Maine Maritime Academy
Castine, Maine

Pier Upgrades and Waterfront Improvements Project
April 8, 2024
ADDENDUM NO. 11

Prospective bidders and all concerned are hereby advised of the following changes/modifications in the Maine Maritime Academy Waterfront Campus Pier Upgrades and Waterfront Improvements Issued-for-Bidding Drawings and Project Manual dated January 26, 2024 and are hereby requested to change their copies accordingly.

Addendum No. 11 consists of 8 pages of Response to Questions, 18 re-issued IFB Drawing Sheets, 1 re-issued Specifications Section, and 1 reference document for a total of 133 pages. Addendum No 11 addresses some of the bidder questions received. Subsequent addendum will address the outstanding bidder questions and revisions to the IFB Drawing Set and the IFB Project Manual.

Submit written questions during the bid phase via email to Jake Jacobs with cc to Cheryl Coviello.

Jake.Jacobs@collierseng.com

Cheryl.Coviello@gza.com

Make the following changes to the Bidding Documents, Project Manual and Specifications:

REVISION TO ADDENDA

Responses to questions on previous addenda.

1. Addendum 6, Response 11 mentions placing drill spoils inside of the pipe pile. Is it a requirement to fill the straight and battered phase I and phase II pier piles with material up to the bottom of the concrete plug at the top of the pile?

   Response 1: No, it is not a requirement.

2. Addendum 7, IFB Specification Section 01 05 00 Supplemental Conditions: Please confirm that the West Docks described in alternate bid item #4 are referring to the floating Dock Sections "A", "B", "C", and "D" along with associated guide piles, cleats, ladders, (1) 8'x60' gangway accessing float A, (1)4'x60' gangway accessing float B, (1) 4'x60' gangway accessing float D

   Response 2: As shown on IFB Drawings G-101 Overall Work Plan and S-104 Waterfront Structures Layout Plan issued with Addendum No. 7, Bid Alternate No. 4 includes the floating dock systems for floating docks A, B, C and D.

   On IFB Drawing S-171 West Floating Docks – Plan, ADD to the sheet title name "Bid Alternate 4".

WEST FLOATING DOCKS - PLAN BID ALTERNATE 4			
PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME	
PROJ MGR: RKC	REVIEWED BY: CWC	CHECKED BY: DDF	DRAWING S-171 SHEET NO. 100 OF 142
DESIGNED BY: AWS	DRAWN BY: MEA	SCALE: AS NOTED	
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	

3. Addendum 7, IFB 00 41 13 Contractor Bid Form: After reviewing the new bid format with 5 bid alternates containing significant scope, please describe in detail the basis of award for this project. Please explain how contract award will be determined. Will award be determined on the basis of the Base Bid only or Base Bid plus Alternates? If it is Base Bid plus Alternates, please confirm that the basis of award will be Base Bid plus Alternate One, then Base Plus Alternate One plus Alternate Two, etc. until funding is exhausted. It is important to know the order in which Alternates will be considered when determining award.

Response 3: Per IFB Specification Section 00 21 13 Instructions to Bidders, Paragraph 2, the Owner reserves the right to accept or reject any or all bids, and, selection is based on the lowest dollar value of an acceptable Base Bid, or any combination of Base Bid plus Alternate Bids. The Alternate Bids included in the selection will not necessarily be in sequential order. The Alternate Bids that, when combined with the Base Bid, serves the best interest of the Owner will be considered.

RESPONSE TO GENERAL QUESTIONS

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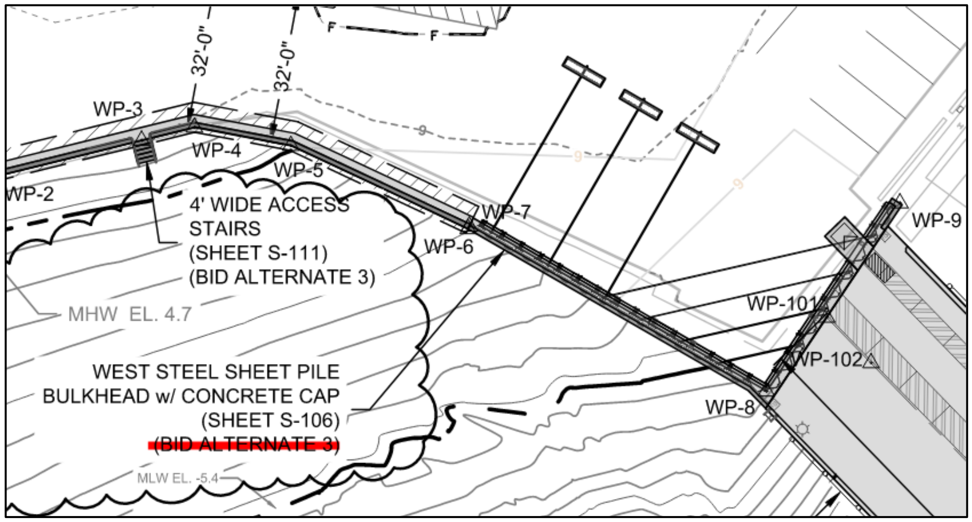
RESPONSE TO IFB DRAWINGS QUESTIONS

4. IFB Drawing S-104: S-104 calls for the Sheet pile bulkhead to be part of Alternate #3. S-105 and S-106 do not indicate this. Please confirm.

Response 4: The West Steel Sheet Pile Bulkhead shall be included in the Base Bid.

On IFB Drawing S-104, DELETE “(Bid Alternate 3)” from the West Steel Sheet Pile Bulkhead callout.



5. IFB S-105: Sheet S-105 says to refer to sheet S-154 for the access stairs but that sheet details the precast mechanical trench. Please advise.

Response 5: Re-issued S-105 revised the sheet reference to S-111.

Add to IFB Drawing S-111 the following notes:

Access Stairs

1. Access Stairs shall be of timber construction with a 36-inch clear width between railings, railings on both sides, open risers and
    a. Minimum tread depth of 9.5 inches
    b. Maximum riser height of 9.5 inches.
2. Access Stairs shall extend one tread below the lowest sand level. Contractor to coordinate with MMA for the lowest sand level. For bidding purposes, assume 9 risers and 9 treads.
3. Contractor to submit for review the proposed access stair framing and details, prior to stair construction. Coordinate connection details and loading to the Modular Block Wall System with the wall manufacturer.

6. IFB Drawing S-115: Reference the horizontal construction joint detailed on the main pier cast-in-place pile caps and edge beams. Please confirm that the lower section of the cap is designed to support the load of the secondary concrete placement.

Response 6: The lower, partial placement of the cast-in-place pile caps and edge beams (generally 2'-4" thick and placed to elev. +10.93) was designed to support the wet concrete of the second and subsequent placements, the deadload reaction of the precast pile caps, and a 100 psf uniform live load surcharge. The lower partial placement was not design for specific equipment or concentrated loads.

7. IFB Drawing S-155 calls out Repairs along the southern bottom face of both the east and west existing breasting platforms. Should it be assumed that entire length and width of the this area is to be repaired? Please consider providing a cubic footage quantity of repair as a basis of bid.

   Response 7: See the attached re-issued IFB Drawing Sheet S-156.

8. IFB S-155: Please clarify that raising of the concrete mooring/breasting platforms are to be covered under bid alternate #2

   Response 8: The raising of the deck of the West Breasting Platform and the East Breasting Platform are covered under the Base Bid. All other work is included under Bid Alternate 2. See the attached re-issued IFB Drawing S-155.

9. IFB Drawing S-167: S-167: Suggested construction sequence recommends that the lower section of the cap is installed prior to rock anchors. It is assumed that the lower cap will support a drill rig. It is also assumed that the lower section of the concrete cap is designed to support the placement of the upper section of cap. Please provide allowable loading on the lower section of cap once concrete has cured to design strength.

   Response 9: See Response 6 above.

10. IFB Drawing S-176: Could you share the wave study for the site?

    Response 10: The metocean analysis completed for the site is attached.

11. IFB Drawing S-176: I counted 11 piles in the design of the attenuator, could this be an even number? Ten?

    Response 11: Base bids on the 11 piles shown. Modifications of the quantity and size of guide piles shall be submitted by the Contractor for review after contract award.

12. IFB Drawing S-176: Do you have any preliminary loading number for the piles?

    Response 12: Pile size and quantity shown are based on the design conditions for a 100-yr recurrence interval flood with 2.3 feet of predicted sea level rise.

    IFB Drawing G-003 Design Criteria and IFB Specification Section 35 51 13.24 Concrete Floating Breakwater provide the design criteria.

    The design criteria provides parameters for Operational Conditions and Survivability Conditions. Operational Conditions represent a 10-year occurrence interval event with no damage to the floating breakwater system. Survivability Conditions represent a 100-year occurrence interval event with some damage to the floating breakwater system that would be repairable without full replacement of the floating breakwater.

The wave heights provided in the design criteria are the H_{max} for the corresponding Operational Conditions and Survivability Conditions. H_{max} is based on the significant wave heights, Hs, from the metocean analysis.

Design Condition	**Estimated H_{max}**	**Metocean Analysis H_S**
Operational (10-yr recurrence event)	6.6 feet	3.9 feet
Survivability (100-yr recurrence event)	8.0 feet	5.1 feet

13. IFB Drawing S-176: The Floating Breakwater Pile Table on sheet S-176 does not appear to take the Rock Socket depth into account when calculating the estimated pile length and may affect the Bid Pile Length. Please clarify.

Response 13: Revise the Floating Breakwater Pile Schedule as shown below.

Floating Breakwater Pile Schedule					
PILE LOCATION	ESTIMATED BEDROCK ELEVATION (ft)	ROCK SOCKET LENGTH (ft)	ROCK ANCHOR LENGTH (ft)	ESTIMATED PILE LENGTH (ft)	BID LENGTH (ft)
1	-77.00	5	0	~~97.00~~ 102	~~105~~ 110
2	-76.00	5	0	~~96.00~~ 101	~~105~~ 110
3	-75.00	5	0	~~95.00~~ 100	~~105~~ 105
4	-73.00	5	0	~~93.00~~ 98	~~100~~ 105
5	-72.00	5	0	~~92.00~~ 97	~~100~~ 105
6	-71.00	5	0	~~91.00~~ 96	~~100~~ 105
7	-69.00	5	0	~~89.00~~ 94	~~100~~ 100
8	-68.00	5	0	~~88.00~~ 93	~~95~~ 100
9	-67.00	5	0	~~87.00~~ 92	~~95~~ 100
10	-65.00	5	0	~~85.00~~ 90	~~95~~ 100
11	-64.00	5	0	~~84.00~~ 89	~~90~~ 95

14. IFB S-177: Travel lift repairs. Please confirm that all timber bracing and walers will be remove in make way for new pile jackets, and will be replaced with new timbers and hardware.

Response 14: See Addendum 10, Response 18 for bracing.
Wales and connection hardware shall be removed and replaced in-kind. Refer to Reference Drawing: Waterfront Improvements Program for Maine Maritime Academy, dated 1990, by T.Y. Lin.

15. IFB Drawing E-201: On drawing E-201 there is a requirement to "relocate existing underground service as required for the installation of the new pad mounted transformers and conduits". Can you please

provide more information regarding the work required to relocate the service? Conduit and cable size, where will it be relocated to, will the conductors need to be replaced? If so, how long is the cable run? How long can the service be without power? Will temporary power be required while this service is without power?

Response 15: See the attached re-issued IFB Drawing E-501. General phasing intent is to have all new equipment downstream of the CMP riser pole installed prior to disconnecting existing service to transformers located in Andrews Hall.

16. IFB Drawing E-201: E-501 shows 5 Circuit breakers that are fed from the 1500kva pad mounted transformer. Note 7 on drawing E-201 requires a stainless steel enclosure to house the 3 grouped circuit breakers associated with the NSMV-480V SPO. Where will the other 2 circuit breakers be located? Drawing E-201 does not indicate their location.

Response 16: All 5 breakers shall be grouped together. The intent of the grouping the 3 circuit breakers for the NSMV-480V SPO in a single enclosure is to facilitate clear understanding of the SPO feed and the individual shunt tripping associated between each breaker and the SPO plug. The 400A and the 1200A breakers shall be exterior rated and mounted adjacent to the stainless-steel enclosure containing the NSMV-480V SPO breakers.

17. IFB Drawing E-201: Please clarify the pad mount transformer pad locations, including the UT-2 transformer?

Response 17: IFB Drawing E-201 shows the general locations. Final locations to be coordinated with CMP and the owner.

18. IFB Drawing E-203: Does the client want dimming for the new lights on the pier?

Response 18: Only Pole fixtures 'A' and 'A1' are scheduled to include automatic dimming..

19. IFB Drawing E-501: Please provide specification for HVS-NSMV Pad mounted switch.

Response 19: See the attached re-issued IFB Specification 26 13 29 updated to callout the basis of design for HVS-NSMV.

20. IFB Drawing E-Series: Is it the intent to have the heat trace circuits on the emergency panel?

Response 20: Yes. Panel A1 is fed from the Generator.

RESPONSE TO IFB PROJECT MANUAL QUESTIONS

21. IFB Specification 00 11 13: Dredge material quantity: the permit indicates 470 cubic yards of dredge material, the notice to contractors indicates 650 cubic yards of dredge material. Please confirm quantity to be carried in bid.

Response 21: Base bids on 650 CY of dredge material.

22. IFB Specification 03 31 30: Specification 03 31 30 Section 2.11 Part D subpart 4 states "Use corrosion-inhibiting admixture in concrete mixtures"

    Is corrosion-inhibiting admixture to be used in all mixes? If not please clarify where it is required.

    Response 22: See Addendum 10, Response 21.

23. IFB Specification 03 31 30: Please provide the required dosage of corrosion-inhibiting admixture required in concrete mixtures.

    Response 23: For concrete mixtures, the Contractor shall submit the chloride ion penetration values from at least one batch of the mixture with and without the admixture making appropriate adjustments to maintain constant water to cementitious materials ratio. The purpose is to establish a correlation with respect to an adjusted value for production chloride ion penetration.

24. IFB Specification 03 31 30: Specification 03 31 30 Section 3.10 Part G Cold-Weather Placement: restricts the placement of concrete above mean high water when the air temperature is below 40 deg F or when the average high and low temperature is expected to fall below 40 deg F for three successive days.

    Looking at average temperatures in Castine, Maine in the last 8 years it appears that the average temperature is below 39 deg F from November to March. Given the restrictions above, there will be very few windows in which concrete can be placed during this 5 month time frame. With the construction schedule already being very compressed and restrictive this requirement places additional burden on being able to complete the project by the prescribed dates. Please consider extending the phase 1 completion date.

    Response 24: Addendum 7 extended the Phase 1 completion date.

25. IFB Specification 03 31 30: Specification 03 31 30 Section 3.10 Part G Cold-Weather Placement: restricts the placement of concrete above mean high water when the air temperature is below 40 deg F or when the average high and low temperature is expected to fall below 40 deg F for three successive days.

    If the contractor is able to maintain a concrete surface temperature of 40 degrees for the durations prescribed in the ACI 306.1-90 specification, when the ambient air temperature is below 40 will they be permitted to place concrete?

    Response 25: The Contractor shall submit for review cold weather concrete procedures. Cold weather concrete work shall be in compliance with ACI 306R-16. ACI 306.1 is a checklist associated with ACI 306R-16.

26. IFB Specification Section 31 23 18: Spec 31 23 18 Rock Removal: is any rock removal anticipated on this project? If so, where and what quantity?

Response 26: **REMOVE** IFB Specification Section 31 23 18 in its entirety. Bedrock removal for the utilities is not anticipated. See the IFB Drawings B-series of sheets for landside boring logs for information on the bedrock depths encountered at these locations.

27. IFB Specification Section 35 59 13.02: Part 3 of Timber Replacement and Timber Fender System Specification states that all piles shall be driven to refusal or to the tip elevation shown on the drawings. It further states, piles shall be installed using a vibratory or impact hammer of sufficient capacity to achieve tip elevations as shown on the drawings. Please provide the required tip elevations for the timber pile.

Response 27: See the attached reissued IFB Drawing S-162.

OTHER REVISIONS TO IFB SPECIFICATIONS

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OTHER REVISIONS TO IFB DRAWINGS

REPLACE the following IFB Drawing Sheets with the attached.

1. G-002 DRAWING SHEET INDEX
2. S-114 PIER PILE PLAN
3. S-124 PIER SECTIONS – 3, SECTION E – TYPE 4B CAP
4. S-125 PIER SECTIONS – 6, SECTION F – PILE CAP TYPE 5
5. S-126 PIER SECTIONS – 7, SECTION G – PILE CAPS 4A/4B @ TRENCH
6. S-129 PIER SECTIONS – 7, SECTION G – PILE CAPS 4A/4B @ TRENCH
7. S-132 PIER PILE DETAILS
8. S-133 PIER PILE AND ROCK ANCHOR DETAILS
9. S-140 CAST-IN-PLACE PIER PILE CAP DETAILS - TYPE 4A/4B
10. S-141 CAST-IN-PLACE PIER PILE CAP DETAILS – TYPE 5A
11. S-142 CAST-IN-PLACE PIER PILE CAP DETAILS – TYPE 5B
12. S-148 EDGE BEAM SECTIONS AND DETAILS - 2
13. S-151 PIER PILE CAP AND BEAM DETAILS – 3
14. S-153 PRE-CAST DECK PLANK DETAILS
15. S-155 MOORING AND BREASTING PLATFORMS REPAIRS AND MODIFICATIONS
16. S-156 MOORING AND BREASTING PLATFORMS REPAIRS AND MODIFICATIONS - 2
17. S-162 TIMBER FENDER SYSTEM SECTIONS AND DETAILS
18. E-501 ELECTRICAL ONE-LINE DIAGRAM

SECTION 261329

MEDIUM-VOLTAGE COMPARTMENTALIZED SWITCHGEAR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes dead-front switchgear.

1.02 DEFINITIONS

A. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

B. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted switchgear and to provide a fully insulated connection. Also called an "elbow connector."

C. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or non-load break, separable insulated connector (bushing).

D. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

E. Hotstick: An insulated stick, usually made of fiberglass, that is used to work energized overhead conductors and operate electrical equipment that is overhead, underground, and compartmentalized.

F. NETA ATS: InterNational Electrical Testing Association, Acceptance Testing Specification.

G. Way: A three-phase or single-phase circuit connection to the bus that may contain combinations of switches and protective devices or may be a solid bus.

1.03 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For pad-mounted switchgear.

1. Include a tabulation of installed devices with features and ratings.

2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations must show major components and features, and they will mimic bus diagram.

3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts and leveling channels.
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
5. Include list of materials.
6. Locate accessory and spare equipment storage.
7. Include single-line diagram.
8. Include control power wiring diagrams.
9. Include copy of nameplate.
10. Switchgear Ratings:
    a. Voltage.
    b. Continuous current.
    c. Short-circuit rating.
    d. BIL.
11. Relay settings.
12. Interface data with monitoring or control network.
13. Wiring Diagrams: For each switchgear assembly, include the following:
    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits, showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.
    e. Schematic diagrams showing connections to remote devices

C. Product Certificates: For pad-mounted switchgear.
1. Switch ratings as listed in IEEE C37.74.
2. Interrupter ratings as listed in IEEE C37.60.
3. Coating system compliance with the IEEE standard listed in "Switchgear Enclosure" Article.
4. Source quality-control reports.

D. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Equipment Qualifications For Products Other Than Those Specified:
1. At the time of submission provide written notice to the Owner of the intent to propose an “or equal” for products other than those specified. Make the “or equal”

submission in a timely manner to allow the Owner sufficient time to review the proposed product, perform inspections and witness test demonstrations.

2. If products other than those specified are proposed for use furnish the name, address, and telephone numbers of at least 5 comparable installations that can prove the proposed products have performed satisfactorily for 3 years. Certify in writing that the Owner's Representatives of the 5 comparable installations will allow inspection of their installation by the Owner's Representative and the Company Field Advisor.

   a. Make arrangements with the Owner's Representatives of 2 installations (selected by the Owner) for inspection of the installations by the Owner's Representative. Also obtain the services of the Company Field Advisor for the proposed products to be present. Notify the Owner a minimum of 3 weeks prior to the availability of the installations for the inspection, and provide at least one alternative date for each inspection.

   b. Only references from the actual Owner's Representative will be accepted. References from dealers, system installers or others, who are not the actual Owner's Representatives of the proposed products, are not acceptable.

      1) Verify the accuracy of all references submitted prior to submission and certify in writing that the accuracy of the information has been confirmed.

3. The product manufacturer shall have test facilities available that can demonstrate that the proposed products meet the contract requirements.

   a. Make arrangements with the test facility for the Owner's Representative to witness test demonstrations. Also obtain the services of the Company Field Advisor for the proposed product to be present at the test facility. Notify the Owner a minimum of 3 weeks prior to the availability of the test facility, and provide at least one alternative date for the testing.

4. Provide written certification from the manufacturer that the proposed products are compatible for use with all other equipment proposed for use for this system and meet all contract requirements.

B. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

C. Testing Agency Qualifications: Accredited by NETA.

   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer:

   1. CMP Connected Gear: Federal Pacific PMDF Switchgear.

   2. HVS-NSMV: G&W PVI21 Switchgear

B. Other Acceptable manufacturers, but not limited to:

1. S&C
2. G&W
3. Eaton
4. Square D

2.02 SYSTEM DESCRIPTION

A. Manufactured Unit: Pad-mounted metering switchgear, designed for application in solidly grounded neutral underground distribution systems.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory, and marked for intended location and application.

C. Comply with IEEE C2.

D. Comply with IEEE C37.74.

2.03 RATINGS

A. CMP Switchgear is applied to a nominal 15 kV (L-L) medium-voltage electrical power system. Minimum ratings of the switchgear must be as follows:

1. Rated Maximum Voltage and Rated BIL: 17.5 kV and 95 kV BIL
2. Continuous and Load Interrupting Current: 600 A.

B. NSMV Switchgear is applied to a nominal 6.6 kV (L-L) medium-voltage electrical power system. Minimum ratings of the switchgear must be as follows:

1. Rated Maximum Voltage and Rated BIL: 17.5 kV and 95 kV BIL
2. Continuous and Load Interrupting Current: 600 A.

2.04 SWITCHGEAR ENCLOSURE

A. Weatherproof enclosure with an integral skid mounting frame, designed for mounting on a concrete pad, suitable to allow skidding or rolling of the switchgear in any direction, and with provision for anchoring the frame to the pad.

B. Enclosure Integrity: Comply with IEEE C57.12.28 for compartmentalized enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

1. Each vertical section must have the following features:

a. Structural design and anchorage adequate to resist loads imposed by 125 mph wind.

b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of each section above expected dew point.

c. Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.

d. Weatherproof ground-fault circuit interrupter duplex receptacles.

e. Power for heaters and receptacles must be provided by control power transformer.

f. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.

C. Corrosion Protection:

1. Enclosure coating system must be factory applied, meeting the requirements of IEEE C57.12.29, in manufacturer's standard color green.

2. Fabricate the support frame, enclosure base, and the enclosure from stainless steel, ASTM A167, Type 304 or 304L. Enclosure coating system must be factory applied, meeting the requirements of IEEE C57.12.29, standard color green.

2.05 SWITCHGEAR CONSTRUCTION

A. Dead-front, front and rear access switchgear.

B. Construct switchgear assembly with switched ways that have front-accessible terminations for cables entering from below and with manual operating provisions with a lineman's hotstick.

C. Viewing Windows: For each switch, located adjacent to manual operating devices, and positioned to show switch contact position.

D. Grounding: Provision to make grounding cable and wire connections at each way.

2.06 BUSHINGS

A. Separable insulated connectors must be used to connect primary cable. Comply with requirements in Section 260513 "Medium-Voltage Cables."

1. Bushings: One-piece, 600 A, BIL ratings the same as the connectors. Comply with IEEE 386.

2. Supply a standoff bracket or parking stand for each bushing, mounted horizontally adjacent to each bushing.

2.07 SURGE ARRESTERS

A. Distribution class; metal-oxide-varistor type, fully shielded, separable elbow type, suitable for plugging into the inserts. Comply with IEEE C62.11 and IEEE 386.

B. Nominal System Line-to-Line Voltage: 15 kV RMS.

C. Maximum Continuous Operating Voltage: 17.5 kV RMS.

D. HVS-NSMV Voltage: Appropriately selected for the 6.6 kV line voltage

2.08 METERING

A. Metering Transformer Compartment:

1. Insulated barrier system provided to restrict immediate direct exposure to interior of the instrument-transformer compartment.

2. Provisions for Instrument Transformers in compliance with CMP standards.

a. CMP CTs and PTs must be coordinated with construction of the compartment.

