curtain™ nozzles with 25 degree (0.4 rad) trajectory.
      11) Shall include a five-year trade warranty.
      12) Shall be manufactured by Rain Bird® Corporation.

2.8 VALVE BOX

1. Rain Bird® Valve Boxes

   a. Rain Bird® valve boxes specifications include but are not limited to:
      1) Shall be made of structural foam HPDE resin that is resistant to ultra-violet light, weather, moisture and chemical action of soils.
      2) Lids shall be clearly marked with the words “IRRIGATION CONTROL VALVE” molded onto the top.
      3) Lid colors are available in black, green and purple designating non-potable water use.
      4) Available sizes include Rain Bird® VB-STD, VB-STD-6EXT, VB-JMB, VB-JMB-6EXT, VB-SPR, VB-MAX, VB-10RND, VB-7RND, and VB-6RND.
      5) Shall include a 5-year trade warranty.
      6) Shall be manufactured by Rain Bird® Corporation.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Stake pipe and equipment layout as follows:

1. Mark routing of pressure supply line and flag heads for first few zones for Owner's review and approval. Owner will review staking and direct changes if required. Review does not relieve installer from coverage problems due to improper placement after staking.

B. Excavate trenches for irrigation system pipe to provide minimum cover per plans and details. Before excavating, establish the location of all underground utilities and obstructions. Dig trenches straight and support pipe continuously on bottom of trench. Clean trench bottom and smooth by removing all rock and organic debris.

C. Barricade trenches that are left open overnight.

3.2 INSTALLATION

A. General: Plans are diagrammatic. Proceed with installation in accordance with the following:
1. Install stop and waste valves, backflow preventers, and other equipment required by local authorities according to laws and regulations in order to make system complete.
2. Install main line, control valves, lateral lines, fittings, and heads/drip line as specified. Avoid conflict with tree locations. Where trenching is required in proximity to trees which are to remain, do not damage roots.
3. Thoroughly flush main lines before installing automatic control valves, and laterals before installing sprinklers. Flush supply lines thoroughly before installing backflow preventers or other regulating devices.
4. Adjust heads to be plumb and flush with finished grades, even with top of soil level or top of material level after completion of grading, seeding or sodding, and rolling of grass areas.
5. Any discrepancies between existing site conditions and those indicated on the plans shall be called to the attention of Owner prior to continuance of the project.

B. Piping: Assemble all mainline and lateral lines in accordance with manufacturer's recommendations with no cul-de-sacs. Assure positive drainage.

1. Pack the opening around the pipe with non-shrink grout at wall penetrations. Fill perimeter slot with backer rod and sealant at exterior face. Repair below grade waterproofing and make penetration watertight.
2. Install PVC pipe in dry weather above 40 degrees F as specified by manufacturer's recommendations. Allow joints to cure a minimum of 8 hours before testing.
3. Lay pipe and make all plastic to plastic joints in accordance with manufacturer's recommendations.

C. Sleeves: Install sleeves before concrete/paving work.

1. Sleeves should be a minimum two times the diameter of the pipe passing through them.
2. Install sleeves at a maximum depth of 24" unless specific site conditions warrant differently.
3. Use a separate sleeve for irrigation wire.

D. Control Valves:

1. Install control valves at plan locations, according to details, and in accordance with manufacturer's recommendations.
2. Install one valve per valve box and provide 12 inches of expansion loop slack wire at all connections inside valve box.

E. Manual Drains:

1. Install per manufacturer's recommendations on upstream and downstream side of backflow preventers and at lowest point along main pressure pipe.
2. Install by teeing down to ¾ inch drain valve. Provide a drainage sump sized to receive volume of drain water.
3. Make manual drain valves accessible by installing an adjustable pipe sleeve to meet finished grade with locking valve marker lid flush with finish grade.

F. Quick-Coupling Valves: Install using 1 inch PVC nipples and schedule 40 ells as detailed. Location as indicated on plans.

G. Backflow Preventer:

1. Install assembly complete for irrigation system with 2 drain valves and 2 shut off valves per detail, local laws and regulations, and per manufacturer's specifications.
2. Install assemblies with drain valves in below grade installations. Provide open box floor with gravel drain sump.

H. Valve Boxes

1. Install over all remote control valves, manual control valves, zone shutoff valves, gate valves, or globe valves. Size to provide adequate room for maintenance.
2. Install boxes on level subgrade with proper drainage so that top of boxes are flush with finish grade material (sod, mulch, rock, etc.). Place parallel or perpendicular to adjacent curbs, sidewalks, or driveways.
3. Imprint a valve control number on each box cover that corresponds to the valve controller in a permanent and legible manner.
4. Place washed gravel aggregate in sump as shown on details.

I. Automatic Controller

1. Stake controller location for approval.
2. Install according to manufacturer's instructions.
3. Mount the panel enclosure so adjustments can be conveniently made by operator.
4. Properly ground controller per local laws and regulations. Make all control wire connections to automatic controller. Coordinate controller installation with other electrical work.
5. Connect remote control valves to controller in numerical sequence as shown on Plans.
6. Pour concrete pedestal base with inserted conduits and bolts if pedestal controller is used. Concrete base to be not less than 6 inches (150 mm) greater in each direction than overall dimensions of controller.
7. Program controller to provide appropriate amount of water for each station.

J. Wire and Electrical Work

1. Use electrical control and ground wire suitable for sprinkler control cable of size indicated on Plans.
2. Tape control wires to underside of pipe at 15 ft intervals.
3. Provide 120-volt power connection (by others) to automatic controller to conform to local codes, ordinances and authorities having jurisdiction.
4. Low Voltage Wiring:
   a. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to main pipe lines with such wires to be consistently located below and to one side of the pipe, or in separate trenches.
   b. Bundle all 24-volt wires at 10-foot intervals and lay with pressure supply line pipe to one side of trench.
   c. Provide an expansion loop at every pressure pipe angle and fitting and at every electric control valve location (in valve box). Form expansion loop by wrapping wire at least 8 times around a ¾-inch pipe and withdrawing pipe.
   d. Make all splices and E.V.C. connections using connectors or similar dry splice method.
   e. Install all control wire splices not occurring at control valve in a separate 10” splice valve box. Install a minimum of 24” of spare wire in splice boxes.
   f. Install control wire for each control valve.
   g. Run 2 spare #14-1 wires from controller pedestal or electric control valve on each and every leg of mainline. Label spare wires at controller and wire stub box.

K. Sprinkler Heads, Emitters, Rotators, and Rotors

1. Install per plans, details, and manufacturer’s recommendations.
2. Flush circuit piping with full head of water and install sprinklers after hydrostatic text is completed.
3. Adjust nozzles to allow for adequate coverage and to minimize overspray onto walks, roads, driveways, and buildings.
4. Locate part-circle sprinklers a minimum distance of 4 inches (100 mm) from walls and 2 inches (50 mm) from other boundaries, unless otherwise indicated.
5. Stake emitter tubing with 1/4” Rainbird® TS-025 tubing stakes.
6. Adjust heads to be plumb and flush with finish grades, even with top of soil level or top of material level after completion of grading, seeding, sodding, and rolling of grass.

L. Thrust Blocks and/or Joint Restraints

1. Install on pipe sized 2” or larger wherever the main pipe line:

   a. Changes any direction at tees, angles, and crosses vertical and horizontal.
   b. Changes at reducers.
   c. Stops at a dead-end.
   d. Valves at which thrust develops when closed.

2. Size of thrust block depends on pressure, pipe size, soil type, and fitting type. As a general rule, one cubic foot (minimum) of concrete is required for each thrust block.

3. Thrust blocks shall rest against undisturbed original soil in direction of thrust.
4. Use joint restraints as manufactured by Harco or Leemco on mainline sizes 3" and greater.

3.3 BACKFILLING

A. Do not begin backfilling operations until system tests and approvals have been completed.
B. Bed all pipe a minimum of 2 inches. Backfill to 6 inches above pipe with soil free of rocks over 1-inch diameter, debris, or organic matter. Backfill remainder of trench with soil of like quality to adjacent areas. Haul away all material not suitable for backfill.
C. Compact backfill in 6-inch lifts thoroughly to prevent settling damage to grades or plant material. Leave trenches slightly mounded to allow for settlement after backfilling is completed. Low areas and damage caused by settling will be repaired by Contractor at no additional cost to the Project or Owner.
D. Prevent soil, rocks, or debris from entering pipes or sleeves.

3.4 FLUSHING AND TESTING

A. Flushing: After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for 5 minutes through furthermost valves. Cap risers after flushing.
B. Testing: Notify Owner 48 hours in advance of all testing. Conduct tests in presence of Owner's Representative.
   1. After backfilling and installation of control valves, fill pressure supply line with water and pressurize to 40 PSI over the designated static pressure or 120 PSI, whichever is greater, for a period of 2 hours.
   2. Leakage, Pressure Loss – Test is acceptable if no leakage or pressure loss is evident during test period.
   3. Leaks – Detect and repair all leaks.
   4. Retest system until test pressure can be maintained for duration of test.
   5. Before final acceptance, test supply line under pressure for a period of 48 hours.

3.05 INSPECTION

A. Arrange for Owner's presence 48 hours in advance of inspection walk-through.
B. Examine areas and conditions under which work of this section if to be performed and ensure a complete and operating installation prior to scheduling a walk-through.
C. Operate each zone in its entirety for Owner at time of walk-through and open all valve boxes as directed.
D. As necessary Owner will generate a list of items to be corrected prior to Final Acceptance.
E. Furnish all materials and perform all work required to correct inadequacies of installed system.

3.6 RESTORATION AND CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.
B. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.

C. Restore all damaged areas to original condition unless otherwise shown on plans at no additional cost to the Project or Owner.
D. Maintain continuous cleaning operation throughout duration of work. Dispose of, off-site, at no additional cost to Project or Owner, all trash or debris generated by installation of irrigation system.

END OF SECTION

SECTION 329200

TURF AND GRASSES

(Trade Bid Required)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.

B. Related Documents
1. Section 1-B – School Bid Depository Conditions and Regulations
2. Section 312500 – Erosion and Sedimentation Control

1.2 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Whatever soil is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of grass seed.

1. Certification of each seed mixture.

2. Testing for germination no more than one year before calendar date of proposed installation.

C. Product certificates.

1.4 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for turf growth.

a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

1.6 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 60 days from date of planting completion

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

1.7 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed:

1. Provide fresh, clean, new-crop seed complying with the tolerance for purity and germination established by the Official Seed Analysts of North America. Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed as specified.

2. The seed mixture for turf fields shall consist of seeds proportioned by weight as follows:

Kentucky Bluegrass*	80%
Ryegrass cv. 'Repell'**	20%

*provide in 3 cultivars of equal proportions
**provide in 2 cultivars of equal proportions

3. Pure live seed percentage of not less than 90% for each cultivar

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: Natural limestone containing not less than 90 percent of total carbonates, ground so that not less than 100 percent passes a 10-mesh sieve, not less than 90 percent passes a 20-mesh sieve, and not less than 50 percent passes a 100-mesh sieve.

2.3 ORGANIC SOIL AMENDMENTS

A. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8, and shall past through a 1 inch screen.

B. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.4 FERTILIZERS

A. Fertilizer shall contain available elements in conformity with the standards of the Association of Official Agricultural Chemists. The fertilizer shall indicate the weight, contents and guarantee analysis shown thereon or on a securely attached tag, as applicable.

1. Water soluble fertilizer shall be completely soluble in water and contain the following percentages of available nutrients by weight. It shall contain a coloring agent.

Nitrogen	16 percent
Phosphoric Acid	32 percent
Potash	16 percent

2.5 MULCHES

A. Mulch shall be composed of cellulose or wood fiber products with no growth or germination inhibiting substances, and shall be manufactured in such a manner that when thoroughly mixed with seed, fertilizer, organic stabilizer, and water will form homogeneous slurry which is capable of being sprayed to form a porous mat at the rate of not less than 60 lbs of mulch material per 1,000 sq ft of unit area. The fibrous mulch in its air-dry state shall contain no more than 15% by weight of water. The fiber shall have a temporary green dye and shall be accompanied by a certificate of compliance that the fiber conforms to these specifications.

2.6 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

A. Preparation of Disturbed Areas:

1. Topsoil salvaged from the site or imported should be screened to remove all coarse fragments that would be objectionable for the proposed athletic field and lawn areas.

2. After spreading at least 4 inches of salvaged or imported topsoil over the new athletic fields and lawn areas, we recommend rototilling the topsoil to a depth that will penetrate 2 to 3 inches into

the underlying substrate in order to create a transitional horizon between the substrate soils and topsoil. The rototilling should be done so that the topsoil is well mixed with the upper portion of the substrate soil. This may require several passes with the rototiller and some drying may be needed between passes to provide good mixing and proper consistence of the topsoil material.

3. After rototilling the topsoil to create a transitional horizon, we recommend adding organic matter (manure, composted leaves, or a mix of readily degradable organic matter) to increase organic matter content, cation exchange capacity, water holding capacity and general tilth of the soil, and this increase the ability of the soil to accept and grow grass. Specifically, we recommend rototilling 3 inches loose depth of organic material into the top 4 inches of topsoil. The area should then be carefully graded and prepared for seeding.

4. We recommend that new topsoil areas be fertilized according to the recommendations specified in the Maine Soil Testing Service reports.

5. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
6. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

B. Finish Grading: Grade areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SEEDING

A. Seeding time shall be between August 13 and September 25.

B. Seeding shall be conducted through the use of a hydroseeder. Application shall not be conducted when wind velocity exceeds 10 mph

C. Sow seed at a total rate of 5 lb/1000 sq. ft.

3.3 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain height appropriate for species without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings.

C. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.4 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION

SECTION 329300

LANDSCAPE WORK
(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this Section.

B. Section 1-B – School Bid Depository Conditions and Regulations

1.02 SUMMARY OF WORK

A. Work included: Provide labor, materials and equipment necessary to complete the work of this Section and, without limiting the generality thereof, furnish and include the following:

1. Planting installation of trees, shrubs and ground covers; planting of lawns and other work as indicated on Site Drawings.

B Related Work Specified in Other Sections:

1. Earthwork: Section 312000
2. Erosion and Sedimentation Control: Section 312500
3. Turf and Grasses: Section 329200

1.03 QUALITY ASSURANCE

A. General: Comply with requirements of Division 1.

B. Source Quality Control:

1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulations applicable to landscape materials.

2. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis and approval by a Maine Certified Landscape Professional.

3. Topsoil: Before delivery of topsoil, furnish written statement giving location of properties from which topsoil is to be obtained.

4. Plant Material:

a. Plant materials shall mean trees, shrubs, ground covers, and plants of all descriptions, required to be furnished for the project and shall conform to all provisions of ANSI Z60.1, 2014 or most current edition.

b. Substitutions: In the event that trees, shrubs, or other plant material specified in the plant list are in the opinion of the Contractor, impossible or unreasonably difficult to obtain, the Contractor shall immediately notify the Owner's Representative to discuss appropriate substitutions. No substitutions of plant material may be made without the prior approval of the Owner's Representative. When authorized, adjustment of contract amount will be made.

5. Inspection: The Owner's Representative reserves the right to inspect any plant materials either at the place of growth or at the site before planting, for compliance with requirements for name, variety, size, quality and health.

6. All work of planting shall be done by a proficient landscape contractor with five years minimum experience.

7. The plant supplier/nursery shall be ALCA certified.

1.04 SUBMITTALS

A. Certification:

1. For information only, submit 2 copies of certificates of inspection as required by governmental authorities, and manufacturer's or vendor's analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

2. Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at the site.

B. Plant Materials:

1. In preparing plants for moving, all precautions customary in good trade practice shall be taken. All plants shall be dug immediately before moving unless otherwise specified. Broken, loose, or manufactured balls will be rejected.

2. All plants shall be packed, transported, and handled with utmost care to insure adequate protection against injury and drying. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches or destroy natural shape. Provide protective covering during delivery.

3. Deliver plant materials after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery, set all plants in shade, protect from weather and mechanical damage, and keep roots moist.

4. Label all plant materials of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.

1.06 JOB CONDITIONS

A. Contractor must examine the subgrade, verify the elevations, observe the conditions under which work is to be performed, and notify the Owner's Representative of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Architect or Landscape Architect.

B. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Contractor shall notify Dig Safe 72 hours prior to any excavation. Hand excavate, as required, to minimize possibility of damage to underground utilities. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned.

C. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, the Contractor shall notify the Owner's Representative before planting. The Contractor shall be responsible for correcting such conditions.

D. Planting and Seeding Seasons: Unless variance is requested in writing and approved by the Owner's Representative, planting and seeding shall be done within the following dates:

Lawns:	April 1 - September 15
Plant Materials:	
Potted and Container Grown Plants	Spring: April 1 - July 15 Fall: Aug. 15 - Nov. 15
Balled and Burlapped Plants	Spring: April 1 - June 15 Fall: Aug. 15 - Oct. 15

E. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to the Owner's Representative. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. Loam or approved topsoil removed within the confines of the project area shall be reused in accordance with Section 312000, Earthwork. If quantity of stockpiled topsoil is insufficient, provide new topsoil which is fertile, friable, natural loam, surface soil, reasonably free of subsoil,

clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2 in. in any dimension, and other extraneous or toxic matter harmful to plant growth. Sand, silt, and clay contents comprising existing or new topsoil shall fall within the following ranges:

Sand	50% - 70%
Silt	2% - 40%
Clay	10% - 28%

B. Submit representative soil samples of new topsoil from off-site sources as well as existing topsoil removed from within confines of site to qualified soil testing laboratory to ascertain what amendments may be necessary to obtain proper tilth, nutrient characteristics, and pH balance in accordance with the following. Provide amendments as necessary at rates indicated on the soil test.

- organic matter: greater than 5% organic matter (by weight)
- pH range: 5.8 to 6.2
- phosphorus/potassium: medium to medium high range
- soluble salt: not greater than 500 ppm

C. Soil Amendments:

1. Lime: Natural limestone containing not less than 90 percent of total carbonates, ground so that not less than 100 percent passes a 10-mesh sieve, not less than 90 percent passes a 20-mesh sieve, and not less than 50 percent passes a 100-mesh sieve.

2. Peat Humus: Peat humus shall be a natural peat approved by the Owner's Representative consisting or sedge, sphagnum or reed peat of such physical condition as will pass through a 1 in. screen and will be readily incorporated with the topsoil. The peat humus shall be free from sticks, stones, roots and other objectionable matter.

3. Fertilizer: Fertilizer shall contain available elements in conformity with the standards of the Association of Official Agricultural Chemists. The fertilizer shall indicate the weight, contents and guarantee analysis shown thereon or on a securely attached tag, as applicable.

   a. Granular fertilizer shall be a commercial grade fertilizer containing the following percentages of available nutrients by weight:

Nitrogen	10 percent
Phosphoric Acid	10 percent
Potash	10 percent

   b. Water soluble fertilizer shall be completely soluble in water and contain the following percentages of available nutrients by weight. It shall contain a coloring agent.

Nitrogen	16 percent
Phosphoric Acid	32 percent
Potash	16 percent

   c. Slow release fertilizer packets shall be slow release fertilizer contained in a polyethylene perforated bag with micropore holes. Each bag shall contain 4 ounces of minimum water soluble fertilizer to be effective for 8 years.

Packages shall contain the following percentage of available elements by weight.

Nitrogen	20 percent
Phosphoric Acid	10 percent
Potash	5 percent

The Owner's Representative may approve the use of other fertilizers providing they contain an equivalent amount of nutrients in an acceptable form.

4. Manure: Manure shall be dehydrated processed, well-rotted manure subject to approval by the Owner's Representative. Manure shall be free of weeds, grass, or harmful chemicals.

2.02 PLANT MATERIALS

A. Quality: Provide trees, shrubs, and other plants complying with the recommendations and requirements of ANSI Z60.1 "Standard for Nursery Stock" as published by the American Landscape & Nursery Association, 2014 edition or current edition. All plants shall be nursery grown unless otherwise stated, and shall have been growing under the same climatic conditions as the location of this project for at least two (2) years prior to award date of this contract.

B. Deciduous Shrubs: Provide balled and burlapped (B&B) deciduous shrubs otherwise noted in plant list. Container grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs as approved by the Owner's Representative.

C. Coniferous and Broadleafed Evergreens: Provide balled and burlapped (B&B) evergreens. Container grown evergreens will be acceptable as approved by the Owner's Representative.

D. Deciduous Trees: Provide balled and burlapped (B&B) deciduous trees unless otherwise noted in plant list. Container grown deciduous trees will be accepted in lieu of balled and burlapped deciduous trees as approved by the Owner's Representative.

2.03 GRASS MATERIAL

A. Grass Seed:

1. Provide fresh, clean, new-crop seed complying with the tolerance for purity and germination established by the Official Seed Analysts of North America. Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, as specified.

2. The seed mixture for lawn areas shall consist of seeds proportioned by weight as follows:

Creeping Red Fescue	20%
Kentucky Bluegrass	70%
Ryegrass cv. ‘Repell’	10%

3. The seed mixture for detention basin areas shall consist of seeds proportioned by weight as follows:

Kentucky Bluegrass	15%
Redtop	2%

Jamestown II	50%
Ryegrass cv. 'Repell'	25%
Birdsfoot Trefoil cv. 'Empire'	3%
White Dutch Clover	5%

2.04 GROUND COVER: Provide plants established and well-rooted in removable containers or integral peat pots and with no less than the minimum number and length of runners required by ANSI Z60.1 for the pot size shown or listed.

2.05 MISCELLANEOUS LANDSCAPE MATERIALS

A. Planting Bed Mulch: Provide shredded bark mulch for planting beds. Do not use material that is decayed or mixed with soil, weeds or other foreign matter. Use material that is large enough in size to prevent it from drifting and blowing in normal wind storms. Submit samples to Owner's Representative for approval prior to delivery of bark mulch to site.

B. Anti-Erosion Mulch: Use "Erosionet" or similar mulch where slopes are too severe to be maintained by planting bed mulch alone.

C. Anti-Desiccant: Emulsion type, film-forming agent or Wilt-Pruf by Nursery Specialty Products, Inc., designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.

D. Wrapping: Wrapping material for tree trunks shall be furnished in strips approximately 4 to 6 inches wide consisting of first quality, 8 oz. per sq. yd. burlap, approved waterproof paper tape or polyethylene film, ASTM D 2103.

E. Stakes and Guys: Provide stakes of sound new hardwood, free of known holes and other defects. Provide wire ties and guys of 2-strand, twisted, pliable galvanized iron wire not lighter than 12 ga. with zinc-coated turnbuckles or an approved equal. Provide new 2-ply garden hose not less than 1/2 in. hose size, cut to required lengths to protect tree trunks from damage by wires or an approved equal.

F. Mulch for Seeded Areas:

1. Straw mulch shall consist of long fibered straw, reasonably free from noxious weeds and other undesirable material. No material shall be used which is too wet, decayed, or compacted as to inhibit even and uniform spreading. No chapped hay, grass clippings or other short fibered material shall be used unless directed by the Owner's Representative.

2. Cellulose fiber mulch shall consist of natural wood, recycled paper or humus cellulose fiber containing no materials which will inhibit seed germination or plant growth. Sufficient non-toxic water soluble green dye shall be added to provide a definite color contrast to the ground surface to aid in even distribution. Cellulose fiber mulch shall be supplied in moisture resistant, sealed bags marked with the manufacturer's name, the air dry weight, and composition of the contents.

G. Mulch Binder: Material for mulch binder may be emulsified asphalt of a type acceptable to the Owner's Representative and may be diluted with water to assure even distribution. Other types of approved mulch binders may be used when authorized by the Owner's Representative.

H. Water: Water used for landscape work shall be free from oil, acids, alkalis, salts, or other substances harmful to plants.

2.06 PREPARATION OF PLANTING SOIL

A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth. Mix specified soil amendments with topsoil at the rates specified. Unless otherwise specified or indicated on the Drawings, the following planting soil mixture (thoroughly mixed by volume) shall be used for backfill around trees and shrubs: dehydrated processed manure 1 part; topsoil 8 parts; peat moss 3 parts.

PART 3 - EXECUTION

3.01 PROTECTION OF PAVEMENT, CURB AND NEW FACILITIES

A. In performance of landscape work, protect new paved surfaces, curbing, concrete and other work from damage due to trucks, equipment and materials. Run only equipment with street or turf tires on wearing course of pavement. Knobby tires and track equipment are not allowed.

3.02 PREPARATION

A. Layout: Locations for trees and outlines of planting bed areas shall be staked on the ground by the Contractor and the stakes marked by plant type at least 48 hours before any plant pits or beds are dug. Owner's Representative shall approve all locations of stakes and planting bed outlines prior to installation of plant material.

B. Preparation for Planting Lawns and Disturbed Areas:

1. Spread topsoil on prepared areas to a minimum depth of 6 in. and as required to meet lines, grades and elevations shown, after light rolling and natural settlement. Before placing the topsoil, loosen and scarify subgrade of lawn areas to a minimum depth of 6 in. Remove stones over 1 1/2 in. in any dimension and sticks, roots, rubbish and other extraneous matter. Adjust soil nutrients prior to topsoil application.

2. Grade lawn area to smooth, even surface with loose, uniformly fine texture. Roll and rake out all pieces of sod, roots, and grass. Remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.

3. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

4. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

C. Preparation of Unchanged Grades: Where lawns are to be planted in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil for lawn planting as follows: till to a depth of not less than 6 in.; apply soil amendments and initial fertilizers as specified; remove high areas and fill in depressions. Till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter. Incorporate soil amendments, as specified, at appropriate stages.

D. Preparation of Planting Beds: Loosen subgrade of planting bed areas to a minimum depth of 6 in. using a cultimulcher or similar equipment. Remove stones over 1 1/2 in. in any dimension, and sticks, stones, rubbish and other extraneous matter. Spread planting soil mixture to the 6" minimum depth and as required to meet lines, grades and elevations shown, after light rolling and natural settlement.

E. Excavation for Trees and Shrubs:

1. Excavate pits in accordance with Typical Planting Details with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation. For balled and burlapped (B&B) trees and shrubs, make excavations at least twice as wide as the ball diameter and a minimum of 1 ft. 6 in. wider than root spread.