B. Meter Socket:

1. Socket requirements in accordance with CMP determinations and standards

2. Accessories:

a. Test Switch

b. Wiring

2.09 WARNING LABELS AND SIGNS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labels and signs.

1. High-Voltage Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s). Legend must be "DANGER HIGH VOLTAGE" printed in two lines of minimum 2 inch high letters. The word "DANGER" must be in white letters on a red background and the words "HIGH VOLTAGE" must be in black letters on a white background.

2. Arc-Flash Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s), warning of potential electrical arc-flash hazards and appropriate personal protective equipment required.

2.10 SOURCE QUALITY CONTROL

A. Factory Tests: Comply with requirements in IEEE C37.60 and IEEE C37.74 for testing procedures.

1. Circuit Resistance Test: Verify that switchgear contacts have been properly aligned and current transfer points have been properly assembled.

2. Power-frequency dry withstand voltage test.

3. Dielectric withstand test; one-minute dry power-frequency.

4. Calibrate overcurrent devices for conformance to published time-current characteristic curves.

5. Sealed Tank Leak Test:

a. Comply with IEC 62271-1 for test procedure for switchgear using SF6.

b. The test procedure for vacuum switchgear must be as follows:

1) Each vacuum tube must be identified by its serial number. Its vacuum pressure level must be tested by the manufacturer of the vacuum interrupter. Document the test results.

2) After assembly of the switchgear way, test the vacuum pressure level of the vacuum tubes by the routine dielectric test across the open contacts. The test voltage must be stated by the manufacturer. The dielectric test must be carried out after the mechanical routine test.

6. Operating tests must verify the following:
    a. Switch position indicators and contacts are in the correct position for both the open and closed positions.
    b. Insulating medium quantity indicator (if provided) is functioning properly.
    c. Circuit configuration is shown correctly.
    d. Mechanical interlocks are in place and operative.
    e. Position and polarity of current transformers meets requirements.
    f. Control, secondary wiring, and accessory devices are connected correctly.
    g. Devices and relays actually operate as intended. Circuits for which operation is not feasible must be checked for continuity.

PART 3 EXECUTION

3.01 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.
    1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
    2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
    3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
    4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and Shop Drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
    5. Unload switchgear, observing packing label warnings and handling instructions.
    6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:
    1. Handle switchgear, in accordance with manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
    2. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
    3. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.

4. Do not damage structure when handling switchgear.

C. Storage:

1. Switchgear may be stored outdoors. If possible, store switchgear at final installation locations on concrete pads. If dry concrete surfaces are not available, use pallets of adequate strength to protect switchgear from direct contact with the ground. Ensure switchgear is level.

2. Protect switchgear from physical damage. Do not store switchgear in the presence of corrosive or explosive gases.

3. Store switchgear with compartment doors closed.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.

F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 ohms at switchgear location.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SWITCHGEAR INSTALLATION

A. Equipment Mounting:

1. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Install level and plumb, tilting less than 1.5 degrees when energized.

C. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and NFPA 70.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and IEEE C2.

3.03 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inch below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.

2. Make joints in grounding conductors and loops by exothermic weld or compression connector.

3. Terminate grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure.

4. Complete the switchgear grounding and surge protector connections prior to making other electrical connections.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.

2. Bundle associated phase, neutral, and equipment grounding conductors together within the switchgear enclosure. Arrange conductors such that there is not excessive strain on the connections that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of switchgear in accordance with Section 260513 "Medium-Voltage Cables."

3.04 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.05 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Campus.

B. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" chapter.

2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.

3. After installing switchgear but before primary is energized, verify that grounding system at the switchgear is tested at the specified value or less.

4. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.

C. Medium-Voltage Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that current and voltage transformer ratios correspond to Drawings.

b. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

2) Make key exchange with devices operated in off-normal positions.

d. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse or circuit breaker ratings match Drawings.

2. Electrical Tests:

3. Inspect bolted electrical connections using a low-resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

4. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

a. Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.

b. Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

c. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

d. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

1) Minimum insulation-resistance values of control wiring must not be less than 2 megohms.

e. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.

2) Verify secondary voltages by energizing the primary winding with system voltage.

f. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

g. Perform system function tests in accordance with "System Function Tests" Article.

h. Verify operation of space heaters.

i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Ground Resistance Test:

1. Visual and Mechanical Inspection:

a. Verify ground system complies with the Contract Documents and NFPA 70 "Grounding and Bonding" Article.

b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.

c. Inspect bolted electrical connections using a calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

d. Inspect anchorage.

2. Electrical Tests:

a. Perform fall-of-potential or alternative test in accordance with IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground must be no more than 5 ohms.

b. Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with Contract Documents.

c. Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

d. Inspect physical and mechanical condition.

e. Inspect anchorage.

E. Nonconforming Work:

1. Switchgear will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

F. Prepare test and inspection reports.

3.06 SYSTEM FUNCTION TESTS

A. System function tests must prove the correct interaction of sensing, processing, and action devices. Perform system function tests after "Field Quality Control" tests have been completed and components have passed specified tests.

1. Develop test parameters and perform tests for evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.

2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.

3. Verify the correct operation of sensing devices, alarms, and indicating devices.

3.07 FOLLOW-UP SERVICE

A. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove necessary covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.

2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 86 deg F.

3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the results as follows:

a. Description of equipment to be tested.

b. Discrepancies.

c. Temperature difference between the area of concern and the reference area.

d. Probable cause of temperature difference.

e. Areas inspected. Identify inaccessible and unobservable areas and equipment.

f. Identify load conditions at time of inspection.

g. Provide photographs and thermograms of the deficient area.

4. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 261329

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3	G-003	DESIGN CRITERIA	
4	G-004	NOTES - 1	REV.5 ADD #7 3/29/2024
5	G-005	NOTES - 2	
6	G-100	EXISTING CONDITIONS PLAN	
7	G-101	OVERALL WORK PLAN	REV.5 ADD #7 3/29/2024
8	G-102	PHASING PLAN	
	GEOTECHNICAL		
9	B-101	SUBSURFACE EXPLORATION PLAN	
10	B-102	SUBSURFACE PROFILE A-A'	
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20	B-205	BORING LOGS - 5	
21	B-206	BORING LOGS - 6	
	CIVIL		
22	C-001	SITE NOTES, SYMBOLS AND ABBREVIATIONS	REV.1 ADD #4 3/8/2024
23	C-101	DREDGE PLAN	REV.1 ADD #7 3/29/2024
24	C-201	GRADING & UTILITY PLAN A	
25	C-202	GRADING & UTILITY PLAN B	REV.2 ADD #6 3/22/2024
26	C-301	EROSION AND SEDIMENTATION CONTROL PLAN	
27	C-302	DREDGE SECTIONS	REV.5 ADD #7 3/29/2024
28	C-701	SITE CONSTRUCTION DETAILS	
29	C-702	SITE CONSTRUCTION DETAILS	REV.1 ADD #3 3/1/2024

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31	S-102	WATERFRONT STRUCTURES DEMOLITION AND REMOVAL PLAN	REV.1 ADD #3 3/1/2024
32	S-103	EXISTING PIER SECTIONS	
33	S-104	WATERFRONT STRUCTURES LAYOUT PLAN	REV.2 ADD #7 3/29/2024
34	S-105	WEST BULKHEAD AND RETAINING WALL PLAN - 1	REV.2 ADD #7 3/29/2024
35	S-106	WEST BULKHEAD AND RETAINING WALL PLAN - 2	REV.2 ADD #7 3/29/2024
36	S-107	WEST BULKHEAD AND RETAINING WALL SECTIONS - 1	REV.2 ADD #7 3/29/2024
37	S-108	WEST BULKHEAD AND RETAINING WALL SECTIONS - 2	REV.1 ADD #3 3/1/2024
38	S-109	WEST BULKHEAD AND RETAINING WALL DETAILS - 1	REV.2 ADD #7 3/29/2024
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40	S-111	WEST BULKHEAD AND RETAINING WALL DETAILS - 3	REV.1 ADD #7 3/29/2024
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42	S-113	PIER LAYOUT PLAN	REV.3 ADD #7 3/29/2024
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44	S-115	PIER FRAMING PLAN	REV.1 ADD #3 3/1/2024
45	S-116	PIER PRE-CAST PLANK PLAN	REV.3 ADD #7 3/29/2024
46	S-117	PIER DECK GRADING PLAN	REV.1 ADD #3 3/1/2024
47	S-118	SOUTH EDGE BEAM ELEVATION AND SECTIONS	REV.1 ADD #6 3/22/2024
48	S-119	NORTH EDGE BEAM ELEVATION AND SECTIONS	
49	S-120	PIER SECTIONS - 1 SECTION A - TYPE 1 CAP	REV.2 ADD #7 3/29/2024
50	S-121	PIER SECTIONS - 2 SECTION B - TYPE 2 CAP	REV.3 ADD #7 3/29/2024
51	S-122	PIER SECTIONS - 3 SECTION C - TYPE 5 CAP	REV.2 ADD #4 3/8/2024
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53	S-124	PIER SECTIONS - 5 SECTION E - TYPE 4B CAP	REV.3 ADD #11 4/8/2024
54	S-125	PIER SECTIONS - 6 SECTION F - TYPE 5 CAP	REV.1 ADD #11 4/8/2024
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56	S-127	PIER SECTIONS - 8 SECTION H - TYPE 5A CAP	REV.2 ADD #7 3/29/2024
57	S-128	PIER SECTIONS - 9 SECTION I - TYPE 5B CAP	REV.2 ADD #7 3/29/2024
58	S-129	PIER SECTIONS - 10 SECTION G - PILE CAPS 5A/5B @ TRENCH	REV.2 ADD #11 4/8/2024
59	S-130 *	PIER SECTIONS - 11 SECTION K - PIER STEM TO T-HEAD	
60	S-131 *	PIER SECTIONS - 12 SECTION X (SPARE SHEET)	
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62	S-133	PIER PILE AND ROCK ANCHOR DETAILS	REV.2 ADD #11 4/8/2024
63	S-134	PIER PILE TABLE	REV.1 ADD #7 3/29/2024
64	S-135	PRECAST PILE CAP DETAILS - TYPE 1	REV.1 ADD #6 3/22/2024
65	S-136	PRECAST PILE CAP DETAILS - TYPE 1A	REV.1 ADD #6 3/22/2024
66	S-137	PRECAST PILE CAP DETAILS - TYPE 2	REV.1 ADD #6 3/22/2024
67	S-138	PRECAST PILE CAP DETAILS - TYPE 3	REV.1 ADD #6 3/22/2024
68	S-139	PRECAST PILE CAP DETAILS - TYPE 5	REV.1 ADD #6 3/22/2024
69	S-140 *	C.I.P. PILE CAP DETAILS - TYPE 4A/4B	REV.3 ADD #11 4/8/2024
70	S-141	C.I.P. PILE CAP DETAILS - TYPE 5A	REV.2 ADD #11 4/8/2024
71	S-142	C.I.P. PILE CAP DETAILS - TYPE 5B	REV.2 ADD #11 4/8/2024
72	S-143 *	C.I.P. PILE CAP DETAILS - TYPE 2A/2D	REV.1 ADD #5 3/15/2024
73	S-144 *	C.I.P. PILE CAP DETAILS - TYPE 2B/2C	
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75	S-146 *	NORTH EDGE BEAM DETAILS	REV.1 ADD #7 3/29/2024
76	S-147 *	EDGE BEAM DETAILS - 1	REV.1 ADD #7 3/29/2024
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84	S-155	MOORING & BREASTING PLATFORMS REPAIRS AND MODIFICATIONS - 1	REV.2 ADD #11 4/8/2024
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90	S-161	FENDER SYSTEM SECTIONS AND DETAILS	REV.1 ADD #7 3/29/2024
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109	M-200	MECHANICAL SITE PLAN - NEW WORK	REV.1 ADD #3 3/1/2024
110	M-201	BOILER PLANT - NEW WORK	
111	M-202	STEAM VAULT - NEW WORK	
112	M-203	STEAM VAULT - NEW WORK - STRUCTURAL	
113	M-204	MECHANICAL TRENCH PLAN - NEW WORK	
114	M-205	MECHANICAL PIER PART PLAN - NEW WORK	
115	M-301	MECHANICAL TRENCH PROFILES - NEW WORK	REV.1 ADD #3 3/1/2024
116	M-302	MECHANICAL SECTIONS - NEW WORK	REV.1 ADD #3 3/1/2024
117	M-401	STEAM P&ID - DEMOLITION	
118	M-501	STEAM P&ID - NEW WORK	REV.1 ADD #3 3/1/2024
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120	M-702	MECHANICAL DETAILS	
121	M-703	MECHANICAL DETAILS	
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124	E-001	ELECTRICAL NOTES, SYMBOLS AND ABBREVIATIONS	
125	E-101	ELECTRICAL DEMO - SITE AND PIER PLAN	
126	E-102	ELECTRICAL - ANDREWS HALL - DEMO	
127	E-201	ELECTRICAL SITE PART PLAN A	REV.1 ADD #3 3/1/2024
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134	E-501	ELECTRICAL ONE-LINE DIAGRAMS	REV.1 ADD #3 3/1/2024
135	E-701	ELECTRICAL DETAILS	
136	E-702	ELECTRICAL DETAILS	REV.1 ADD #3 3/1/2024
137	E-703	ELECTRICAL DETAILS	
138	E-801	ELECTRICAL SCHEDULES	REV.1 ADD #3 3/1/2024
	ARCHITECTURAL		
139	A-001	SHIP UTILITY STRUCTURAL & ARCHITECTURAL NOTES, SPECIFICATIONS, SYMBOLS AND ABBREVIATIONS	
140	A-101	SHIP UTILITY FLOOR PLAN	
141	A-201	SHIP UTILITY EXTERIOR ELEVATIONS	
142	A-501	SHIP UTILITY SECTIONS & DETAILS	

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
6	ADDENDUM #11	DDF	4/8/2024
5	ADDENDUM #7	DDF	3/29/2024
4	ADDENDUM #6	DDF	3/22/2024
3	ADDENDUM #5	DDF	3/15/2024
2	ADDENDUM #4	DDF	3/8/2024
1	ADDENDUM #3	DDF	3/1/2024

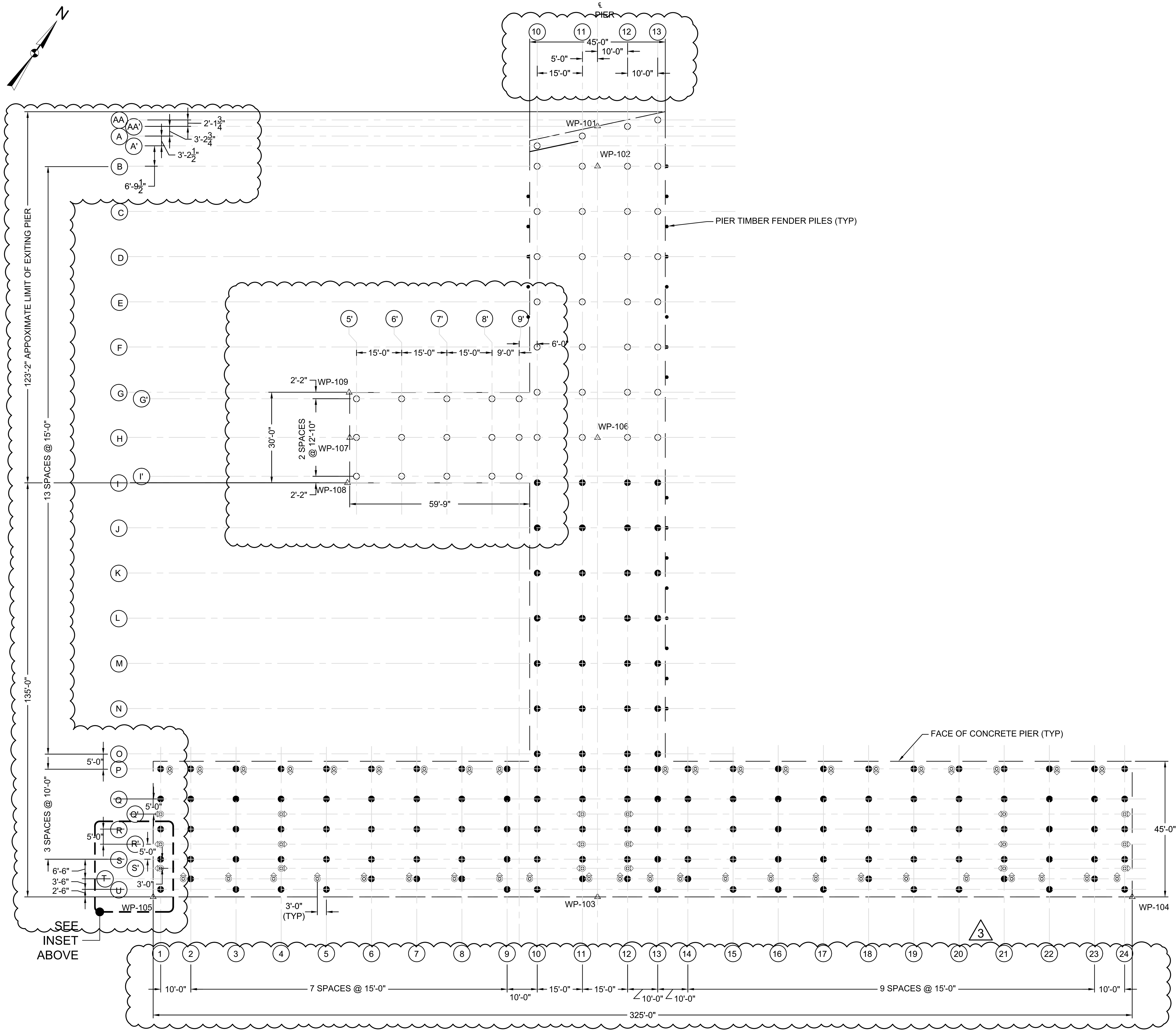
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

DRAWING SHEET INDEX

PREPARED BY:
GZA GeoEnvironmental, Inc.
www.gza.com

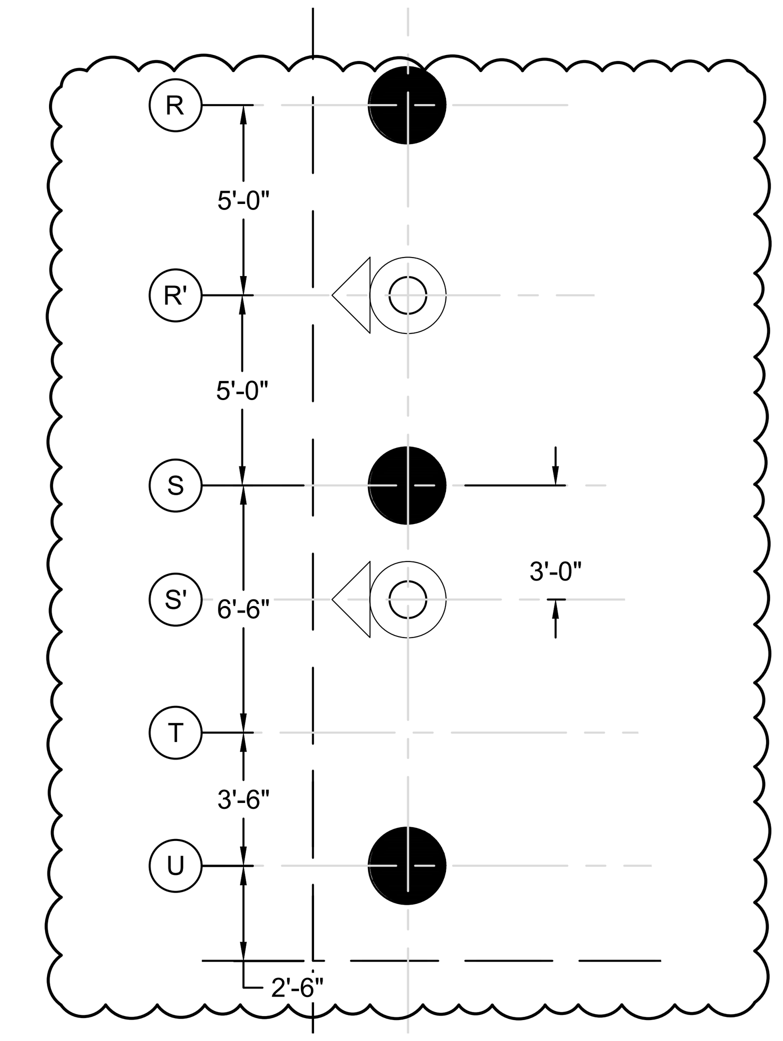
PREPARED FOR:
MAINE MARITIME ACADEMY
CASTINE, ME

PROJ MGR: RKC	REVIEWED BY: CWC	CHECKED BY: DDF	DRAWING
DESIGNED BY:	DRAWN BY: MEA	SCALE:	G-002
DATE: OCTOBER 2024	PROJECT NO. 35109.00	REVISION NO.	SHEET NO. 2 OF 142



PIER PILE PLAN

1/16" = 1'-0"



INSET

LEGEND

- (1) PILE BENT NUMBER
- (A) PILE ROW DESIGNATION
- TIMBER FENDER PILE
- PIER SUPPORT PLUMB PILE WITH 0 FT ROCK ANCHOR, 0 FT ROCK SOCKET
- PIER SUPPORT PLUMB PILE WITH 5 FT ROCK SOCKET
- PIER SUPPORT BATTER PILE WITH 20 FT ROCK ANCHOR, 5 FT ROCK SOCKET
- WP-101 WORKING/LAYOUT POINT (SEE DRAWING S-104)

PIER PLAN NOTES:

1. PIER SUPPORT PILES SHALL BE 24" DIA. x 0.625" THICK STEEL PIPE PILES. SEE PROJECT SPECIFICATIONS.
2. SEE SHEET S-133 FOR ROCK ANCHOR AND ROCK SOCKET INFORMATION.
3. SEE DRAWING S-134, PIER PILE TABLE FOR ADDITIONAL INFORMATION.
4. SEE WATERFRONT STRUCTURES LAYOUT PLAN (S-104) FOR WORKING POINT (WP) COORDINATES.

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
3	ADDENDUM #11	DDF	4/08/2024
2	ADDENDUM #7	DDF	3/29/2024
1	ADDENDUM #3	DDF	3/1/2024

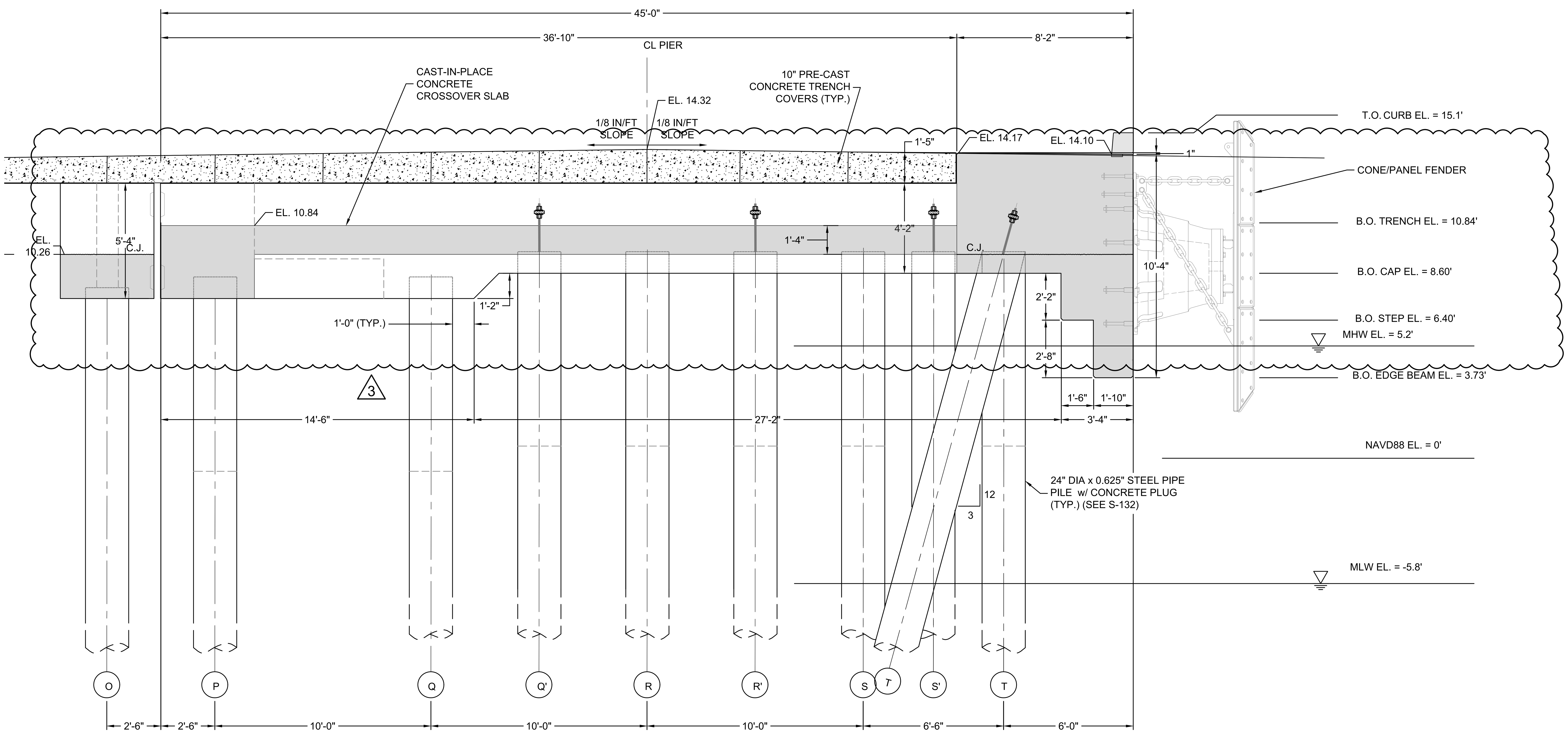
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PIER PILE PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY: CWC	CHECKED BY: DDF	DRAWING
DESIGNED BY: MAR/AFS	DRAWN BY: BDW/MEA	SCALE:	S-114
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 43 OF 142



E
S-113 S-124

SECTION: TYPE 4B PILE CAP (C.I.P.)

3/8" = 1'-0"

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
3	ADDENDUM #11	DDF	4/8/2024
2	ADDENDUM #7	DDF	3/29/2024
1	ADDENDUM #5	DDF	3/15/2024

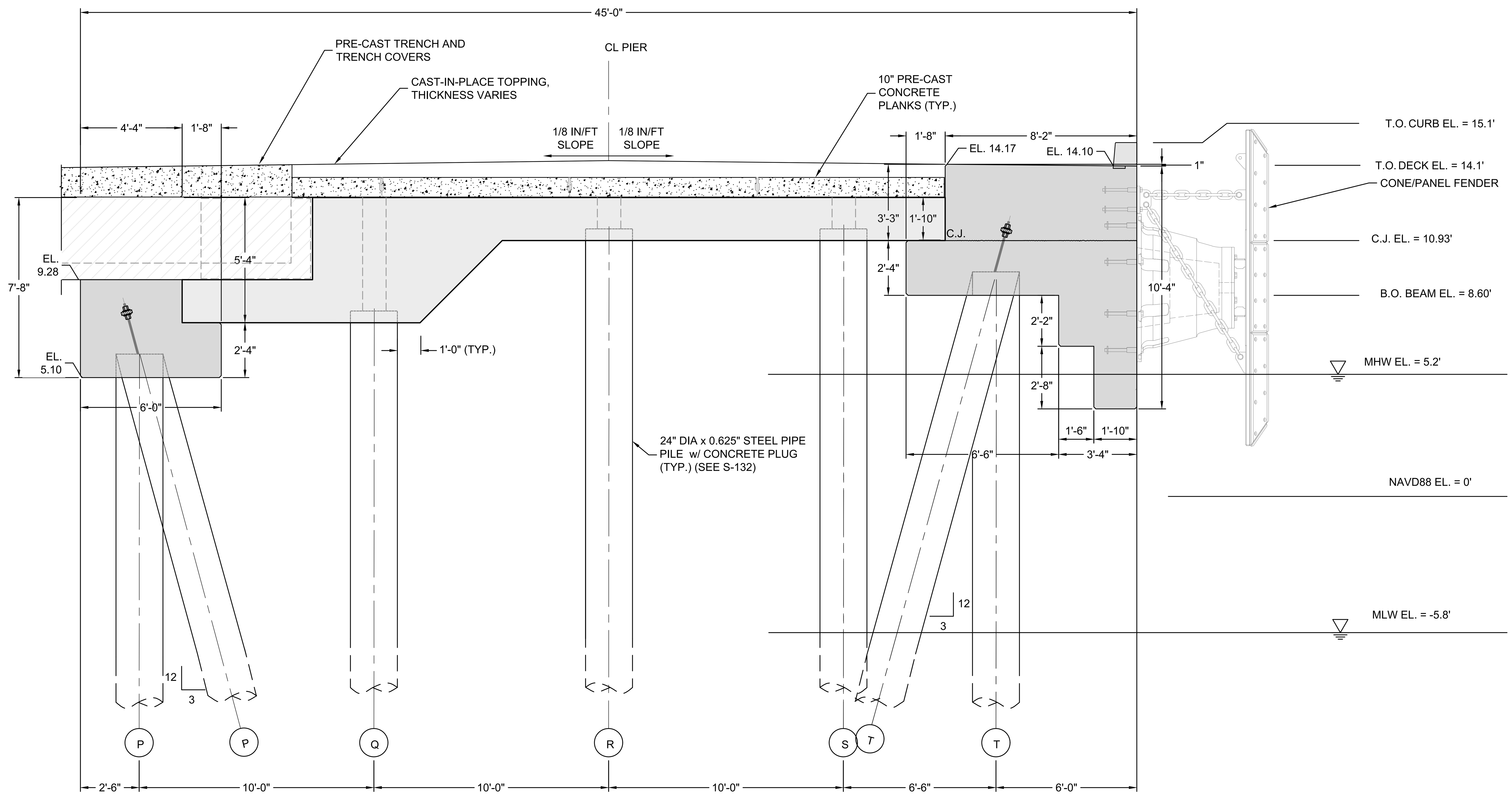
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PIER SECTIONS - 3
SECTION E - TYPE 4B CAP

PREPARED BY:
GZA GeoEnvironmental, Inc.
www.gza.com

PREPARED FOR:
MAINE MARITIME ACADEMY
CASTINE, ME

PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-124
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 53 OF 142



F SECTION: TYPE 5 PILE CAP (PRE-CAST) BETWEEN BENTS 12 & 13

S-113 | S-125

3/8" = 1'-0"

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
0	ADDENDUM #11	DDF	4/8/2024

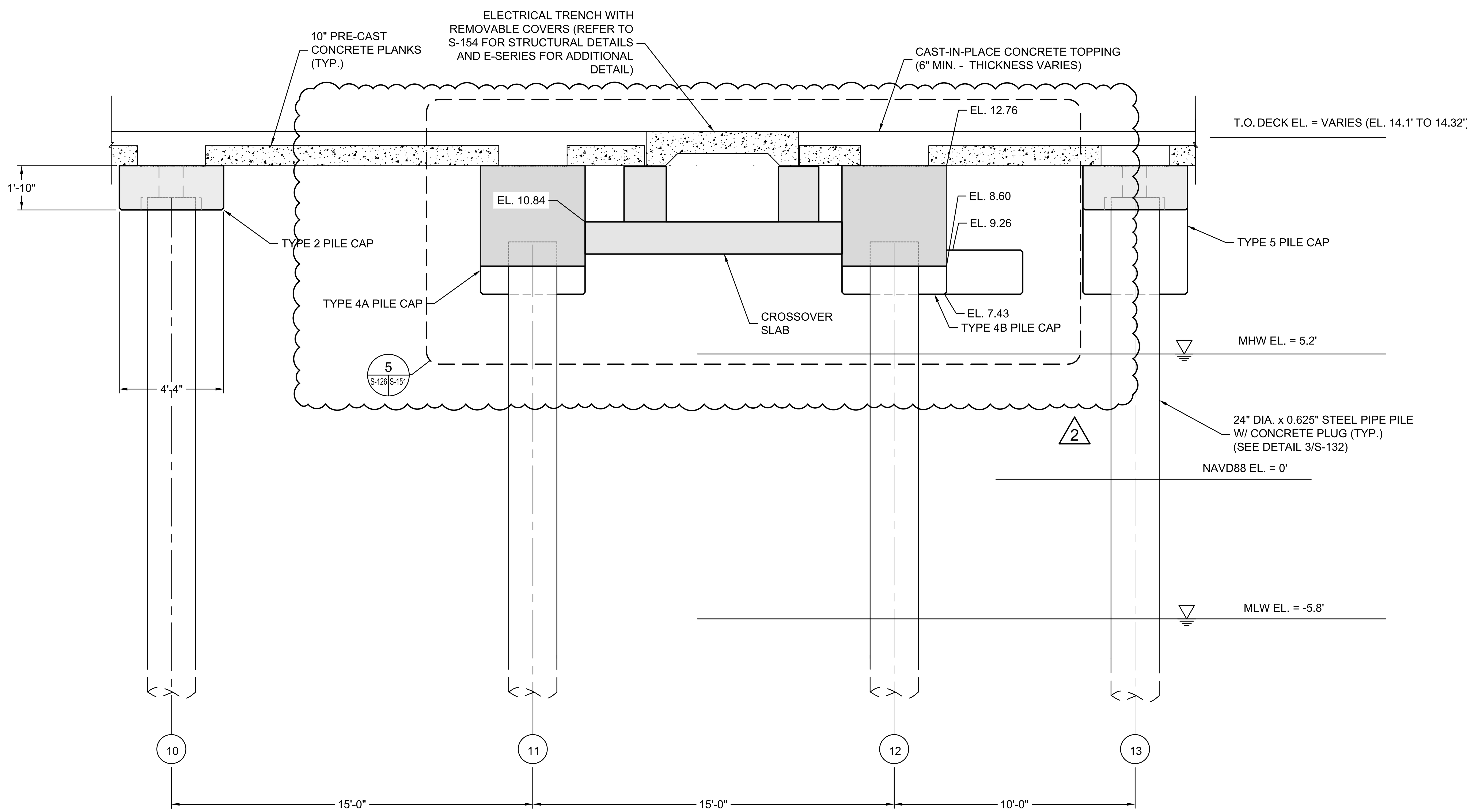
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PIER SECTIONS - 6
SECTION F - PILE CAP TYPE 5

PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-125
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 54 OF 142



G
S-113
S-126

SECTION: PILE CAP 4A & 4B @ TRENCH (C.I.P.)

3/8" = 1'-0"

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/8/2024
1	ADDENDUM #4	DDF	3/8/2024

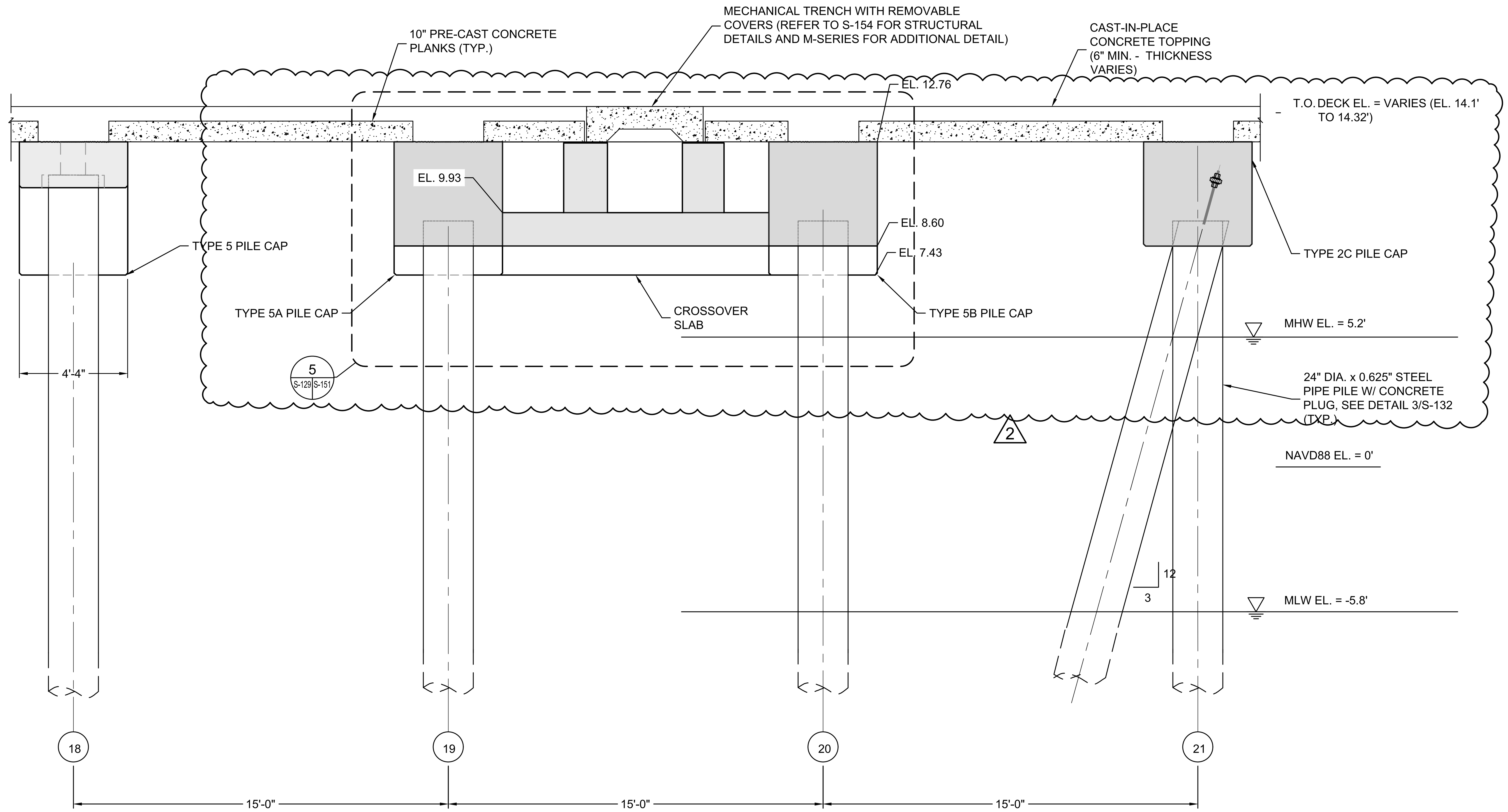
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PIER SECTIONS - 7
SECTION G - PILE CAPS 4A/4B @ TRENCH

PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-126
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 55 OF 142



J
S-113
S-129

SECTION: PILE CAP 5A & 5B @ TRENCH (C.I.P.)

3/8" = 1'-0"

S-127
S-128

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

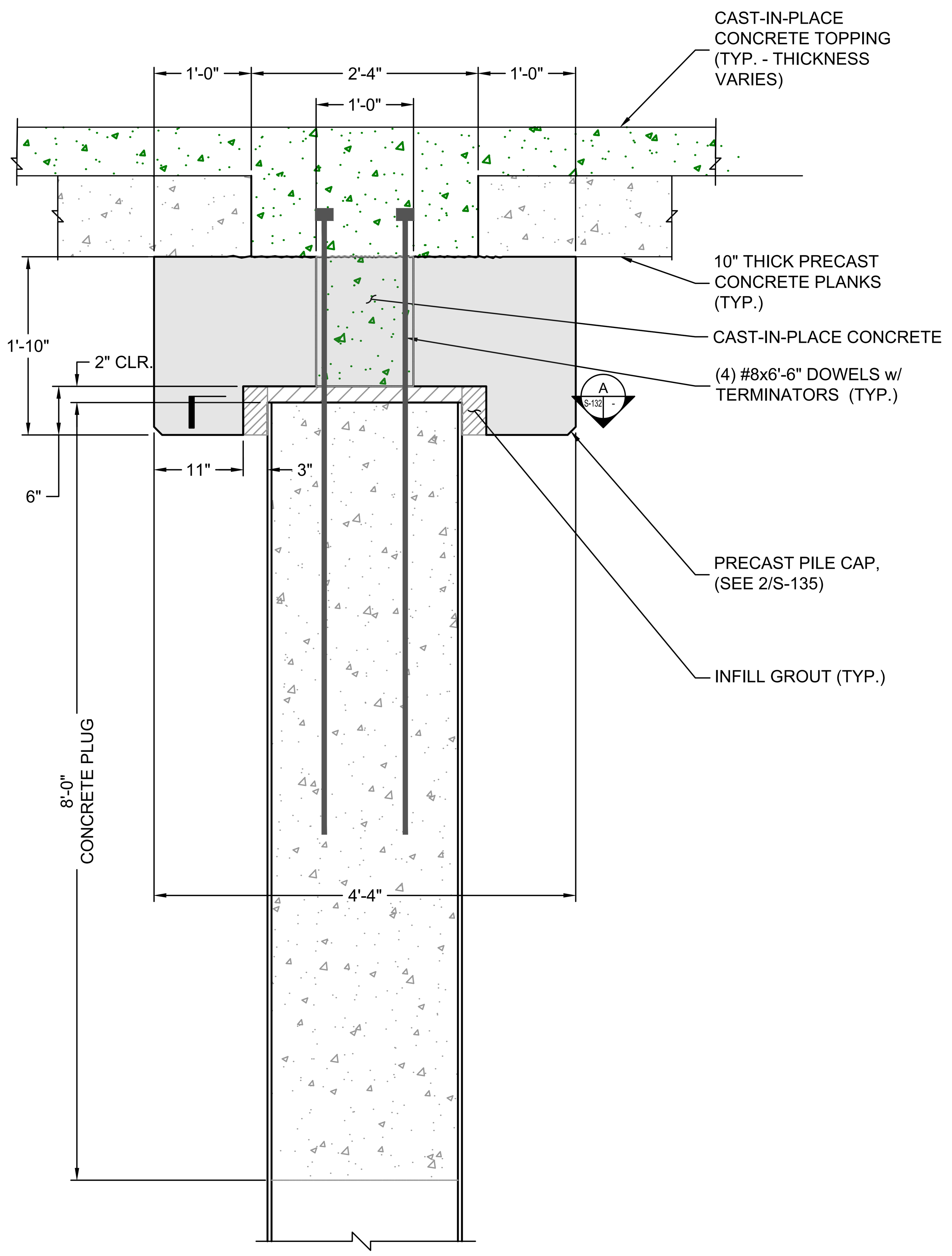
NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/8/2024
1	ADDENDUM #4	DDF	3/8/2024

MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

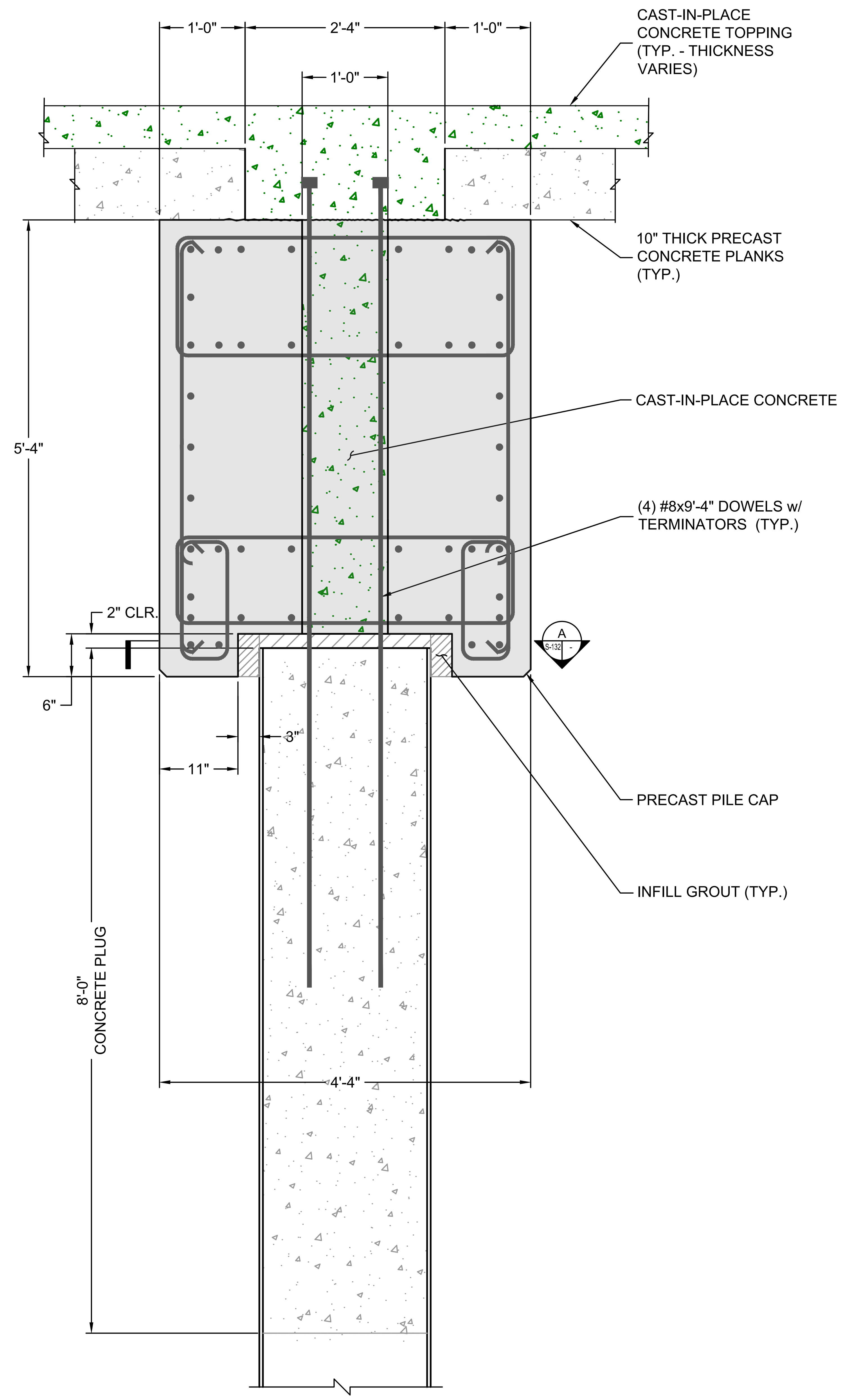
PIER SECTIONS - 10
SECTION G - PILE CAPS 5A/5B @ TRENCH

PREPARED BY:	PREPARED FOR:
GZA GeoEnvironmental, Inc. www.gza.com	MAINE MARITIME ACADEMY CASTINE, ME

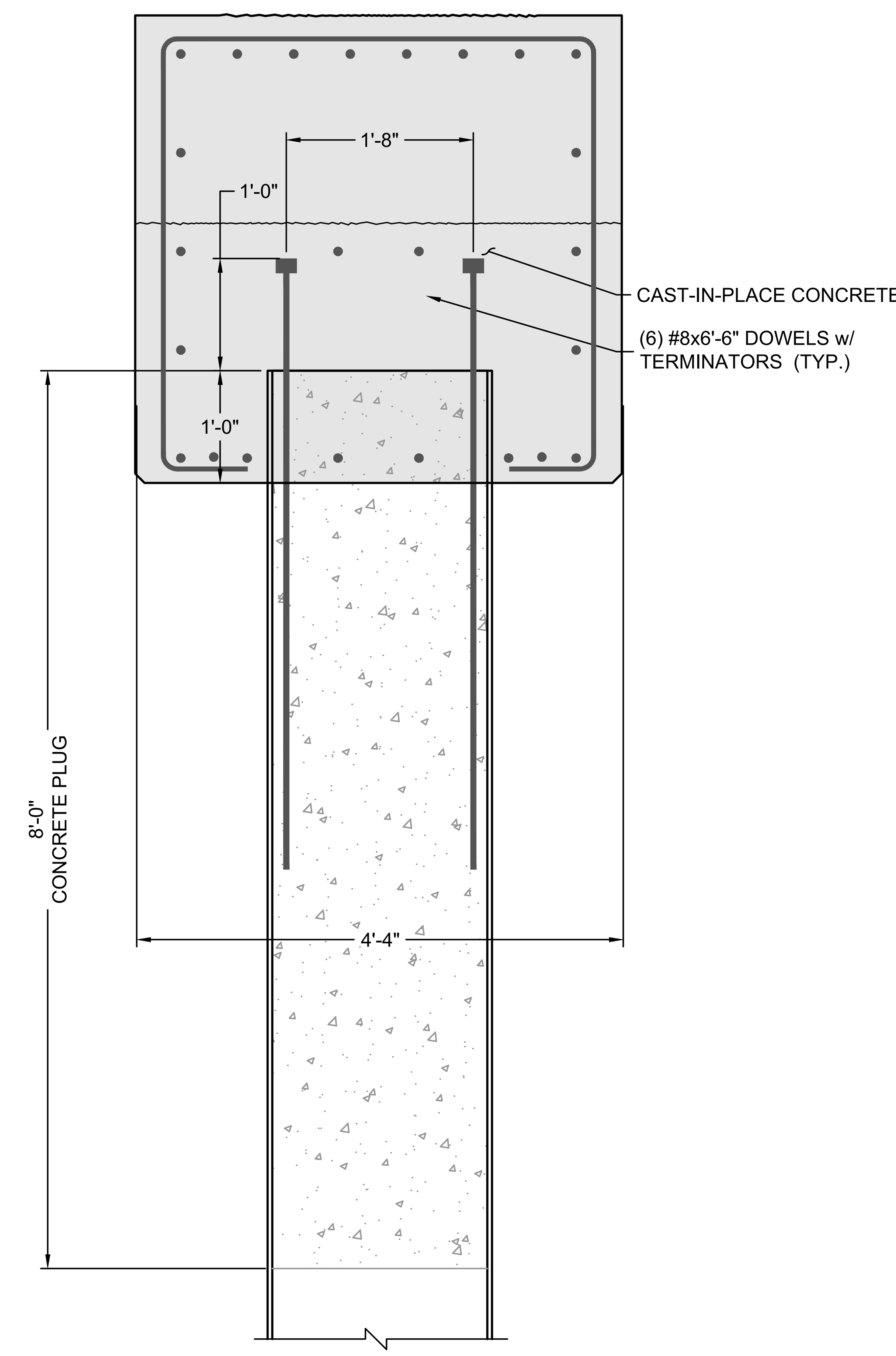
PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-129
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 58 OF 142