3.03 PLANTING

A. Planting Trees and Shrubs:

1. Planting shall be done in accordance with Planting Details. Set balled and burlapped (B&B) stock on layer of planting soil mixture, plumb and in center of pit or trench with top of ball at same elevation as adjacent finished landscape grades. Placing root balls on compacted soil or ledge is not permitted. When set, carefully remove burlap from sides of balls; retain on bottom only if removal is impossible without damage to root balls. Place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3-full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.

2. Set container grown stock as specified for balled and burlapped stock, removing containers in such a way as to not damage roots. Set plants such that 1/8 of the depth of the root ball is above finish grade, or 2" minimum.

3. Dish completed planting pits to form shallow (4") saucer to collect water. Mulch pits, trenches and planted areas with at least 4 in. thickness of shredded bark or equivalent substitute approved by Owner's Representative.

4. Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage. If deciduous trees or shrubs are moved in full-leaf, spray with anti-desiccant at nursery before moving and again 2 weeks after planting.

5. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Remove dead, broken, or diseased branches. Prune trees to retain required height and spread. Unless otherwise directed by the Owner's Representative, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character and accomplish their use in the landscape design. Pruning cuts shall be made to outside the branch color or branch bark ridge; tree paint is not permitted. Required shrub sizes are the size after pruning. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

6. Wrap tree trunks of 2 in. caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures required before wrapping. Wrapping shall only be present from November 1st to April 1st.

7. Immediately after planting, guy and stake trees of 1 1/2 in. caliper or larger or over 6 ft. in height on planting schedule. Allow plants to have normal sway to promote strong growth.

8. Plant labels shall be removed immediately after acceptance by Architect.

B. Seeding New Lawns:

1. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.

2. Rates of Application:

a. Limestone and 10-10-10 shall be applied based on soil testing and analysis to be approved by Architect prior to application.

b. Seed for lawn areas shall be sown at the rate of 5 lbs. per 1000 sq. ft. of coverage.

3. The hydraulic spray method shall be used for seeding all areas unless alternative methods are approved by the Owner's Representative.

4. Application Procedure:

a. Hydraulic Spray Method: The hydraulic spray method of sowing seed shall be done with an Architect approved machine operated by a competent crew. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. Contractor shall furnish seed and fertilizer labels to Owner's Representative prior to mixing. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates. If the Owner's Representative finds the application uneven or otherwise unsatisfactory, he may require the hydraulic spray method to be abandoned and the balance of the work done as specified under another method.

b. Mechanical Method:

The mechanical method shall be used only when approved by the Owner's Representative. Fertilizing and liming shall be done when the soil is in a moist condition and at least 24 hrs. before sowing the seed. The fertilizer and lime shall be applied to the soil by means of a mechanical spreader or be applied to the soil by means of a mechanical spreader or other Architect approved method capable of maintaining a uniform rate of application and shall be thoroughly harrowed, raked or otherwise mixed with the soil to a depth of not less than 1 in. The fertilizer and lime shall not be applied together unless applied hydraulically.

Grass seed of the required mixture and quality shall be sown by a mechanical seeder or other method which will sow the seed uniformly over the entire area to be seeded.

5. Mulching:

a. Cellulose fiber mulch shall be applied as a waterborne slurry. The cellulose fiber and water shall be thoroughly mixed and sprayed on the area to be covered so as to form a uniform mat of mulch at the rate of not less than 60 lbs. at mulch material per 1,000 sq. ft. unit of area.

Cellulose fiber mulch may be mixed with the proper quantities of seed, fertilizer, and agricultural limestone as required, or may be applied separately the next day after seeding.

b. Straw mulch shall be spread evenly and uniformly over any designated areas or as directed by the Owner's Representative in the field so to avoid damage to seeded areas. Unless otherwise directed, mulch shall be applied at the rate of 3 tons per acre. Too heavy application of mulch material shall be thinned.

Unless otherwise authorized, the mulch shall be anchored in place by uniformly applying an acceptable mulch binder at a rate of 10 to 13 gallons per 1,000 sq. ft. Application of a concentrated stream of mulch binder will not be allowed. Asphalt mulch binder may be omitted when authorized and when there is a danger of the asphalt defacing the surface of nearby structures, houses, vehicles or other objects. Other methods of anchoring mulch may be used subject to the approval of the Owner's Representative.

C. Planting Ground Cover: Space plants as shown or scheduled. Excavate subgrade to a depth of 6 inches for contiguous groundcover area and backfill with planting soil. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water. Water thoroughly after planting, taking care not to cover crowns of plants with wet soils. Protect from hot sun and wind for several days. Remove protection when plants show evidence of recovery from transplanting shock. Mulch areas between ground cover plants; place not less than 4 in. thick.

3.04 FERTILIZING TREES AND SHRUBS

A. Water Soluble Fertilizer:

1. The first liquid feeding will be permitted as the first watering only during backfilling of the plant, unless otherwise directed by the Owner's Representative. All seedlings will be liquid fed during planting. The second liquid feeding will be made the following spring season, no later than June 30th.

2. Liquid fertilizer shall be completely dissolved and mixed in water at the rate of 6 lbs. of the fertilizer concentrate to 100 gallons of water.

3. The resulting solution shall be poured in the plant pit as directed by the Owner's Representative. A second application at the same rate shall be applied as directed by the Owner's Representative. The solution shall be applied at the following rates for each application:

Plants up to 2 ft. in height shall receive 4 quarts.
Plants above 2 ft. and up to 6 ft. shall receive 6 quarts.
Plants above 6 ft. and up to 12 ft. shall receive 12 quarts.
Plants above 12 ft. shall receive 16 quarts.

B. Slow Release Fertilizer Packets:

1. All woody plants except evergreen seedlings shall be fertilized with slow release fertilizer packets at the time of planting, unless otherwise directed by the Owner's Representative. Fertilizer packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 6 to 8 inches. Packets shall not be cut, ripped or damaged.

2. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

The application rates shall be as follows:

Type of Plants	No. of Packets
Evergreen Trees	
Under 18 inches height	1
18 inches to 3 ft. height	2
3 ft. to 6 ft. height	3
Over 6 ft. height	4
Deciduous Trees	
Under 6 ft. height	2
6 ft. to 12 ft. height or under 4 in. caliper	3
Over 4 inches caliper	4
Shrubs	1
Under 2 ft. height or spread	
2 ft. to 3 ft. height or spread	2
Over 3 ft. height or spread	3
Vines and Ground Covers	1

3.05 MISCELLANEOUS LANDSCAPING

A. Watering: Thoroughly water all plants after delivery to the site and immediately after planting. This shall mean full and thorough saturation of all backfill in the pits and beds during the same day of planting. Apply water only by open end hose at a very low pressure to avoid air pockets and injury to the roots. Continue to water all plants and lawns as required to promote healthy growth during the establishment period.

B. Mulching: Within two (2) days after planting, mulch all tree pits and planting beds with 4 in. layers of mulching material.

3.06 MAINTENANCE AND ACCEPTANCE

A. Lawns:

1. Maintain lawns by watering (maintain a moist seed bed at all times), fertilizing, weeding, mowing, trimming, and other operations such as rolling, re-grading and re-planting as required to establish a smooth, acceptable lawn, free of eroded or bare areas. Provide

at least three cuttings when lawn height reaches 3½ inches (mow to height of 2½"); mow in alternate direction each mowing.

a. Areas will be accepted only upon attainment of a reasonably thick uniform stand of grass of not less than 80 percent coverage of permanent grasses, free from thin or bare spots.

2. The acceptance of any seeded areas will be in writing. After acceptance, the contractor will be relieved of further expense for maintaining the areas, except for damage resulting from his own or his subcontractor's operations.

B. Trees and Shrubs:

1. The acceptability of the plant material furnished and planted under this Contract shall be at the end of a period of establishment, during which the Contractor, as necessary, shall employ all possible means to preserve the plants in a healthy and vigorously growing condition and to insure their successful establishment. The establishment period shall extend for a period of one (1) calendar year from the date of final acceptance of the project. During this period, the Contractor shall water, cultivate and prune the plants, repair guy wires and stakes, mouse bait as may be required and do any other work necessary to maintain the plants in a healthy growing condition. This shall include seasonal spraying with approved insecticides or fungicides as may be required. The Contractor shall also be responsible for protecting the plants from mice and other rodents. All dead or rejected plants shall be promptly removed from the project and replaced by live healthy plants meeting the same specifications, if such plants are declared unacceptable during this planting season. Otherwise, they shall be replaced during the next subsequent planting season. No payment shall be made for unsatisfactory work during the establishment period.

2. The period of establishment shall commence at the date of final acceptance. Necessary replacements shall be made so that at the time of final acceptance all plants shall be in a healthy, vigorous growing condition and free from sizable die-back.

3. It shall be the sole responsibility of the Contractor to replace any unsatisfactory plants on the project regardless of whether they are specifically designated by the Owner's Representative. In the case of individual doubtful plants, the Contractor may call upon the Owner's Representative to make a determination as to their acceptability, but it shall not be incumbent on the Owner's Representative to furnish the Contractor with exact lists of replacements.

4. All replacements of plants shall be completed by the end of the planting season prior to the final acceptance date. Any small quantity of plants which fail between the end of the planting season and the final acceptance date shall be canceled from the list of accepted plants and the Contractor will receive no payment for them. If a sizable number fails, the Owner's Representative may extend the date of final acceptance to the subsequent planting season, in which case, the Contractor will be subject to liquidated damages, to be established by the Owner's Representative. All replacement planting shall conform in every way to the requirements of the original planting. The Owner's Representative may require that any replacement plants that are not dormant, or that are planted late in the season, be sprayed, as directed, with an approved anti-desiccant.

3.07 CLEANUP AND PROTECTION: During landscape work, store materials and equipment where directed. Keep pavements clean and work area in an orderly condition. Protect landscape work and materials from

damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.08 RESTORATION: All pavements, seeded and planted areas, structures and substructures not specifically provided for in the contract disturbed by the Contractor during the execution of the work shall be restored by the Contractor, in a manner satisfactory to the Owner's Representative, to their original conditions at no additional cost to the Owner.

END OF SECTION

SECTION 331000

MANHOLES, CATCH BASINS AND PRECAST CONCRETE

(Trade Bid Required)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this Section.

1.02 SUMMARY

A. Work includes: provide drainage manholes and catch basins, and precast concrete items as shown on the drawings. This section includes:

1. Precast drainage manholes.
2. Precast catch basins.
3. Frames and covers, and grates.
4. Concrete light bases.
5. Electric/Tel-data manholes.
6. Decontamination Tank

B. Related Work Specified in Other Sections:

1. Division 31 Section"Earthwork"
2. Division 33 Section "Utilities"
3. Section 221300 – Sewers, Drains, and Site Piping

C. Related Documents

1. Sanford Sewerage District Standard Specification

2. Section 1-B - School Bid Depository Condition and Regulations

1.03 QUALITY ASSURANCE

A. Provide complete manhole, catch basin, and precast concrete structures capable of supporting AASHTO H20 loading.

B. All precast concrete shall comply with ASTM C913 "Standard Specification for Precast Concrete Water and Wastewater Structures."

C. Precast Manhole and Catch Basin Components: ASTM C478.

D. Average strength of 4,000 psi at 28 days. Light pole bases shall have an average strength of 5,000 psi at 28 days.

1.04 SUBMITTALS

A. Shop Drawings: Submit for approval:

1. Precast manholes, catch basins, and all precast concrete items prior to fabrication indicating compressive strength.
2. Show components to be used and elevations of top of precast sections, base and pipe inverts, location/angle of pipe penetrations, steps, for each structure.

B. Antifloatation Slab Design Certificate: The Contractor may provide the precast structures requiring antifloatation slabs as one complete unit. If provided as a monolithic unit, submit a certificate of design signed by a Professional Engineer licensed in the State of Maine, certifying that the structure including the slab has been designed to withstand all forces including soil, traffic and hydrostatic in accordance with all applicable laws, regulations, rules and codes.

C. Product Data: Manufacturers' product data and installation instructions for frames, covers, grates, precast items, manhole sleeves, joint sealants and frost barrier.

D. Pipe to Manhole Connections

1.05 Adminstrative Requirements

A. Trade Bids for work under this Section shall be for the complete work of this Section and shall be filed under the provisions and requirements specified under Division 01 – General Requirements.

1. Special attention is directed to Section 1-B – School Bid Depository Conditions and Regulations and all Sections within Division 01 – General requirements which are hereby made a part of this Section of the Specifications.

PART 2 - PRODUCTS

2.01 SANITARY MANHOLE:

A. All sewer construction shall comply with the standards and specifications of the Sanford Sewerage Districts.

B. Provide complete manhole and precast concrete structures capable of supporting AASHTO H-20 loading. Precast concrete shall comply with ASTM C913 "Standard Specification for Precast Concrete Water and Wastewater Structures

C. Base Sections: Precast monolithic construction with steps.

D. Barrel Sections: Precast with steps.

E. Top Sections: Precast eccentric cone with steps. Use flat cover only if shown on drawings.

F. Steps: Conform to ASTM C478 for load carrying capacity and pull out resitance, installed at 12-inches on center forming a continuous ladder. Acceptable manufacturers: Reliabel Steel Products, Inc., M.A. Industries, Inc. or equal to above.

G. Pipe to Manhole Connections:

a. Pipe to Manhole connections shall be flexible, watertight manhole sleeves.
b. Cast into the manole base and sized to the type of pipe being used
c. Type of flexible joint being used shall be approved by the Engineer. Install materials according to the Manufacturer's instruction. Acceptable manufacturers; Lock Joint ny Interpace Corporation, Kor N Seal by Trelleborg, Press Wedge II by Press-Seal Gasket Corporation, A-Lok Manhole Pipe Seal by A-Loc Corporation, or approved equivalent.

H. Joints Between Precast Sections: Watertight, shiplap type, seal with two rings of 1-inch diameter butyl rubber sealant.

I. Waterproofing: The exterior surface of all manholes shall be given two coats of bituminous waterproofing material at an application rate of 75-100 square feet per gallon, per coat. The coating shall be applied after the manholes have cured adequately and can be applied by brush or spray in accordance with the manufacturers writing instruction. Sufficient time shall be allowed between coats to permit sufficient drying so that the application of the second coast has no affect on the first.

2.02 CATCH BASINS AND DRAIN MANHOLES

A. Provide complete manhole and precast concrete structures capable of supporting AASHTO H-20 loading. Precast concrete shall comply with ASTM C913 "Standard Specification for Precast Concrete Water and Wastewater Structures

B. Base Sections: Precast monolithic construction. Drain manholes shall have steps..

C. Barrel Sections: Precast. Drain manholes shall have steps .

D. Top Sections: Precast concentric cone, eccentric, or flat cover if required by grade.

E. Steps: Conform to ASTM C478 for load carruing capacity and pull out resitance, installed at 12-inches on center forming a continuous ladder. Acceptable manufacturers: Reliabel Steel Products, Inc., M.A. Industries, Inc. or equal to above.

F. Pipe to Manhole Connections:

a. Pipe to Manhole connections shall be flexible, watertight manhole sleeves.
b. Cast into the manole base and sized to the type of pip being used
c. Type of flexible joint being used shall be approved by the Engineer. Install materials according to the Manufacturer's instruction. Acceptable manufacturers; Lock Joint ny Interpace Corporation, Kor N Seal by Trelleborg, Press Wedge II by Press-Seal Gasket Corporation, A-Lok Manhole Pipe Seal by A-Loc Corporation, or approved equivalent.

G. Joints between precast sections: Watertight, shiplap type, seal with two rings of 1-inch diameter butyl rubber sealant.

2.04 MASONRY MATERIALS

A. Concrete Masonry Units: ASTM C139.

B. Mortar: Type M, ASTM C270. Use Type II Portland cement, Type S lime. Proportions for Mortar: 1 part Portland cement, 1/4 part hydrated lime,3 to 3 3/4 parts sand.

2.05 FRAMES, GRATES AND COVERS

A. Cast iron: ASTM A48 Class 30.

B. Castings shall be smooth with no sharp edges

C. Constructed to support H-20 loading.

D. Manhole frames and covers: Minimum 24" dia. opening, minimum weight 300 pounds.

1. Standard frame and cover: Castings shall be from East Jordan Foundry, refer to Contract Documents for casting model number and application.

2. Special frame nad cover: Castings shall be 30” Pamrex Hinged Locking Cover by Pamm Access Covers, or approved equal. Refer to Contract Documents.
3. Utility name shall be cast into cover.

E. Catch Basin Frames and Grates: Castings shall be from East Jordan Foundry, refer to Contract Documents for casting model number and application.

2.07 GREASE INTERCEPTOR

A. Shall be constructed in accordance with Contract Documents.

B. Average strength of 4,000 psi at 28 days

C. Constructed to support H-20 loading.

D. Interior of tank shall be coating with epoxy sealant.

E. Coat exterior of concrete bitumastic sealant.

2.08 MISCELLANEOUS

A. Joint Sealants:

1. Butyl Rubber Sealant: One inch diameter strips as manufactured by Kent Seal, or Engineer approved equal.

B. Dampproofing: Bituminous coating to be Dehydrate No. 4 Dampproof by W.R. Grace of Bitumastic Super Service Black by Koppers Co. for field application, or Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF MANHOLES

A. Placement: Place bases on compacted bedding material so manhole structure is plumb and pipe inverts are at proper elevations. Place barrel and top sections in the appropriate height combinations. Plug all lifting holes inside and out with non-shrink grout.

B. Joints: Follow manufacturer's instructions for sealing joints between precast sections. Provide two rings of 1-inch diameter butyl rubber sealant. Point joints inside and out with butyl caulk.

C. Frame and Covers: Set to final grade as shown on the Drawings or set flush with pavement grade in paved areas or 2" below finish grade in unpaved roads or 24" above grade in cross-country areas. Provide adequate temporary covers (conforming with applicable local, State and Federal regulations) to prevent accidental entry until final placement of frame and cover is made.

D. Set manhole frames and covers to final grade only after pavement base course has been applied, or after final grading of gravel roads.

E. Inverts: See detail on drawings.

F. Steps: Replace steps out of plumb and out of proper horizontal placement.

G. Testing and Acceptance: All sanitary sewer components shall comply with the testing requirements of the Sanford Sewerage District.

1. General:
    a. Perform either a vacuum test or combination of the exfiltration and infiltration tests on all manholes.
    b. All testing must be performed in the presence of the District
    c. Suitably plug all pipes entering each manhole and brace plugs to prevent blow out.
2. Exfiltration Tests After Backfilling:
    a. Fill each manhole with water to the top of the manhole frame.
    b. A period of up to 2 hours may be permitted, if the Contractor so wishes, to allow for absorption.
    c. At the end of the absorption period, refill each manhole with water to the top of the manhole frame and begin the 4-hour test period.
    d. At the end of the 4-hour test period, refill each manhole to the top of the manhole frame and measure the volume of water added. The leakage for each manhole shall not exceed 1/16 gallon per foot of diameter per vertical foot (above ground water) per 4-hour period.
3. Infiltration Tests:
    a. When the groundwater is above the bottom of the manhole, infiltration testing may be performed on that portion of the manhole below water level.
    b. After a 15-minute period, if no water is visibly moving down the interior surfaces of a manhole, the portion of the manhole below groundwater may be considered to be satisfactorily watertight.
    c. The remaining portion above the groundwater level must be tested for exfiltration as specified above.
4. Vacuum Test:
    a. The manhole shall be tested by a vacuum test after assembly of the manhole, connection piping and backfilling.
    b. Plug all lifting holes completely with non-shrink grout.
    c. Properly tighten all boot clamps and brace all plugs to prevent them from being sucked into the manhole.
    d. Install the testing equipment according to the manufacturer's instructions.
    e. A vacuum of 10 inches of Hg shall be drawn on the manhole and the loss of 1 inch of Hg vacuum timed. The manhole shall be considered to have passed the test if the time for the loss of 1 inch of Hg vacuum is two (2) minutes or longer.
    f. If the manhole fails the initial test, the Contractor shall locate the

g. If the manhole fails the initial test, the Contractor shall locate the leak(s) and make repairs. The manhole shall be retested until a satisfactory test result is obtained.
h. If a satisfactory vacuum test cannot be obtained, the manhole shall be water exfiltration tested and repaired as necessary.

5. Manhole Repairs:
   a. Correct leakage by reconstruction, replacement of gaskets and/or other methods as approved by the District.
   b. The use of lead-wood or expanding mortar will not be permitted.
6. After the manholes have been backfilled and prior to final acceptance, any signs of leaks or weeping visible inside the manholes shall be repaired and the manhole made watertight.

3.02 INSTALLATION OF CATCH BASINS

A. Placement: Place bases on compacted bedding material so catch basins structure is plumb and pipe inverts are at proper elevations. Place barrel and top sections in the appropriate height combinations. Plug all lifting holes inside and out with non-shrink grout.

B. Joints: Follow manufacturer's instructions for sealing joints between precast sections. Provide two rings of 1-inch diameter butyl rubber sealant. Point joints inside and out with butyl caulk.

C. Frame and covers: Set to final grade as shown on the drawings. Use two rings of 1-inch diameter butyl rubber sealant between frame and chimney joints. Provide downward force to frame so as to compress the joint and provide a watertight seal and prevent future settlement. Point compressed joint with butyl rubber caulk sealant.

D. Inverts: See detail on drawings.

3.04 INSTALLATION OF GREASE INTERCEPTOR

A. Interceptor shall be installed in strict accordance with the manufacturer's recommendations and according to plans and specifications.

B. The Grease Interceptor Tank shall be installed on level, compacted bed of 8-inch thick ¾" crushed stone.

C. Sytems shall be backfilled after placement with structural fill, compacted in lifts as defined in Section 312000. Backfill of all sides of structure shall be performed simultaneously to prevent unbalanced lateral pressures during construction.

D. All joints shall be made watertight. Manufacturer shall seal joints with a plastic flexible gasket conforming to AASHTO M-198-75 for bitumen gasket.

E. System shall be cleaned & emptied prior to start-up of system. Follow manufacturer's recommendations for testing and start-up.

3.05 INSTALLATION OF MISCELLANEOUS PRECAST STRUCTURES

A. Install as shown on drawings.

END OF SECTION

SECTION 33 46 00
SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Building perimeter and basement foundation wall drainage systems including piping, accessories, bedding aggregate and filter fabric.

1.02 RELATED REQUIREMENTS

A. Section 31 23 15 - Building Pad Earthwork

B. Section 33 46 10 – Soil Gas Depressurization System.

1.03 REFERENCE STANDARDS

A. ASTM D1784 – Standard Specification for Rigid Poly Vinyl Chloride Compounds, 2008.

B. ASTM D2729 - Standard Specification for Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings; 2003.

C. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials, 2014.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate dimensions, layout of piping, high and low points of pipe inverts, gradient of slope between corners and intersections.
   1. Provide design engineer's seal on all shop drawings, as a Professional Engineer, licensed in Maine.

C. Product Data: Provide data on pipe drainage products, pipe accessories, and filter fabric and aggregate.

D. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.

1.05 SYSTEM PERFORMANCE

A. The Contractor shall be solely responsible for the subdrainage system performance. The Contractor shall provide the proposed piping layout to the Geotechnical Engineer at least two weeks prior to installation. The piping layout shall be designed and sealed by a Professional Engineer licensed in the State of Maine.
   1. The proposed piping layout shall avoid other utilities and footings.
   2. The piping layout shall provide redundant flow paths from any point in the system to the discharge point away from the building.
   3. The piping layout shall be include pipe inverts and cleanouts.
   4. The piping layout shall adhere to other criteria presented in Sections of the Specification.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. Drainage Pipe: ASTM D3350, 4 inch inside diameter; smooth bore, slotted HDPE pipe with required fittings.
   1. Application: Building perimeter

B. Polyvinyl Chloride Pipe: ASTM D2729; S&D SDR-35, PVC, ASTM D1784 4 inch inside diameter; perforated with two rows of holes, 120 degrees apart; provide all required fittings.
   1. Application: Basement perimeter.

C. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.02 AGGREGATE AND BEDDING

A. Drainage Fill: Clean free-draining sand around perimeter foundation drains meeting requirements of 2014 Maine DoT 703.22 Type B Underdrain Backfill material.

B. Crushed Stone: 2014 Maine DOT Standard Specification 703.13 Crushed Stone, 3/4 inch.

2.03 ACCESSORIES

A. Filter Fabric: 6 oz per sq. yd, nonwoven, water pervious type, black polyolefin.
   1. Product: 140N by Mirafi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout Drawings.

3.02 INSTALLATION

A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.

B. At outside edge of perimeter building footings, located perforated drain pipe enveloped in 12 inches of Underdrain Sand, located approximately 6 inches above the bottom of the footing. Drains shall be located around the entire building.

C. At basement foundation walls, locate perforated drain pipe wrapped in filter fabric at the outside (backfill) side edge of footings, between the bottom of footing elevation and 12 inches below bottom of slab elevation, enveloped all around in 6 inches minimum of crushed stone.

D. Lay all pipe to pitch at least 0.1 percent downward toward the discharge points.

E. Perimeter Drains: Backfill within 3 feet laterally of the exterior walls above the drainage pipe and drainage fill with freely-draining material.

F. Provide PVC capped cleanouts at grade for perimeter drains and brass cover floor cleanouts at interior floor slabs at turns in the systems to facilitate maintenance.

G. The piping layout shall provide redundant flow paths from any point in the system to the discharge points away from the building.

H. Place pipe with perforations or slots facing down. Mechanically join pipe ends.

I. Run discharge piping to outlets as indicated on the Civil Drawings.

J. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.

3.03 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspection and testing.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.04 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

SECTION 33 46 10
SOIL GAS DEPRESSURIZATION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Soil gas depressurization system including sub-grade vapor barrier membrane, venting crushed stone layer, piping, system labeling and underslab vapor retarder.
   1. In-line fans to depressurize the piping system are not part of the scope of this Section, but may be installed by the Owner at a later date in response to system testing.

1.02 RELATED REQUIREMENTS

A. Section 07 21 00 - Thermal Insulation: Underslab vapor retarder.

B. Section 07 90 05 - Joint Sealers.

C. Section 31 23 15 - Building Pad Earthwork

1.03 REFERENCE STANDARDS

A. ASTM D1784 – Standard Specification for Rigid Poly Vinyl Chloride Compounds, 2008.

B. ASTM D2665 – Standard Specification for Poly Vinyl Choride (PVC Drain, Waste, and Vent Pipe and Fittings, 2011.

C. ASTM D2729 - Standard Specification for Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings; 2011.

D. ASTM E1465 - Standard Practice for Radon Control Options for the Design and Construction of New Low Rise Residential Buildings; 2008.