1 DETAIL:PLUMB STEEL PILE CONNECTION TO PLANK (SHALLOW)
S-120 S-132 SCALE: 1" = 1'-0"

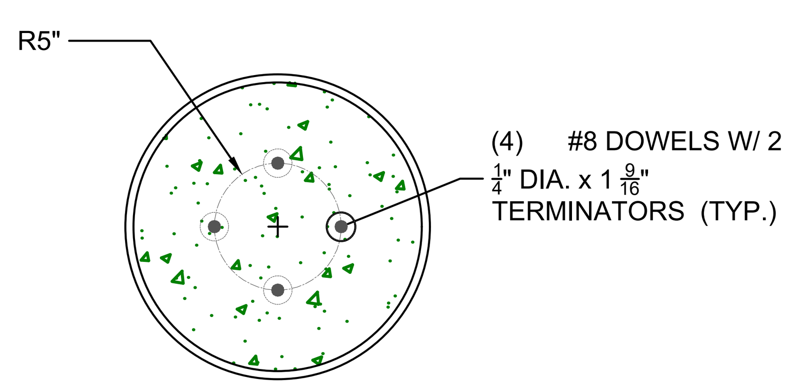


2 DETAIL:PLUMB STEEL PILE CONNECTION TO PLANK (DEEP)
S-120 S-132 SCALE: 1" = 1'-0"



3 DETAIL: STEEL PILE CONNECTION TO CAST-IN PLACE CONCRETE
S-120 S-132 SCALE: 1" = 1'-0"

3



A DETAIL: PILE CONNECTION TO PRE-CAST
S-132 -- SCALE: 1" = 1'-0"

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
3	ADDENDUM #11	DDF	4/8/2024
2	ADDENDUM #5	DDF	3/15/2024
1	ADDENDUM #4	DDF	3/8/2024

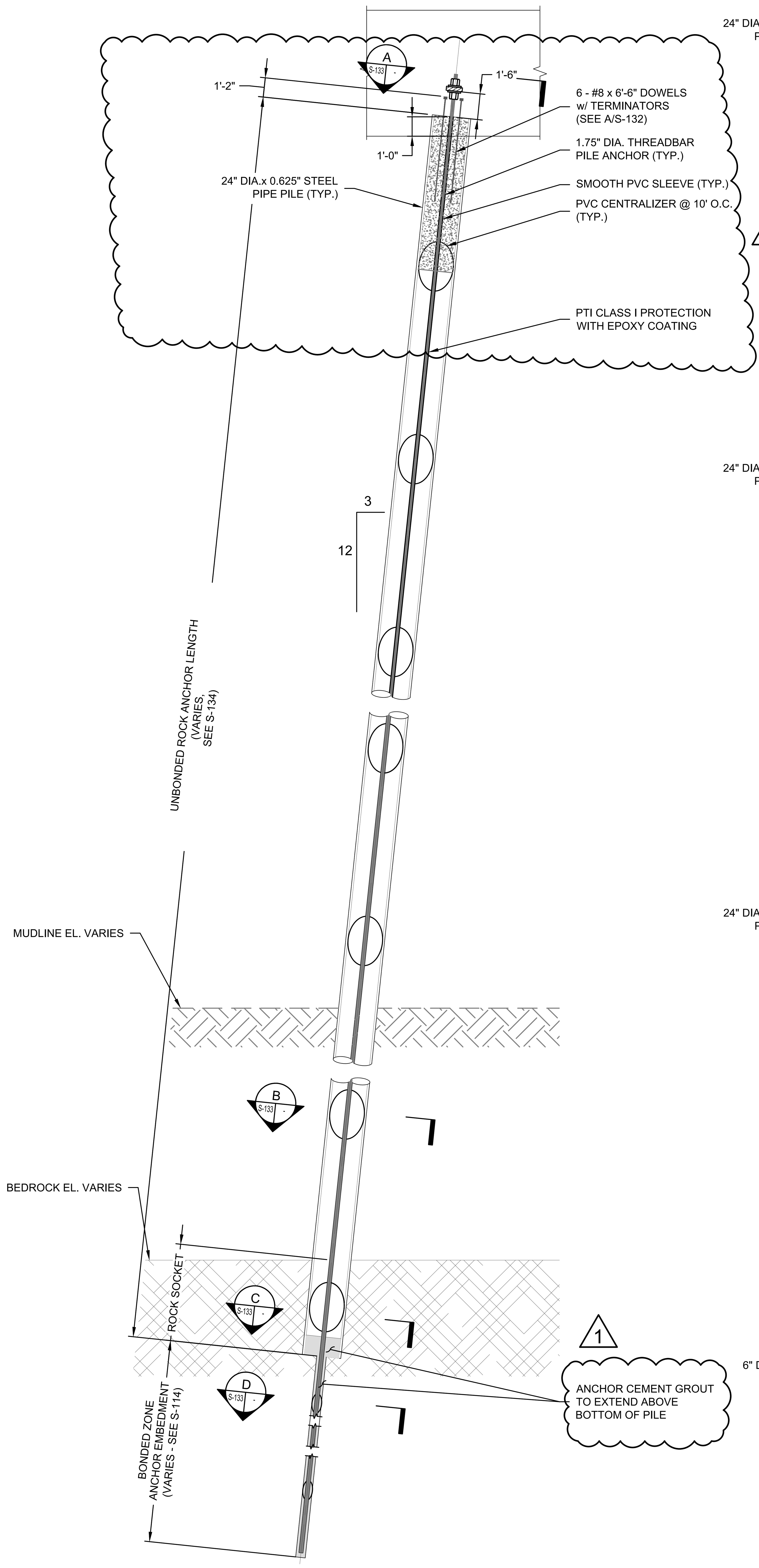
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PIER PILE DETAILS

PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

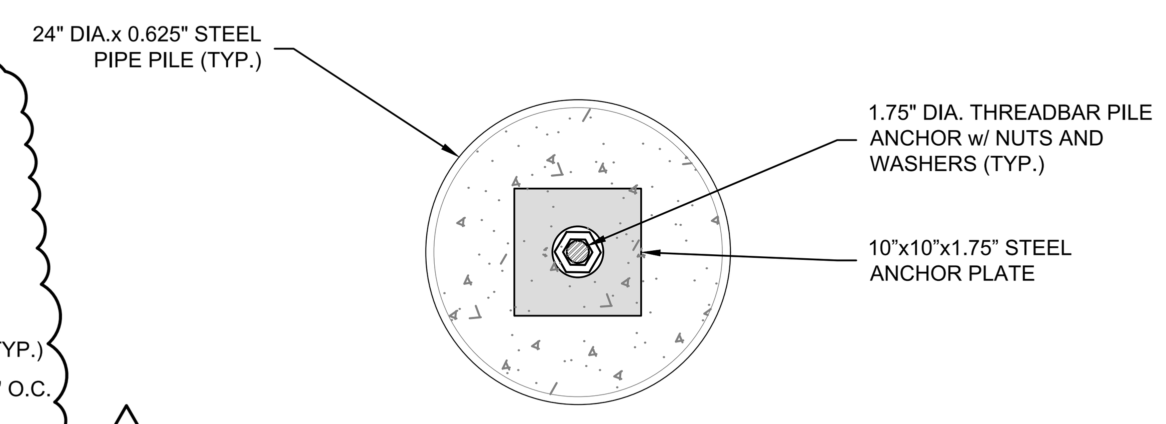
PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-132
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 61 OF 142



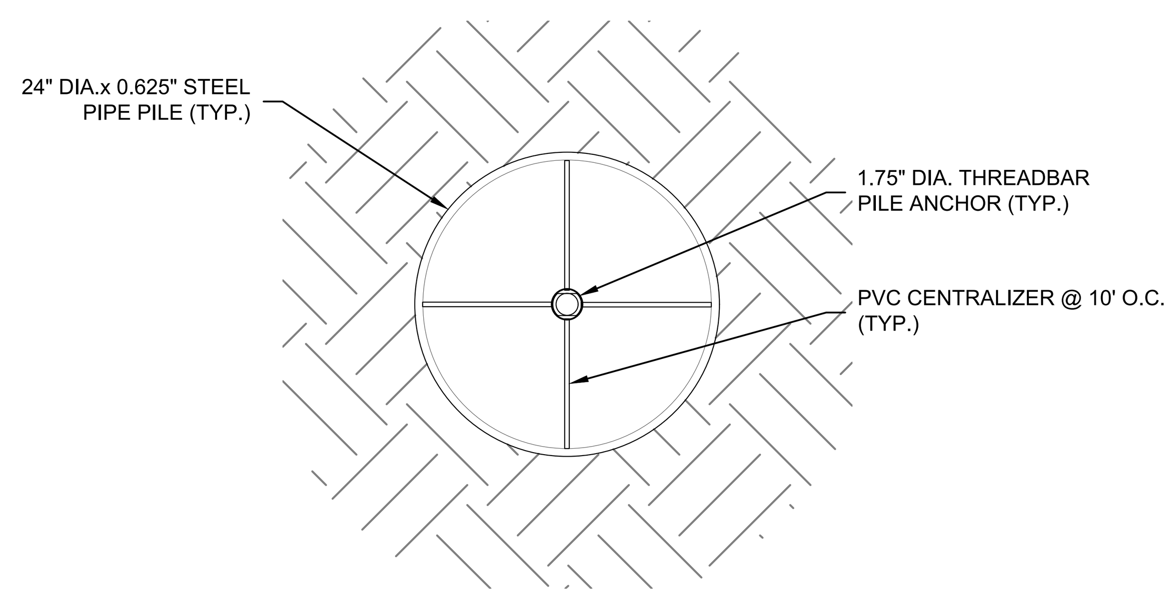
1 S-114 S-133 DETAIL - TYPICAL ROCK ANCHOR

NOT TO SCALE



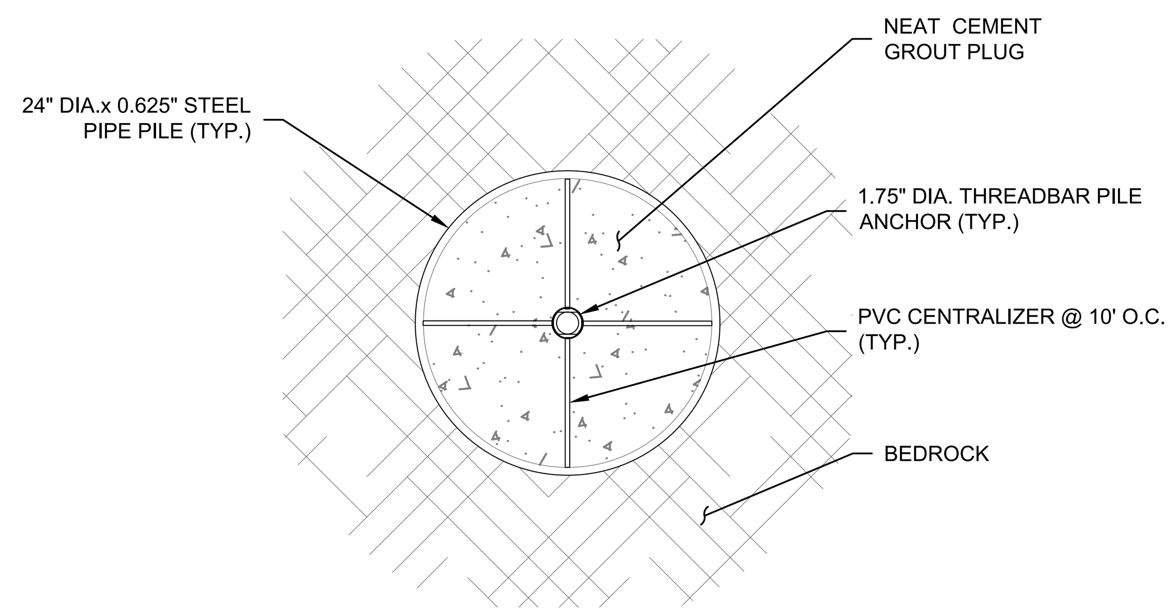
A S-133 SECTION - TYPICAL ROCK ANCHOR PLATE

NOT TO SCALE



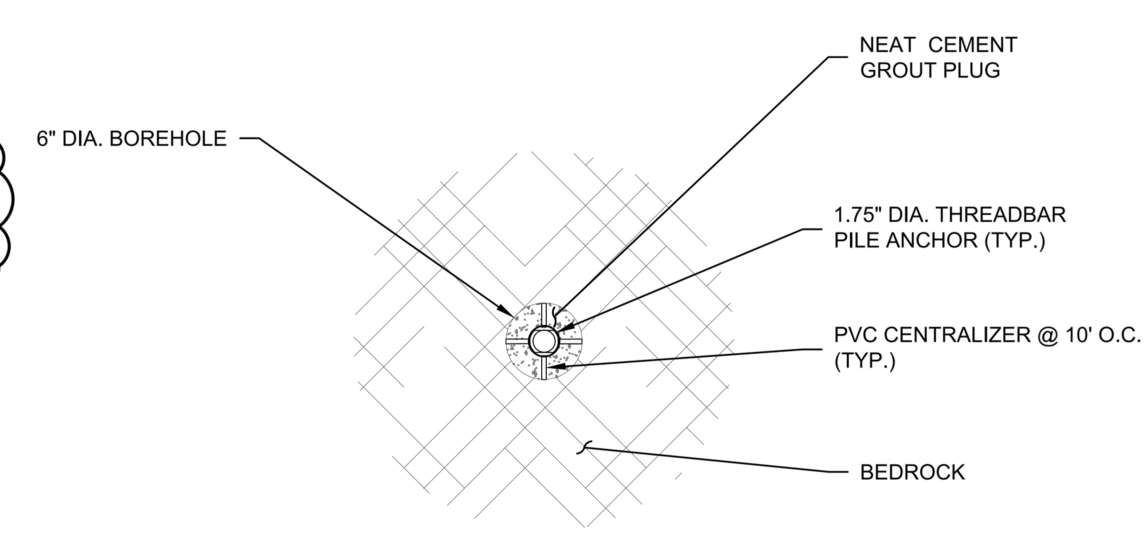
B S-133 SECTION - TYPICAL ROCK ANCHOR (UNBONDED ZONE)

NOT TO SCALE



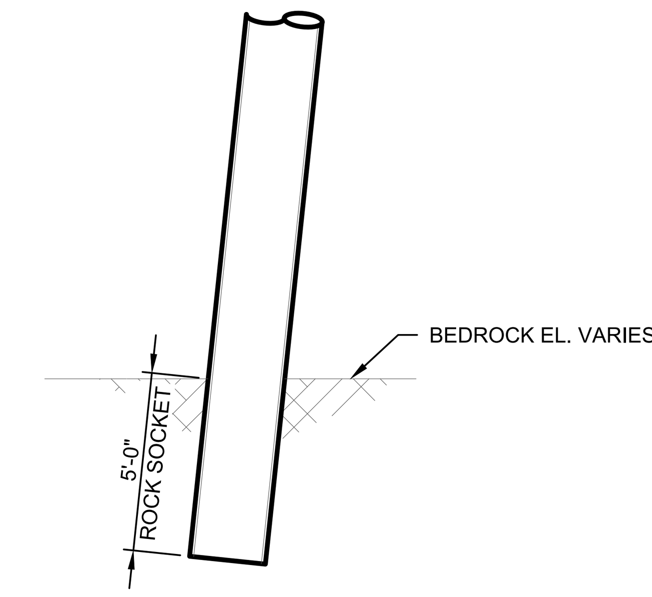
C S-133 SECTION - TYPICAL ROCK ANCHOR (ROCK SOCKET)

NOT TO SCALE



D S-133 SECTION - TYPICAL ROCK ANCHOR (BONDED ZONE)

NOT TO SCALE



3 S-114 S-133 DETAIL - PIER PILE EMBEDMENT

NOT TO SCALE

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/8/2024
1	ADDENDUM #7	DDF	3/29/2024

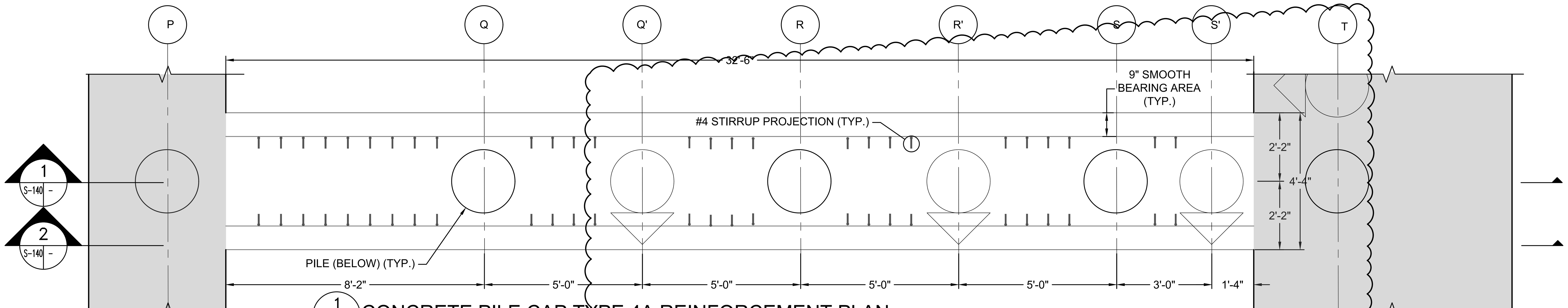
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PIER PILE AND ROCK ANCHOR DETAILS

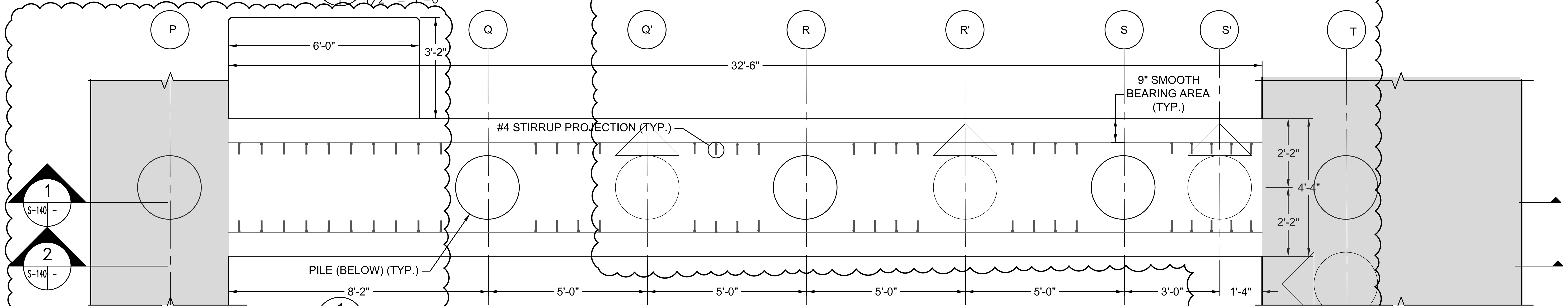
PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

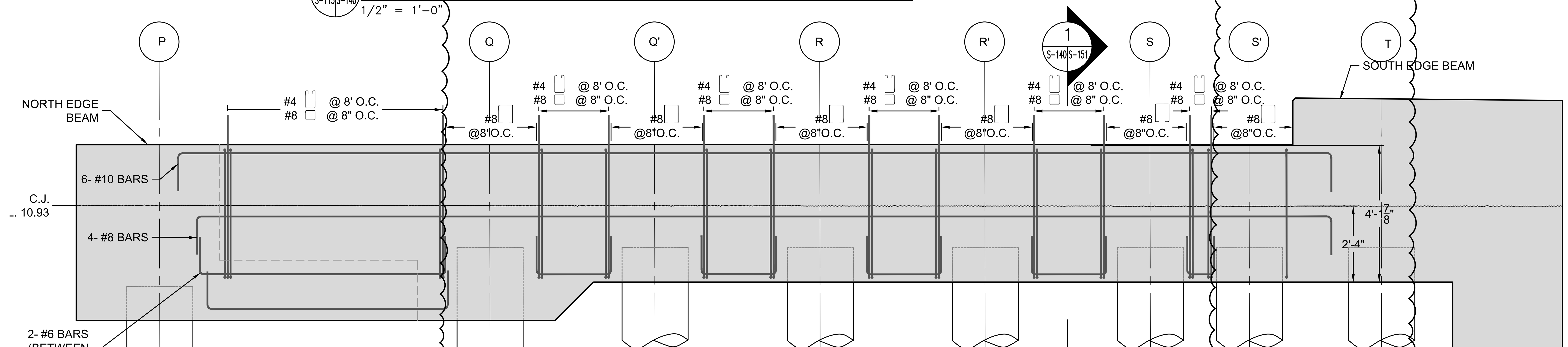
PROJ MGR: RKC	REVIEWED BY: CWC	CHECKED BY: DDF	DRAWING
DESIGNED BY: AFS	DRAWN BY: MEA	SCALE: AS NOTED	S-133
DATE: JANUARY 2024	PROJECT NO. 35109.00	REVISION NO.	SHEET NO. 62 OF 142



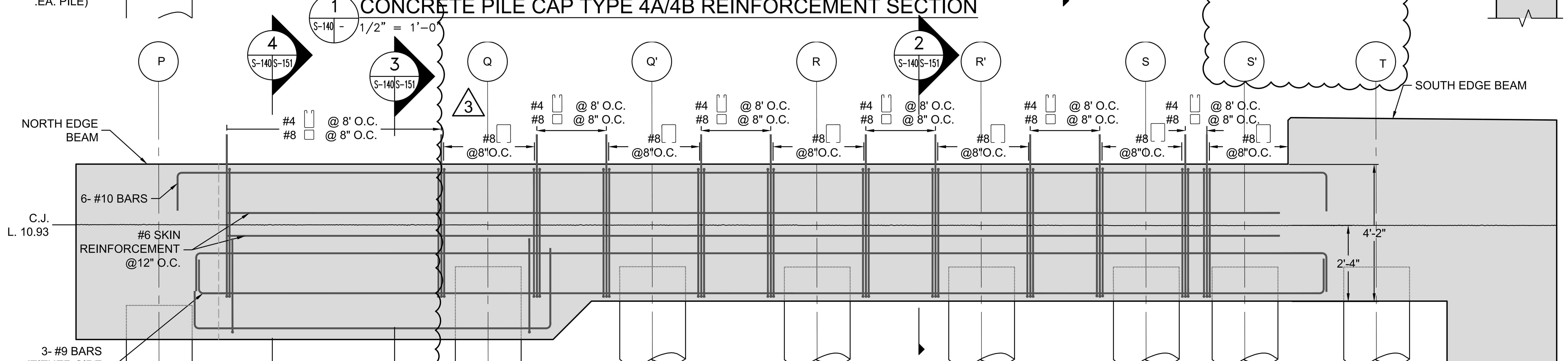
1 S-115 S-140 CONCRETE PILE CAP TYPE 4A REINFORCEMENT PLAN
1/2" = 1'-0"



1 S-115 S-140 CONCRETE PILE CAP TYPE 4B REINFORCEMENT PLAN
1/2" = 1'-0"



1 S-140 CONCRETE PILE CAP TYPE 4A/4B REINFORCEMENT SECTION
1/2" = 1'-0"



2 S-140 CONCRETE PILE CAP TYPE 4A/4B REINFORCEMENT SECTION
1/2" = 1'-0"

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

PILE CAP NOTES:

1. ALL CONCRETE EXPOSED TO WEATHER SHALL HAVE A MINIMUM OF 3" CLEAR COVER. ALL CONCRETE NOT EXPOSED TO WEATHER SHALL HAVE A MINIMUM OF 1.5" CLEAR COVER.