E. State of Maine Radon Rules and Radiation Act.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe products, pipe accessories, and sub-grade vapor barrier, sealants and aggregate.

C. Project Record Documents: Record location of pipe runs, connections and risers.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. Polyvinyl Chloride Pipe: ASTM D2729; S&D PVC, ASTM D1784 4 inch inside diameter; perforated with two rows of holes, 120 degrees apart; provide all required fittings.
   1. Application: Sub-slab vent piping.

B. Polyvinyl Chloride Pipe: ASTM D2665; Schedule 40, DWV PVC, ASTM D1784 plain end, solid; all required fittings from the same manufacturer as the pipe.
   1. Pipe Size: 4 inch inside diameter, 6 inch inside diameter at piping headers.
   2. Applications: Riser piping.

2.02 AGGREGATE AND BEDDING

A. Venting Crushed Stone Fill: ASTM C33; gradation as follows:

Sieve Size	Percent Passing
1 inch	100 %
3/4 inch	90-100%
1/2 inch	20-55%
3/8 inch	0-15 %
No. 4	0-5%

2.03 ACCESSORIES

A. Pipe Couplings and Fittings: Solid plastic, as recommended by the piping manufacturer.

B. Pipe Welding Solvent: As recommended by the piping manufacturer.

C. Vent Riser Pipe Insulation: Jacketed 1 inch thick rigid fiberglass pipe insulation.

D. Sub-grade Vapor Barrier Membrane: Reinforced, multi-layer polyethylene.
   1. Vapor Permeability:
   2. Tape: As recommended by the membrane manufacturer
   3. Product: Dura-Skrim 6WB

E. Slab and Foundation Wall Penetration Sealant: Polyurethane; gun grade.
   1. Applications: All slab-on-grade control joints, isolation joints, construction joints, pipe, conduit and other penetrations.
   2. Product: NP1 by BASF

F. Sealant Backer Rod: As specified in Section 07 90 05.

PART 3 EXECUTION

3.01 SUB-GRADE VAPOR BARRIER INSTALLATION

A. A sub-grade vapor barrier shall be continuously installed at least 12 inches below slabs-on-grade, and may be installed below sub-slab plumbing piping. The sub-grade vapor barrier shall extend from the perimeter foundation wall horizontally inward at least 25 feet and in no case shall extend less than 20 feet beyond the inner extents of crushed stone placed for foundation bearing. All membrane seams and piping penetrations through the sub-grade vapor barrier shall be sealed air-tight with tape as recommended by the vapor barrier membrane manufacturer. The sub-grade vapor barrier shall be sealed to the perimeter foundation walls.

3.02 FOUNDATION WALL PENETRATIONS

A. All perimeter foundation wall penetrations shall be sealed utilizing backer rod and sealant or for large annual spaces, backer rod and one-part expanding foam sealant, as specified herein.
   1. All sealants shall be installed in accordance with manufacturer's recommendations and Section 07 90 10 - Sealants.

B. There shall be no foundation penetrations that allow the sub-slab area to be exposed to ambient air or surrounding soil gases.

3.03 VENTING CRUSHED STONE FILL INSTALLATION

A. Venting crushed stone base shall be installed in conformance with requirements of Section 31 23 15 - Building Pad Earthwork, subgrade preparation.

B. Provide a twelve (12) inch minimum thickness layer at the basement slab area and an eight (8) inch minimum thick layer of Venting Crushed Stone Fill under all other building slab-on-grade areas directly below floor slabs for installation of sub-slab vent piping.

3.04 SUB-SLAB VENT PIPING INSTALLATION

A. See Drawings for layout of sub-slab piping and pipe riser locations. All sub-slab areas shall be within 50 feet of the sub-slab piping. All sub-slab areas isolated by foundation walls, shall be served by at least one sub-slab piping run.

B. Install pipe and pipe fittings in accordance with pipe manufacturer's instructions, nested within the Venting Crushed Stone Fill Zone. Install piping with holes facing the sides of the pipe. All joints shall be sealed in accordance with pipe manufacturer's instructions.

C. End of each pipe run shall be left open.

3.05 UNDERSLAB VAPOR RETARDER

A. An underslab vapor retarder shall be installed directly below slabs-on-grade as specified in Section 07 21 00 - Thermal Insulation. All edges, tears and penetrations shall be continuously

sealed air-tight. Vapor retarder shall be inspected and any deficiencies corrected prior to concrete pour.

3.06 VENT PIPE RISERS

A. Sub-slab vent piping shall be connected to vertical 4 inch minimum size pipe risers extending up through the building roof. Risers shall be routed as directly as possible to and through the roof. Multiple risers may be connected together within in the building, prior to roof discharge. Piping headers that connect multiple risers serving more than 20,000 sq. ft. of sub-slab area shall be 6 inch minimum diameter.
   1. Horizontal vent pipe offsets shall be pitched 1/4 inch per foot back to the floor penetration.
   2. All vent pipe joints shall be sealed in accordance with pipe manufacturer's instructions.
   3. Vent pipes shall terminate at least 2 feet above roof surfaces and shall be located at least 10 feet laterally from any building air intake locations.
   4. Vent pipes shall be insulated where exposed and where run in unconditioned spaces.
   5. Horizontal and vertical vent piping shall be supported as per drain-waste-vent piping in accordance with the Plumbing Code. Supports shall be provided above and below future locations of in-line fans.
   6. Vent pipe system, where located above accessible ceilings, behind access panels, and in exposed locations shall be labeled with manufactured, self-sticking labels, "Soil Gas System". Locate labels where piping is visible in an unobtrusive location on the pipe insulation jacket.

B. Vent pipe risers through the roof shall be flashed into the roofing system under the scope of Section 07 53 00 - Elastomeric Membrane Roofing.

3.07 RADON TESTING

A. The Owner shall conduct radon testing prior to occupancy and post-occupancy. If such testing determines that an active system is required, the Owner shall install system de-pressurization fans and vacuum monitoring equipment under a separate contract.

3.08 RADON REDUCTION SYSTEM LABEL

A. Radon Reduction System shall be labeled in accordance with ASTM E1465, Section 6.9 and the State of Maine Radon Rules. Below is sample information to be included in the system labeling, assuming the system will remain inactive at the time of building occupancy. If testing determines otherwise, the system labeling shall be written to reflect the system characteristics at the time of occupancy.

B. Radon Reduction System requirements for the system label (fan-powered pipe route, but without a fan initially installed):
   1. Radon Reduction System
   2. Radon System Specification: Practice E1465
   3. Type: Soil Depressurization - Fan-powered pipe route.
   4. Status: Fan not installed - not operating
   5. Upgrade Option: Install radon fans.
   6. Description: A soil depressurization radon reduction system is installed in this building. It is not operating or complete because the radon fans and system monitor are not installed.
   7. Radon Testing: This building was tested for radon while unoccupied and post-occupancy. Because radon test results were acceptable, radon fans were not installed. Radon re-testing shall occur upon change in building ownership, HVAC equipment changes, renovations, additions, or as otherwise determined by the Owner or authority having jurisdiction.

3.09 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspection and testing.

B. Request inspections after completion of the following, prior to concealment of the wok:
   1. Perimeter foundation penetrations sealing.
   2. Sub-grade vapor barrier.

3. Prior to and immediately after placing crushed stone at sub-slab vent piping.
4. Vent riser piping.

C. See Section 07 21 00 for inspection requirements of underslab vapor retarder.

3.10 PROTECTION

A. Protect sub-slab system from damage or displacement until slabs are poured.

END OF SECTION

APPENDIX “A”

R E P O R T

October 14, 2015
12-0471 S

Explorations and Geotechnical Engineering Services

Proposed Sanford High School & Regional Technical Center
Main Street and Old Mill Road
Sanford, Maine

PREPARED FOR:
Sanford School Department
Attention: David Theoharides, Superintendent of Schools
917 Main Street – Suite 200
Sanford, Maine 04073

PREPARED BY:
S. W. Cole Engineering, Inc.
286 Portland Road
Gray, Maine 04039
207-657-2866

S.W.COLE
ENGINEERING, INC.

- *Geotechnical Engineering*
- *Construction Materials Testing and Special Inspections*
- *GeoEnvironmental Services*
- *Test Boring Explorations*

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12-0471 S

October 14, 2015

Sanford School Department
Attention: David Theoharides, Superintendent of Schools
917 Main Street – Suite 200
Sanford, Maine 04073

Subject: Explorations and Geotechnical Engineering Services
Proposed Sanford High School & Regional Technical Center
Main Street and Old Mill Road
Sanford, Maine

Dear Superintendent:

In accordance with our Agreement, dated March 5, 2015, we have performed subsurface explorations for the subject project in Sanford, Maine. This report summarizes our findings and geotechnical engineering recommendations relative to foundations, earthwork and pavements associated with the proposed construction. The contents of this report are subject to the limitations set forth in Attachment A.

1.0 INTRODUCTION

1.1 Scope and Purpose

The purpose of our services was to obtain subsurface information at the site in order to provide geotechnical recommendations for foundations, earthwork and pavement associated with the proposed construction. Our scope of services included: test boring, rod probe and test pit explorations; soils laboratory testing; geotechnical analyses of the subsurface findings; geotechnical review of civil and foundation plans and preparation of this report.

1.2 Proposed Construction

Based on the plans provided and our discussions with you, we understand a former sand and gravel pit east of the intersection of Old Mill Road and Route 109 in South Sanford is proposed for construction of the new Sanford High School and Regional

Technical Center campus. We understand the proposed building will be a 1 and 2-story steel-framed structure with on-grade floor slabs situated in the northern portion of the site with paved parking to the south of the building and athletic fields south, west, and southwest of the building. A new access road will enter the site from Route 109 and exit to Route 4 to the south.

We understand the building is proposed at a Finished Floor Elevation of 254.0 feet (project datum) and a partial mechanical basement is planned with a finished floor elevation of about 242 feet. Proposed and existing site features are illustrated on the "Exploration Location Plan" attached as Sheet 1.

2.0 EXPLORATION AND TESTING

2.1 Explorations

Several phases of subsurface explorations have been performed at the site, including preliminary explorations for previous proposed site concepts and recent explorations for the current proposed site layout. Subsurface explorations made at the site include:

- Twenty-two test pits (TP-101 through TP-106 and TP-201 through TP-216) made on January 6 and 7, 2014 for preliminary phase investigation of the original site layout;

- Six test borings (B-1 through B-5 and B-8) and one rod probe (P-1) made on January 7 and 8, 2014 for preliminary phase investigation of the original site layout;

- Eleven test borings (B-101 through B-111) made on May 6 through 8, 2014 for preliminary phase investigation of the current site layout;

- Twenty-six test borings (B-201 through B-228 and B-301 through B-306, excluding B-203, B-211 through B-213, B-221, B-223, B-225, and B-226) made between March 23 and April 3, 2015 for design phase engineering of the current site layout. The excluded borings were proposed for future building expansion areas, but were not deleted from our scope as requested by others;

- Thirty-two test pits (TP-301 through TP-332) made on March 19 and 20, 2015 for design phase engineering of the current site layout;

- Three hand pushed tile probes (P-101 through P-103) made on April 9, 2015 for design investigation of the current site layout.

The explorations were made by drilling and excavation companies working under subcontract to S. W. Cole Engineering, Inc. (S.W.COLE). The hand pushed tile probes were made by S.W.COLE. The exploration locations were selected in collaboration with the design team and Maine Department of Education. S.W.COLE established in exploration locations in the field using a survey grade Trimble GPS. The approximate exploration locations are shown on the "Exploration Location Plan" attached as Sheet 1. Logs of the explorations and a key to the notes and symbols used on the logs are attached as Appendix A.

2.2 Testing

The borings were performed using a combination of hollow-stem auger, solid-stem auger, cased wash-boring, rock coring, and rod probing techniques. The soils in the test borings were sampled at 2 to 5 foot intervals using a split spoon sampler and Standard Penetration Test (SPT) methods. SPT blow counts are shown on the logs. The test pits were made using a tracked excavator with bulk samples obtained using a hand shovel.

Soil samples obtained from the explorations were returned to our laboratory for further classification and testing. Laboratory testing included grain size analyses, soil moisture content, and organic content. Moisture content and organic content test results are noted on the logs. Grain size analyses are attached as Appendix B.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Surficial and Historical

The site is located in the Mousam River Valley northwest of the intersection of Route 109 and Route 4 in South Sanford, Maine. Surface relief across the site is generally characterized by terraces and ridges with wetland troughs between and approximately parallel to the Mousam River. A flood plain bench exists along the edge of the current

Mousam River channel along the east side of the site. We understand portions of the site were historically used as a sand and gravel borrow source. As a result, several access roads and pathways existing across the site.

Based on available historical mapping, we understand that the Mousam River was dammed downstream from the site as early as the 1940's. The dam resulted in an impoundment known as Jagger Pond which appears to have inundated portions of the site. The dam and Jagger Pond apparently were removed in favor of the current wastewater treatment plant. Historical topographic mapping is attached as Appendix C.

3.2 Soil and Bedrock

According to the Maine Geologic Survey, Surficial Soils Map, the surficial soils generally consist of glacio-fluvial outwash deposits of sand and gravel overlying bedrock within the high elevation terraces and ridges and wetland soils in the lower elevation troughs. Similarly, alluvial deposits of sand, silt, gravel and organics are generally mapped within the flood plain immediately adjacent to the current channel of the Mousam River. We understand the terrace and ridge areas of the site were previously mined for sand and gravel. A surficial soils map of the site is attached as Appendix D.

The explorations encountered subsurface conditions similar to the soil deposits mapped on the Maine Geologic Survey Surficial Soils map. In general,

- The explorations performed in the higher terrace and ridge areas of the site encountered sand and gravel overlying glacial till and bedrock.

- The explorations performed in the wetland trough over the western portion the site for the original site layout encountered organic peat soils overlying sand and gravel deposits.

- The explorations performed in the flood plain immediately adjacent to the Mousam River encountered sand and gravel overlying glacial till overlying bedrock. Organic peat soils were encountered at borings B-4 and B-111, and B-301. The peat appears to exist as discontinuous and erratic seams within the alluvial sand and gravel soils which is typical of the Mousam River Valley.

- Layers of uncontrolled fills, likely remnant from previous site usage, were encountered at some explorations erratically across the site, including within the southern portion of the proposed school building and athletic field footprints.

- Shallow bedrock was generally encountered in the central ridge of the site generally defined by borings B-224 to B-6. Bedrock outcrops were observed at B-6 and TP-105. Shallow bedrock is also present along a portion of the proposed access road alignment along the west edge of the site. A map of bedrock geology of the site is attached in Appendix D. Some readily visible bedrock outcrops were located using GPS and are displayed on the "Exploration Location Plan" attached as Sheet 1.

For more detailed subsurface information at the exploration locations, please refer to the attached logs.

3.3 Groundwater

Groundwater was generally at the ground surface within the wetland in the western portion of the site. In the explorations around the wetland and in the flood plain along the river, groundwater was generally 1 to 8 feet below the ground surface. In the higher terrace in the northwest portion of the site, groundwater was not observed within the 5 to 10 foot depth explored.

Groundwater likely becomes perched on relatively shallow bedrock encountered beneath higher elevation terrace and ridge areas of the site. Long-term groundwater levels are likely influenced by the level of the Mousam River. It should be anticipated that seasonal groundwater levels will fluctuate, especially during periods of snowmelt and precipitation.

3.4 Frost and Seismic

The 100-year Air Freezing Index for the Sanford, Maine area is about 1,407-Farenheit degree-days, which corresponds to a frost penetration depth on the order of 4.5 feet. Based on the subsurface findings, we interpret the site soils to correspond to Seismic Soil Site Class D, according to 2009 International Building Code.

4.0 EVALUATION AND RECOMMENDATIONS

4.1 General Findings

Based on the subsurface findings, the proposed construction appears feasible from a geotechnical standpoint. The principle geotechnical considerations include:

- The proposed building footprint is generally underlain by sand and gravel deposits overlying glacial till and bedrock. Alluvial soils with seams of organic peat and layers of uncontrolled fill were encountered at explorations in the central and southern portions of the proposed footprint. Rammed aggregate piers (RAPs) are recommended to improve foundation bearing surfaces beneath these portions of the building footprint. Uncontrolled fills should be densified with a vibratory roller compactor prior to placing Granular Borrow to raise building area grades.

- Following densification of uncontrolled fills and ground improvement using RAPs, conventional spread footing foundations and on-grade floor slabs appears suitable for the proposed structures.

- The terrace and ridge areas of the site contain sand and gravel deposits overlying relatively shallow bedrock. These areas are generally higher in elevation and are anticipated to be cut to establish finished grades. The sand and gravel provide a borrow source for granular fill for reuse on-site. The bedrock will require blasting and may be blended with on-site sands to create premium gravels for building and pavement construction.

- Explorations performed at the wetland area in the western portion of the site encountered 3 to 14 feet of organic peat overlying sand and gravel deposits. The peat soils appeared generally thinnest around the edge of the wetland and thickest in the center. This wetland area may represent a prior stream braid or channel of the Mousam River that was likely in-filled with the current wetland. Construction over this wetland is not considered feasible, in our opinion; however, the roads and athletic fields proposed around the edges of the wetland may feasibly be built provided the organic soils are completely removed prior to constructing fills, utilities and surface improvements. Removal of the organic soils will be difficult and will require careful excavation and dewatering.

- Groundwater was encountered at relatively shallow depths in lower elevations across the site, including within the proposed building footprint. Open cut excavations shallower than about 5 feet may be feasible with sump and pump dewatering techniques. Deeper excavations, such as for utilities, may require sheetpiling and well-point dewatering systems.

- Imported Granular Borrow, Structural Fill, and Crushed Stone will be needed for construction.

4.2 Site and Subgrade Preparation

We recommend that site preparation begin with the construction of an erosion control system to protect adjacent drainage ways and areas outside the construction limits. Surficial organics, roots and topsoil should be completely removed from areas of proposed fill and construction. As much vegetation as possible should remain outside the construction areas to lessen the potential for erosion and site disturbance. We recommend the existing water impoundments be drained and organics removed before filling.

Proposed Building: Following site grubbing, exposed granular soils and uncontrolled fills should be proof-rolled with 3 to 5 passes of a vibratory roller having a static weight of at least 10 tons. Areas which become soft and yielding should be overexcavated and replaced with compacted Granular Borrow. Granular Borrow should be placed and compacted to raise grades below the proposed structures.

As discussed, organic peat seams are present in the native alluvial soils below portions of the building. As such, ground improvement by RAPs will be needed beneath load bearing walls and columns after filling to 2 feet below finished floor elevation has been achieved. The approximate limits of RAP improvement are shown on Sheet 1, attached.

Footings supported on RAP improved ground should be underlain with 6 inches of compacted Structural Fill. Footings outside the RAP treatment area should be underlain with 6 inches of compacted Structural Fill overlying compacted Granular Borrow or stable native, non-organic soils. Final cuts to subgrade elevation in native soils should be completed using a smooth-edged bucket to reduce disturbance of the bearing soils. Footings founded on bedrock should be underlain with 6 inches of crushed stone to remove hard points below the footings. At least 6-inches of compacted Crushed Stone

wrapped in non-woven geotextile, such as Mirafi 160N or equivalent, should be installed below basement footings. At least 12-inches of geotextile wrapped Crushed Stone should be provided below the basement floor slab. Blasted bedrock subgrades, if encountered, should be thoroughly choked with crushed stone prior to placing new fills. Loose and overblasted bedrock should be removed and replaced with compacted Granular Borrow.

Proposed Grandstand, Bleacher and Concessions Structures: Following site grubbing, all uncontrolled fill should be removed and replaced with compacted Granular Borrow beneath the bleacher and concessions structures. Footings for the grandstands and pressbox must extend through uncontrolled fills to undisturbed native sands. The approximate limits of uncontrolled fill removal and extension of footings through uncontrolled fill for these structures is shown on Sheet 1, attached.

Proposed Athletic Track, Fields and Courts: Following site grubbing, all uncontrolled fill beneath the synthetic turf field should be proof-rolled with 3 to 5 passes of a vibratory smooth drum roller having a static weight of at least 10 tons. Areas that become soft or yielding after proof-rolling should be removed and replaced with compacted Granular Borrow.

We recommend the athletic track, pole vault and long jump running surfaces, as well as tennis courts, be underlain with non-frost susceptible material to frost depth (4.5 feet below finished grade) to help reduce the potential for frost heaves. These areas should also be provided with MaineDOT Type B Underdrains routed to gravity outlets.

It appears that portions of the athletic fields and track will overlie wetland and peat bog areas. All peat and organics must be completely removed from beneath the proposed athletic field and track areas until granular soils, free from peat and organics, are encountered. The removal of peat and organics should extend horizontally outward from the edge 1-foot for every 1 foot of vertical depth (1H:1V bearing splay). Backfill for peat and organic removal should consist of compacted MaineDOT Granular Borrow.

Paved Areas: Following site grubbing, exposed granular subgrade soils should be proof rolled with 3 to 5 passes of a vibratory roller having a static weight of at least 10 tons. Areas that become soft and yielding during proof-rolling should be overexcavated and replaced with Granular Borrow. Areas of organic and peat soils should be completely

removed to expose underlying stable native non-organic soils, then backfilled with compacted Gravel Borrow, Rock Borrow or Granular Borrow. The removal of the peat and organics should extend horizontally outward from the edge 1-foot for every 1 foot of vertical depth (1H:1V bearing splay). Blasted bedrock subgrades below paved areas should be thoroughly choked with Crushed Stone prior to placing fills.

4.3 Excavation, Blasting and Dewatering

Excavation work will generally encounter native sand and gravel, glacial till, bedrock, peat and organics. Areas of uncontrolled fills associated with past site usage will be encountered across the site. Saturated soils and groundwater will be encountered at lower elevations across the site. Care must be exercised during construction to limit disturbance of the bearing soils. Earthwork and grading activities should occur during drier Summer and Fall seasons. Final cuts to subgrade should be performed with a smooth-edged bucket to help minimize soil disturbance.

Extensive removal of peat and organics will be required where paved areas and athletic fields are proposed over the existing wetland area. The peat extended to depths as great as 8 feet at the explorations performed near the proposed construction. Free water is present at the ground surface in the wetland area. Careful excavation and dewatering will be needed for peat removal, likely including sheetpile cofferdams and heavy pumping.

Bedrock encountered at the site will require blasting. We recommend removing bedrock in mass to a depth of at least 5 feet below finished floor elevation in the building and 2 feet in proposed paved and landscape areas. Deeper bedrock removal will likely be needed for installation of underground utilities and landscaping. The blasted bedrock may remain on-site and be crushed and blended with sand to create pavement base and subbase aggregates. Alternatively, the blasted bedrock may be reused as Rock Borrow to backfill areas of peat removal. We recommend that blasting be performed by a licensed, qualified contractor and that pre-blast surveys should be performed on surrounding structures and wells within at least 500 feet of the blast area.

Open excavations in sand and gravel shallower than about 5 feet appear feasible with conventional sump and pump dewatering techniques. Deeper excavations, such as for utilities, may require braced excavations and sheetpiling with well-point dewatering systems for groundwater control. Excavations to remove organic peat soils may also

require the installation of cofferdams, stabilizing berms and dewatering methods to limit the impact to wetlands and help reduce the volume of materials excavated. Controlling the water levels to at least one foot below planned excavation depths will help stabilize subgrades during construction.

Excavations must be properly shored or sloped in accordance with OSHA regulations to prevent sloughing and caving of the sidewalls during construction. Care must be taken to preclude undermining adjacent structures, utilities and roadways. The design, planning and construction of excavations, excavation support and dewatering are the responsibility of the contractor. We recommend the contract documents require engineered shop drawings of shoring and dewatering plans for excavations below groundwater and excavations to remove peat and organics.

4.4 Foundations and Walls

The building may be supported on spread footings founded on properly prepared subgrades. As discussed, we recommend that ground improvement using Rammed Aggregate Piers (RAP) be performed below footings in portions of the school building where peat seams were encountered in the native alluvial soils and uncontrolled fills are present. We recommend removing and replacing uncontrolled fills below spread footings supporting the bleachers, stadium lighting and ancillary structures.

4.4.1 Spread Footings and Basement Walls

For spread footings supported on properly prepared subgrades, including areas recommended for RAP ground improvement, we recommend the following geotechnical parameters for foundation and RAP design consideration:

Geotechnical Parameters for Spread Footings and Basement Walls	
Design Frost Depth	4.5 feet
Net Allowable Soil Bearing Pressure	3.0 ksf or less
Base Friction Factor	0.35
Total Unit Weight of Backfill	130 pcf (compacted Structural Fill)
At-Rest Lateral Earth Pressure Coefficient	0.5 (compacted Structural Fill)
Internal Friction Angle of Backfill	32° (compacted Structural Fill)
Total Post-Construction Settlement	1 inch of less
Differential Post-Construction Settlement	½ inch or less

4.4.2 Rammed Aggregate Piers

We recommend that ground improvement using Rammed Aggregate Piers (RAP) be installed to a tip elevation of 234 feet below load bearing foundations (columns and walls) in Areas A1, A3, B, E, F1 and F2 of the building where peat seams and uncontrolled fills where encountered in the explorations. Additionally, we recommend RAPs be installed below basement footings to improve bearing capacity for the shallow groundwater conditions anticipated in basement area. We recommend a groundwater elevation of 240 feet be assumed for RAP design.

We recommend displacement RAPs as they densify the ground surrounding the aggregate pier elements. Displacement RAP's are a ground improvement technique which is designed and installed by a specialty geotechnical contractor. RAP installation consists of systematically inserting a hollow steel mandrel through the weak or organic soils and into suitable bearing soils, and then repeatedly extracting and ramming while feeding aggregate into the mandrel. The result is a series of stiff, compacted aggregate columns in a matrix of densified in-situ soils. The approximate limits of RAP improvement below the building (load bearing footings only) are illustrated on Sheet 1.

We recommend the contract documents require an engineered submittal for RAPs to improve ground conditions to meet or exceed the geotechnical parameters for bearing capacity and settlement as recommended herein. The RAP submittal should be prepared and sealed by a Professional Engineer licensed in the State of Maine and endorsed by the RAP Installer and Geopier Foundation Company.

4.4.3 Segmental Retaining Walls

We anticipate exterior segmental retaining walls (SRW), such as Redi-Scape, will be needed. We recommend the facing blocks be founded on a minimum 6-inch thick leveling course of compacted Crushed Stone overlying properly prepared native soil or bedrock subgrades, or properly compacted new fill overlying properly prepared subgrades.

Based on the site soils and our understanding of the proposed construction, we provide the following soil parameters for use by a wall design engineer in their design of the segmental retaining wall:

Geotechnical Parameters of Segmental Block Retaining Wall			
Wall Segment	**Friction Angle**	**Cohesion**	**Unit Weight**
Retained Soil (Granular Borrow)	30 degrees	0 psf	125 pcf
Reinforced Backfill (Structural Fill)	32 degrees	0 psf	130 pcf
Foundation Soil (Sandy Soils)	30 degrees	0 psf	125 pcf
Net Allowable Bearing Capacity	3 ksf (properly prepared subgrade)		
Anticipated Settlement	up to 1 inch (post-construction)		
Seismic Soil Site Class	D (IBC 2009)		

Design of the retaining wall and evaluation of base sliding, overturning and internal stability of the wall are the responsibility of the wall design engineer. The wall designer must account for construction surcharge loads and future live load conditions. S.W.COLE is available to provide SRW design. S.W.COLE should be retained to perform a global stability analysis of the SRW and to review the SRW submittal if designed by others.

4.4.4 Seismic Considerations

Based on the subsurface findings, we interpret the site soils to correspond to Seismic Soil Site Class D according to IBC 2009/ASCE 7-05. We recommend the following seismic design parameters for the 2,500-year design earthquake:

RECOMMENDED SEISMIC DESIGN PARAMETERS (2,500-year Design Earthquake)		
Peak Ground Acceleration (PGA)	0.2-second Spectral Acceleration (S_s)	1-second Spectral Acceleration (S_1)
0.203 g	0.356 g	0.08 g

NOTE: Seismic design parameters from USGS accessed May 21, 2015.

Liquefiable soils typically consist of loose, fine sands and non-plastic silts below the groundwater table. Based on the subsurface findings, it is our opinion the soils at the site are not susceptible to liquefaction during a seismic event and therefore the risk of lateral spread and seismic induced settlement are negligible.

4.5 Foundation Drainage

We recommend an underdrain system be installed along the outside edge of perimeter footings. Except for the basement footings, we recommend a 4-inch diameter smooth-bore, slotted HDPE pipe enveloped in 12 inches of Underdrain Sand. For the basement, we recommend a 4-inch diameter, perforated SDR-35 foundation drain pipe bedded in the layer of geotextile wrapped Crushed Stone below the basement footings. The underdrain

pipes must have a positive gravity outlet protected from freezing, clogging and backflow. Surface grades should be sloped away from the building for positive surface water drainage. General underdrain details are illustrated on Sheet 2.

4.6 Slab-On-Grade Floors

On-grade floor slabs in heated areas may be designed using a subgrade reaction modulus of 120 pci provided the slab is underlain by at least 12-inches of compacted Structural Fill, or 12-inches of compacted Crushed Stone in basement areas, placed over properly prepared subgrades. The structural engineer or concrete consultant must design steel reinforcing and joint spacing appropriate to slab thickness and function.

We recommend installation of a subslab radon venting system. We also recommend a sub-slab vapor retarder particularly in areas of the building where the concrete slab will be covered with an impermeable surface treatment or floor covering that may be sensitive to moisture vapors. The vapor retarder must have a permeance that is less than the floor cover or surface treatment that is applied to the slab. The vapor retarder must have sufficient durability to withstand direct contact with the sub-slab base material and construction activity. Additionally, the vapor retarder may be underlain with a shim layer of stone dust over structural fill or non-woven geotextile fabric over crushed stone. The vapor retarder material should be placed according to the manufacturer's recommended method, including the taping and lapping of all joints and wall connections. The architect and/or flooring consultant should select the vapor retarder products compatible with flooring and adhesive materials.

The floor slab should be appropriately cured using moisture retention methods after casting. Typical floor slab curing methods should be used for at least 7 days. The architect or flooring consultant should assign curing methods consistent with current applicable American Concrete Institute (ACI) procedures with consideration of curing method compatibility to proposed surface treatments, flooring and adhesive materials.

4.7 Entrance Slabs and Sidewalks

Entrance slabs and sidewalks adjacent to the building must be designed to reduce the effects of differential frost action between adjacent pavement, doorways, and entrances. We recommend that non-frost susceptible Structural Fill be provided to a depth of at least 4.5 feet below the top of entrance slabs. This thickness of Structural Fill should extend the full width of the entrance slab and outward at least 4.5 feet, thereafter

transitioning up to the bottom of the adjacent sidewalk or pavement gravels at a 3H:1V or flatter slope. General details of this frost transition zone are attached as Sheet 2.

4.8 Backfill and Compaction

We recommend the following fill and backfill materials for construction:

Granular Borrow: Fill to raise grades in building, athletic field and paved areas should be sand or silty sand meeting the requirements for 2014 Standard Specification MaineDOT 703.19 Granular Borrow. Fills over wet subgrades may require MaineDOT 703.19 Granular Borrow of Underwater Backfill.

Gravel Borrow: Backfill for areas of peat removal may be sand and gravel meeting the requirements for 2014 MaineDOT Standard Specification 703.20 Gravel Borrow.

Rock Borrow: Backfill for areas of peat removal may be blasted bedrock meeting the requirements for 2014 MaineDOT Standard Specification 703.21 Rock Borrow and should be placed according the MaineDOT Standard Specification requirements.

Structural Fill: Fill to repair soft areas, backfill for foundations, slab base material and material below exterior entrances and sidewalks should be clean, non-frost susceptible sand and gravel meeting the gradation requirements for Structural Fill as given below:

Structural Fill	
Sieve Size	**Percent Finer by Weight**
4 inch	100
3 inch	90 to 100
¼ inch	25 to 90
#40	0 to 30
#200	0 to 5

Crushed Stone: Crushed Stone, used beneath foundations and for underdrain aggregate, should meet the requirements of 2014 MaineDOT Standard Specification 703.13 Crushed Stone ¾-Inch.

Underdrain Sand: Clean, free-draining sand around perimeter foundation drains meeting the requirement of 2014 MaineDOT 703.22 Type B Underdrain Backfill Material.

Reuse of Site Soils: The terrace and ridge areas of the site contain sand and gravel deposits overlying relatively shallow bedrock. These areas are generally higher in elevation and are anticipated to be cut to establish finished grades. The sand and gravel provide a borrow source for granular fill for reuse on-site. The bedrock will require blasting and may be blended with on-site sands to create premium gravels for building and pavement construction.

Placement and Compaction: Fill should be placed in horizontal lifts and compacted such that the desired density is achieved throughout the lift thickness with 3 to 5 passes of the compaction equipment. Loose lift thicknesses for grading, fill and backfill activities should not exceed 12 inches. Thicker lifts of fill are permissible for Rock Borrow.

We recommend that fill and backfill in building and paved areas be compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557. We recommend that fill and backfill in landscape and playfield areas be compacted to at least 92 percent of its maximum dry density as determined by ASTM D-1557. Crushed Stone should be compacted with 3 to 5 passes of a vibratory plate compactor having a static weight of at least 500 pounds.

4.9 Weather Considerations

Construction activity should be limited during wet and freezing weather and the site soils may require drying before construction activities may continue. The contractor should anticipate the need for water to temper fills in order to facilitate compaction during dry weather. If construction takes place during cold weather, subgrades, foundations and floor slabs must be protected during freezing conditions. Concrete and fill must not be placed on frozen soil; and once placed, the concrete and soil beneath the structure must be protected from freezing.

4.10 Paved Areas

We anticipate paved areas will be subjected primarily to passenger vehicle and light delivery truck traffic with occasional heavy delivery truck traffic. Considering the site soils, and proposed usage, we offer the following pavement section for consideration. Materials are based on MaineDOT Standard Specifications.

FLEXIBLE (HMA) PAVEMENT SECTION	
Pavement Layer	**Material Thickness**
MaineDOT 9.5 mm Hot Mix Asphalt (50 Gyration Design)	1 ¼ inches
MaineDOT 19.0 mm Hot Mix Asphalt (50 Gyration Design)	2 ¼ inches
MaineDOT 703.06 Aggregate Base Type A	6 inches
MaineDOT 703.06 Aggregate Subbase Type D	12 inches

Hot mix asphalt pavement should be compacted to 92 to 97 percent of its theoretical maximum density as determined by ASTM D-2041. A tack coat should be used between successive lifts of bituminous pavement.

RIGID (CONCRETE) PAVEMENT SECTION	
Pavement Layer	**Material Thickness**
Concrete – 4,500 psi compressive, 500 psi flexural, 1 ½ inch aggregate, with 6 ±1% air entrainment	7 inches
MaineDOT 703.06 Aggregate Subbase Type D, Crushed	12 inches

The base and subbase materials should be compacted to at least 95 percent of their maximum dry density as determined by ASTM D-1557. It should be understood that frost penetration can be on the order of 4.5 feet in this area. In the absence of full depth excavation of frost susceptible soils below paved areas and subsequent replacement with non-frost susceptible compacted fill, frost penetration into the subgrade will occur and some heaving and distress of pavement must be anticipated.

4.11 Design Review and Construction Testing

S.W.COLE should review the construction documents prior to bidding to determine that our earthwork, foundation and pavement recommendations have been properly interpreted and implemented.

A testing and special inspections program should be implemented during construction to observe compliance with the construction documents. S.W.COLE should be retained to provide geotechnical observations during earthwork, RAP, foundation and paving construction activities, as well as providing testing and special inspection services for soils, concrete, masonry, steel, and spray-applied fireproofing.

5.0 CLOSURE

It has been a pleasure to be of assistance to you with this phase of your project. We look forward to working with you during the construction phase of the project.

Sincerely,

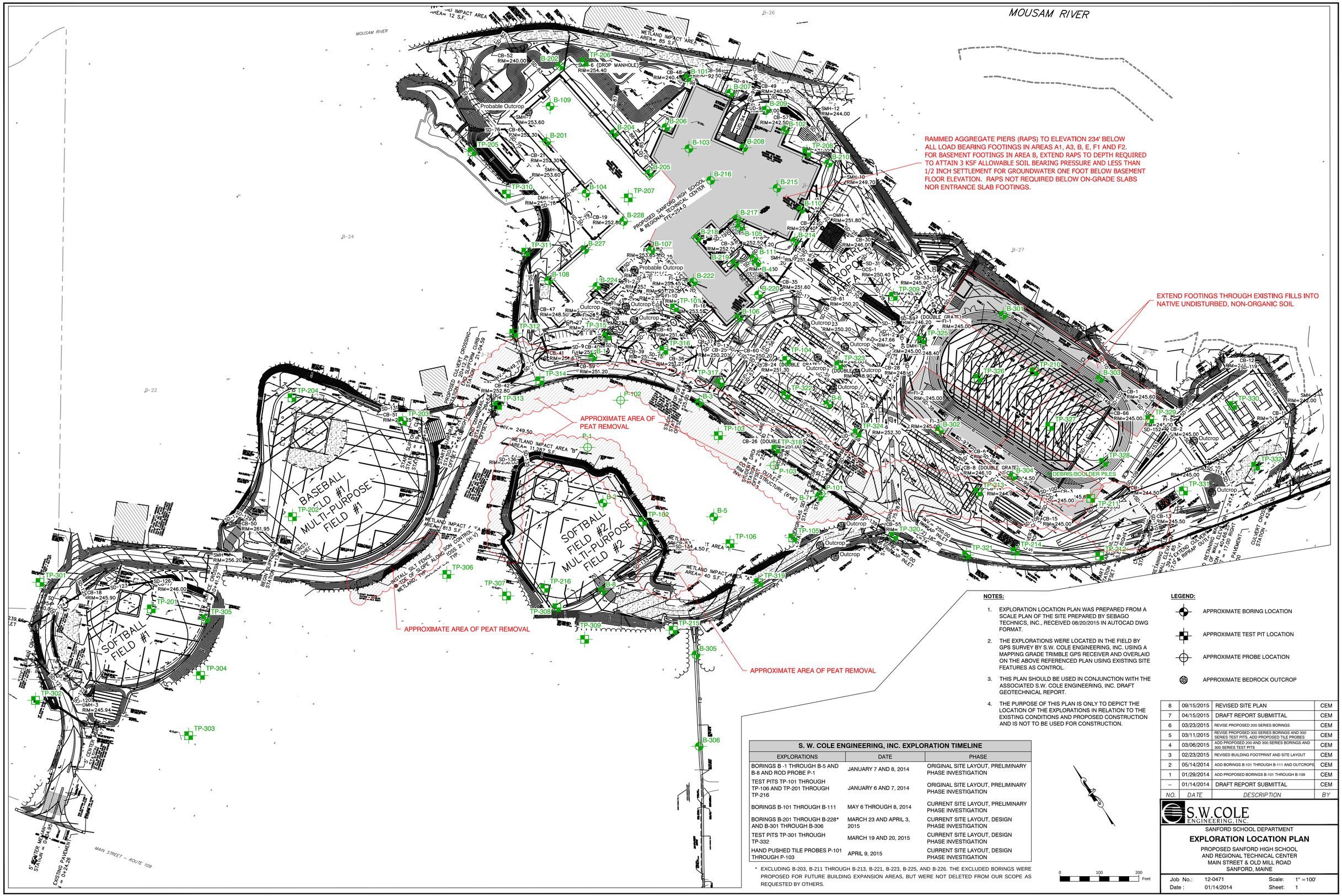
S. W. Cole Engineering, Inc.

Evan M. Walker, P.E.
Geotechnical Engineer

Timothy J. Boyce, P.E.
Senior Geotechnical Engineer

STATE OF MAINE
TIMOTHY J.
BOYCE
No. 9263
LICENSED
PROFESSIONAL ENGINEER

EMW:tjb



NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A SCALE PLAN OF THE SITE PREPARED BY SEBAGO TECHNICS, INC., RECEIVED 08/20/2015 IN AUTOCAD DWG FORMAT.
2. THE EXPLORATIONS WERE LOCATED IN THE FIELD BY GPS SURVEY BY S.W. COLE ENGINEERING, INC. USING A MAPPING GRADE TRIMBLE GPS RECEIVER AND OVERLAID ON THE ABOVE REFERENCED PLAN USING EXISTING SITE FEATURES AS CONTROL.
3. THIS PLAN SHOULD BE USED IN CONJUNCTION WITH THE ASSOCIATED S.W. COLE ENGINEERING, INC. DRAFT GEOTECHNICAL REPORT.
4. THE PURPOSE OF THIS PLAN IS ONLY TO DEPICT THE LOCATION OF THE EXPLORATIONS IN RELATION TO THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION AND IS NOT TO BE USED FOR CONSTRUCTION.

LEGEND:

- APPROXIMATE BORING LOCATION
- APPROXIMATE TEST PIT LOCATION
- APPROXIMATE PROBE LOCATION
- APPROXIMATE BEDROCK OUTCROP

S. W. COLE ENGINEERING, INC. EXPLORATION TIMELINE

EXPLORATIONS	DATE	PHASE
BORINGS B -1 THROUGH B-5 AND B-8 AND ROD PROBE P-1	JANUARY 7 AND 8, 2014	ORIGINAL SITE LAYOUT, PRELIMINARY PHASE INVESTIGATION
TEST PITS TP-101 THROUGH TP-106 AND TP-201 THROUGH TP-216	JANUARY 6 AND 7, 2014	ORIGINAL SITE LAYOUT, PRELIMINARY PHASE INVESTIGATION
BORINGS B-101 THROUGH B-111	MAY 6 THROUGH 8, 2014	CURRENT SITE LAYOUT, PRELIMINARY PHASE INVESTIGATION
BORINGS B-201 THROUGH B-228* AND B-301 THROUGH B-306	MARCH 23 AND APRIL 3, 2015	CURRENT SITE LAYOUT, DESIGN PHASE INVESTIGATION
TEST PITS TP-301 THROUGH TP-332	MARCH 19 AND 20, 2015	CURRENT SITE LAYOUT, DESIGN PHASE INVESTIGATION
HAND PUSHED TILE PROBES P-101 THROUGH P-103	APRIL 9, 2015	CURRENT SITE LAYOUT, DESIGN PHASE INVESTIGATION

* EXCLUDING B-203, B-211 THROUGH B-213, B-221, B-223, B-225, AND B-226. THE EXCLUDED BORINGS WERE PROPOSED FOR FUTURE BUILDING EXPANSION AREAS, BUT WERE NOT DELETED FROM OUR SCOPE AS REQUESTED BY OTHERS.

0 100 200 Feet

NO.	DATE	DESCRIPTION	BY
8	09/15/2015	REVISED SITE PLAN	CEM
7	04/15/2015	DRAFT REPORT SUBMITTAL	CEM
6	03/23/2015	REVISE PROPOSED 200 SERIES BORINGS	CEM
5	03/11/2015	REVISE PROPOSED 300 SERIES BORINGS AND 300 SERIES TEST PITS, ADD PROPOSED TILE PROBES	CEM
4	03/06/2015	ADD PROPOSED 200 AND 300 SERIES BORINGS AND 300 SERIES TEST PITS	CEM
3	02/23/2015	REVISED BUILDING FOOTPRINT AND SITE LAYOUT	CEM
2	05/14/2014	ADD BORINGS B-101 THROUGH B-111 AND OUTCROPS	CEM
1	01/29/2014	ADD PROPOSED BORINGS B-101 THROUGH B-109	CEM
--	01/14/2014	DRAFT REPORT SUBMITTAL	CEM

S.W.COLE ENGINEERING, INC.

SANFORD SCHOOL DEPARTMENT

EXPLORATION LOCATION PLAN

PROPOSED SANFORD HIGH SCHOOL
AND REGIONAL TECHNICAL CENTER
MAIN STREET & OLD MILL ROAD
SANFORD, MAINE

Job No.: 12-0471 Scale: 1" =100'
Date : 01/14/2014 Sheet: 1

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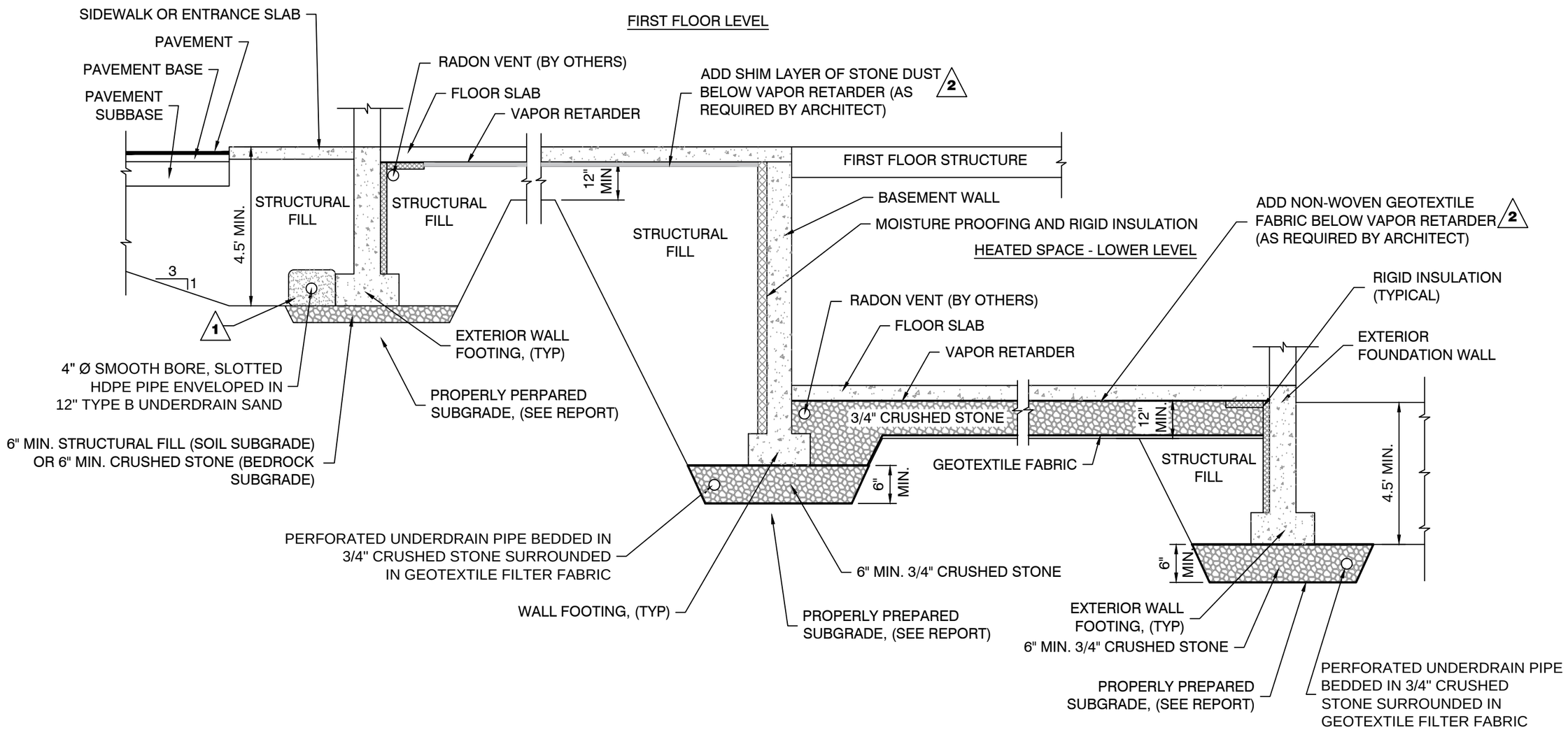


NOTE:

1. UNDERDRAIN INSTALLATION AND MATERIAL GRADATION RECOMMENDATIONS ARE CONTAINED WITHIN THIS REPORT.

2. DETAIL IS PROVIDED FOR ILLUSTRATIVE PURPOSES ONLY, NOT FOR CONSTRUCTION.

NO.	DATE	DESCRIPTION	BY
2	10/14/15	ADD STONE DUST AND NON-WOVEN GEOTEXTILE FABRIC	CEM
1	09/15/15	REVISE UNDERDRAIN	CEM
0	04/15/2015	REPORT SUBMISSION	CEM

S.W.COLE ENGINEERING, INC.

SANFORD SCHOOL DEPARTMENT

UNDERDRAIN DETAIL

PROPOSED SANFORD HIGH SCHOOL
AND REGIONAL TECHNICAL CENTER
MAIN STREET & OLD MILL ROAD
SANFORD, MAINE

Job No.:	12-0471	Scale:	Not to Scale
Date :	04/15/2015	Sheet:	2

R:\2012\12-0471.1\CAD\Drawings\12-0471 Details_rev2.dwg, 10/14/2015 3:41:55 PM, 1:1, CEM, S. W. Cole Engineering, Inc.