NO.	ISSUE/DESCRIPTION	BY	DATE
3	ADDENDUM #11	DDF	4/8/2024
2	ADDENDUM #7	DDF	3/29/2024
1	ADDENDUM #6	DDF	3/22/2024

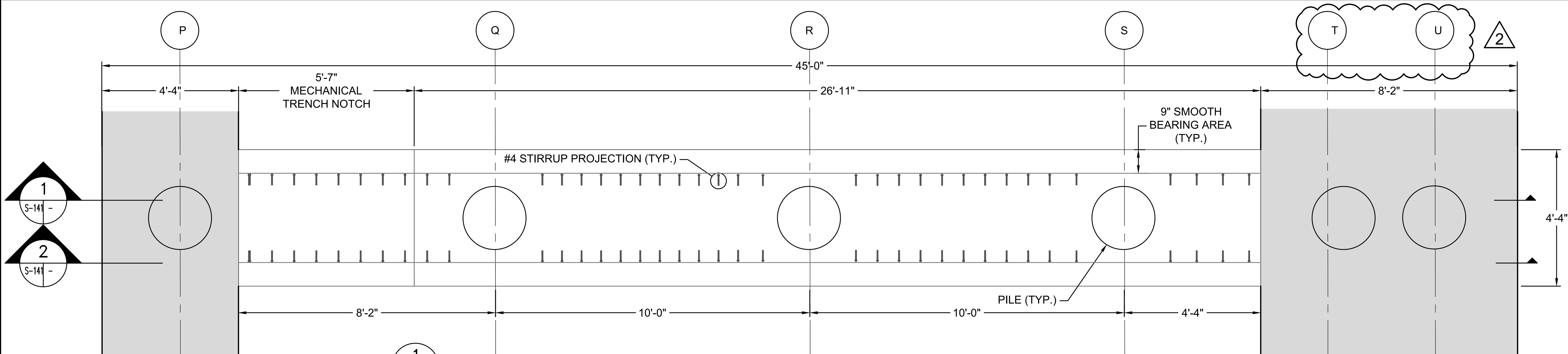
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

CAST-IN-PLACE PIER PILE CAP DETAILS - TYPE 4A/4B

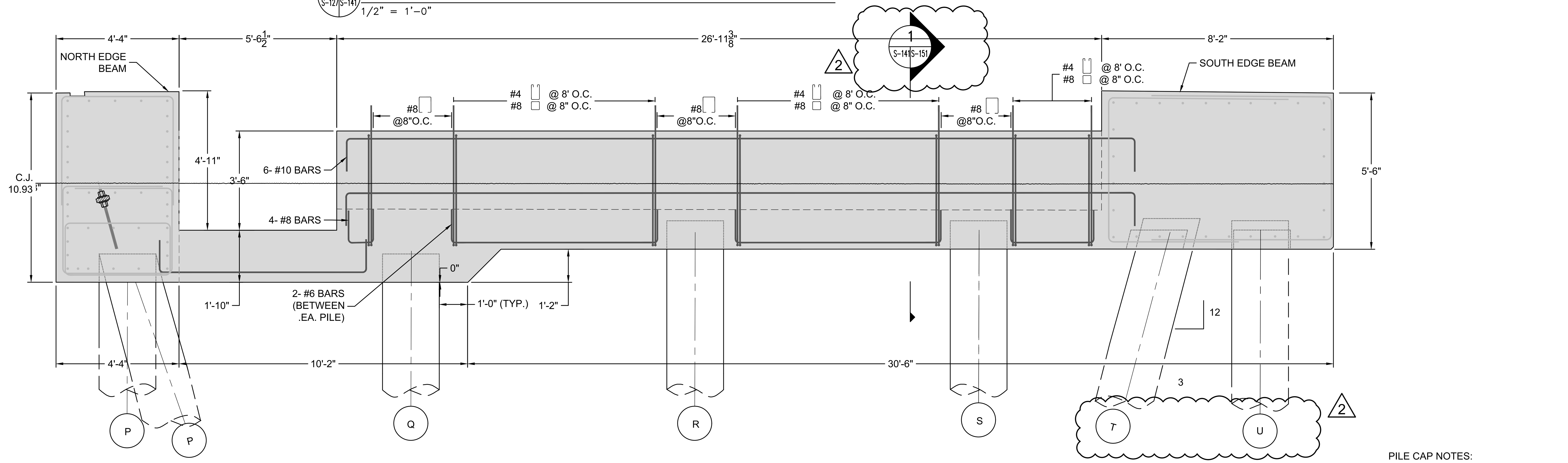
PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

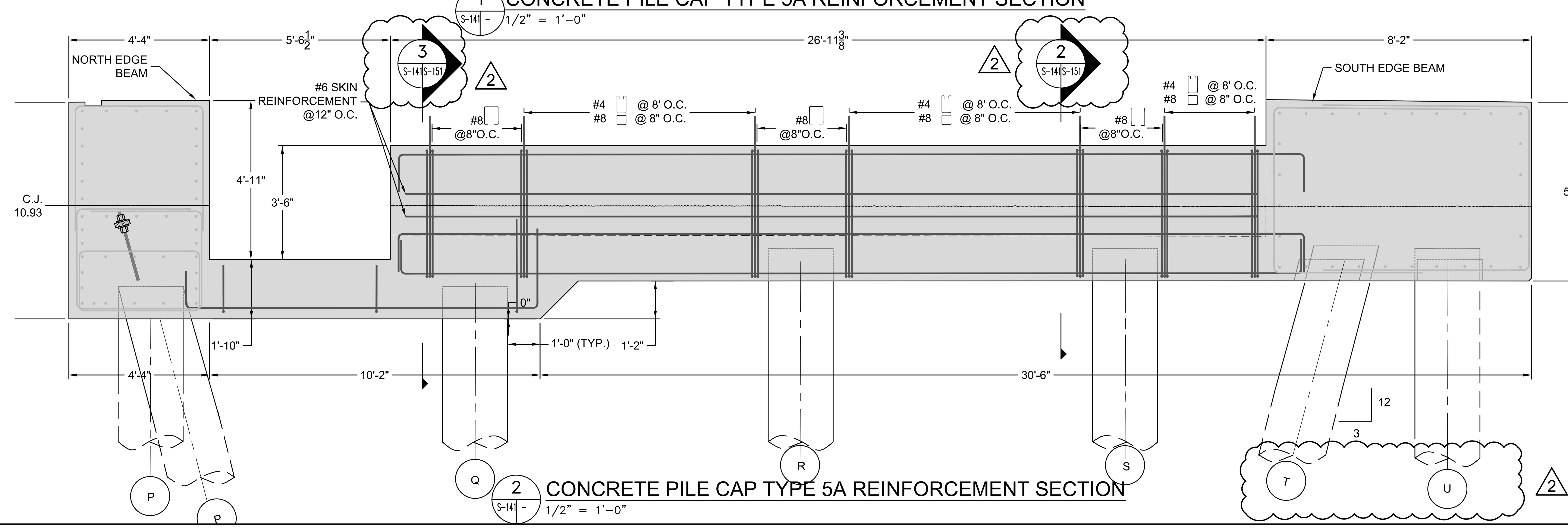
PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-140
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 69 OF 142



1 (S-127/S-141) CONCRETE PILE CAP TYPE 5A REINFORCEMENT PLAN
1/2" = 1'-0"



1 (S-141) CONCRETE PILE CAP TYPE 5A REINFORCEMENT SECTION
1/2" = 1'-0"



2 (S-141) CONCRETE PILE CAP TYPE 5A REINFORCEMENT SECTION
1/2" = 1'-0"

PILE CAP NOTES:

1. ALL CONCRETE EXPOSED TO WEATHER SHALL HAVE A MINIMUM OF 3" CLEAR COVER. ALL CONCRETE NOT EXPOSED TO WEATHER SHALL HAVE A MINIMUM OF 1.5" CLEAR COVER.

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/08/2024
1	ADDENDUM #7	DDF	3/29/2024

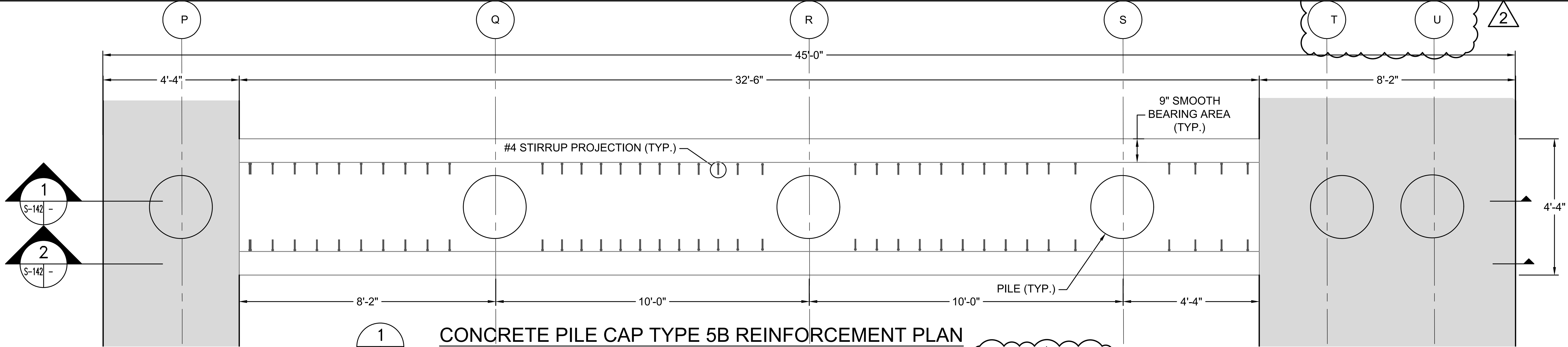
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

CAST-IN-PLACE PIER PILE CAP DETAILS - TYPE 5A

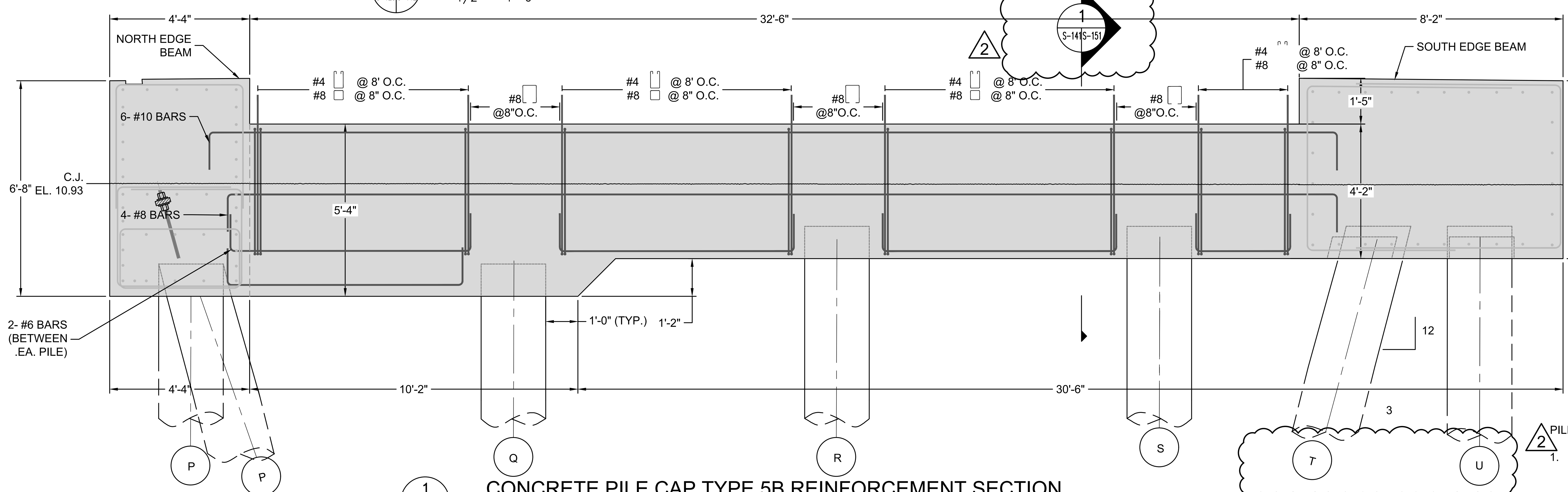
PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-141
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 70 OF 142



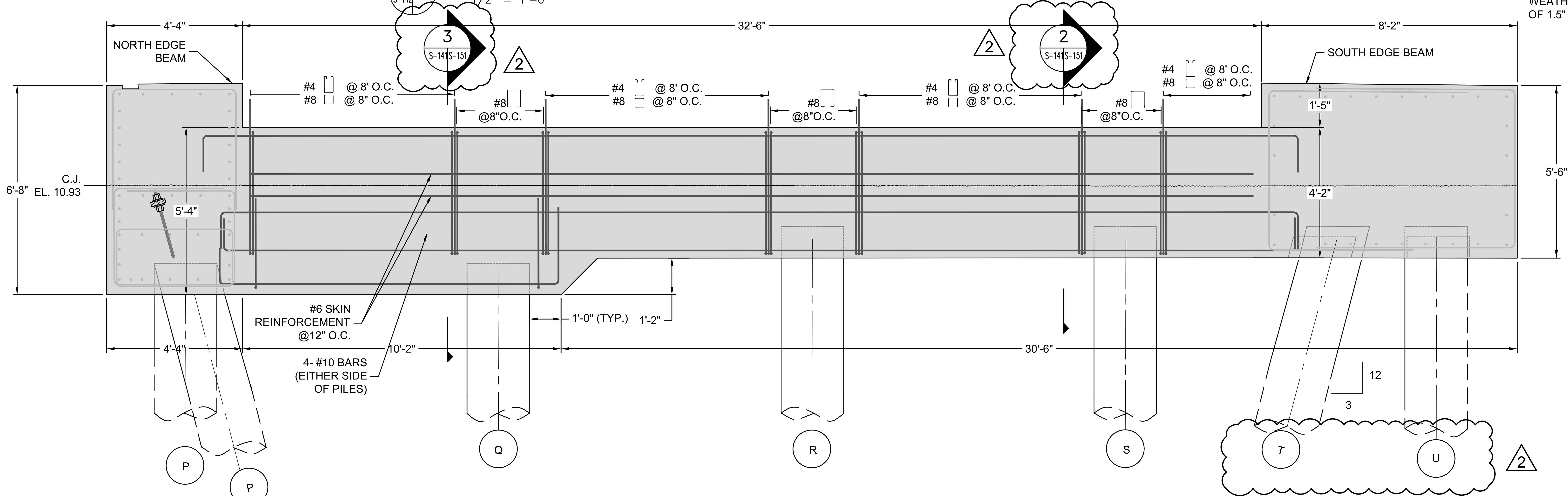
CONCRETE PILE CAP TYPE 5B REINFORCEMENT PLAN
1/2" = 1'-0"



PILE CAP NOTES:

1. ALL CONCRETE EXPOSED TO WEATHER SHALL HAVE A MINIMUM OF 3" CLEAR COVER. ALL CONCRETE NOT EXPOSED TO WEATHER SHALL HAVE A MINIMUM OF 1.5" CLEAR COVER.

CONCRETE PILE CAP TYPE 5B REINFORCEMENT SECTION
1/2" = 1'-0"



CONCRETE PILE CAP TYPE 5B REINFORCEMENT SECTION
1/2" = 1'-0"

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/08/2024
1	ADDENDUM #7	DDF	3/29/2024

MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

CAST-IN-PLACE PIER PILE CAP DETAILS - TYPE 5B

PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-142
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 71 OF 142

NOT USED

2

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/8/2024
1	ADDENDUM #7	DDF	3/29/2024

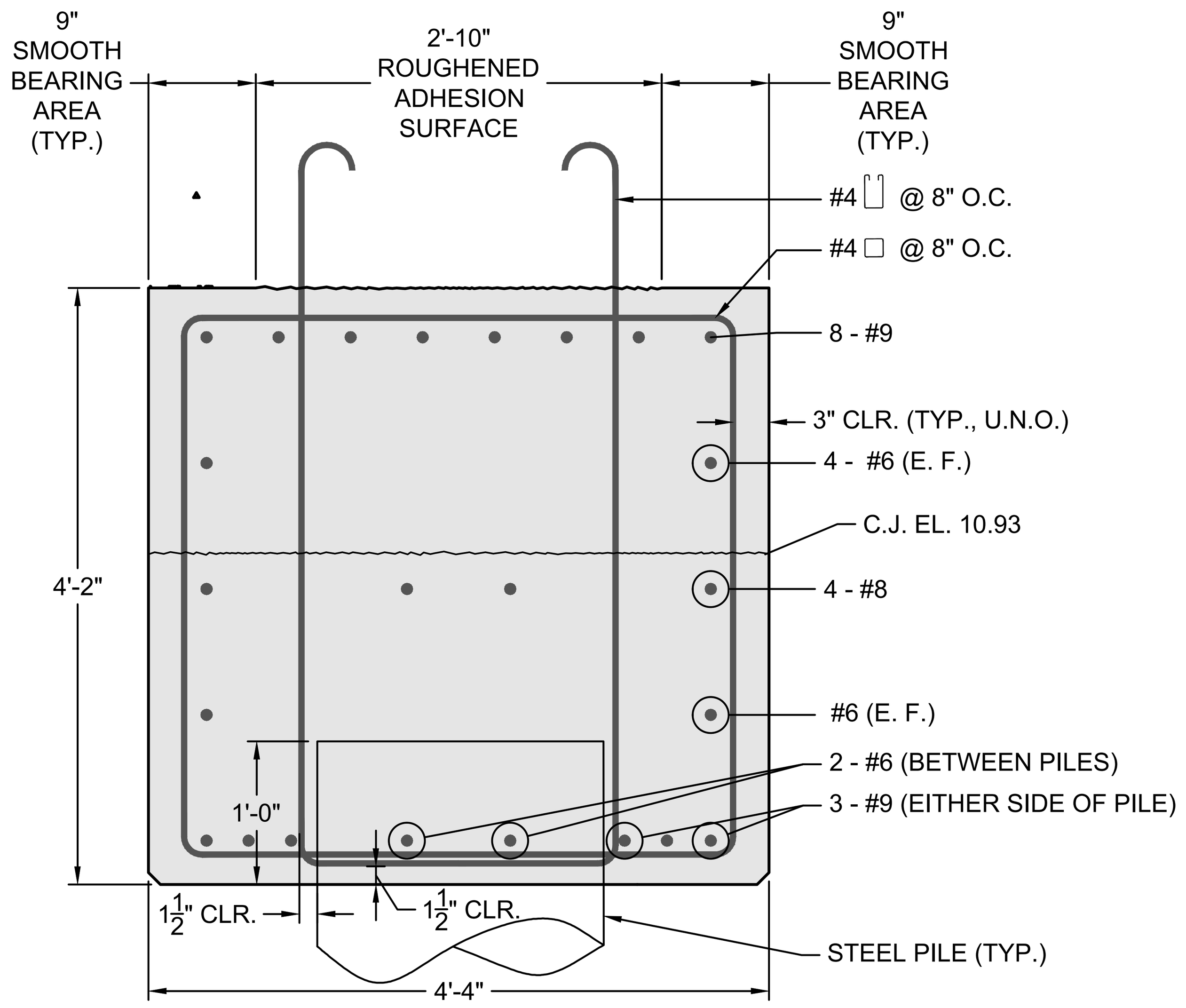
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

EDGE BEAM SECTIONS AND DETAILS - 2

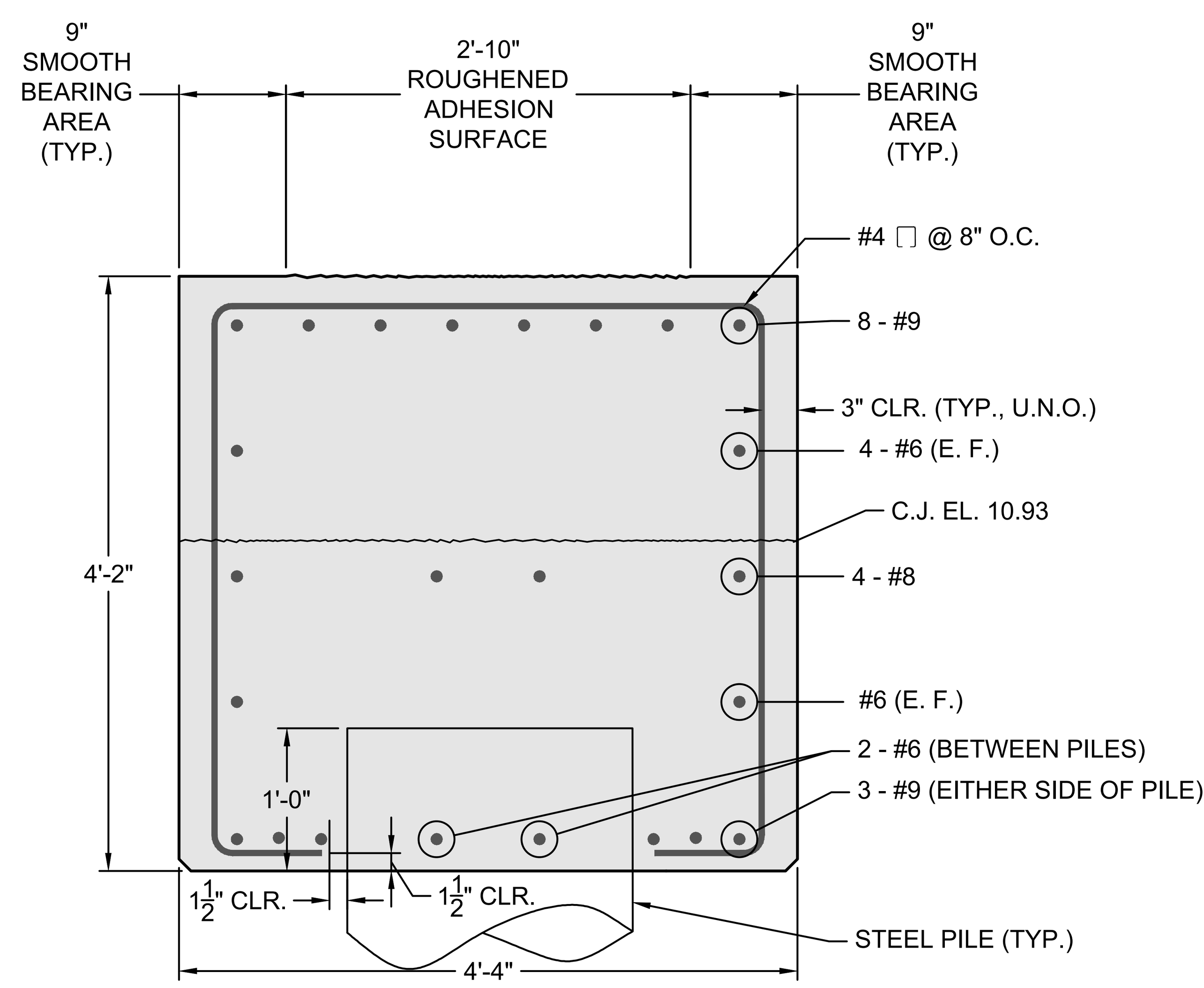
PREPARED BY:
GZA GeoEnvironmental, Inc.
www.gza.com

PREPARED FOR:
MAINE MARITIME ACADEMY
CASTINE, ME

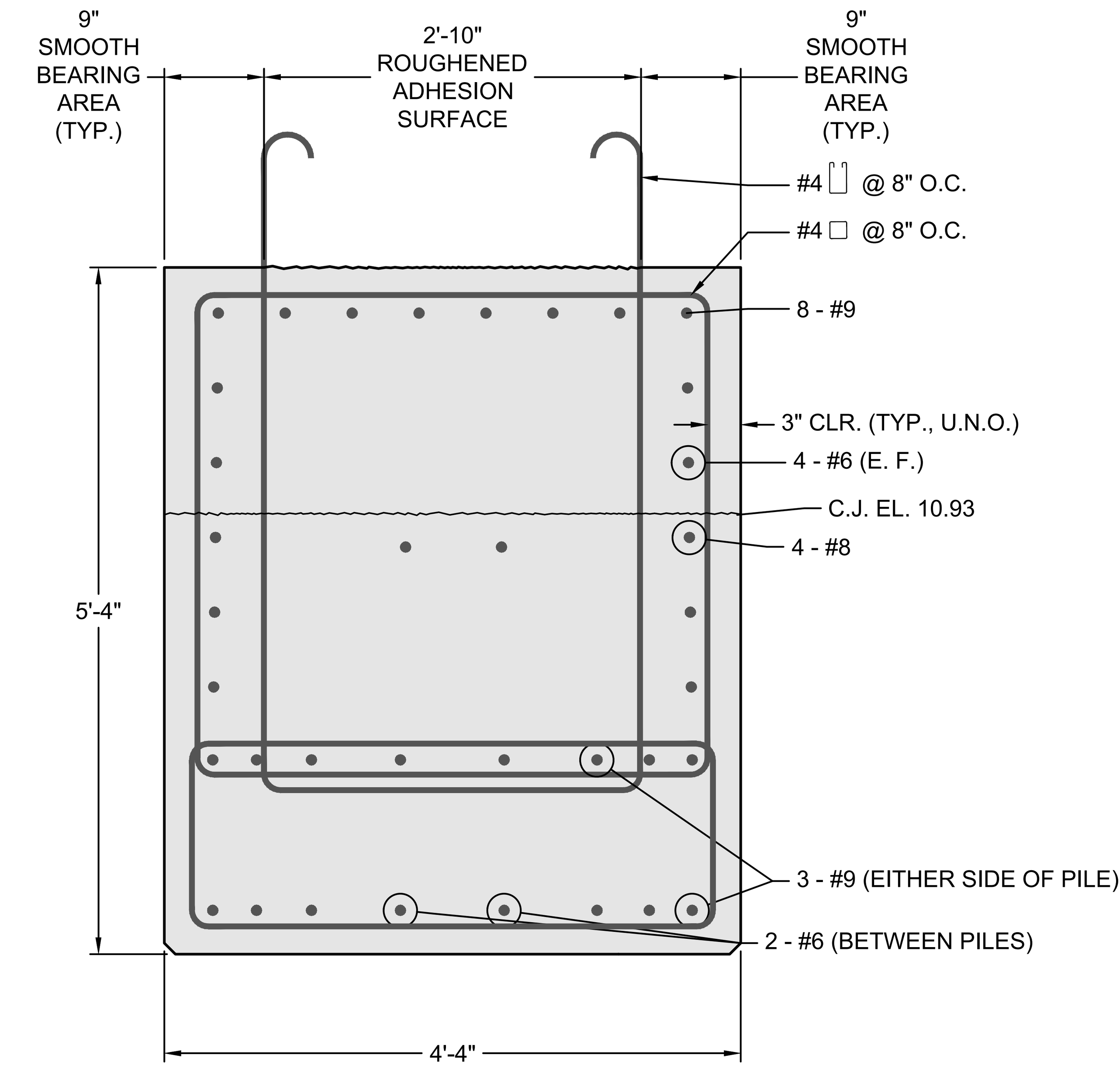
PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-148
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 77 OF 142