APPENDIX A

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-1**
SHEET:	OF
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
WET @ 5.5' / GROUNDWATER @ 7.0'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF AND TOPSOIL
	1D	24"	2"	7.0'	5	5	5	52		BROWN GRAVELLY SAND SOME SILT WITH COBBLES & BOULDERS ~ MEDIUM DENSE TO DENSE ~
	2D	6"	5"	10.5'	50/6"				11.2'	….WITH BEDROCK FRAGMENTS
										REFUSAL @ 11.2 FEET (PROBABLE BEDROCK)

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-1**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-2**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ 4.0'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF & TOPSOIL
	1D	24"	3"	4.0'	5	5	5	6		BROWN SAND WITH GRAVEL ~ LOOSE TO MEDIUM DENSE ~
	2D	24"	6"	6.0'	11	12	14	19	9.5'	
										REFUSAL @ 9.5' (PROBABLE BEDROCK)

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-2**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-3**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
	1D	24"	1"	2.0'	WOH	WOH	WOH	WOH		BROWN FIBROUS PEAT ~ VERY SOFT ~
	2D	24"	2"	4.0'	WOH	WOH	WOH	WOH	4.0'	
	3D	24"	9"	6.0'	3	7	16	20	6.0'	BROWN SAND SOME GRAVEL WITH ORGANICS ~ MEDIUM DENSE ~
	4D	24"	7"	8.0'	11	16	18	20	9' +/-	GRAY-BROWN SAND SOME GRAVEL SOME SILT ~ DENSE ~
	5D	24"	24"	12.0'	5	6	5	6		BROWN SAND SOME GRAVEL TRACE SILT ~ LOOSE TO MEDIUM DENSE ~ 2' OF SAND HEAVE IN AUGERS AT 15'...AUGERS ADVANCED WITHOUT SAMPLING ...GRAVELLY LAYER 17' TO 19' PROBABLE SAND
										BOTTOM OF EXPLORATION @ 30.0

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-3**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-4**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ 5.5'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF & TOPSOIL
	1D	24"	7"	7.0'	3	6	9	12	8' +/-	BROWN GRAVELLY SAND TRACE SILT ~ LOOSE TO MEDIUM DENSE ~
	2D	24"	14"	12.0'	3	5	6	10	15.0'	BROWN SAND WITH 2" PEAT SEAM IN SAMPLER ~ LOOSE TO MEDIUM DENSE ~
										2' OF SAND HEAVE IN AUGERS AT 15'...ABANDONED BOREHOLE BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-4**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-5**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/8/2014
DATE FINISH:	1/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	140 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
GROUNDWATER @ SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
	1D	24"	1"	2.0'	WOH		1-18"			
	2D	24"	6"	4.0'	WOH - 12"		1-12"			
	3D	24"	6"	7.0'	WOH-24"					DARK BROWN PEAT
	4D	24"	16"	9.0'	WOH-24"					~ VERY LOOSE / SOFT ~
	5D	24"	14"	11.0'	WOH-24"					w = 897.5% O = 62.6%
	6D	24"	6"	13.0'	WOH-24"					
									14.0'	
	7D	24"	6"	15.0'	WOH-12"		1	4	14.5'	ORANGE-BROWN SAND, TRACE SILT ~ LOOSE ~
	8D	24"	8"	17.0'	3	2	3	4	17.0'	GRAY-BROWN SAND TRACE SILT, TRACE GRAVEL ~ LOOSE ~
	9D	24"	8"	22.0'	9	12	16	9		BROWN GRAVELLY SAND TRACE SILT ~ MEDIUM DENSE ~
									24.8'	...WITH COBBLES
	10D	24"	8"	27.0'	16	20	13	17		GRAY-BROWN GRAVELLY SILTY SAND ~ DENSE ~
									30.5'	
	11D	24"	8"	32.0'	10	5	4	5		GRAY SILTY SAND TRACE GRAVEL ~ LOOSE TO MEDIUM DENSE ~
									35.0'	
										BOTTOM OF EXPLORATION @ 35.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-5**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-6**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										BEDROCK OUTCROP @ GROUND SURFACE

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-6**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-7**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	
DATE FINISH:	
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										NOT DRILLED DUE TO ACCESS

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-7**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-8**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/7/2014
DATE FINISH:	1/7/2014
ELEVATION:	
SWC REP.:	TJB

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4 1/2" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION

GROUNDWATER @ 5.5'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF & TOPSOIL
	1D	24"	4"	4.0'	3	5	6	8		BROWN GRAVELLY SAND SOME SILT ...WITH BEDROCK FRAGMENTS
	2D	24"	3"	6.0'	6	20	20	27		
										REFUSAL @ 7.5' (PROBABLE BEDROCK)

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-8**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**P-1**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	1/8/2014
DATE FINISH:	1/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER

LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE

DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PROBABLE PEAT
									4.9'	HYDRAULIC PUSH ROD PROBE - STRATA CHANGE @ 4.9' - PROBABLE SAND
										BOTTOM OF EXPLORATION @ 4.9'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
DRILLER - VISUALLY
SOIL TECH. - VISUALLY
LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-1**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-101**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 7' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.8'	FOREST DUFF / BROWN SAND, SOME SILT, WITH ORGANICS
	1D	24"	16"	2.0'	1	1	2	2	2.0'	ORANGE-BROWN SAND, TRACE SILT, WITH ROOTLETS
									6.0'	BROWN SAND, SOME SILT ~ DENSE ~
	2D	24"	18"	7.0'	15	18	21	21		
	3D	24"	16"	9.0'	16	23	19	23		w = 9.5% BROWN SAND AND GRAVEL, SOME SILT, WITH COBBLES
	4D	24"	14"	12.0'	21	33	18	18		~ DENSE ~
									15.0'	ORANGE-BROWN SILTY GRAVEL AND SAND
	5D	24"	12"	17.0'	9	12	16	30	16.7'	~ MEDIUM DENSE ~
	6D	2"	2"	17.2'	50-2"				17.2'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
										REFUSAL @ 17.2' PROBABLE BOULDER OR BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
X	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-101**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-102**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/8/2014
DATE FINISH:	5/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 7.5' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN AND BLACK SILTY SAND WITH ORGANICS
	1D	24"	16"	16.0'	1	1	3	3	2.0'	ORANGE-BROWN SAND, SOME GRAVEL, SOME SILT, WITH ROOTLETS
	2D	10"	10"	6.3'	4	50-4"			8.0'	BROWN GRAVELLY SAND, SOME SILT, WITH FREQUENT COBBLES ~ DENSE ~ COBBLE 5' - 5.5' +/-
	3D	24"	20"	10.0'	21	44	34	26		GRAY-BROWN SILTY SAND SOME GRAVEL WITH COBBLES (GLACIAL TILL) w = 11.7% ~ DENSE TO VERY DENSE ~
	4D	24"	18"	12.0'	15	23	20	19		
									15.0'	
	5D	23"	23"	16.9'	11	26	36	50-5"	16.9'	GRAY-BROWN SILTY GRAVEL AND SAND WITH COBBLES (GLACIAL TILL) ~ VERY DENSE ~
									17.2'	PROBABLE WEATHERED BEDROCK - ADVANCE BY AUGER
										REFUSAL @ 17.2' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
X	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-102**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-103**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/8/2014
DATE FINISH:	5/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	2.0'	1	1	1	2		BROWN SAND, TRACE SILT, TRACE FINE GRAVEL
										~ LOOSE ~
	2D	24"	18"	4.0'	1	3	3	3	3.8'	
									4.5'	BROWN FINE TO MEDIUM SAND, SOME SILT ~ LOOSE ~
										BROWN SAND AND GRAVEL, SOME SILT
	3D	24"	16"	7.0'	10	21	21	18	7.0'	~ DENSE ~
									8.0'	BROWN SAND, TRACE SILT ~ DENSE ~
	4D	24"	16"	9.0'	26	21	24	41		
										BROWN SANDY GRAVEL, TRACE SILT
									11.0'	~ DENSE ~
	5D	24"	18"	12.0'	17	19	11	12		BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)
									12.9'	~ MEDIUM DENSE ~
										REFUSAL @ 12.9'
										PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-103**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-104**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
NO FREE WATER OBSERVED

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.8'	FOREST DUFF
	1D	24"	12"	2.0'	2	6	11	18	2.0'	BROWN GRAVELLY SAND, SOME SILT, TRACE ROOTLETS
										REFUSAL @ 2.0'
										PROBABLE BEDROCK
										NOTE:
										MOVED 5' TO NE: REFUSAL @ 2.1'
										MOVED 10' TO NE: REFUSAL @ 2.5'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-104**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-105**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2.5'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF
	1D	24"	14"	2.0'	1	5	6	3		BROWN GRAVELLY SAND, SOME SILT, WITH TRACE ROOTLETS
										BROWN GRAVELLY MEDIUM TO COARSE SAND, TRACE SILT ~ MEDIUM DENSE ~ w = 15.8%
	2D	24"	18"	7.0'	2	8	9	18	7.0'	
	3D	24"	18"	9.0'	9	12	20	20	10.0'	BROWN GRAVELLY SAND, TRACE SILT WITH OCCASIONAL GRAY-BROWN SILT SEAMS, WITH FREQUENT COBBLES ~ MEDIUM DENSE TO DENSE ~
	4D	24"	16"	12.0'	10	14	21	25	12.0'	ORANGE-BROWN GRAVELLY SILTY SAND WITH COBBLES (GLACIAL TILL) ~ DENSE ~
	5D	24"	16"	14.0'	14	18	22	22	20.0'	BROWN GRAVELLY SILTY SAND WITH FREQUENT COBBLES AND BOULDERS (GLACIAL TILL) ~ DENSE ~ ~ NO SAMPLING BELOW 5D, ADVANCE BY ROLLER CONE ~
										BOTTOM OF EXPLORATION @ 20.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
X	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-105**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-106**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 8' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF
	1D	24"	16"	2.0'	1	3	4	6		BROWN GRAVELLY SAND, SOME SILT WITH TRACE COAL AND ROOTLETS (FILL)
	2D	24"	14"	7.0'	4	4	4	4		~ LOOSE ~
									8.0'	
	3D	24"	16"	9.0'	4	4	2	2		BROWN MEDIUM TO COARSE SAND, TRACE SILT, TRACE GRAVEL
									10.0'	~ LOOSE ~
	4D	24"	16"	12.0'	3	6	9	17		BROWN SANDY GRAVEL, SOME SILT
	5D	24"	16"	14.0'	14	24	14	8		~ MEDIUM DENSE TO DENSE ~
									15.0'	
	6D	24"	18"	17.0'	3	7	7	9	17.0'	ORANGE-BROWN WITH BLACK LAYERS FINE SAND, SOME SILT, WITH TRACE ROOTLETS ~ MEDIUM DENSE ~
									18.0'	ORANGE-BROWN SILTY FINE TO MEDIUM SAND ~ DENSE ~
	7D	24"	20"	19.0'	10	18	18	17		GRAY-BROWN GRAVELLY SILT AND SAND (GLACIAL TILL)
	8D	24"		22.0'	7	12	20	22		~ DENSE ~
									25.0'	
									26.0'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
	9D	24"	20"	27.0'	17	13	17	44	27.0'	GRAY SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 27.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-106**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-107**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURAED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
	1D	10"	8"	0.8'	1	50-4"			0.5'	FOREST DUFF
									4.0'	BROWN SILTY SAND SOME GRAVEL WITH FREQUENT COBBLES AND BOULDERS, WITH ORGANICS (FILL) ~ MEDIUM DENSE ~
									6.0'	DARK BROWN SILTY SAND, SOME GRAVEL (FILL) ~ MEDIUM DENSE ~
	2D	24"	16"	7.0'	5	8	11	8	7.0'	BROWN SILTY SAND, SOME GRAVEL ~ MEDIUM DENSE ~
	3D	24"	14"	9.0'	10	9	9	8		BROWN SILT AND SAND, TRACE GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	24"	18"	12.0'	3	5	8	8	12.0'	
	5D	10"	10"	12.8'	10	50-4"			12.8'	BROWN GRAVELLY SILTY SAND WITH BEDROCK FRAGMENTS (GLACIAL TILL)
									14.5'	PROBABLE BEDROCK - ADVANCE BY ROLLER CONE
										REFUSAL @ 14.5' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-107**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-108**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/6/2014
DATE FINISH:	5/6/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	1	2	5	5	2.0'	ORANGE-BROWN SAND, SOME GRAVEL, TRACE SILT, WITH ROOTLETS
									5.0'	BROWN SAND, SOME GRAVEL, TRACE SILT ~ MEDIUM DENSE ~
										REFUSAL @ 5.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-108**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-109**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HW	4"	300 LBS.	24"
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:	NQ	2"		

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 3' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS
	1D	24"	16"	2.0'	2	4	4	5	2.0'	BROWN SAND, TRACE SILT
										BROWN GRAVELLY SAND, SOME SILT, WITH COBBLES ~ MEDIUM DENSE ~
	2D	1"	1"	5.1'	50-1"				5.1'	
										BEDROCK - ADVANCE BY ROLLER CONE TO 6.0' - BEGIN CORE LIGHT GRAY GRANITE GRADING TO DARK GRAY GRAYWACKE AT 10.5' HARD; FINE TO COARSE GRAINED SLIGHTLY WEATHERED, IRON OXIDE STAINING ON FRACTURE SURFACES
	R1	5.0'	4.8'	11.0'	RQD = 65%, FAIR				11.0'	FRACTURE ANGLES AT 5, 20, 40 & 60 DEGREES FROM HORIZONTAL
										BOTTOM OF EXPLORATION @ 11.0'

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

	DRILLER - VISUALLY
X	SOIL TECH. - VISUALLY
	LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-109**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-110**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/8/2014
DATE FINISH:	5/8/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET AT GROUND SURFACE
SOILS SATURATED BELOW 1' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.8'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	2.0'	1	2	2	2	2.0'	ORANGE-BROWN SAND, SOME SILT, WITH ROOTLETS
									4.5'	BROWN SAND, SOME SILT, TRACE GRAVEL ~ MEDIUM DENSE ~
									6.0'	BROWN GRAVELLY SAND, TRACE SILT, WITH COBBLES ~ VERY DENSE ~
	2D	24"	18"	7.0'	30	31	30	20	10.0'	GRAY-BROWN SILTY SAND, SOME GRAVEL, WITH COBBLES (GLACIAL TILL) ~ VERY DENSE ~
	3D	24"	16"	12.0'	5	7	5	7	15.0'	GRAY-BROWN SAND, SOME SILT, SOME GRAVEL, WITH COBBLES (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	5"	5"	15.4'	50-5"				16.4'	GRAY-BROWN GRAVELLY SILTY SAND WITH FREQUENT COBBLES (GLACIAL TILL) ~ MEDIUM DENSE ~
										REFUSAL @ 16.4' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-110**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-111**
SHEET:	1 OF 1
PROJECT NO.:	12-0471.1
DATE START:	5/7/2014
DATE FINISH:	5/7/2014
ELEVATION:	
SWC REP.:	EMW

PROJECT / CLIENT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING CO. : GREAT WORKS TEST BORING, INC. DRILLER: JEFF LEE

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	SSA	4" O.D.		
SAMPLER:	SSA	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF
	1D	24"		2.0'	2	2	1-12"			DARK BROWN SILTY SAND WITH ORGANICS AND PEAT SEAMS ~ VERY LOOSE ~
	2D	24"	14"	4.0'	WOH - 24"				4.0'	
	3D	24"	10"	7.0'	18	26	40	48	8.0'	BROWN SAND AND GRAVEL, SOME SILT ~ VERY DENSE ~
	4D	24"	14"	12.0'	7	7	8	20	11.5'	DARK BROWN WITH BLACK STAINING SAND, SOME SILT ~ MEDIUM DENSE ~
									15.0'	BROWN GRAVELLY SAND, SOME SILT ~ DENSE ~
										REFUSAL @ 15.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 2" SHELBY TUBE
S = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-111**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-201**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/25/2015
DATE FINISH:	3/25/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	5	7	9	7	4.0'	BROWN GRAVEL AND SAND, SOME SILT ~ MEDIUM DENSE ~
	2D	24"	16"	6.0'	4	4	6	7	5.5'	BROWN GRAVELLY MEDIUM TO COARSE SAND, TRACE SILT ~ MEDIUM DENSE ~
									8.0'	RUST BROWN TO GRAY SILT AND SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
	3D	24"	18"	10.0'	4	5	10	14	12.0'	GRAY-BROWN GRAVELLY SILTY SAND (GLACIAL TILL) ~ MEDIUM DENSE ~
										REFUSAL @ 12.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-201**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-202**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.0'	ORANGE-BROWN SILTY FINE SAND WITH ROOTS
	1D	24"	16"	4.0'	2	4	4	5		LIGHT BROWN SILTY FINE SAND WITH OCCASIONAL SILT PARTINGS
	2D	24"	18"	6.0'	5	8	7	9	7.0'	~ LOOSE TO MEDIUM DENSE ~
	3D	24"	14"	11.0'	10	8	10	8	14.0'	BROWN SANDY GRAVEL SOME SILT ~ MEDIUM DENSE ~
	4D	24"	20"	16.0'	6	7	7	10	17.0'	GRAY-BROWN SILTY SAND, TRACE GRAVEL ~ MEDIUM DENSE ~
	5D	4"	4"	19.3'	65-4"				19.3'	BROWN TO ORANGE-BROWN GRAVELLY SILTY SAND ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 19.3'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-202**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-204**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 1' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	10	20	18	8	4.2'	DARK BROWN SANDY GRAVEL, SOME SILT (POSSIBLE FILL) ~ DENSE ~
	2D	24"	8"	6.0'	3	2	3	4	6.5'	BROWN FINE TO MEDIUM SAND, TRACE SILT ~ LOOSE ~
	3D	24"	14"	8.0'	5	7	17	15		ORANGE-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
	4D	2"	2"	9.2'	50-2"				9.2'	
										REFUSAL @ 9.2' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-204**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-205**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/25/2015
DATE FINISH:	3/25/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	NW	3"	140 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
										COBBLES IN TOP 2'
	1D	24"	6"	4.0'	12	12	10	8		BROWN SAND AND GRAVEL, SOME SILT
	2D	24"	3"	6.0'	13	12	9	10		~ MEDIUM DENSE ~
	3D	24"	14"	8.0'	10	9	10	10		<RUNNING SANDS/SAND HEAVE BELOW 8'>
									9.0'	
									9.5'	BROWN SILTY SAND AND GRAVEL ~ VERY DENSE ~
	4D	24"	8"	11.0'	35	31	17	18		GRAY-BROWN TO LIGHT BROWN SILTY GRAVELLY SAND (GLACIAL TILL)
										~ VERY DENSE ~
	5D	11"	8"	14.9'	17	50-5"			14.9'	
									15.8'	PROBABLE WEATHERED BEDROCK - ADVANCE BY ROLLER CONE
										REFUSAL @ 15.8'
										PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-205**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-206**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	16"	4.0'	4	5	6	7		BROWN FINE TO MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~
	2D	24"	18"	6.0'	8	7	12	14		
									8.0'	
	3D	24"	18"	10.0'	5	6	9	14	10.0'	LIGHT BROWN SILTY FINE SAND ~ MEDIUM DENSE ~
	4D	24"	16"	15.0'	8	9	10	13		BROWN SAND AND GRAVEL, SOME SILT WITH OCCASIONAL COBBLES ~ MEDIUM DENSE ~
									18.0'	
									19.0'	BROWN MEDIUM TO COARSE SAND, TRACE SILT ~ MEDIUM DENSE ~
	5D	24"	20"	20.0'	6	10	24	33	20.0'	BROWN TO GRAY GRAVELLY SILTY SAND (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 20.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-206**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-207**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST FROM GROUND SURFACE
SOILS SATURATED BELOW 5' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
										ROOTS EXTEND TO 3' +/-
	1D	24"	18"	4.0'	3	3	4	5		BROWN SAND, TRACE SILT
									4.5'	~ LOOSE ~
	2D	24"	16"	6.0'	6	9	15	19		BROWN SILTY FINE SAND
									7.0'	~ MEDIUM DENSE ~
	3D	24"	18"	8.0'	8	10	10	14	8.0'	BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
	4D	24"	12"	10.0'	5	14	17	13		BROWN SILTY SAND AND GRAVEL
										~ MEDIUM DENSE TO DENSE ~
									13.0'	
									13.5'	BROWN FINE SAND, TRACE SILT ~ MEDIUM DENSE ~
	5D	24"	6"	15.0'	14	9	8	19		BROWN GRAVELLY SAND, SOME SILT
										~ MEDIUM DENSE ~
									18.0'	
									19.0'	BROWN MEDIUM TO COARSE SAND, TRACE SILT ~ DENSE ~
	6D	23"	20"	19.9'	11	30	50	50-5"	19.9'	GRAY GRAVELLY SILTY SAND (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 19.9'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-207**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-208**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST FROM GROUND SURFACE,
WET BELOW 4' +/-, SATURATED BELOW 7' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.5'	LIGHT BROWN FINE SAND, TRACE SILT ~ MEDIUM DENSE ~
	1D	24"	16"	4.0'	3	15	28	25	4.0'	BROWN GRAVELLY SAND, SOME SILT ~ DENSE ~
	2D	24"	12"	5.3'	24	67	50-4"		7.0'	BROWN SILTY SAND AND GRAVEL WITH FREQUENT COBBLES ~ VERY DENSE ~
	3D	24"	16"	10.0'	13	11	14	19		GRAY-BROWN GRAVELLY SILTY SAND (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	24"	12"	15.0'	10	11	11	16	15.0'	
										BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-208**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-209**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.0'	BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
									3.0'	BROWN MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~
	1D	24"	16"	4.0'	6	14	21	23		BROWN SANDY GRAVEL, SOME SILT, WITH FREQUENT COBBLES
	2D	24"	16"	6.0'	22	34	42	50		~ VERY DENSE ~
									8.0'	
									8.5'	BROWN SILTY SAND AND GRAVEL ~ DENSE ~
	3D	24"	16"	10.0'	13	17	23	22		BLACK CEMENTED OXIDE SEAM @ 8.5'
										ORANGE-BROWN SILTY GRAVEL AND SAND
	4D	11"	8"	13.9'	17	50-5"			13.9'	~ DENSE TO VERY DENSE ~
										BOTTOM OF EXPLORATION @ 13.9'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-209**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-210**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS MOIST BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	12"	4.0'	7	14	21	27	4.5'	BROWN SILTY GRAVEL AND SAND WITH COBBLES ~ DENSE TO VERY DENSE ~
	2D	24"	14"	6.0'	25	23	17	13	8.1'	BROWN SILTY SAND, SOME GRAVEL ~ DENSE ~
										REFUSAL @ 8.1' PROBABLE BOULDER OR BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-210**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-214**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS SATURATED BELOW 8' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									3.0'	ORANGE WITH DARK BROWN LAYERS SILTY SAND WITH ORGANICS ~ VERY LOOSE ~
	1D	24"	14"	4.0'	1-12"		1	1		
	2D	24"	16"	6.0'	2	4	6	7	6.0'	LIGHT BROWN FINE SAND, SOME SILT ~ MEDIUM DENSE ~
	3D	24"	18"	8.0'	5	5	7	8	8.0'	LIGHT BROWN FINE TO MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~
	4D	24"	16"	10.0'	4	6	5	6	10.0'	BROWN SAND, TRACE SILT WITH SILTY FINE SAND SEAMS ~ MEDIUM DENSE ~
	5D	24"	20"	12.0'	5	6	7	6	14.0'	BROWN MEDIUM TO COARSE SAND, TRACE SILT WITH SILTY FINE SAND SEAMS ~ MEDIUM DENSE ~ <RUNNING SANDS / SAND HEAVE IN AUGERS BELOW 8' +/->
	6D	24"	20"	15.0'	8	10	23	20		BROWN GRAVELLY SILTY SAND WITH OCCASIONAL COBBLES (GLACIAL TILL) ~ MEDIUM DENSE TO DENSE ~
	7D	24"	2"	20.0'	5	8	9	9		
	8D	7"	4"	23.6'	47	50-1"			23.6'	<PUSHING GRAVEL/COBBLE AT 7D & 8D>
										BOTTOM OF EXPLORATION @ 23.6'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-214**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-215**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/25/2015
DATE FINISH:	3/25/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	NW	3"	140 LBS.	30"
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 3' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	6.0'	20	22	17	19	9.0'	BROWN GRAVELLY SAND, SOME SILT ~ DENSE ~
									9.5'	ORANGE-BROWN GRAVELLY SILTY SAND ~ VERY DENSE ~
	2D	24"	12"	11.0'	35	32	17	13	11.4'	GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ DENSE ~
									11.7'	PROBABLE WEATHERED BEDROCK - ADVANCE BY ROLLER CONE REFUSAL @ 11.7' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-215**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-216**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/26/2015
DATE FINISH:	3/26/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	4 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 4' +/-
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	4.0'	2	4	4	5	5.0'	BROWN SAND, TRACE SILT, TRACE FINE GRAVEL ~ LOOSE ~
	2D	24"	16"	6.0'	5	6	8	16	8.0'	LIGHT BROWN SILTY FINE SAND ~ MEDIUM DENSE ~
	3D	24"	8"	10.0'	11	12	14	11		GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
	4D	24"	8"	15.0'	8	8	14	14	15.0'	
										BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-216**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-217**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 2' +/-
FREE WATER IN BOREHOLE @ 3'

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	18"	4.0'	3	5	6	8	4.5'	LAYERED BROWN MEDIUM SAND, TRACE SILT AND BROWN SILTY FINE SAND ~ MEDIUM DENSE ~
	2D	24"	16"	6.0'	4	14	14	13	4.6'	DARK BROWN SILTY SAND ~ MEDIUM DENSE ~
									6.0'	ORANGE-BROWN GRAVELLY SILTY SAND ~ MEDIUM DENSE ~
	3D	24"	14"	8.0'	6	6	9	10	9.0'	BROWN SILTY SAND, SOME GRAVEL, WITH COBBLES ~ MEDIUM DENSE ~
	4D	24"	8"	11.0'	15	19	25	23	14.0'	BROWN MEDIUM TO COARSE SAND SAND, SOME GRAVEL, SOME SILT WITH COBBLES ~ DENSE ~
	5D	15"	6"	15.2'	14	25	50-3"		15.2'	BROWN GRAVELLY SILTY SAND ~ DENSE ~
										REFUSAL @ 15.2' PROBABLE BOULDER OR BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-217**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-218**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST AT GROUND SURFACE
SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	4	24	11	12	2.0'	BROWN FINE TO MEDIUM SAND, TRACE SILT ~ DENSE ~
	2D	24"	16"	4.0'	17	26	23	23		BROWN TO ORANGE-BROWN GRAVEL AND SAND, SOME SILT
	3D	24"	8"	6.0'	14	20	20	21		~ DENSE TO VERY DENSE ~
	4D	24"	4"	8.0'	15	24	30	27		
									9.0'	
	5D	24"	16"	11.0'	7	26	19	13	10.5'	ORANGE-BROWN MEDIUM TO COARSE SAND, TRACE SILT, TRACE GRAVEL ~ DENSE ~
									14.0'	ORANGE-BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
	6D	24"	18"	16.0'	4	5	8	8		<6" SAND HEAVE IN SAMPLER @ 6D>
									19.0'	ORANGE-BROWN SAND, SOME SILT, TRACE GRAVEL WITH SILTY SAND AND GRAVELLY SAND SEAMS ~ MEDIUM DENSE ~
										BOTTOM OF EXPLORATION @ 19.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-218**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-219**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	14	16	14	13	4.0'	BROWN SAND AND GRAVEL, SOME SILT ~ MEDIUM DENSE ~
	2D	24"	10"	6.0'	13	19	16	11	6.0'	BROWN TO ORANGE-BROWN SILTY SAND AND GRAVEL ~ DENSE ~
	3D	24"	14"	8.0'	7	10	10	8		BROWN TO ORANGE-BROWN FINE TO MEDIUM SAND, TRACE SILT ~ MEDIUM DENSE ~ <RUNNING SANDS / SAND HEAVE @ 4D >
	4D	24"	16"	10.0'	2	3	10	6	9.8'	TURNS DARK RUST-BROWN @ 8', WITH BLACK OXIDE LAYER 9' - 9.1'
									19.0'	GRAY SANDY SILT TRACE GRAVEL (PROBABLE GLACIAL TILL) <ATTEMPTED SAMPLE @ 15' - RUNNING SANDS / SAND HEAVE IN AUGERS>
	5D	24"	14"	21.0'	58	34	36	52	21.0'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 21.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-219**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-220**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST FROM GROUND SURFACE
SOILS SATURATED BELOW 9' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	8"	4.0'	3	9	9	10	4.0'	BROWN SILTY SAND, SOME GRAVEL, WITH PLASTIC (FILL) ~ MEDIUM DENSE ~
	2D	24"	12"	6.0'	13	14	17	12	6.0'	BROWN GRAVELLY SAND, SOME SILT, WITH ASPHALT (FILL) ~ DENSE ~
	3D	24"	6"	8.0'	11	18	13	13		DARK BROWN GRAVELLY SAND, SOME SILT, WITH ORGANICS (FILL) ~ MEDIUM DENSE TO DENSE ~
	4D	24"	4"	10.0'	6	8	16	22	10.0'	< SPOON BOUNCING @ 4D - PROBABLE WOOD IN FILL >
	5D	24"	10"	12.0'	11	13	10	12		BROWN GRAVELLY SAND, SOME SILT ~ MEDIUM DENSE ~
	6D	24"	14"	14.0'	7	8	4	4	13.5'	
	7D	24"	14"	16.0'	4	4	4	4		BROWN FINE SAND, TRACE SILT ~ LOOSE ~
										TURNS DARK RUST BROWN/BLACK TO ORANGE BELOW 19'
	8D	24"	14"	21.0'	3	4	4	7		< RUNNING SANDS/ SAND HEAVE IN AUGERS >
									24.0'	
	9D	16"	6"	25.3'	18	50	50-4"		25.3'	BROWN GRAVELLY SILTY SAND ~ VERY DENSE ~
										BOTTOM OF EXPLORATION @ 25.3'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-220**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-222**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/24/2015
DATE FINISH:	3/24/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST BELOW 2' +/-
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	3	5	7	10		BROWN TO DARK BROWN SILTY GRAVELLY SAND WITH COBBLES, BOULDERS AND ORGANICS (FILL)
	2D	24"	16"	4.0'	6	8	12	17		
	3D	24"	10"	6.0'	6	7	9	10		~ MEDIUM DENSE ~
	4D	24"	16"	8.0'	21	29	17	12	8.0'	
										REFUSAL @ 8.0' PROBABLE BOULDER OR BEDROCK NOTE: MOVED SOUTHEAST 5' AND ADVANCED AUGERS - REFUSAL @ 7'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-222**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-224**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
ALL SOILS MOIST