1 CONCRETE PILE CAP TYPE 4A/4B/5A/5B SECTION
S-141 S-151 1/2" = 1'-0"
S-142

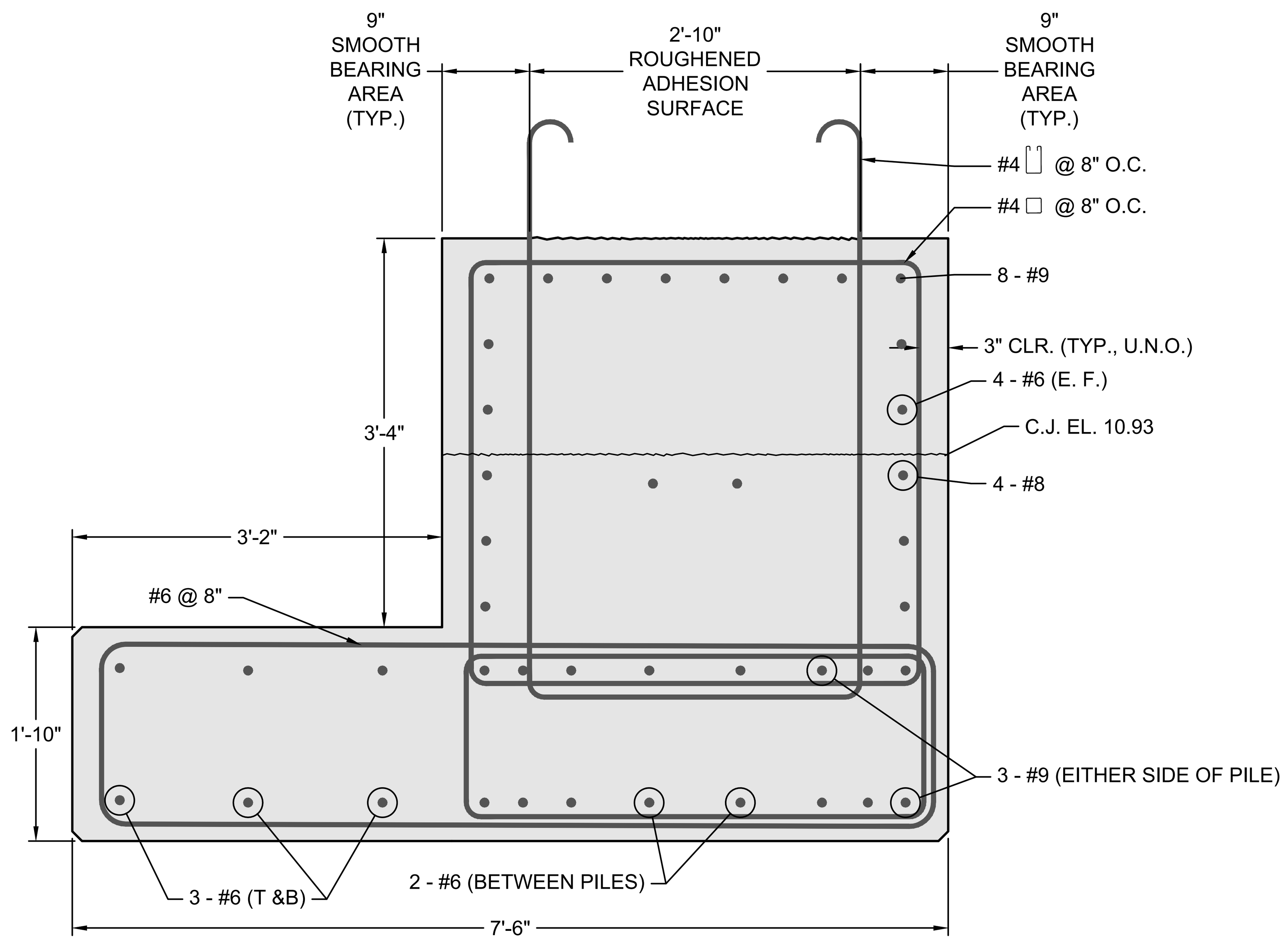


2 CONCRETE PILE CAP TYPE 4A/4B/5A/5B SECTION
S-141 S-151 1/2" = 1'-0"
S-142

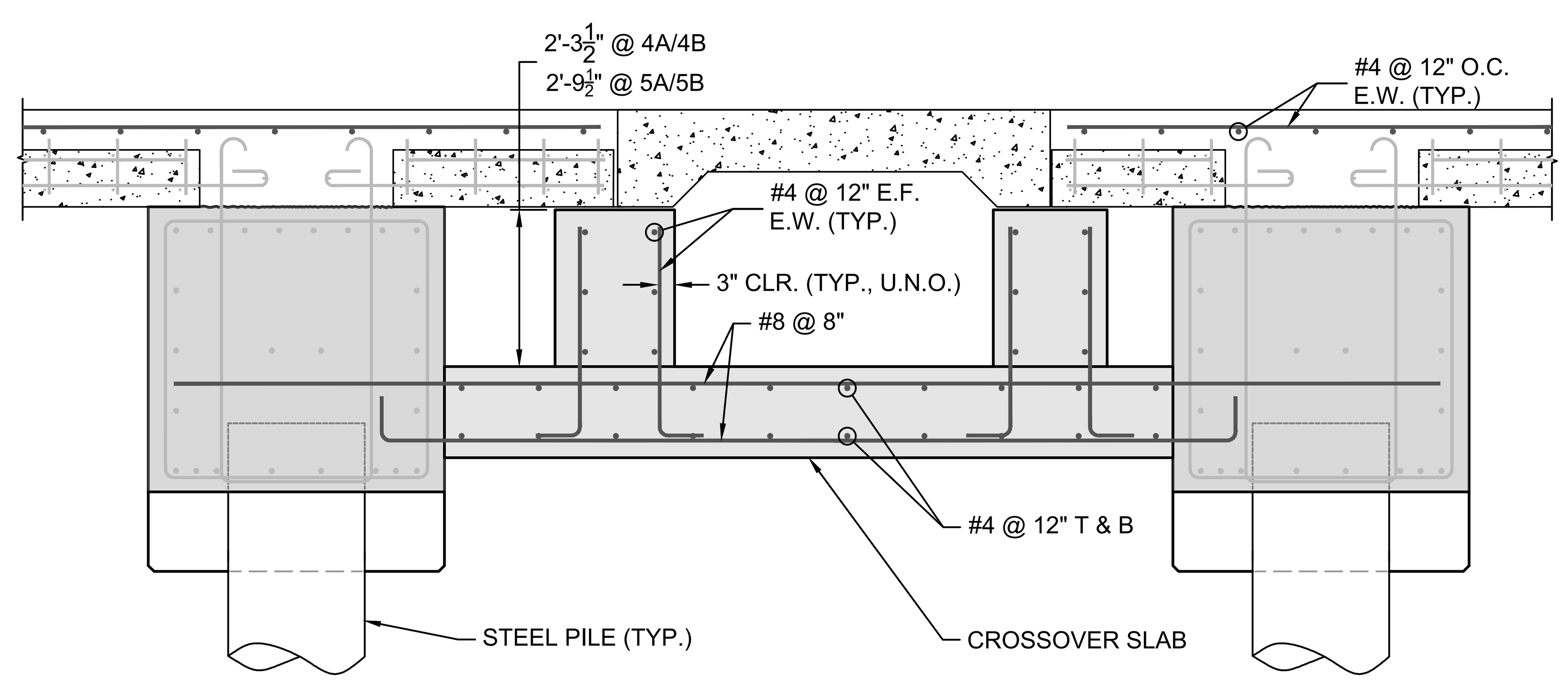


3 CONCRETE PILE CAP TYPE 4A/5A/5B SECTION
S-141 S-151 1/2" = 1'-0"
S-142

2



4 CONCRETE PILE CAP TYPE 4B SECTION
S-141 S-151 1/2" = 1'-0"
S-142



5 CONCRETE CROSSOVER SLAB TYPE 4A/4B/5A/5B SECTION
S-126 S-151 1/2" = 1'-0"
S-129

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/8/2024
1	ADDENDUM #7	DDF	3/29/2024

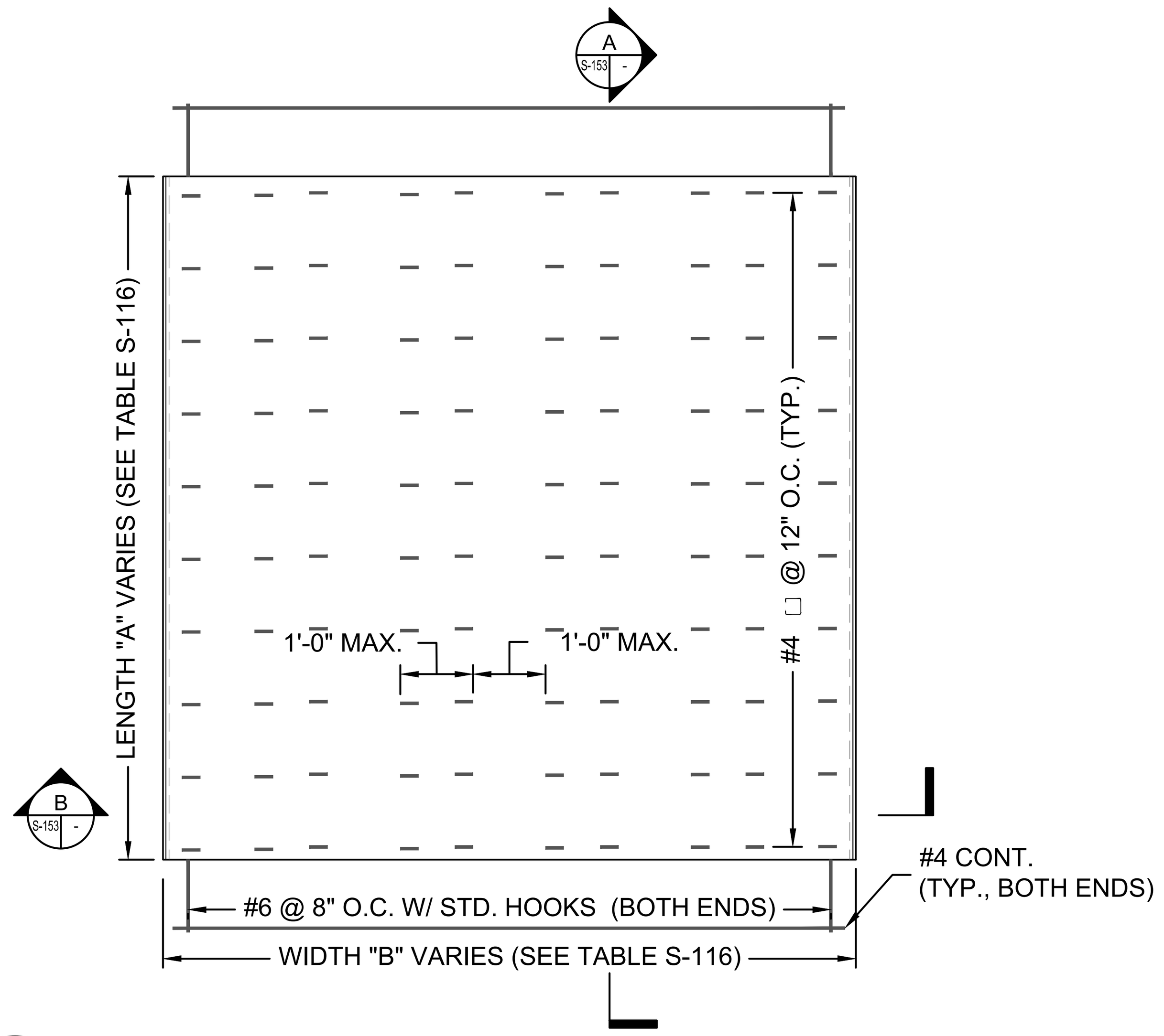
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PIER PILE CAP AND BEAM DETAILS - 3

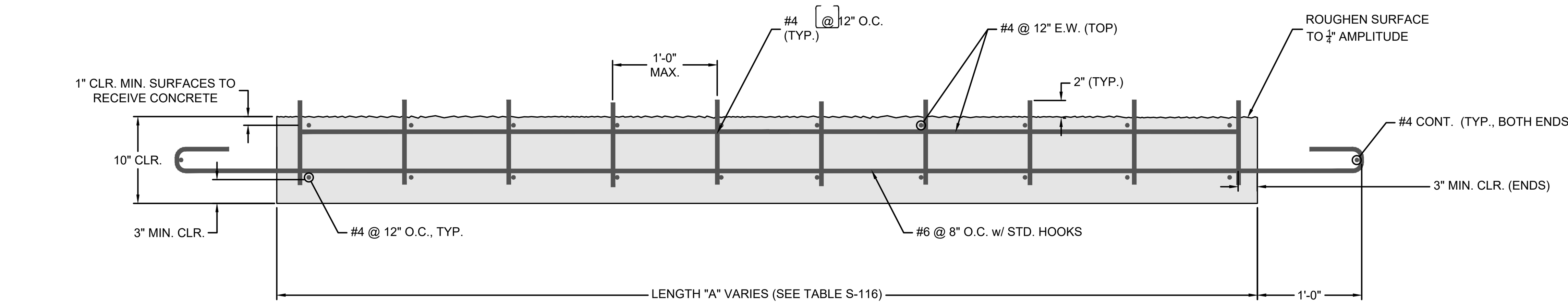
PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

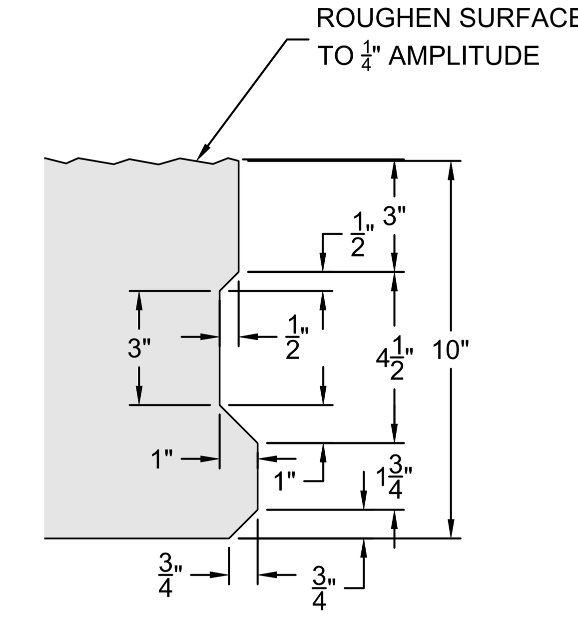
PROJ MGR: RKC	REVIEWED BY:	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-151
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 80 OF 142



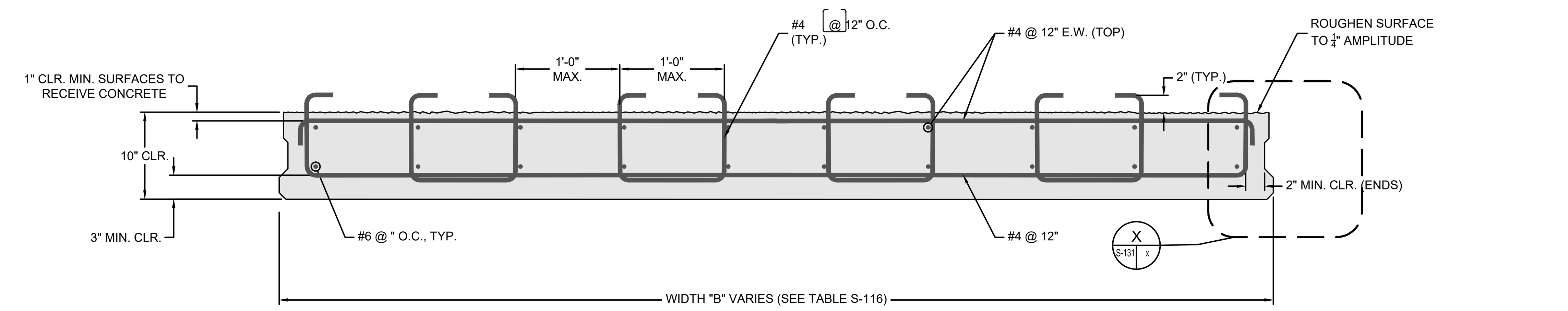
A S-153 DETAIL: TYPICAL PRE-CAST CONCRETE PLANK LAYOUT
1/2" = 1'-0"



A S-153 SECTION: PRE-CAST CONCRETE PLANK
1" = 1'-0"



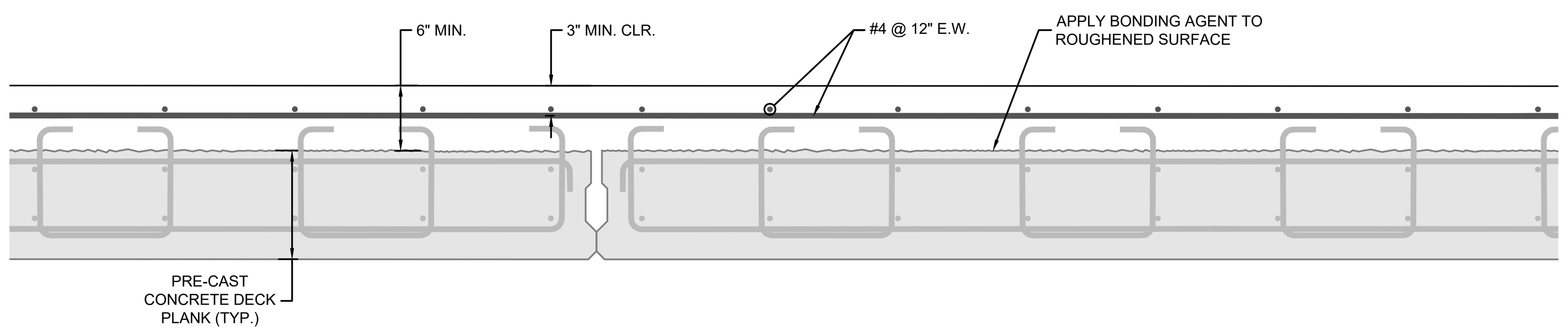
A S-153 DETAIL: PRE-CAST CONCRETE PLANK KEYWAY
3" = 1'-0"



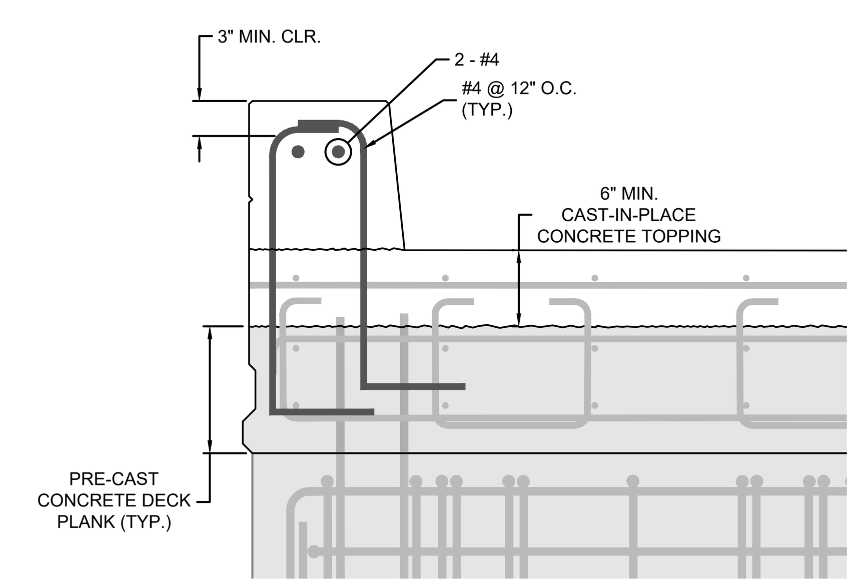
B S-153 SECTION: PRE-CAST CONCRETE PLANK
1" = 1'-0"

DECK PLANK NOTES:

1. CONTRACTOR & PRE-CAST MANUFACTURER SHALL COORDINATE LOCATION OF PLANKS PROJECTING REINFORCEMENT WITH CLOSURE POUR BENT CAP STIRRUPS TO AVOID INTERFERENCE.
2. EQUALLY SPACE LEGS OF SHEAR TIES.
3. CONTRACTOR SHALL FIELS VERIFY ALL DIMENSIONS "A" & "B" PRIOR TO FABRICATION OF PRE-CAST PLANKS.
4. CONTRACTOR SHALL COORDINATE OPENINGS, EMBEDMENTS, INSERTS, SLEEVES, & PENETRATIONS PRIOR TO STARTING FABRICATION.



1 S-153 DETAIL: CAST-IN-PLACE CONCRETE TOPPING
1" = 1'-0"



2 S-153 DETAIL: CURB REINFORCEMENT @ PRE-CAST PLANKS "A" & "I" (BENTS A - G & I -O)
1" = 1'-0"

2

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/08/2024
1	ADDENDUM #5	DDF	3/15/2024

2

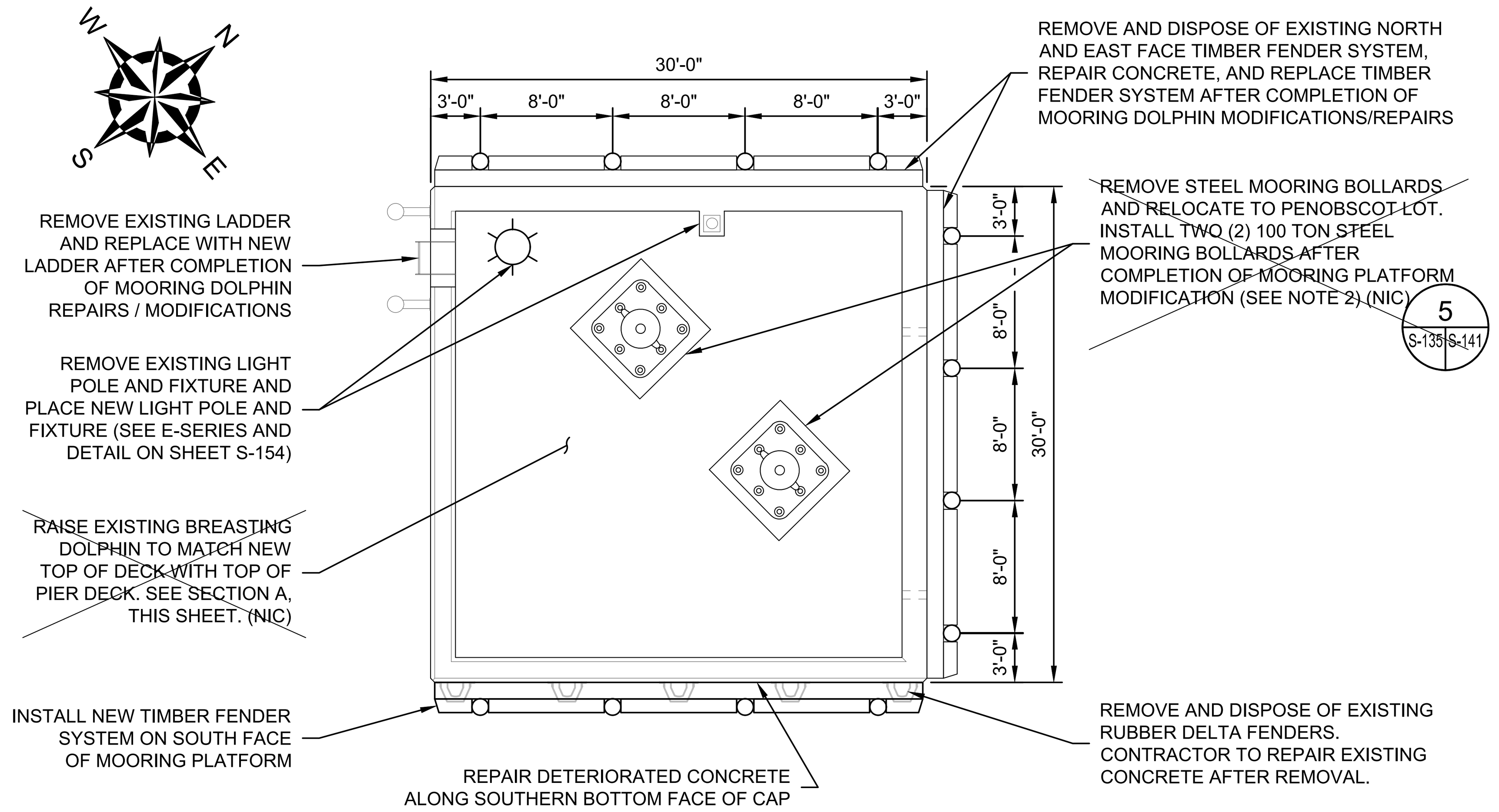
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

PRE-CAST DECK PLANK AND DECK TOPPING DETAILS

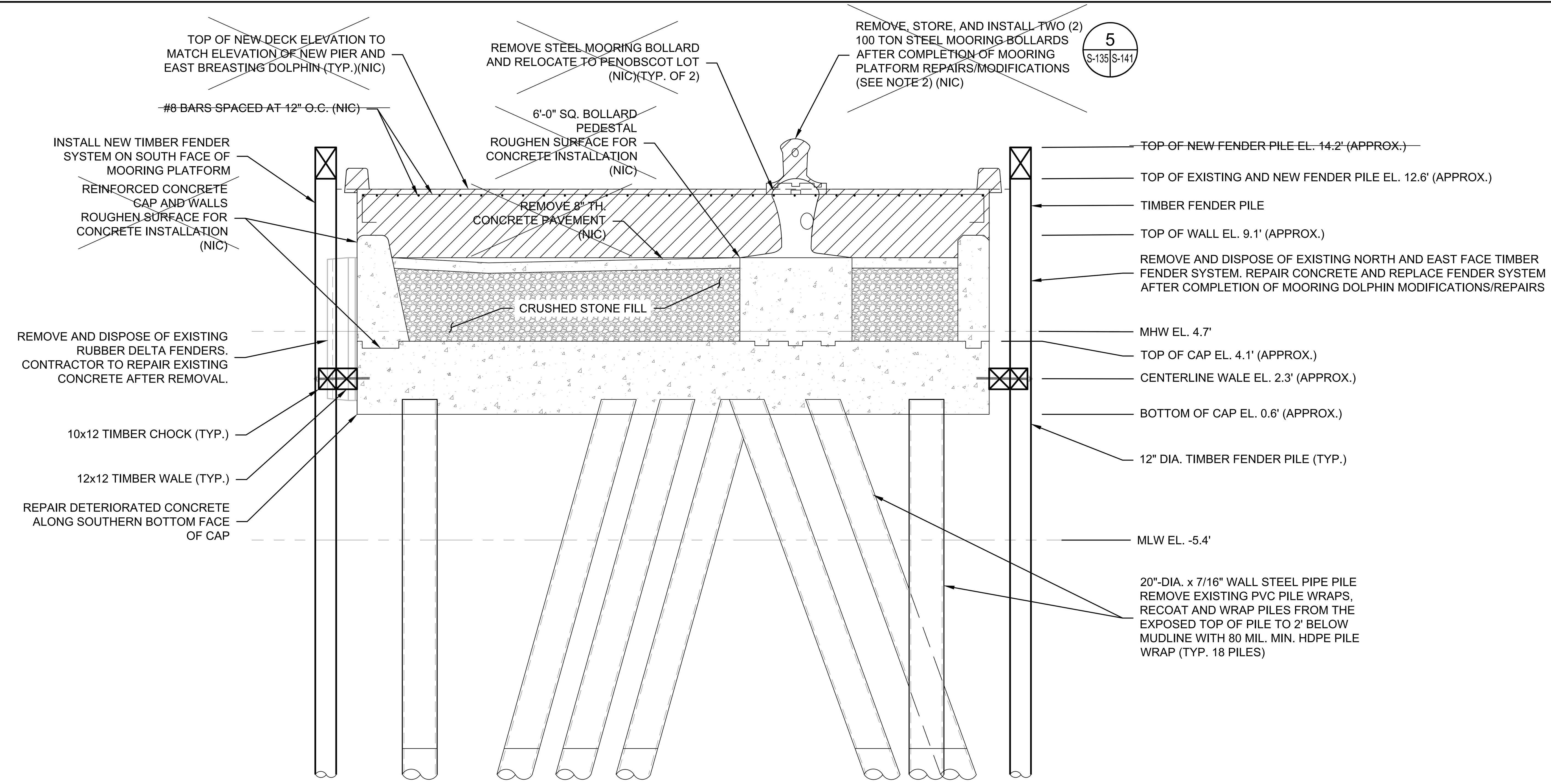
PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

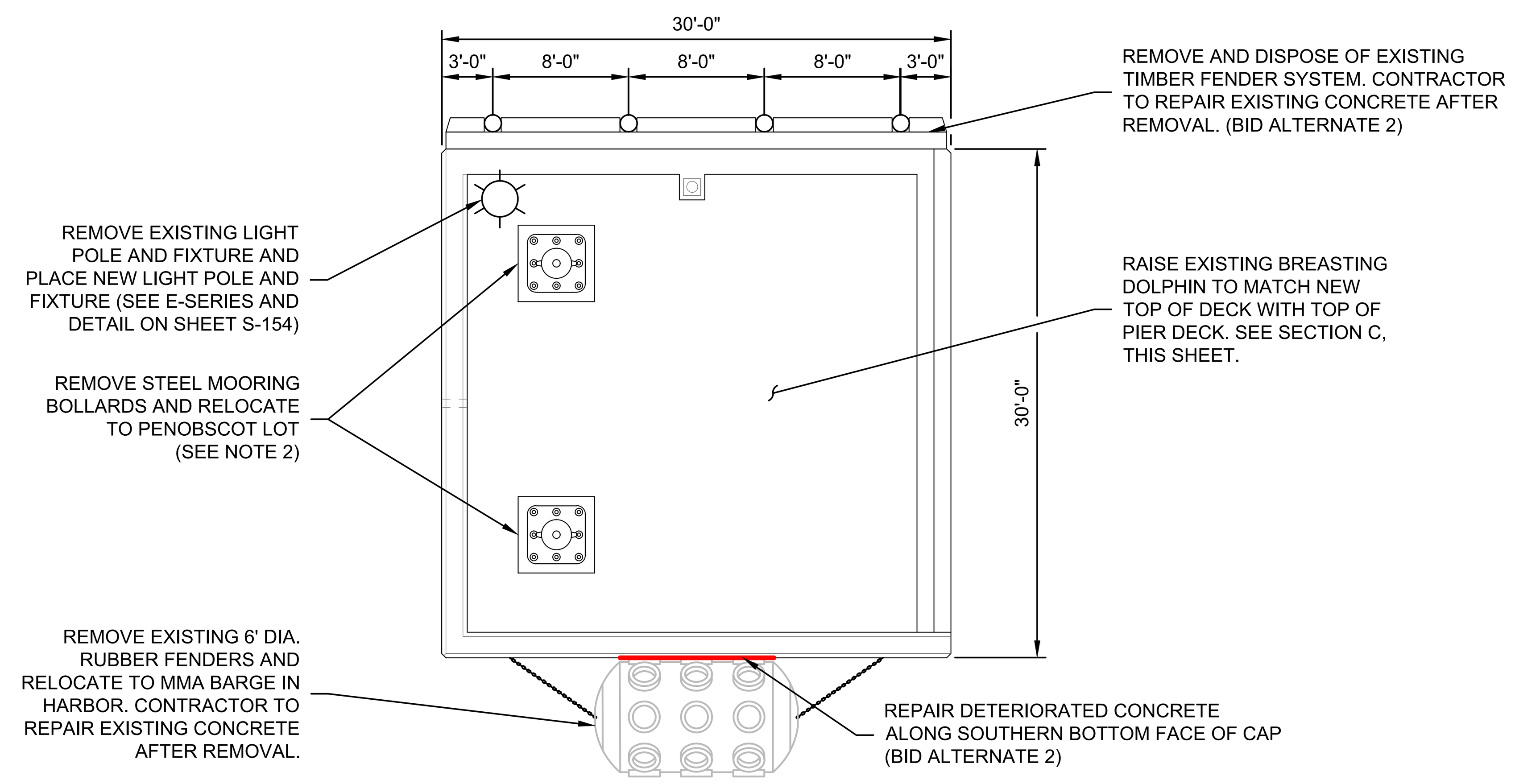
PROJ MGR: RKC	REVIEWED BY: C	CHECKED BY:	DRAWING
DESIGNED BY: MAR	DRAWN BY: BDW	SCALE:	S-153
DATE: JANUARY 2024	PROJECT NO. 03.0035109.00	REVISION NO.	SHEET NO. 82 OF 142



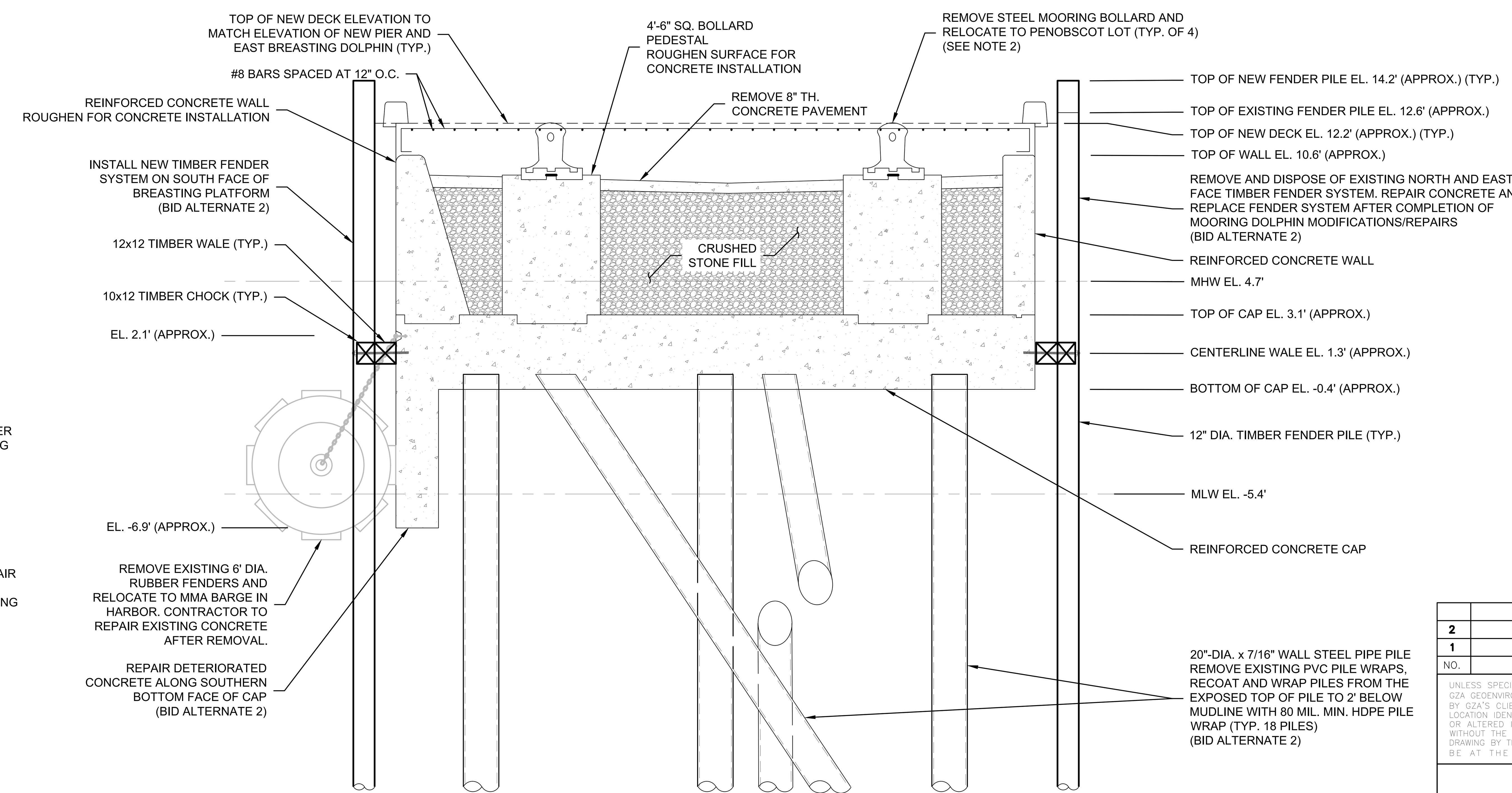
1
S-101 S-155
DETAIL - EXISTING MOORING PLATFORM (BID ALTERNATE 2)
SCALE: 1" = 8'



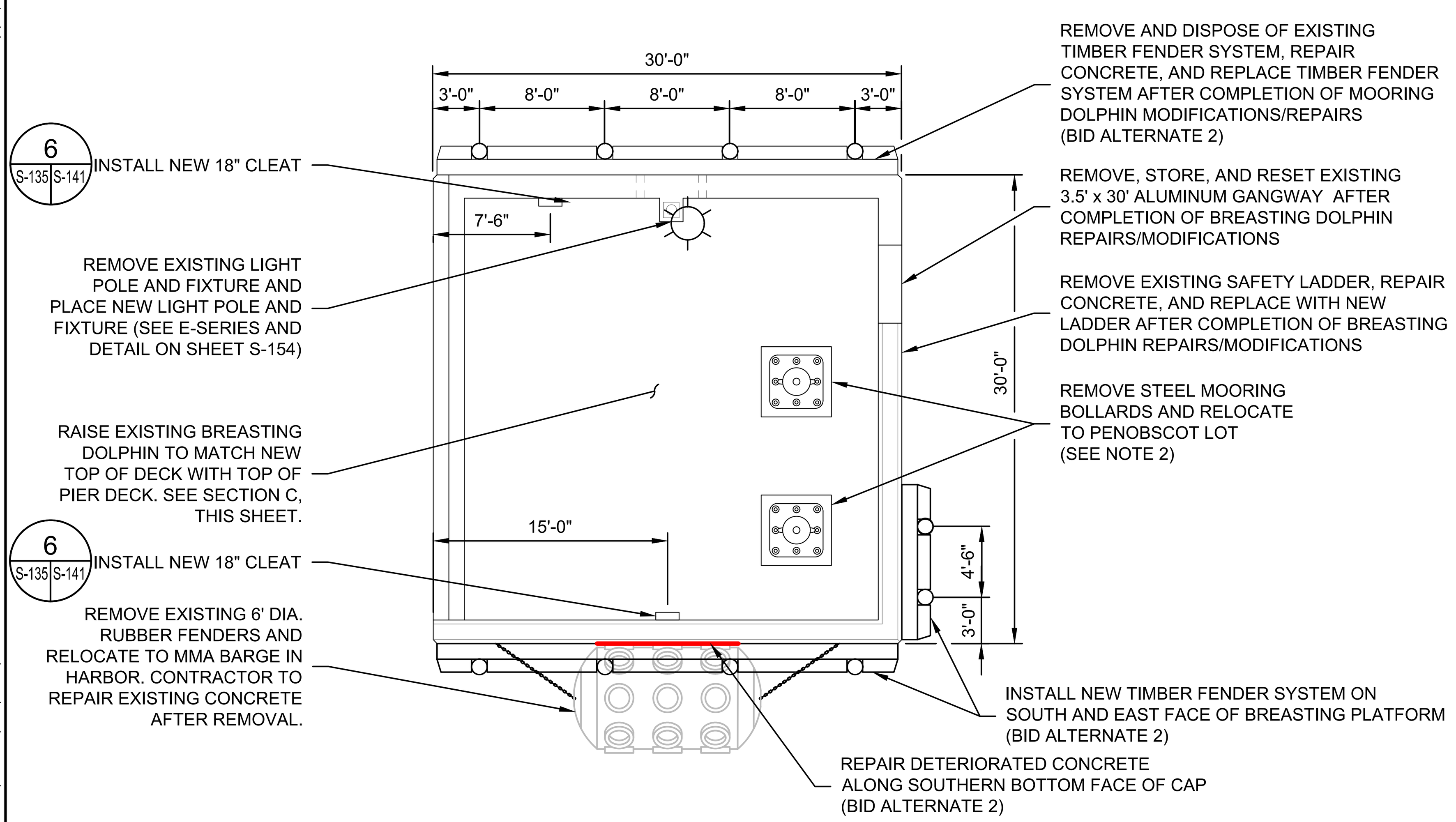
A
S-101 S-155
SECTION - EXISTING MOORING PLATFORM (BID ALTERNATE 2)
SCALE: 1" = 4'



2
S-101 S-155
DETAIL - EXISTING BREASTING PLATFORM (WEST)
SCALE: 1" = 8'



C
S-101 S-155
SECTION - EXISTING BREASTING PLATFORM (EAST)
SCALE: 1" = 4'



3
S-101 S-155
DETAIL - EXISTING BREASTING PLATFORM (EAST)
SCALE: 1" = 8'

NOTES:

1. DETAILS ON THIS SHEET ARE A COMPILATION OF AVAILABLE ARCHIVE INFORMATION. ACTUAL CONDITIONS MAY VARY. REFER TO REFERENCE DRAWINGS FOR ADDITIONAL DETAILS.
2. CONTRACTOR SHALL INSPECT THE EXISTING MOORING BOLLARDS FOR RE-USE AFTER THE COMPLETION OF THE MOORING PLATFORM MODIFICATIONS.
3. FOR DETERIORATED CONCRETE REPAIR DETAILS SEE DRAWINGS S-156

2

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

0 2.0' 4' 8' 12'
SCALE IN FEET 1" = 4'

NO.	ISSUE/DESCRIPTION	BY	DATE
2	ADDENDUM #11	DDF	4/8/2024
1	ADDENDUM #7	DDF	3/29/2024

MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

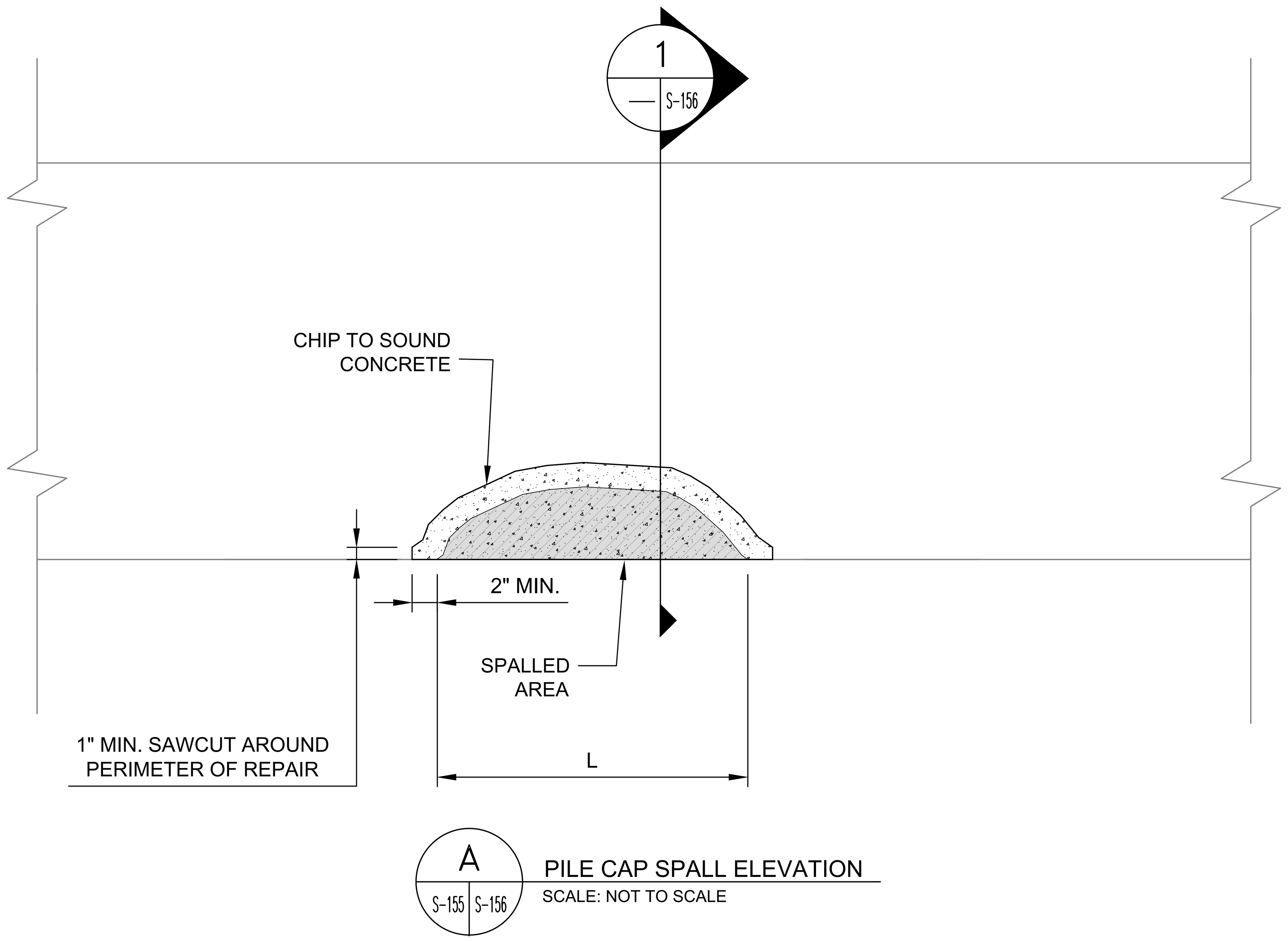
MOORING AND BREASTING PLATFORMS REPAIRS AND MODIFICATIONS

PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

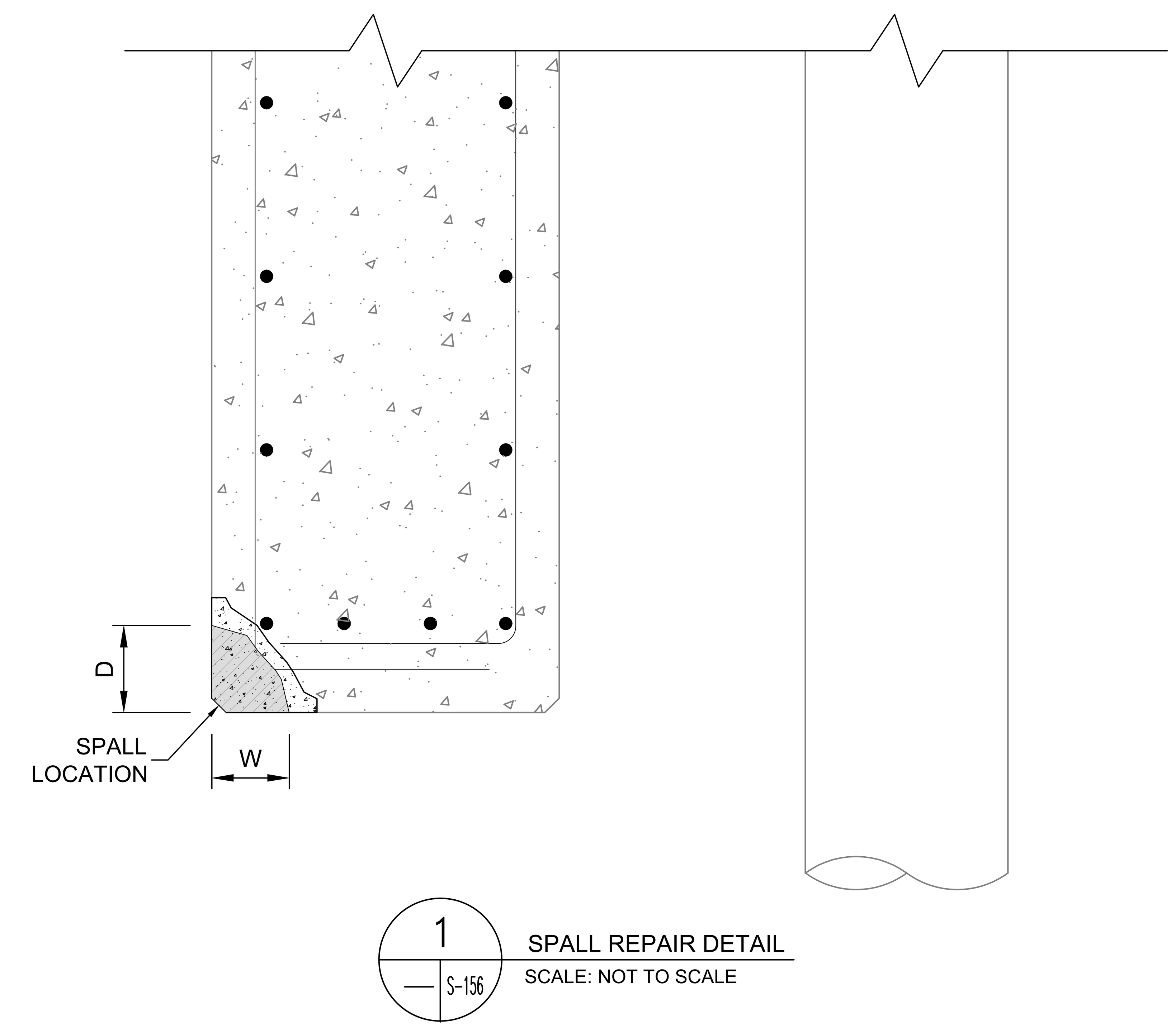
PROJ MGR: RKC	REVIEWED BY: CWC	CHECKED BY: DDF	DRAWING
DESIGNED BY:	DRAWN BY: MEA	SCALE: AS NOTED	S-155
DATE: JANUARY 2024	PROJECT NO. 35109.00	REVISION NO.	SHEET NO. 84 OF 142

MOORING AND BREASTING PLATFORM SPALL DIMENSIONS			
STRUCTURE	LENGTH 'L' (FT)	WIDTH 'W' (IN)	DEPTH 'D' (IN)
MOORING PLATFORM	2'-0"	1'-0"	1"
BREASTING PLATFROM (EAST)	4'-6"	1'-0"	4"
BREASTING PLATFROM (WEST)	6'-0"	1'-0"	6"



PILE CAP SPALL ELEVATION

SCALE: NOT TO SCALE



SPALL REPAIR DETAIL

SCALE: NOT TO SCALE

TYPICAL POLYMER CEMENT CONCRETE REPAIR SEQUENCE (4" MAX. DEPTH):

1. PROVIDE 1" DEEP SAWCUT AT EXPOSED PERIMETER OF REPAIR LIMITS.
2. REMOVE AND DISPOSE OF EXISTING DAMAGED CONCRETE WITHIN REPAIR LIMITS.
3. CLEAN EXISTING CONCRETE SURFACES THOROUGHLY WITH HIGH PRESSURE AIR OR WATER.
4. PLACE BONDING AGENT ON EXISTING CONCRETE SURFACES.
5. PLACE AND CURE POLYMER CEMENT.