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.3'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	16"	2.0'	1	1	3	13	0.8'	BROWN SAND, SOME SILT ~ LOOSE ~
									3.0'	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE ~
										REFUSAL @ 3.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-224**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-227**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	4.0'	3	7	17	12		BROWN WITH ORANGE STAINING SILTY SAND, SOME GRAVEL (GLACIAL TILL)
	2D	24"	16"	6.0'	3	7	7	6		~ MEDIUM DENSE ~
	3D	24"	18"	11.0'	11	29	38	46	10.8'	
										PROBABLE WEATHERED BEDROCK
									12.5	
										REFUSAL @ 12.5' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-227**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-228**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/23/2015
DATE FINISH:	3/23/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS MOIST BELOW 2' +/-
SOILS SATURATED BELOW 4' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
									2.5'	BROWN GRAVELLY SAND, TRACE SILT ~ MEDIUM DENSE ~
	1D	24"	14"	4.0'	6	11	14	12		BROWN GRAVELLY SILTY SAND (GLACIAL TILL) ~ MEDIUM DENSE ~
	2D	24"	14"	6.0'	7	12	9	16	6.1'	
										REFUSAL @ 6.1' PROBABLE BEDROCK
										NOTE: MOVED NE 6' AND ADVANCED AUGERS - REFUSAL @ 6.5'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-228**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-301**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS WET FROM GROUND SURFACE
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	2.0'	2	1	2	2	3.0'	BROWN FINE TO MEDIUM SAND, TRACE SILT ~ LOOSE ~
	2D	24"	20"	4.0'	2	4	5	5		2" DARK BROWN FIBROUS PEAT SEAM @ 5'
	3D	24"	20"	6.0'	3	5	6	6		BROWN SILTY FINE SAND
	4D	24"	24"	8.0'	6	7	9	11		~ MEDIUM DENSE ~
									10.0'	<RUNNING SANDS IN AUGERS BELOW 5'>
	5D	24"	8"	11.0'	3	6	34	22		BROWN GRAVELLY SAND, SOME SILT
										~ VERY DENSE ~
	6D	18"	3"	15.5'	20	50	106		15.5'	<SAMPLER PUSHING GRAVEL OR COBBLE A@ 6D>
										BOTTOM OF EXPLORATION @ 15.5'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-301**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-302**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 2' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	4.0'	12	11	21	24	3.5'	BROWN SANDY GRAVEL, SOME SILT ~ MEDIUM DENSE ~
	2D	24"	16"	6.0'	6	14	14	28	6.0'	GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL) ~ MEDIUM DENSE TO DENSE ~
									7.0'	PROBABLE WEATHERED BEDROCK - ADVANCE BY AUGER
										REFUSAL @ 7.0' PROBABLE BEDROCK

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-302**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-303**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS DAMP FROM GROUND SURFACE
SOILS SATURATED BELOW 6' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									1.0'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS
	1D	24"	14"	4.0'	3	4	4	4		LIGHT BROWN TO BROWN SAND, SOME SILT
	2D	24"	18"	6.0'	5	7	7	10		~ LOOSE TO MEDIUM DENSE ~
	3D	24"	16"	8.0'	6	4	4	5		WITH ORANGE STAINING @ 9'-10' +/-
	4D	24"	16"	11.0'	3	5	8	9		
	5D	24"	20"	16.0'	4	7	8	7	15.5'	
										BROWN GRAVELLY SAND, TRACE SILT ~ MEDIUM DENSE TO VERY DENSE ~
	6D	24"	6"	21.0'	16	30	29	26	21.0'	<SAMPLER PUSHING GRAVEL @ 6D>
										BOTTOM OF EXPLORATION @ 21.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-303**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-304**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	3/27/2015
DATE FINISH:	3/27/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:	SS	1 3/8"	140 LBS.	30"
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED BELOW 1' +/-

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
									2.3'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS (PROBABLE FILL) ~ LOOSE TO MEDIUM DENSE ~
	1D	24"	18"	4.0'	1	4	11	12		ORANGE-BROWN TO BROWN SAND, TRACE SILT (PROBABLE FILL) ~ MEDIUM DENSE ~
	2D	9"	9"	4.8'	14	50-3"				
									6.0'	BOULDERS AND COBBLES TO 4.8' - 6' +/- (PROBABLE FILL)
	3D	24"	18"	8.0'	6	13	16	19		GRAY-BROWN GRAVELLY SILT AND SAND (GLACIAL TILL) ~ MEDIUM DENSE TO DENSE ~
	4D	24"	18"	10.0'	12	14	16	23	10.0'	
	5D	24"	16"	15.0'	17	18	17	15	15.0'	GRAY GRAVELLY SILTY SAND WITH OCCASIONAL COBBLES (GLACIAL TILL) ~ DENSE ~
										BOTTOM OF EXPLORATION @ 15.0'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-304**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-305**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED FROM SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										FOREST DUFF AND TOPSOIL OVERLYING BROWN SAND, SOME SILT
									10.0'	BOTTOM OF EXPLORATION @ 10.0' NOTE: NO SAMPLING - AUGER PROBE

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-305**

S.W.COLE ENGINEERING, INC.

BORING LOG

BORING NO.:	**B-306**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/3/2015
DATE FINISH:	4/3/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: S.W.COLE EXPLORATIONS, LLC. DRILLER: BOB MARCOUX

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	HSA	2 1/4"		
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
SOILS SATURATED FROM SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										FOREST DUFF / TOPSOIL OVERLYING BROWN SILTY FINE TO MEDIUM SAND BECOMES GRAVELLY BELOW 5'
									10.0'	BOTTOM OF EXPLORATION @ 10.0' NOTE: NO SAMPLING - AUGER PROBE

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **B-306**

S.W.COLE ENGINEERING, INC.

PROBE LOG

BORING NO.:	**P-101**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/9/2015
DATE FINISH:	4/9/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: DRILLER:

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
FREE WATER AT GROUND SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PEAT AND ORGANICS <HAND PUSH STEEL TILE PROBE TO REFUSAL>
									3.5'	GRANULAR SOILS @ 3.5'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-101**

S.W.COLE ENGINEERING, INC.

PROBE LOG

BORING NO.:	**P-102**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/9/2015
DATE FINISH:	4/9/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: DRILLER:

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
FREE WATER AT GROUND SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PEAT AND ORGANICS <HAND PUSH STEEL TILE PROBE TO REFUSAL>
									8.1'	GRANULAR SOILS @ 8.1'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-102**

S.W.COLE ENGINEERING, INC.

PROBE LOG

BORING NO.:	**P-103**
SHEET:	1 OF 1
PROJECT NO.:	12-0471
DATE START:	4/9/2015
DATE FINISH:	4/9/2015
ELEVATION:	
SWC REP.:	E. WALKER

PROJECT: PROPOSED SANFORD HIGH SCHOOL & REGIONAL TECHNICAL CENTER
CLIENT : SANFORD SCHOOL DEPARTMENT
LOCATION: ROUTE 109 & OLD MILL ROAD, SANFORD, MAINE
DRILLING FIRM: DRILLER:

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:				
SAMPLER:				
CORE BARREL:				

WATER LEVEL INFORMATION
FREE WATER AT GROUND SURFACE

CASING BLOWS PER FOOT	SAMPLE NO.	PEN.	REC.	DEPTH @ BOT	SAMPLER BLOWS PER 6" 0-6	6-12	12-18	18-24	DEPTH	STRATA & TEST DATA
										PEAT AND ORGANICS <HAND PUSH STEEL TILE PROBE TO REFUSAL>
									4.2'	GRANULAR SOILS @ 4.2'

SAMPLES:
D = SPLIT SPOON
C = 3" SHELBY TUBE
U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH. - VISUALLY
[ ] LABORATORY TEST

REMARKS:
STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING NO.: **P-103**

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-101

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS	
		2.5	BROWN GRAVELLY SILTY SAND WITH COBBLES (GLACIAL TILL)	
			REFUSAL @ 2.5' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 2.5' REFUSAL DEPTH TO WATER: NO FREE WATER OBSERVED

TEST PIT TP-102

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS	
S-1	4-5'		BROWN GRAVEL AND SAND, SOME SILT SIDEWALLS CAVING @ 4.5'	
			BOTTOM OF EXPLORATION @ 6.5'	

COMPLETION DEPTH: 6.5' DEPTH TO WATER: HEAVY SEEPAGE @ 4.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-103

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF	
		4.5	DARK BROWN FIBROUS PEAT TRACE SAND, TRACE GRAVEL	w = 487.5% O = 79.5%
			GRAY-BROWN SAND, SOME SILT, TRACE GRAVEL	
			BOTTOM OF EXPLORATION @ 5.5'	

COMPLETION DEPTH: 5.5' DEPTH TO WATER: GROUNDWATER AT SURFACE TEST PIT FILLED W/ WATER

TEST PIT TP-104

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		2.0	FOREST DUFF / BROWN SILTY SAND WITH ROOTS AND ORGANICS	
		8.0	BROWN GRAVELLY SAND SOME SILT WITH COBBLES BECOMES SILTY BELOW 6' +/-	
			BROWN SILTY SAND SOME GRAVELY WITH COBBLES (GLACIAL TILL)	
			BOTTOM OF EXPLORATION @ 9.0'	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-105

DATE: _____ SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			BEDROCK OUTCROP AT GROUND SURFACE	

COMPLETION DEPTH: _____ DEPTH TO WATER: _____

TEST PIT TP-106

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / VEGETATION	
		3.0	DARK BROWN FIBROUS PEAT TRACE SAND, TRACE GRAVEL	
			BROWN SAND AND GRAVEL, TRACE TO SOME SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 8.5'	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: GROUNDWATER AT SURFACE

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-201

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	DISTURBED BROWN SILTY SAND WITH ORGANICS PLASTIC DEBRIS AND RUBBER HOSE AT GROUND SURFACE	
		6.8	SAND, SOME SILT, TRACE GRAVEL ORANGE STAINING @ 4.5'	w = 7.9%
			REFUSAL @ 6.8' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 6.8' REFUSAL DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-202

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5'	FOREST DUFF / BROWN SILTY SAND WITH ROOTS AND ORGANICS	
		8.0'	BROWN GRAVELLY SAND, TRACE SILT	w = 3.4%
			REFUSAL @ 8.0' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 8.0' REFUSAL DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-203

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SAND, SOME SILT WITH ROOTS AND ORGANICS	
		2.0		
			BROWN AND ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL	
		5.2		
		5.4	WEATHERED BEDROCK	
			REFUSAL @ 5.4' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 5.4' REFUSAL DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-204

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		2.0	ORANGE-BROWN SAND, TRACE SILT, TRACE GRAVEL WITH ROOTS	
			BROWN SAND, TRACE SILT, TRACE GRAVEL WITH GRAVELLY LAYERS	
			BOTTOM OF EXPLORATION @ 10.5'	

COMPLETION DEPTH: 10.5' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-205

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SAND SOME SILT WITH ORGANICS	
		0.8		
		2.0	BROWN SAND SOME SILT	
			BROWN SAND, SOME SILT, SOME GRAVEL WITH COBBLES AND BOULDERS WITH SILTY LAYERS BELOW 3.5'	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: PERCHED SEEPAGE @ 3.5'

TEST PIT TP-206

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		1.2		
			ORANGE-BROWN TO BROWN SILTY FINE TO MEDIUM SAND WITH ROOTS TO 3.5'	
		4.0		
			BROWN SAND AND GRAVEL, TRACE SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: MODERATE SEEPAGE @ 7'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-207

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		1.0	BROWN SAND AND GRAVEL, TRACE SILT WITH COBBLES	
		5.0	GRAY-BROWN SILTY GRAVELLY SAND WITH COBBLES	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: HEAVY SEEPAGE @ 5'

TEST PIT TP-208

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		0.8	ORANGE-BROWN SILTY SAND, TRACE GRAVEL, WITH COBBLES AND ROOTS	
		2.5	BROWN GRAVELLY SILTY SAND WITH COBBLES AND BOULDERS	
		6.0	GRAY-BROWN SILTY GRAVELLY SAND WITH COBBLES ~ DENSER DIGGING ~	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 9.2' DEPTH TO WATER: MODERATE SEEPAGE @ 7'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-209

DATE: 1/7/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF	
		4.6	DARK BROWN TO BROWN SILTY SAND, SOME GRAVEL WITH COBBLES, BOULDERS, ROOTS, ORGANICS (FILL)	
		5.1	DARK BROWN SILTY SAND WITH ORGANICS (RELIC TOPSOIL)	
			LIGHT BROWN SAND, TRACE SILT	
			BOTTOM OF EXPLORATION @ 9.0'	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS DAMP TO MOIST

TEST PIT TP-210

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		3.8	BROWN GRAVELLY SAND, SOME SILT WITH BOULDERS, COBBLES, ROOTS, ORGANICS (FILL)	
		6.0	DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS (RELIC TOPSOIL / FILL)	
		8.0'	BROWN GRAVELLY SAND, SOME SILT WITH COBBLES	
			BROWN GRAVEL AND SAND, TRACE SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 9.0'	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-211

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF	
		1.0		
			DARK BROWN GRAVELLY SILTY SAND WITH BOULDERS, COBBLES. ORGANICS, STUMPS, ROOTS (FILL)	
		5.0		
			GRAY-BROWN GRAVELLY MEDIUM TO COARSE SAND, TRACE SILT	
			BOTTOM OF EXPLORATION @ 7.0'	

COMPLETION DEPTH: 7.0' DEPTH TO WATER: HEAVY SEEPAGE @ 5'

TEST PIT TP-212

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		0.8		
			BROWN SILTY SAND, SOME GRAVEL WITH ROOTS (FILL)	
		3.5		
			BROWN GRAVELLY SAND, TRACE SILT	
			BOTTOM OF EXPLORATION @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: HEAVY SEEPAGE @ 3.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-213

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / ORGANICS	
		2.5	DARK BROWN GRAVELLY SILTY SAND WITH BOULDERS, ORGANICS, STUMPS (FILL)	
		3.5	DARK BROWN SILTY SAND WITH ORGANICS AND ROOTS (RELIC TOPSOIL)	
		6.0	BROWN GRAVELLY SAND, SOME SILT WITH COBBLES	
			GRAY-BROWN SANDY GRAVEL, TRACE SILT WITH COBBLES	
			BOTTOM OF EXPLORATION @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: HEAVY SEEPAGE @ 3.5'

TEST PIT TP-214

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		3.0	BROWN SILTY SAND SOME GRAVEL WITH COBBLES, BOULDERS, ROOTS, ORGANICS (FILL)	
		3.8	DARK BROWN SILTY SAND WITH ORGANICS (RELIC TOPSOIL)	
			BROWN MEDIUM TO COARSE SAND AND GRAVEL, TRACE SILT	
			BOTTOM OF EXPLORATION @ 7.5'	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: HEAVY SEEPAGE @ 6.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC160 BLC

SWC REP.: E. WALKER
PROJECT NO.: 12-0471.1

TEST PIT TP-215

DATE: 1/6/14 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		0.8	ORANGE-BROWN SILTY SAND WITH ROOTS	
		2.5	BROWN SAND, TRACE TO SOME SILT, TRACE GRAVEL	
			BOTTOM OF EXPLORATION @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: ALL SOILS DAMP TO MOIST

TEST PIT TP-216

DATE: _____ SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / BROWN SILTY SAND WITH ORGANICS	
		1.5	DARK BROWN TO ORANGE-BROWN SILTY SAND WITH ROOTS	
		7.1	BROWN SAND, TRACE SILT, TRACE GRAVEL	
			REFUSAL @ 7.1' (PROBABLE BEDROCK)	

COMPLETION DEPTH: 7.1' DEPTH TO WATER: ALL SOILS DAMP TO MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-301

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.5	ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL, WITH ROOTS	
		8.5	BROWN GRAVELLY SAND, TRACE SILT	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: HEAVY SEEPAGE @ 7.5'

TEST PIT TP-302

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		3.5	DARK BROWN TO BROWN SILTY SAND, SOME GRAVEL WITH ORGANICS CONCRETE SLAB PIECES (FILL)	
		3.8	DARK BROWN SILTY SAND WITH ORGANICS (RELIC TOPSOIL)	
		8.5	BROWN TO ORANGE-BROWN SAND, TRACE SILT, TRACE FINE GRAVEL ORANGE-BROWN OXIDE CEMENTED LAYER @ 6.5'	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: HEAVY SEEPAGE @ 7'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-303

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		5.0	ROOTS EXTEND TO 3' +/- BROWN SAND, SOME GRAVEL, SOME SILT WITH FREQUENT COBBLES AND BOULDERS	
		6.5	BROWN SILTY SAND, SOME GRAVEL WITH FREQUENT COBBLES AND BOULDERS	

COMPLETION DEPTH: 6.5' DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-304

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.5	ORANGE-BROWN SAND, SOME SILT, WITH ROOTS	
		9.0	LIGHT BROWN FINE TO MEDIUM SAND, TRACE TO SOME SILT WITH SOME GRAVEL @ 7.5	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-305

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.2	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		8.0	BROWN SAND, SOME GRAVEL, TRACE SILT WITH GRAVELLY SEAMS	
		8.7	LIGHT BROWN FINE TO MEDIUM SAND, TRACE SILT	

COMPLETION DEPTH: 8.7' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-306

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5'	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
			PROBABLE BEDROCK @ 0.5' NOTE: PEAT AND ORGANICS OBSERVED WEST OF TEST PIT LOCATION	

COMPLETION DEPTH: 0.5' (REFUSAL) DEPTH TO WATER: ALL SOILS SATURATED

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-307

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		0.9	ROOTS EXTEND TO 2' +/- ORANGE-BROWN TO BROWN MEDIUM TO COARSE SAND, SOME GRAVEL, TRACE SILT WITH OCCASIONAL GRAVELLY LAYERS	
		8.5		

COMPLETION DEPTH: 8.5' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-308

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		0.7	ROOTS EXTEND TO 2.5' +/- ORANGE-BROWN TO BROWN MEDIUM SAND, TRACE GRAVEL, TRACE SILT TURNS LIGHT BROWN WITH DEPTH	
		7.5		

COMPLETION DEPTH: 7.5' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-309

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SAND, SOME SILT WITH ORGANICS	
		0.8	ROOTS EXTEND TO 2' +/- ORANGE-BROWN TO LIGHT BROWN MEDIUM TO COARSE SAND, TRACE GRAVEL, TRACE SILT WITH OCCASIONAL LAYERS OF FINE SAND, SOME SILT	
		7.5		

COMPLETION DEPTH: 7.5' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-310

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
			FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		0.8	ORANGE-BROWN TO BROWN SAND, SOME SILT	
		6.0	GRAY GRAVELLY SILTY SAND WITH OCCASIONAL COBBLES (GLACIAL TILL)	
		8.0	NOTE: HEAVY SIDEWALL CAVING AND SEEPAGE BELOW 3.5'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: FREE WATER @ 3.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-311

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		6.5	ORANGE-BROWN TO LIGHT BROWN SILTY SAND, SOME GRAVEL WITH OCCASIONAL COBBLES AND BOULDERS DIFFICULT EXCAVATION BELOW 5.5' DUE TO FREQUENT COBBLES AND BOULDERS	

COMPLETION DEPTH: 6.5' DEPTH TO WATER: SEEPAGE @ 2' +/-

TEST PIT TP-312

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		7.5	ORANGE-BROWN GRAVEL AND SAND, TRACE TO SOME SILT WITH FREQUENT COBBLES ~ DENSE EXCAVATING ~	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: SOILS SATURATED BELOW 5.5' +/- SEEPAGE @ 6' +/-

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-313

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		4 +/-	FOREST DUFF OVERLYING BROWN FIBROUS PEAT	
		6.5 +/-	BROWN TO ORANGE-BROWN MEDIUM TO COARSE SAND, TRACE GRAVEL, TRACE SILT	
			NOTE: SHALLOW WATER OBSCURED TEST PIT OBSERVATIONS	

COMPLETION DEPTH: 6.5' +/- DEPTH TO WATER: FREE WATER BELOW 0.5'

TEST PIT TP-314

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		6 +/-	FOREST DUFF OVERLYING BROWN FIBROUS PEAT	
		7 +/-	BROWN MEDIUM SAND, TRACE SILT	
			NOTE: SHALLOW WATER OBSCURED TEST PIT OBSERVATIONS	

COMPLETION DEPTH: 7' +/- DEPTH TO WATER: FREE WATER BELOW 0.5'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-315

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.3	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.5	BROWN GRAVELLY SAND, SOME SILT, WITH FREQUENT COBBLES	
			BEDROCK @ 1.5'	

COMPLETION DEPTH: 1.5' (REFUSAL) DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-316

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		6.0	ROOTS EXTEND TO 2' +/- BROWN GRAVEL AND SAND, SOME SILT WITH FREQUENT COBBLES AND OCCASIONAL BOULDERS	
		7.5	ORANGE-BROWN MEDIUM SAND, TRACE SILT, TRACE GRAVEL	

COMPLETION DEPTH: 7.5' DEPTH TO WATER: ALL SOILS DAMP

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-317

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.7	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		8.5	ROOTS EXTEND TO 2.5' +/- BROWN GRAVELLY SAND, TRACE TO SOME SILT, WITH FREQUENT COBBLES	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: ALL SOILS DAMP

TEST PIT TP-318

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		3 +/-	FOREST DUFF OVERLYING BROWN FIBROUS PEAT	
		4+/-	BROWN MEDIUM TO COARSE SAND, SOME FINE GRAVEL, TRACE SILT	
			NOTE: SHALLOW WATER OBSCURED TEST PIT OBSERVATIONS	

COMPLETION DEPTH: 4' +/- DEPTH TO WATER: FREE WATER @ GROUND SURFACE

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-319

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.5	DARK BROWN SILTY SAND, TRACE GRAVEL, WITH ROOTS AND ORGANICS (FILL)	
		4.0	LIGHT BROWN SAND, SOME SILT, WITH ROOTS (PROBABLE FILL)	
		9.5	ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL WITH OCCASIONAL LAYERS OF GRAVELLY MEDIUM TO COARSE SAND	

COMPLETION DEPTH: 9.5' DEPTH TO WATER: HEAVY SEEPAGE @ 8.5'

TEST PIT TP-320

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.0	BROWN FINE TO MEDIUM SAND, SOME GRAVEL, TRACE SILT WITH FREQUENT COBBLES AND BOULDERS	
		10.0	FRACTURED BEDROCK WITH SEAMS OF BROWN SILTY SAND	
			SOUND BEDROCK @ 10.0' NOTE: SLOPING BEDROCK - REFUSAL AS SHALLOW AS 2.5' ON SOUTH SIDE	

COMPLETION DEPTH: 2.5' TO 10' (REFUSAL) DEPTH TO WATER: SEEPAGE @ TOP OF SOUND BEDROCK

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-321

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.0	ORANGE-BROWN SAND, SOME SILT, SOME GRAVEL, WITH ROOTS	
		5.0	BROWN SAND, SOME GRAVEL, SOME SILT WITH FREQUENT COBBLES	
		6.0	BROWN FINE TO MEDIUM SAND, SOME SILT	
		10.0	BROWN SAND, SOME GRAVEL, SOME SILT WITH FREQUENT COBBLES	

COMPLETION DEPTH: 10.0' DEPTH TO WATER: SEEPAGE @ 9'

TEST PIT TP-322

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.5	ORANGE-BROWN GRAVELLY SAND, SOME SILT, WITH ROOTS	
		5.6	LIGHT BROWN SILTY SAND, SOME GRAVEL, WITH OCCASIONAL COBBLES AND BOULDERS (GLACIAL TILL)	
			PROBABLE BEDROCK @ 5.6'	

COMPLETION DEPTH: 5.6' (REFUSAL) DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-323

DATE: 3/19/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
			BROWN GRAVELLY SAND, TRACE SILT	
		4.7	PROBABLE BEDROCK @ 4.7'	

COMPLETION DEPTH: 4.7' (REFUSAL) DEPTH TO WATER: ALL SOILS DAMP SEEPAGE @ 4.6'

TEST PIT TP-324

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
			ROOTS EXTEND TO 2' +/- ORANGE-BROWN TO BROWN GRAVELLY SAND, SOME SILT WITH FREQUENT COBBLES AND OCCASIONAL BOULDERS	
		6.0	BROWN SILTY GRAVELLY SAND WITH FREQUENT COBBLES	
		7.5		
		8.0	WEATHERED BEDROCK	
			BEDROCK @ 8.0'	

COMPLETION DEPTH: 8.0' DEPTH TO WATER: ALL SOILS MOIST

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-325

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		2.0	DARK BROWN GRAVELLY SAND, SOME SILT, WITH ROOTS AND ORGANICS (FILL)	
		6.0	BROWN GRAVEL AND SAND, SOME SILT WITH FREQUENT COBBLES WITH OCCASIONAL SILTY SAND LAYERS	
		7.0	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)	
			PROBABLE BEDROCK @ 7.0'	

COMPLETION DEPTH: 7.0' (REFUSAL) DEPTH TO WATER: SEEPAGE @ 6.9'

TEST PIT TP-326

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.4	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.2	BROWN GRAVEL, SOME SAND, SOME SILT, WITH FREQUENT COBBLES (FILL)	
		7.8	BROWN SILTY GRAVELLY SAND WITH FREQUEN COBBLES (GLACIAL TILL)	
			PROBABLE BEDROCK @ 7.8' NOTE: REFSUAL SURFACE SLOPES UPWARD TO 2.5' DEPTH ON NORTH SIDE	

COMPLETION DEPTH: 2.6' - 7.8' (REFUSAL) DEPTH TO WATER: SEEPAGE @ TOP OF REFUSAL SURFACE

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-327

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		1.5	BROWN SILTY SAND, SOME GRAVEL, WITH ROOTS AND ORGANICS	
		5.0	BROWN MEDIUM TO COARSE SAND AND GRAVEL WITH FREQUENT COBBLES	
		9.0	BROWN SILTY SAND, SOME GRAVEL WITH OCCASIONAL COBBLES AND BOULDERS (GLACIAL TILL)	

COMPLETION DEPTH: 9.0' DEPTH TO WATER: ALL SOILS MOIST

TEST PIT TP-328

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.8	ORANGE-BROWN GRAVELLY SAND, TRACE SILT ROOTS/ROOTLETS EXTEND TO 4.8'	
		5.2	BLACK CEMENTED OXIDE SAND, TRACE SILT	
		8.5	GRAY-BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)	

COMPLETION DEPTH: 8.5' DEPTH TO WATER: SEEPAGE @ 4.8'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-329

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.0	BROWN GRAVELLY SILTY SAND WITH BOULDERS, COBBLES, ROCK SLABS, ASPHALT, PLASTIC (FILL)	
		9.0	BROWN SILTY SAND, SOME GRAVEL (GLACIAL TILL)	

COMPLETION DEPTH: 9.0'
DEPTH TO WATER: WATER PERCHED IN FILLS HEAVY SEEPAGE @ 4'

TEST PIT TP-330

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		1.0	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		3.0	LIGHT BROWN SILTY FINE SAND	
		6.8	ORANGE-BROWN FINE SAND, SOME SILT	
		7.0	BROWN GRAVELLY SAND, SOME SILT	

COMPLETION DEPTH: 7.0'
DEPTH TO WATER: SEEPAGE @ 2.8'

S.W.COLE ENGINEERING, INC.

TEST PIT LOGS

PROJECT: PROPOSED SANFORD H.S. & REGIONAL TECH. CENTER
CLIENT: SEBAGO TECHNICS, INC.
LOCATION: ROUTE 109, SANFORD, MAINE
EXCAVATOR: BROWN INDUSTRIAL GROUP / VOLVO EC140

SWC REP.: E. WALKER
PROJECT NO.: 12-0471

TEST PIT TP-331

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		4.0	ORANGE-BROWN GRAVELLY SAND, SOME SILT WITH FREQUENT COBBLES AND BOULDERS	
		10.0	LIGHT BROWN SILTY GAVELLY SAND WITH FREQUENT COBBLES AND BOULDERS (GLACIAL TILL)	

COMPLETION DEPTH: 10.0'

DEPTH TO WATER: SOILS DAMP FROM GROUND SURFACE SATURATED BELOW 7' +/-

TEST PIT TP-332

DATE: 3/20/15 SURFACE ELEVATION: _____ LOCATION: SEE SHEET 1

SAMPLE NO.	SAMPLE DEPTH	DEPTH (FT)	STRATUM DESCRIPTION	TEST RESULTS
		0.8	FOREST DUFF / DARK BROWN SILTY SAND WITH ORGANICS	
		8.0	ROOTS EXTEND TO 3' +/- ORANGE-BROWN TO BROWN GRAVELLY SAND, SOME SILT WITH LAYERS OF MEDIUM TO COARSE SAND AND GRAVEL	
		9.0	LIGHT BROWN SILTY FINE SAND	
			BOULDERS OR BEDROCK @ 9.0'	

COMPLETION DEPTH: 9.0' (REFUSAL)

DEPTH TO WATER: HEAVY SEEPAGE @ 8'

KEY TO THE NOTES & SYMBOLS
Test Boring and Test Pit Explorations

All stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Key to Symbols Used:

w	-	water content, percent (dry weight basis)
q_u	-	unconfined compressive strength, kips/sq. ft. - laboratory test
S_v	-	field vane shear strength, kips/sq. ft.
L_v	-	lab vane shear strength, kips/sq. ft.
q_p	-	unconfined compressive strength, kips/sq. ft. – pocket penetrometer test
O	-	organic content, percent (dry weight basis)
W_L	-	liquid limit - Atterberg test
W_P	-	plastic limit - Atterberg test
WOH	-	advance by weight of hammer
WOM	-	advance by weight of man
WOR	-	advance by weight of rods
HYD	-	advance by force of hydraulic piston on drill
RQD	-	Rock Quality Designator - an index of the quality of a rock mass.
γ_T	-	total soil weight
γ_B	-	buoyant soil weight

Description of Proportions:

Trace:	0 to 5%
Some:	5 to 12%
"Y"	12 to 35%
And	35+%

Description of Stratified Soils

Parting:	0 to 1/16" thickness
Seam:	1/16" to ½" thickness
Layer:	½" to 12" thickness
Varved:	Alternating seams or layers
Occasional:	one or less per foot of thickness
Frequent:	more than one per foot of thickness

REFUSAL: **Test Boring Explorations** - Refusal depth indicates that depth at which, in the drill foreman's opinion, sufficient resistance to the advance of the casing, auger, probe rod or sampler was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

REFUSAL: **Test Pit Explorations** - Refusal depth indicates that depth at which sufficient resistance to the advance of the backhoe bucket was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

Although refusal may indicate the encountering of the bedrock surface, it may indicate the striking of large cobbles, boulders, very dense or cemented soil, or other buried natural or man-made objects or it may indicate the encountering of a harder zone after penetrating a considerable depth through a weathered or disintegrated zone of the bedrock.

APPENDIX B

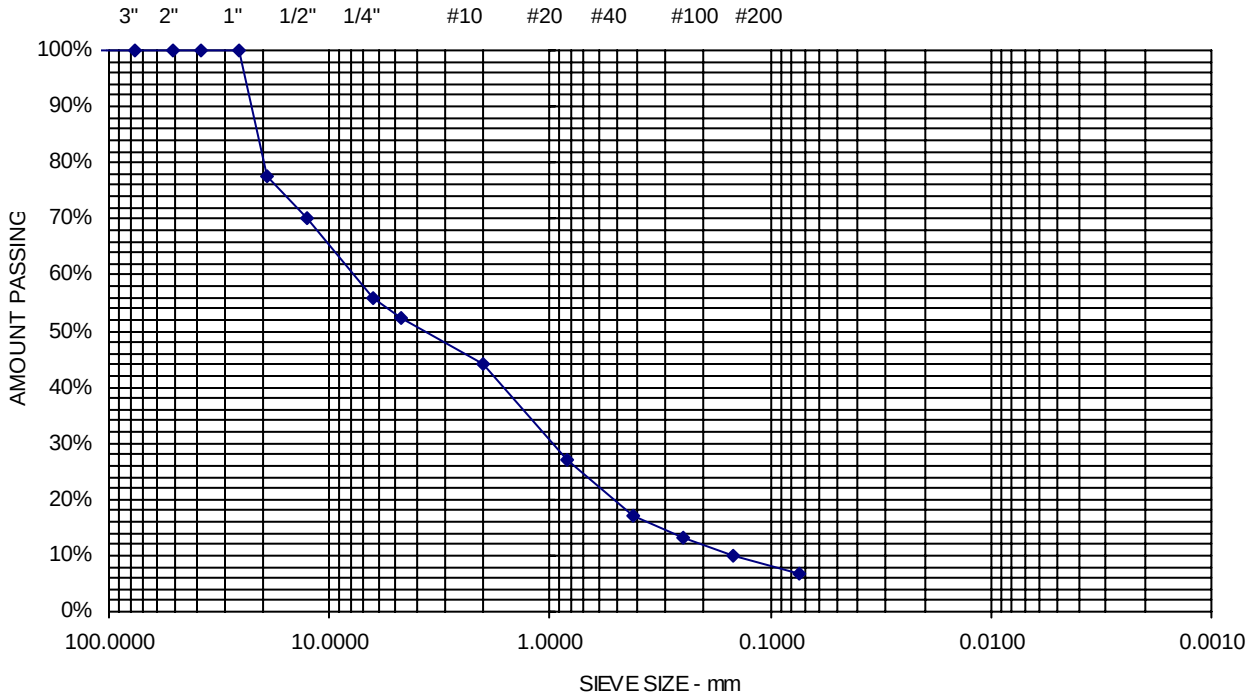
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	18199G
		Date Received	5/20/2014
		Date Completed	5/22/2014
Material Source	**B-101 3D 7-9**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**78**	
12.5 mm	**1/2"**	**70**	
6.3 mm	**1/4"**	**56**	
4.75 mm	**No. 4**	**52**	47.5% Gravel
2.00 mm	**No. 10**	**44**	
850 um	**No. 20**	**27**	
425 um	**No. 40**	**17**	45.6% Sand
250 um	**No. 60**	**13**	
150 um	**No. 100**	**10**	
75 um	**No. 200**	**6.9**	6.9% Fines



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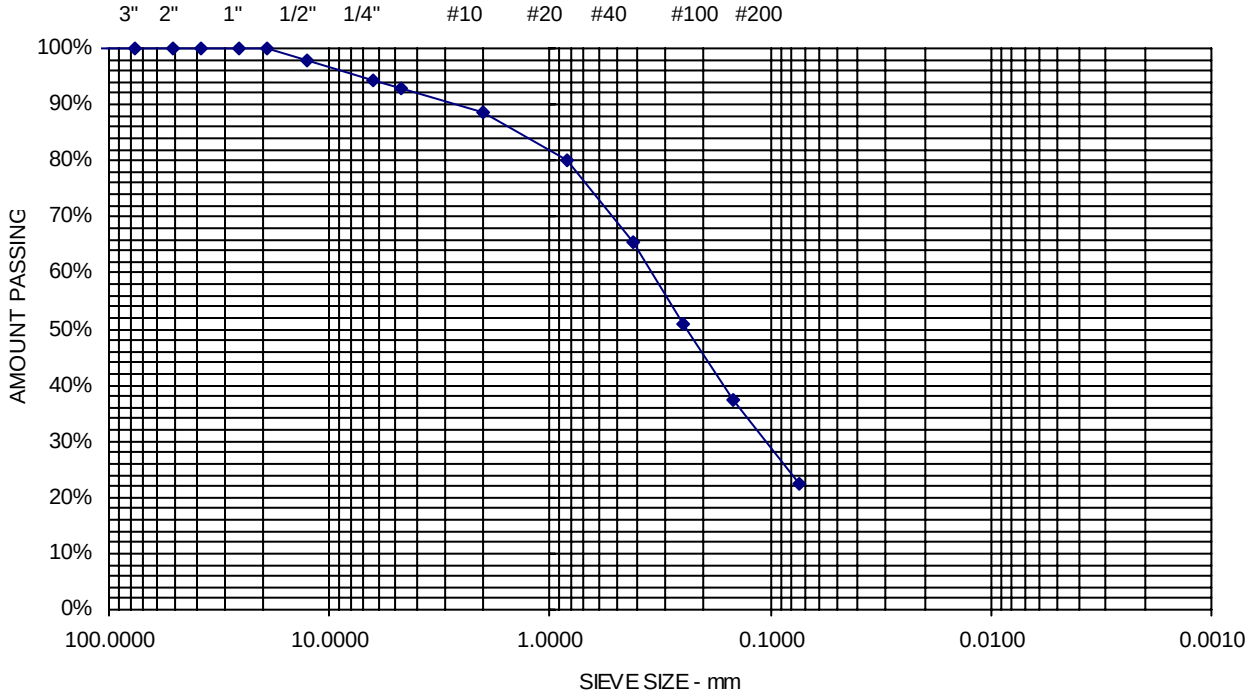
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	18200G
		Date Received	5/20/2014
		Date Completed	5/22/2014
Material Source	**B-102 4D 10-12**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**100**	
12.5 mm	**1/2"**	**98**	
6.3 mm	**1/4"**	**94**	
4.75 mm	**No. 4**	**93**	7% Gravel
2.00 mm	**No. 10**	**89**	
850 um	**No. 20**	**80**	
425 um	**No. 40**	**66**	70.5% Sand
250 um	**No. 60**	**51**	
150 um	**No. 100**	**37**	
75 um	**No. 200**	**22.6**	22.6% Fines



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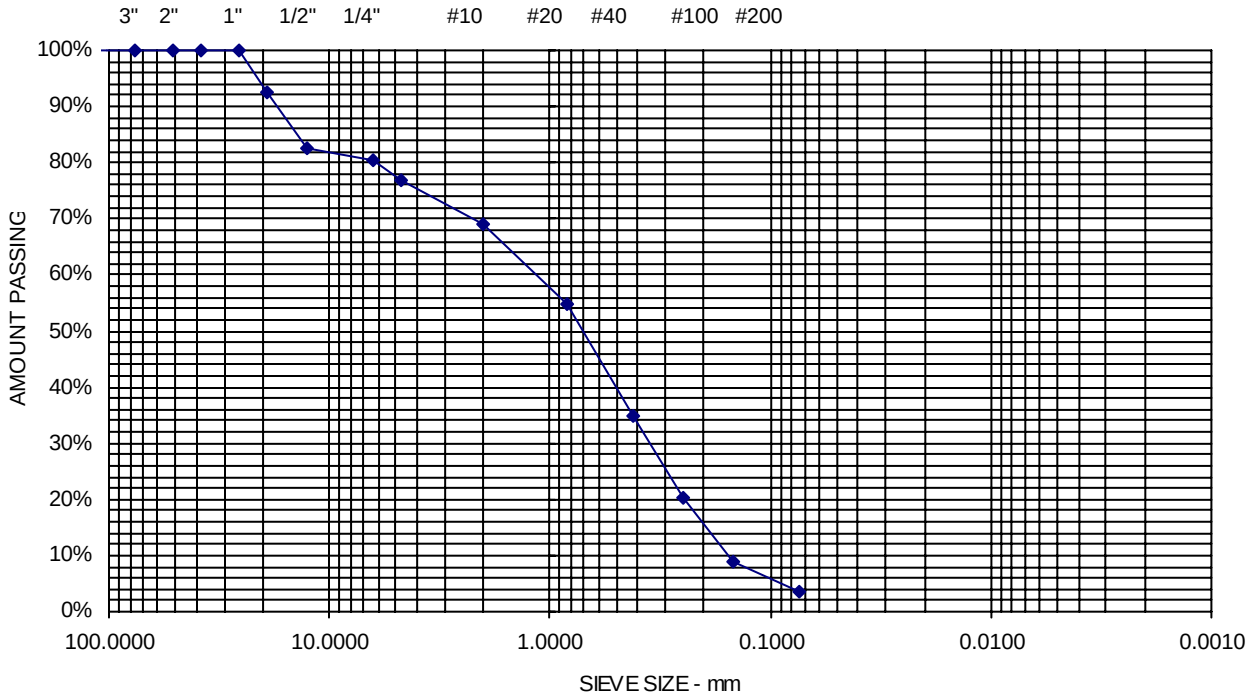
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	18198G
		Date Received	5/20/2014
		Date Completed	5/22/2014
Material Source	**B-105 2D 5-7**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**93**	
12.5 mm	**1/2"**	**83**	
6.3 mm	**1/4"**	**80**	
4.75 mm	**No. 4**	**77**	23.3% Gravel
2.00 mm	**No. 10**	**69**	
850 um	**No. 20**	**55**	
425 um	**No. 40**	**35**	73% Sand
250 um	**No. 60**	**20**	
150 um	**No. 100**	**9**	
75 um	**No. 200**	**3.7**	3.7% Fines



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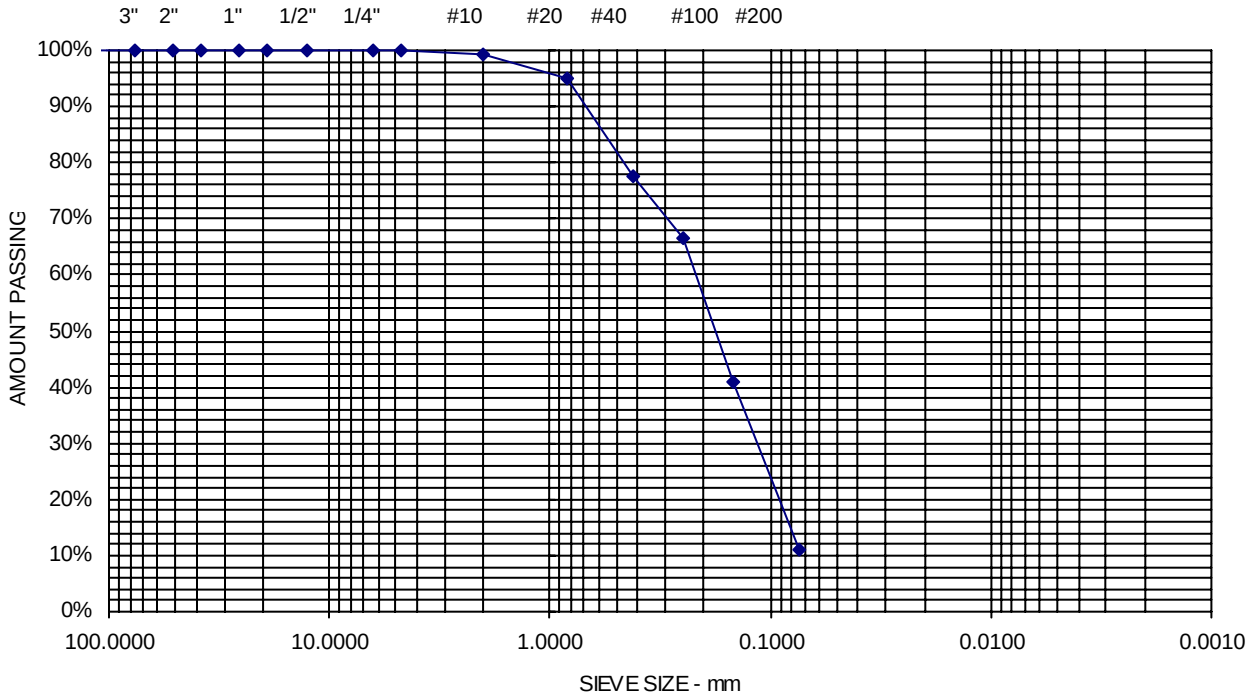
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	17805G
		Date Received	1/9/2014
		Date Completed	1/13/2014
Material Source	**TP-201 3-4**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**100**	
19.0 mm	**3/4"**	**100**	
12.5 mm	**1/2"**	**100**	
6.3 mm	**1/4"**	**100**	
4.75 mm	**No. 4**	**100**	0.1% Gravel
2.00 mm	**No. 10**	**99**	
850 um	**No. 20**	**95**	
425 um	**No. 40**	**78**	88.8% Sand
250 um	**No. 60**	**66**	
150 um	**No. 100**	**41**	
75 um	**No. 200**	**11.1**	11.1% Fines



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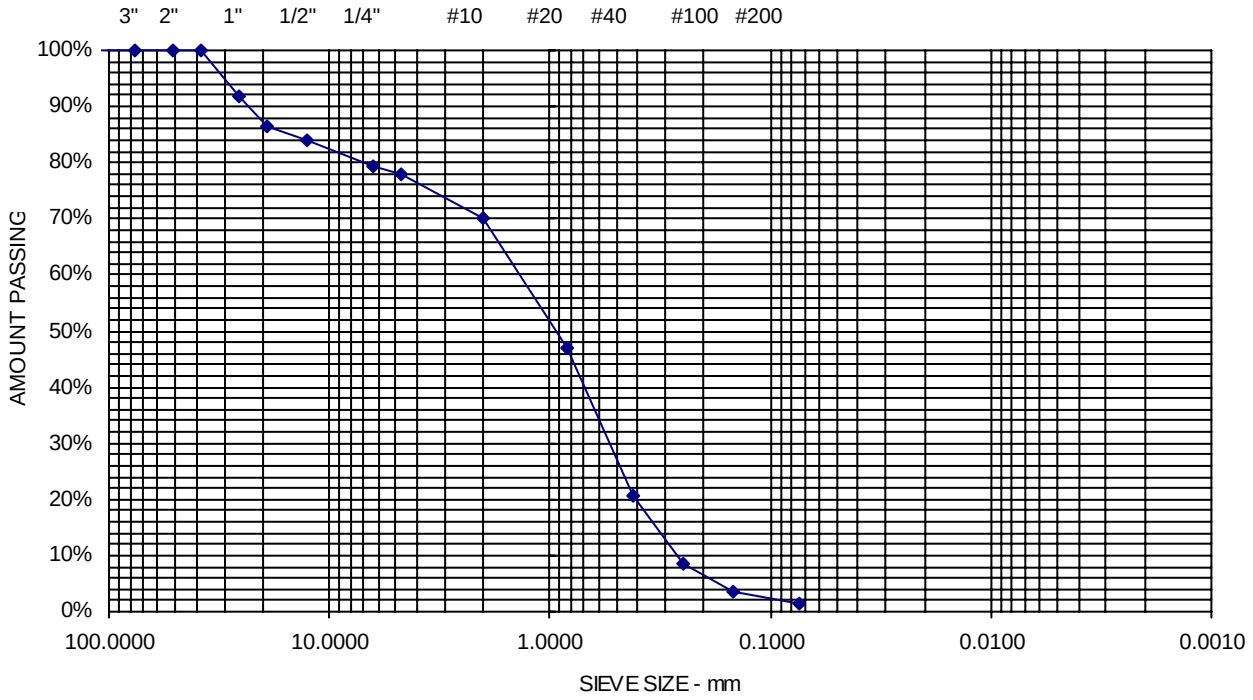
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	SANFORD ME - ELEMENTARY, HIGH SCHOOL & REGIONAL TECHNICAL CENTER - SITE EVALUATION & SELECTION	Project Number	12-0471.1
Client	SEBAGO TECHNICS, INC.	Lab ID	17806G
		Date Received	1/9/2014
		Date Completed	1/14/2014
Material Source	**TP-202 2-3**	Tested By	JUSTIN BISSON

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150 mm	**6"**	**100**	
125 mm	**5"**	**100**	
100 mm	**4"**	**100**	
75 mm	**3"**	**100**	
50 mm	**2"**	**100**	
38.1 mm	**1-1/2"**	**100**	
25.0 mm	**1"**	**92**	
19.0 mm	**3/4"**	**86**	
12.5 mm	**1/2"**	**84**	
6.3 mm	**1/4"**	**79**	
4.75 mm	**No. 4**	**78**	22% Gravel
2.00 mm	**No. 10**	**70**	
850 um	**No. 20**	**47**	
425 um	**No. 40**	**21**	76.4% Sand
250 um	**No. 60**	**9**	
150 um	**No. 100**	**3**	
75 um	**No. 200**	**1.6**	1.6% Fines



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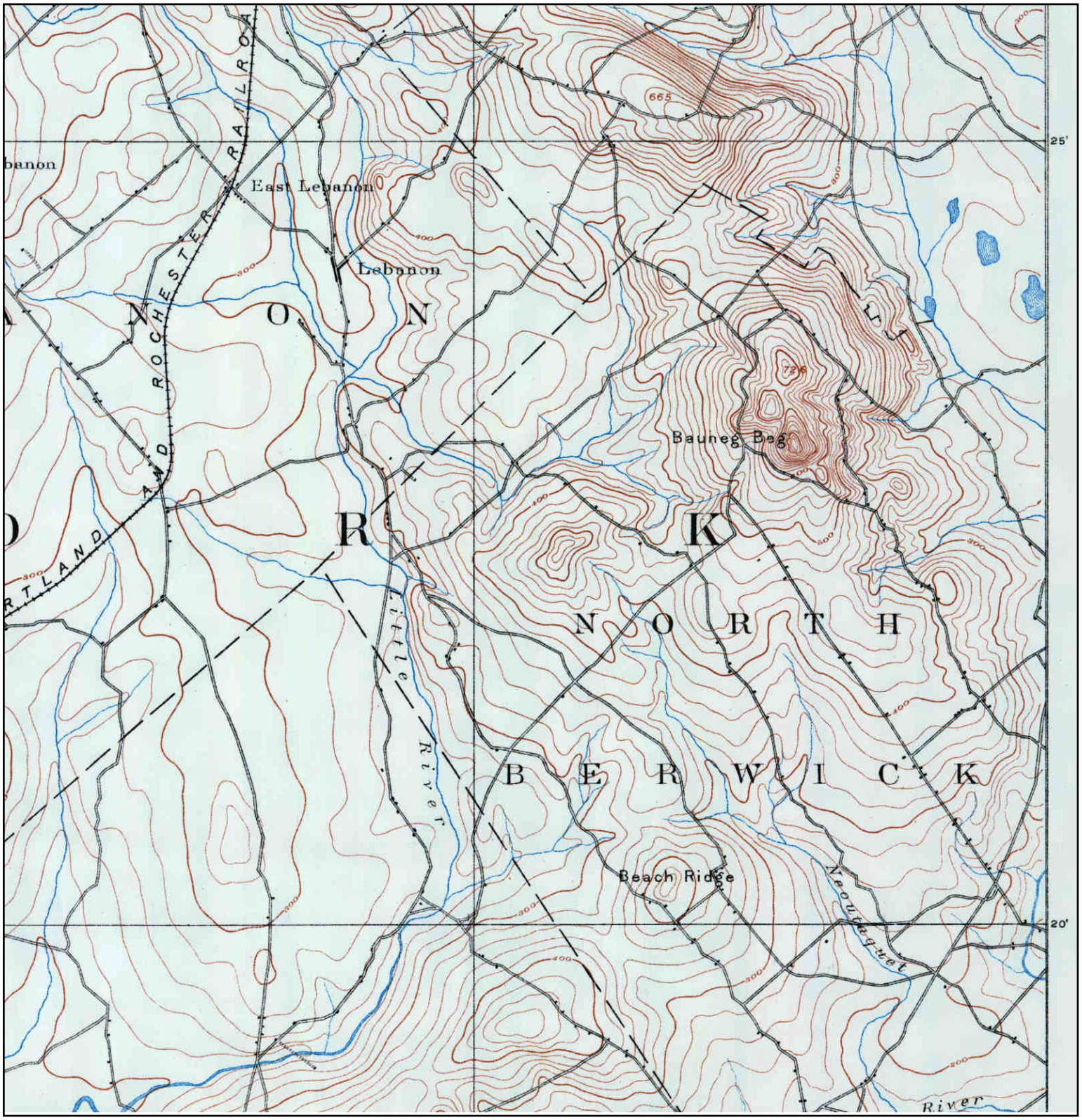
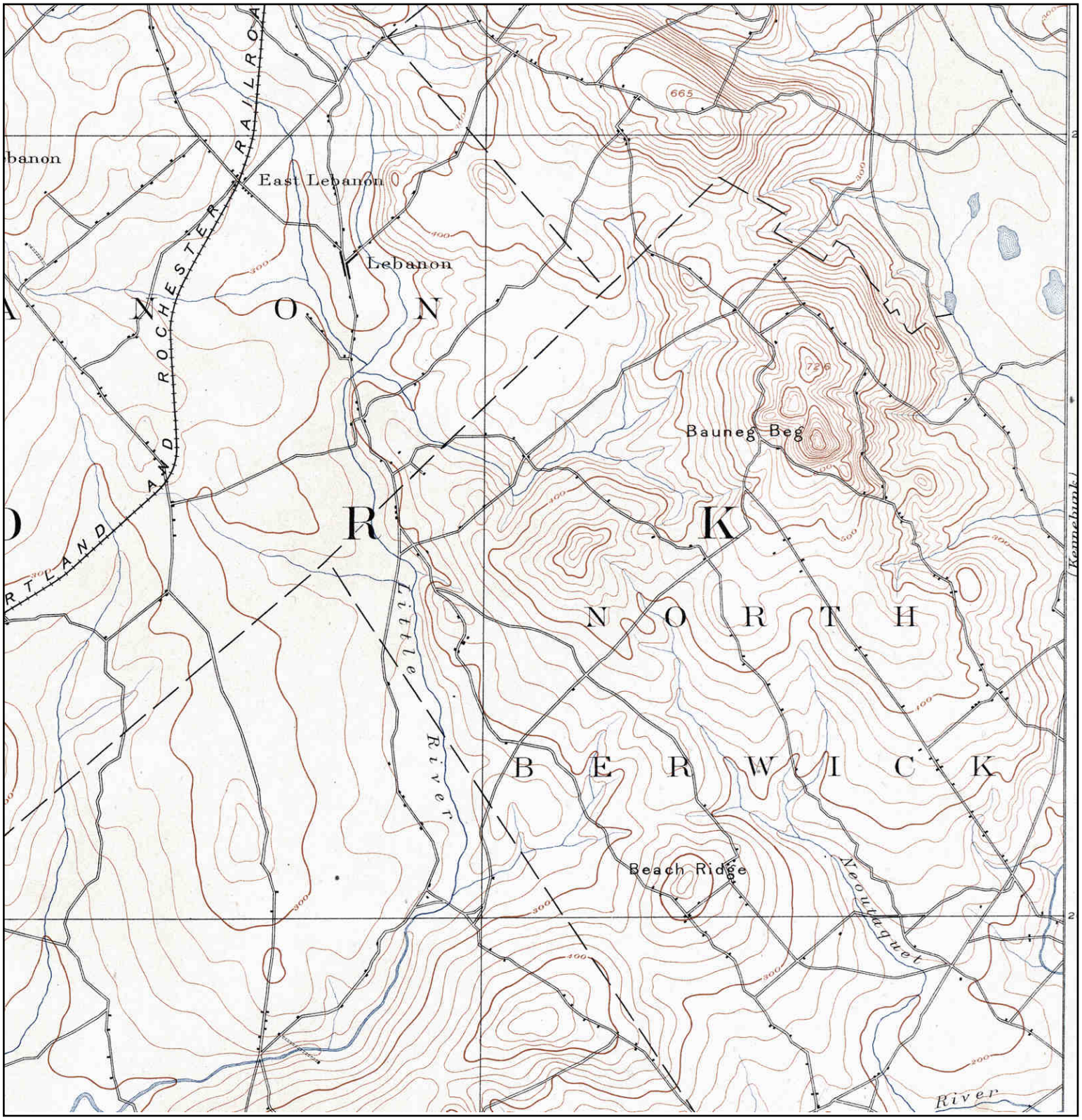
APPENDIX C

Historical Topographic Map



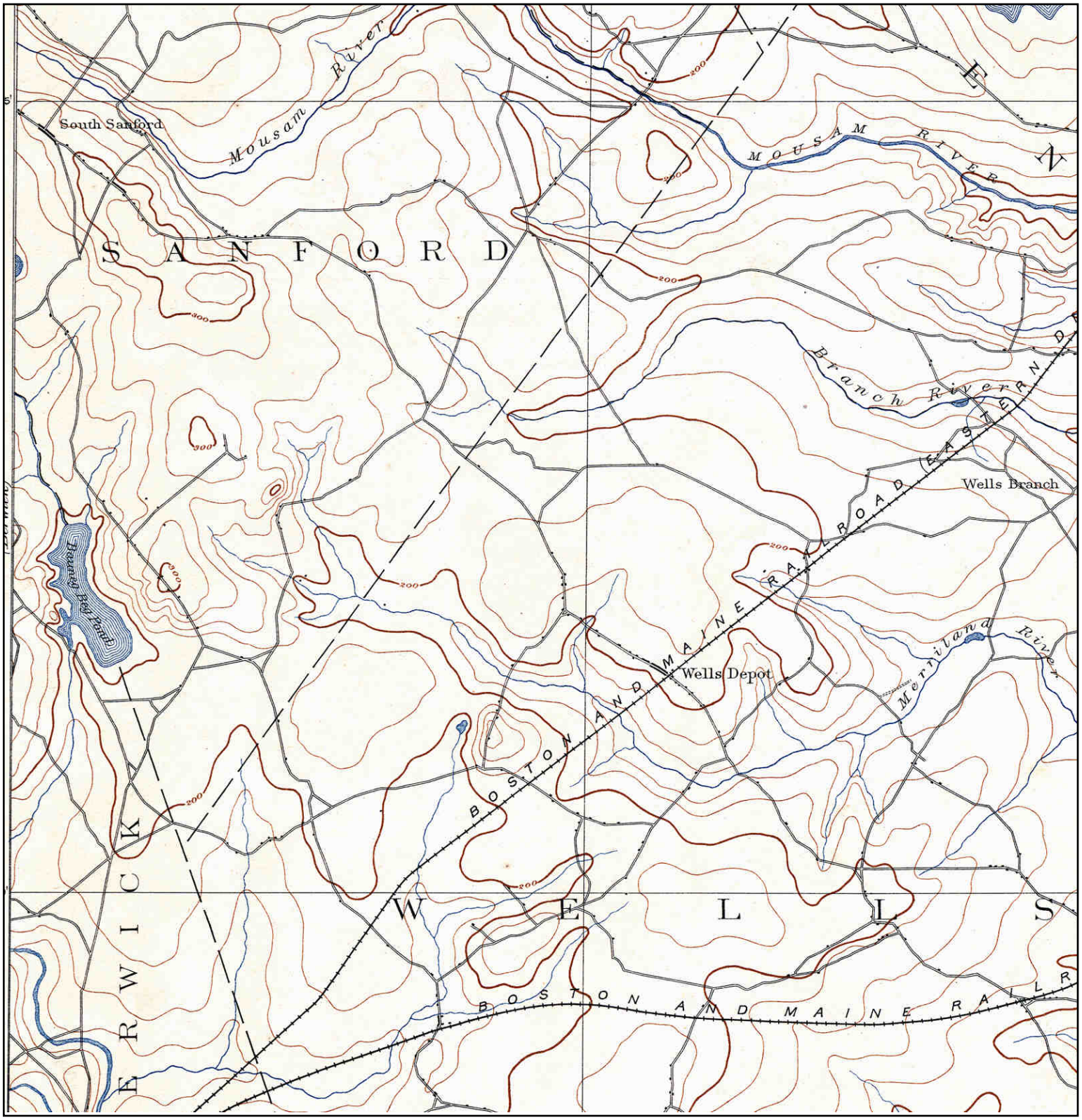
N	TARGET QUAD NAME: BERWICK MAP YEAR: 1891 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map



N	TARGET QUAD NAME: BERWICK MAP YEAR: 1893 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map



N	TARGET QUAD NAME: KENNEBUNK MAP YEAR: 1898 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map

N	TARGET QUAD NAME: KENNEBUNK MAP YEAR: 1944 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

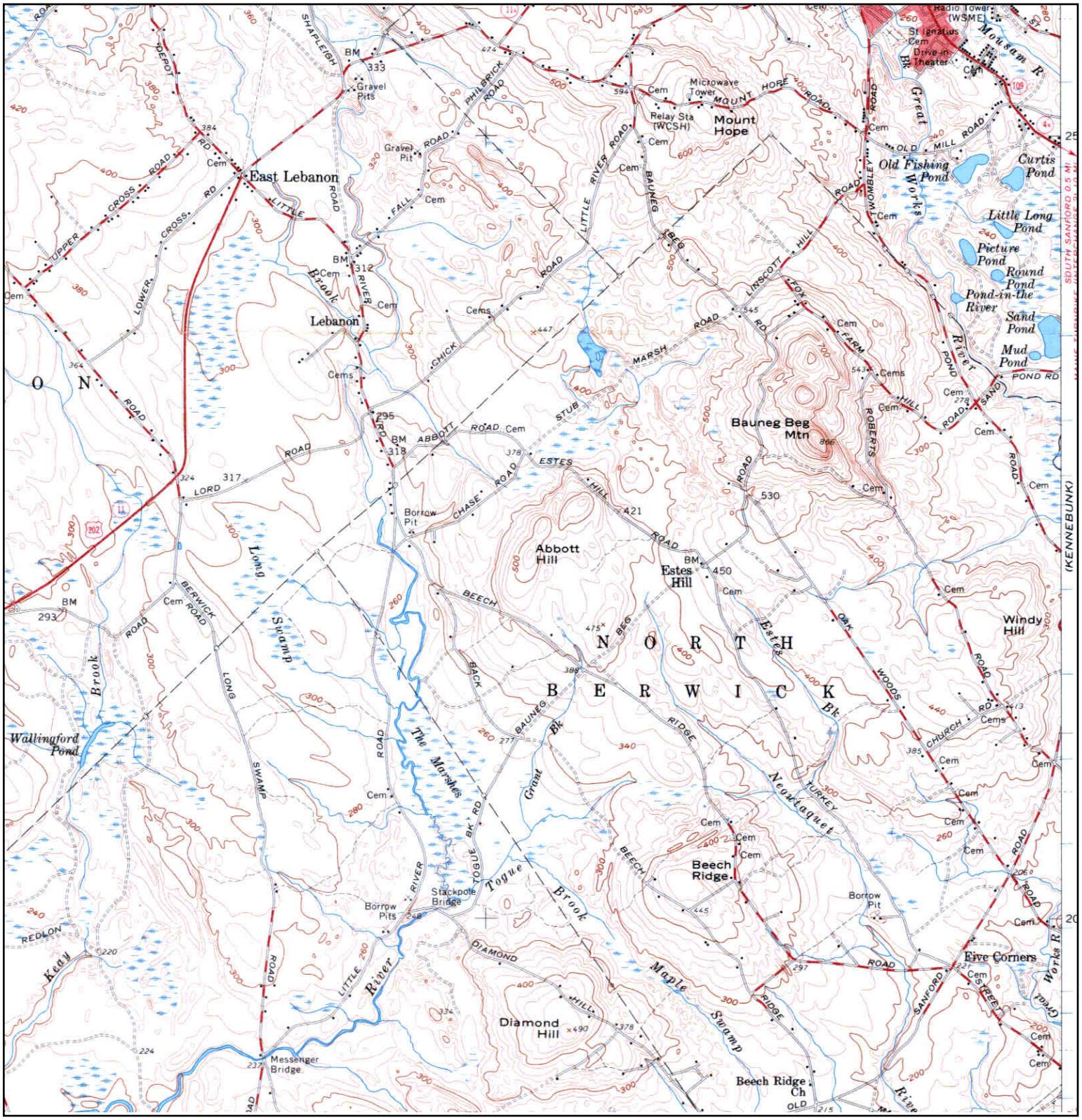
Historical Topographic Map

N	TARGET QUAD NAME: BERWICK MAP YEAR: 1944 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map

N	TARGET QUAD NAME: KENNEBUNK MAP YEAR: 1956 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map



N	TARGET QUAD NAME: BERWICK MAP YEAR: 1958 SERIES: 15 SCALE: 1:62500	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

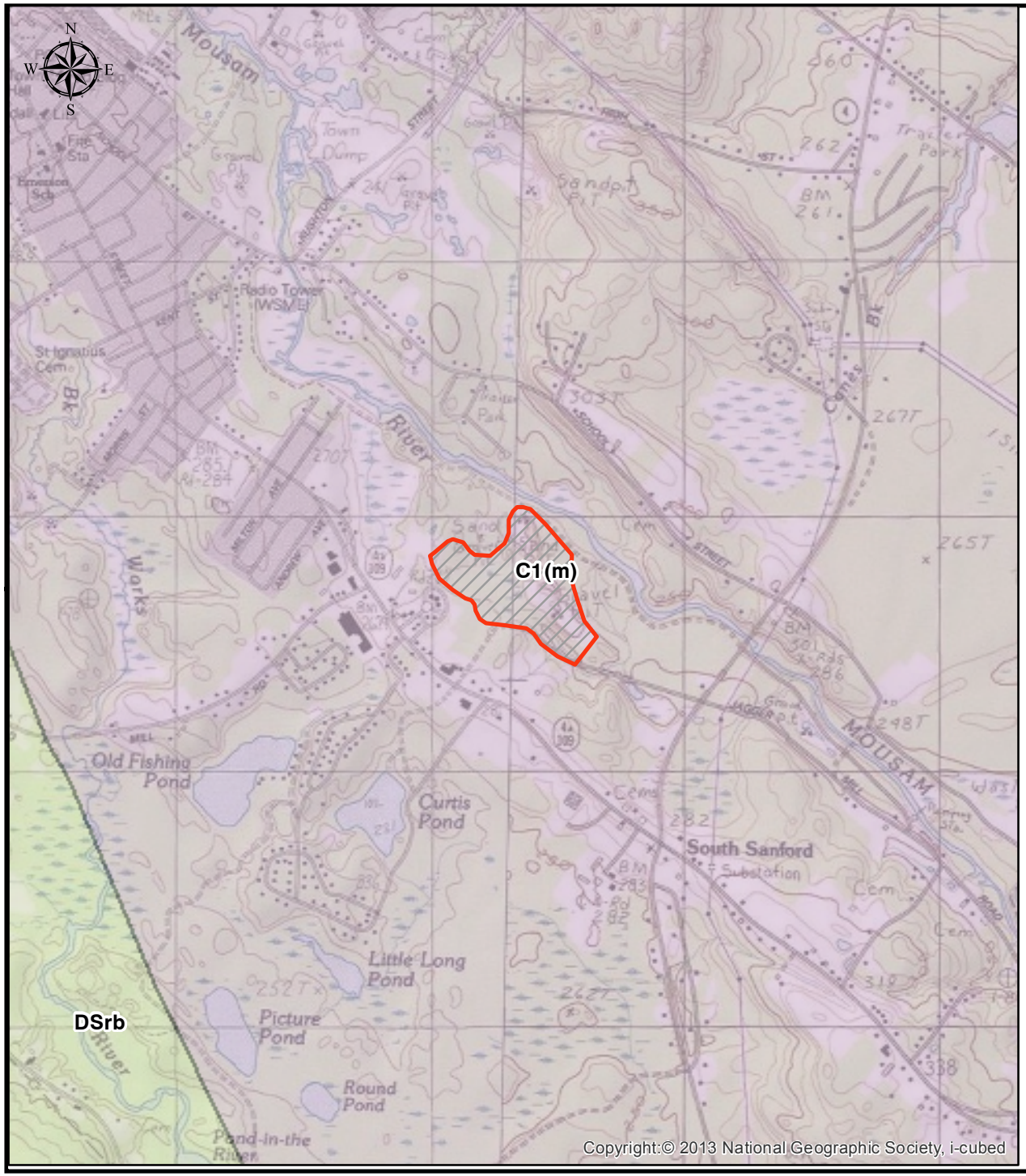
Historical Topographic Map

N	**TARGET QUAD** NAME: SANFORD MAP YEAR: 1983 PROVISIONAL SERIES: 7.5 SCALE: 1:24000	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

Historical Topographic Map

N	TARGET QUAD NAME: ALFRED MAP YEAR: 1983 PROVISIONAL SERIES: 7.5 SCALE: 1:24000	SITE NAME: Proposed Sanford High School ADDRESS: Maine Street Sanford, ME 04073 LAT/LONG: 43.4206 / -70.7493	CLIENT: SW Cole Engineering, Inc. CONTACT: Evan Walker INQUIRY#: 4249035.1 RESEARCH DATE: 03/31/2015

APPENDIX D



S.W.COLE ENGINEERING, INC.

BEDROCK GEOLOGY

DATA REFERENCE

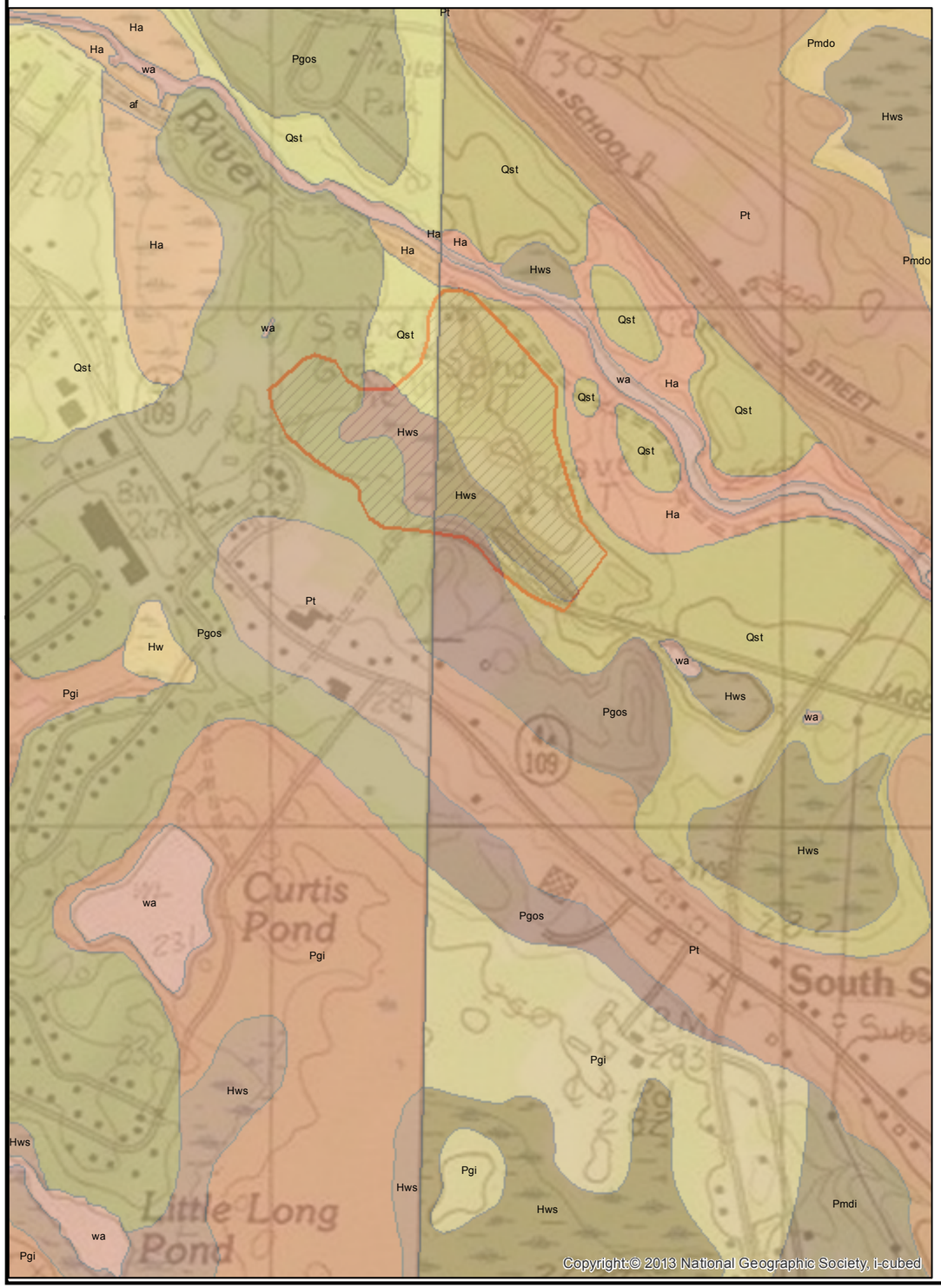
BEDROCK GEOLOGY FROM MAINE DEPARTMENT OF CONSERVATION (MEDOC), MAINE GEOLOGICAL SURVEY (MGS)

Approx_Site

SANFORD, MAINE

1,000 0 1,000 2,000 3,000 4,000

Scale in Feet



SANFORD

- Ha|Stream alluvium - Sand, silt, gravel, and organic material. Deposited on flood plains of modern rivers and streams.
- Hwm|Wetland deposits - marsh
- Hws|Wetland deposits - wooded swamps
- Hw|Wetland deposits - Undifferentiated. Peat, muck, and fine-grained inorganic sediments. Deposited in poorly drained areas.
- Pge|Esker deposits - Sand and gravel deposited by meltwater streams in glacial tunnels. Chevrons indicate inferred direction of glacial stream flow.
- Pgi|Ice-contact deposits - Undifferentiated sand and gravel deposits formed in contact with melting glacial ice.
- Pgos|Sanford outwash plain deposits - Glaciofluvial sand and gravel deposited as an extensive outwash plain in the Mousam and Great Works River valleys.
- Pgo|Glacial outwash - Undifferentiated glaciofluvial sand and gravel deposited in the Little and upper Mousam River valleys.
- Phm|Hummocky moraine - Glacial till with hummocky topography. Usually contains many boulders. Lenses of sand, gravel, and silt are locally abundant.
- Plf|Lacustrine fan deposits - Deltaic sand and gravel deposited into glacial lakes in the Middle Branch Mousam River and Stub Marsh valleys.
- Plmd1|Lacustrine delta deposit - Deltaic sand and gravel deposited into glacial Lake Mousam. Corresponds to Plmd1 of Boothroyd (1997) and Meglioli and Thompson (1997).
- Pmdi|Marine delta - Ice-contact, glaciomarine delta deposited in the Mousam and Great Works River valleys.
- Pt|Till - Loose to very compact, poorly sorted, mostly non-stratified mixture of sand, silt, and gravel deposited by glacial ice. Locally contains lenses of water-laid sediment.
- Qst|Stream terrace deposits - Sand and gravel deposited on erosional terraces at elevations between the original Sanford outwash plain surface and the modern flood plain.
- af|Artificial fill - Man-made unit. May be composed of any material. Commonly seen as highway and railroad embankments, and landfills.
- wa|Water

ALFRED

- Ha|Stream alluvium - Gray to brown fine sand and silt with some gravel. Comprises flood plains along present streams and rivers. Extent of alluvium approximates areas of potential flooding.
- Hws|Wooded swamps - Muck, peat, silt, and sand. Poorly drained areas, often with standing water.
- Hw|Wetland - Muck, peat, silt, and sand. Poorly drained areas, often with standing water. Hws - wooded swamps; Hw - undifferentiated.
- Pemc|End moraine - May occur as a series or complex of moraines (Pemc).
- Pem|End moraine - Coarse gravel and sand, some till and silt. Generally occur within glacial marine sediments (Pp, Pps), and are complexly interstratified with them. Formed at or near the ice front during retreat of marine-based glacier.
- Pge|Esker - Coarse gravel and sand comprising distinct linear ridge forms, mostly in major valleys. Generally surrounded by Pgi deposits, and terminating in ice-contact deltas (Pmdi). May be more than 10 m thick.
- Pgi|Ice-contact deposits (undifferentiated) - Coarse gravel and sand in areas not mapped as deltas or Pge. Primarily kettled glacial stream deposits in the immediate vicinity of eskers (Pge). Average thickness probably between 10 and 15 m.
- Pgos|Sanford outwash plain deposits - Glaciofluvial sand and gravel deposited as an extensive outwash plain in the Mousam and Great Works River Valleys.
- Pgo|Outwash - Sand, gravel, and minor silt deposited by glacial streams in a proglacial (away from ice) setting. Generally confined to major river valley. Sometimes terraced. Average thickness probably between 5 and 10 m.
- Pmdi|Marine delta - Heads of deltas are commonly kettled (Pmdi) and mark ice frontal positions.
- Pmdo|Marine delta - Sediments in distal portions of deltas (Pmdo) commonly grade into glacial marine sediments (Pp, Pmrs).
- Pmd|Marine delta - Coarse sand and gravel grading to sand and silt. Flat to gently sloping constructional surface formed by glacial streams discharging into late-glacial sea.
- Pp|Presumpscot Formation - Massive to laminated gray and blue gray (weathering brown) silt and silty clay. Locally may contain boulders, sand, and gravel. Variable thickness. Deposited during late glacial marine submergence.
- Pt|Till - Gray to gray brown poorly sorted mixture of silt, sand, pebbles, cobbles, and boulders. Forms a blanket deposit over bedrock, and is inferred to underlie younger sediments where not exposed at surface.
- Qst|Stream terrace deposits - Sand and gravel deposited on erosional terraces at elevations between the original Sanford outwash plain surface and the modern flood plain.
- wa|Water
- Approx_Site

N
W E
S

DATA REFERENCE
SURFICIAL GEOLOGY FROM MAINE GEOLOGICAL SURVEY (MGS)

1,000 0 1,000
Scale in Feet

SURFICIAL GEOLOGY