TYPICAL POLYMER CEMENT REPAIR SEQUENCE (>4" DEPTH):

1. PROVIDE 1" DEEP SAWCUT AT EXPOSED PERIMETER OF REPAIR LIMITS.
2. REMOVE AND DISPOSE OF EXISTING SPALLED OR DAMAGED CONCRETE WITHIN REPAIR LIMITS. REMOVE AND DISPOSE CONCRETE TO THE REPAIR LIMITS INDICATED. IF REINFORCING IS EXPOSED, REMOVE CONCRETE TO 1" BEYOND EXPOSED REINFORCING.
3. EXISTING REINFORCEMENT IN GOOD CONDITION REMAINS IN PLACE, UNLESS NOTED OTHERWISE. REMOVE AND DISPOSE EXISTING DETERIORATED STEEL REINFORCING WITH MORE THAN 25% SECTION LOSS. INSTALL NEW REINFORCING IN REQUIRED AREAS TO MATCH EXISTING REBAR.
4. INSTALL REBAR HOOKS WHERE REQUIRED.
5. CLEAN EXISTING EXPOSED REINFORCING STEEL SURFACES IN ACCORDANCE WITH SSPC-SP6, NACE NO.3. CLEAN EXISTING CONCRETE SURFACES THOROUGHLY WITH HIGH PRESSURE AIR OR WATER.
6. PLACE BONDING AGENT ON EXISTING CONCRETE SURFACES.
7. PLACE AND CURE POLYMER CEMENT.

NOTES:

1. WATER SHALL BE POTABLE, CLEAR, AND FREE FROM OIL, ACID, ALKALI, ORGANIC MATTER, SILT, DETERGENTS, OR OTHER DELETERIOUS SUBSTANCES
2. CONTRACTOR SHALL CONTAIN ALL CONCRETE DEBRIS. NO CONCRETE DEBRIS SHALL BE ALLOWED INTO THE WATERBODY.
3. CONTRACTOR SHALL PREPARE AND SUBMIT FOR REVIEW A DESCRIPTION OF THE PROPOSED REPAIR PROCEDURES AND PRODUCTS.

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2024

0 2.0' 4' 8' 12'
SCALE IN FEET 1" = 4'

NO.	ISSUE/DESCRIPTION	BY	DATE
1	ADDENDUM #11	DDF	4/8/2024

MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

MOORING AND BREASTING PLATFORMS
REPAIRS AND MODIFICATIONS - 2
BID ALTERNATE 2

PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

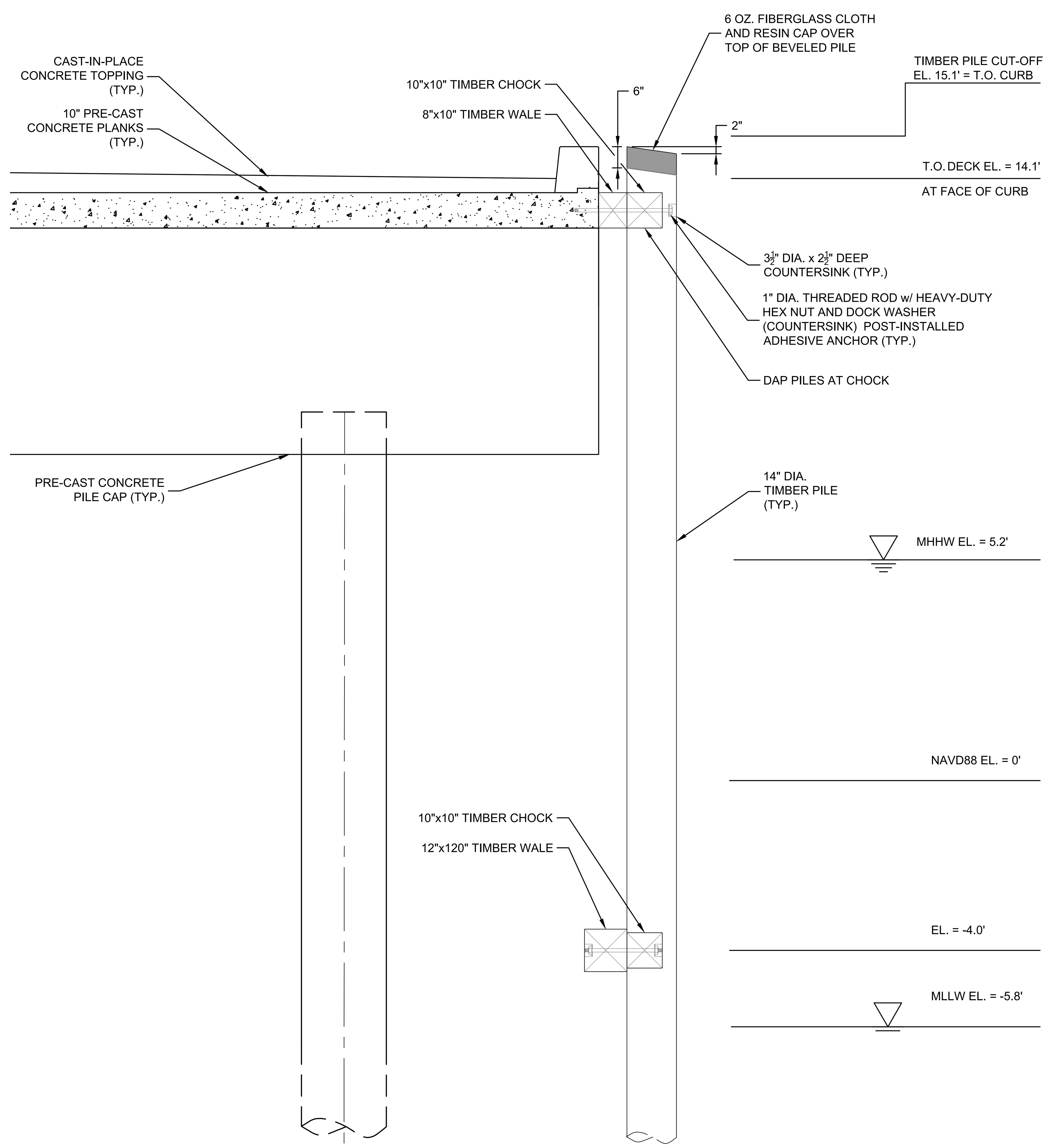
PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY: CWC	CHECKED BY: DDF	DRAWING
DESIGNED BY:	DRAWN BY: MEA	SCALE: AS NOTED	S-156
DATE: JANUARY 2024	PROJECT NO. 35109.00	REVISION NO.	SHEET NO. 85 OF 142

1 S-113 S-162 DETAIL - TIMBER FENDER PILE PLAN

SCALE: 1" = 2'

1



A S-162 - SECTION - TIMBER FENDER PILE

SCALE: 1" = 2'

TIMBER PILE LENGTHS FOR BID PURPOSES ONLY

BENTS B-G	70 L.F.
BENTS H-O	80 L.F.

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 26, 2023

0 1' 2' 4' 6'
SCALE IN FEET 1" = 2'

NO.	ISSUE/DESCRIPTION	BY	DATE
1	ADDENDUM #11	DDF	4/8/2024

MAINE MARITIME ACADEMY WATERFRONT CAMPUS
PIER UPGRADES AND WATERFRONT IMPROVEMENTS
CASTINE, MAINE

TIMBER FENDER SYSTEM SECTIONS AND DETAILS

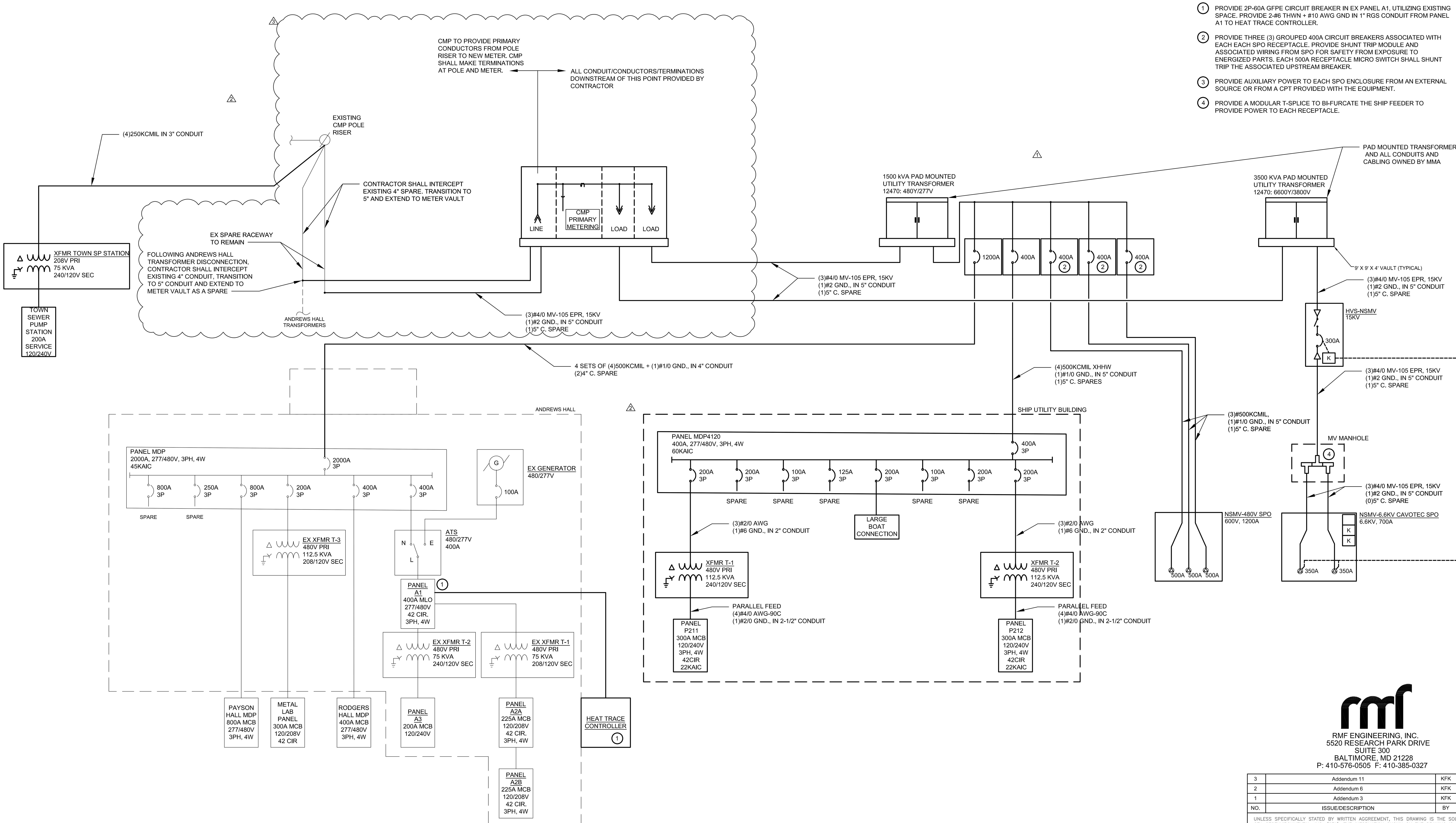
PREPARED BY: GZA GeoEnvironmental, Inc. www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: RKC	REVIEWED BY: CWC	CHECKED BY: DDF	DRAWING
DESIGNED BY: DDF	DRAWN BY: MEA	SCALE: AS NOTED	S-162
DATE: JANUARY 2024	PROJECT NO. 35109.00	REVISION NO.	SHEET NO. 91 OF 142

DRAWING NOTES:

1. PROVIDE 2P-60A GFPE CIRCUIT BREAKER IN EX PANEL A1, UTILIZING EXISTING SPACE. PROVIDE 2-#6 THWN + #10 AWG GND IN 1" RGS CONDUIT FROM PANEL A1 TO HEAT TRACE CONTROLLER.
2. PROVIDE THREE (3) GROUPED 400A CIRCUIT BREAKERS ASSOCIATED WITH EACH EACH SPO RECEPTACLE. PROVIDE SHUNT TRIP MODULE AND ASSOCIATED WIRING FROM SPO FOR SAFETY FROM EXPOSURE TO ENERGIZED PARTS. EACH 500A RECEPTACLE MICRO SWITCH SHALL SHUNT TRIP THE ASSOCIATED UPSTREAM BREAKER.
3. PROVIDE AUXILIARY POWER TO EACH SPO ENCLOSURE FROM AN EXTERNAL SOURCE OR FROM A CPT PROVIDED WITH THE EQUIPMENT.
4. PROVIDE A MODULAR T-SPLICE TO BI-FURCATE THE SHIP FEEDER TO PROVIDE POWER TO EACH RECEPTACLE.



RMF ENGINEERING, INC.
5520 RESEARCH PARK DRIVE
SUITE 300
BALTIMORE, MD 21228
P: 410-576-0505 F: 410-385-0327

NO.	ISSUE/DESCRIPTION	BY	DATE
3	Addendum 11	KFK	4/8/2024
2	Addendum 6	KFK	3/22/2024
1	Addendum 3	KFK	3/1/2024

MAINE MARITIME ACADEMY WATERFRONT IMPROVEMENTS PROJECTS
MAINE MARITIME ACADEMY WATERFRONT CAMPUS
CASTINE, MAINE

APPROVED:

STATE OF NEW YORK · JARED T. MARKLE · 107516 · LICENSED PROFESSIONAL ENGINEER

I.F.B.
NOT FOR CONSTRUCTION
JANUARY 19, 2024

ELECTRICAL ONE-LINE DIAGRAM

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com

PREPARED FOR: MAINE MARITIME ACADEMY CASTINE, ME

PROJ MGR: KFK	REVIEWED BY: KFK	CHECKED BY: AHJ	DRAWING
DESIGNED BY: KFK/RSR	DRAWN BY: RSR	SCALE: NONE	E-501
DATE: JANUARY 2024	PROJECT NO. 35109.00	REVISION NO.	SHEET NO. 134 OF 142

ENGINEERING EVALUATION REPORT

File No. 03.0035109.00
October 14, 2022
03.0035109.00

To: Internal Project Memorandum

From: Michael Gardner, WEDG
Daniel Stapleton, P.E.

Re: Engineering Evaluation Report - Metocean Data Analysis
Maine Maritime Academy
Castine, Maine

This report presents the results of the Metocean Data Analysis performed by GZA GeoEnvironmental (GZA) in support of evaluation and design of proposed improvements at the Massachusetts Maritime Academy (MMA) Waterfront Campus. This report is subject to the Limitations presented in **Attachment 1**.

PURPOSE

The MMA is planning improvements to the facility site and waterfront. These improvements include a modification of the existing pier or new pier for berthing of the 525-foot long National Security Multi-Mission Vessel (NSMV).

The purpose of GZA's metocean data analysis is to characterize the environmental site conditions applicable to: 1) evaluation of facility vulnerability to coastal flooding; 2) design of waterfront structures; and 3) evaluation of vessel mooring requirements. The environmental conditions evaluated include: 1) wind; 2) water level (tidal and coastal flood); 3) waves (height, period and direction); and 4) tidal and wind-generated currents.

GZA's evaluation characterizes the environmental conditions for a range of annual recurrence interval floods up to the 100-year recurrence interval event.

GZA's metocean data analysis was based on available existing data sources and included:

- Storm Typology
- Wind Intensity and Direction
- Tidal Datums
- Tidal and Wind-Generated Currents
- Relative Sea Level Rise
- Extreme (Coastal Storm Tide) Water Levels
- Deepwater Wave Heights and Periods
- Synthetic Hydrographs
- Precipitation

GZA developed also developed a Digital Elevation Model (DEM) representing bathymetric and topographic conditions.

METHODOLOGY AND STUDY DETAILS

The methodology and study details are presented in the **Attachments**. The report "Heavy Weather Mooring, Maine Maritime Academy", prepared by Glosten and dated January 20, 2022 includes some metocean data used for analysis and design of an alternative NSMV mooring configuration. GZA reviewed that report as part of our metocean data analysis.

RESULTS

GZA completed metocean data analyses to characterize the environmental wind, water level, wave and currents to be used for: 1) flood hazard characterization; 2) flood resilience planning and design; and 3) development of environmental hydrostatic, hydrodynamic and wave loads applied to the proposed waterfront structures, under current and future sea level conditions (evaluated for 25, 50 and 75-year milestones). The metocean data analysis utilized multiple, authoritative, publicly available data sources as well as GZA analyses.

COASTAL SETTING

The project site is located on the southeastern shore of Castine, Maine. The project site's shoreline abuts Castine Harbor, which is hydraulically connected to Penobscot Bay, the Gulf of Maine, and the Atlantic Ocean. See **Figures 1** and **2** for the project site location. The project site is located on a southward facing peninsula. The site abuts a relatively narrow, deep channel separating Castine, ME and several islands off of Brooksville, ME. The orientation of the channel trends northeast to southwest (approximately 50 degrees from true north). The shoreline in the vicinity of the project area is approximately parallel to the channel.

The facility includes a series of shore-parallel (northeast-southwest) docks and piers, including berthing for a large vessel.

The configuration of the channel and landforms affects wind, waves, currents and water levels affecting the project site. In particular, wind and waves from the south and southwest transform around the islands and enter the channel and harbor. Tidal currents also flow in a northeast-southwest direction. In addition to the southwest-northeast fetch, the MMA piers are also exposed to an approximately 2.5-mile fetch to the southeast.

Bathymetry and Topography

The bathymetry in the vicinity of the project site is presented in **Attachment 2** and includes a naturally deep navigation channel (Elevation -80 feet NAVD88), which extends into the Gulf of Maine. The bathymetry at the deepwater pier is about -40 feet NAVD88.

The project site upland area topography is generally around Elevation 10 to 12 feet NAVD88 at the waterfront (Sea Street) and slopes up to 70 to 120 feet NAVD88 within the campus area.

Tides

The tidal datums at MMA were developed based on NOAA tide stations at Bar harbor and Portland as well as NOAA tidal simulations at Castine. **Attachment 4** presents tidal datum details. Tidal datums at Castine are presented in **Table 2**.

Prevailing Winds

The prevailing winds are from the North and the South-Southwest with sustained wind speeds on the order of 5 to 25 miles per hour (mph) – see **Attachment 3**.

STORM TYPOLOGY

Extreme conditions of wind, water levels, waves and currents are the non-prevailing conditions that occur during coastal storm events. For this study, these coastal storm environmental conditions are characterized in terms of annual exceedance probability (defined as annual recurrence intervals) ranging from 1-year to 100-year recurrence interval.

For recurrence intervals ranging from 1-year to about 50-years, the environmental conditions result predominantly from extratropical and post-tropical storms including large synoptic extratropical storms ("Nor-easters") and post-tropical tropical storms. Tropical cyclones (tropical storms and hurricanes) contribute to the environmental conditions with lower probability events (recurrence intervals at and greater than 50 to 100 years). The top 10 recorded coastal flood events at the NOAA Portland and Bar Harbor tidal stations have been due to extratropical Nor-easters (e.g., January 2018). Tropical cyclones (any category hurricane) in the project vicinity occur with an approximately 50-year frequency (with major hurricanes of category 3 or greater occurring with about a 290-year frequency. Tropical storms and post-tropical storms occur with greater frequency. The cooler waters of the Gulf of Maine and Penobscot Bay tend to reduce tropical storm intensity north of Cape Cod.

Consistent with the site coastal setting, historical storm tracks and observed winds, the wind directions for these storm types in the vicinity of the project can be of varied direction.

EXTREME WINDS

Extreme winds were evaluated based on statistical analysis of Bar Harbor airport data and comparison to ASCE 7 wind speeds. The data indicate that intense wind directions can be variable, with the predominant intense winds (up to about 40 mph) coming from a northerly direction and the most intense winds (>50 mph) observed from a southerly direction.

Attachment 3 presents wind details. The all-direction 1-minute sustained wind speed ranges from about 60 mph (10-year recurrence interval) to 74 mph (100-year recurrence interval). Inferred all-direction wind intensities for different recurrence intervals and time averaging durations are summarized in **Table 3**.

EXTREME WATER LEVELS

The project site and vicinity are vulnerable to coastal flood inundation and waves. As shown by the effective FEMA FIS (**Attachment 7**), the MMA waterfront area (up to about Sea Street) floods during the 100-year recurrence interval flood. Flood pathways include flood inundation due to stillwater elevations exceeding the ground surface elevations. Coastal flooding also includes the effects of waves including wave run-up and overtopping and transformation at the waterfront and adjacent inland area.

Extreme stillwater water levels that are predicted to occur during coastal storms under the current climate and sea level (based on several data sources) are presented in **Attachment 8** and are summarized in **Table 1**. The FEMA 100-year recurrence interval flood stillwater elevation, which is based on interpolation of historical, observed water levels) is 9.6 feet NAVD88. The USACE North Atlantic Coast Comprehensive Study (NAACS), which is developed with an alternative methodology, estimates Mean and Upper Bound 100-year stillwater elevations of 8.7 and 11.7 feet NAVD88, respectively.

Sea level rise will increase the antecedent tidal levels, which will in turn increase the flood stillwater elevations. This increase is hydrodynamic, in particular within sheltered waters like Castine Harbor. However, a preliminary estimate of the effect (with uncertainty) can be made by linearly superimposing sea level rise to the currently predicted stillwater elevation. Using an intermediate-high SLR projection of 2, 3 and 4 feet by 2050, 2075 and 2100 and preliminarily assuming linear superposition the current FEMA stillwater elevation for the 100-year recurrence interval of 9.6 feet NAVD88 would increase to approximately 11.6, 12.6, and 13.6 feet NAVD88, respectively.

EXTREME WAVES

Castine Harbor is sheltered from larger oceanic waves and swells by several offshore islands to the South, East, and West. Although the Harbor is sheltered from larger oceanic waves, some offshore wave energy within Penobscot Bay can reach the harbor from the southwest. The harbor is exposed to local wind-driven waves from the southwest, where open exposure to the fetch can extend for greater than 7 miles and the southeast (approximately 2.5-mile fetch). The effective FEMA FIS indicates a coastal high hazard (high velocity) VE flood hazard zone along the shoreline (indicating waves greater than 3 feet), with a Base Flood Elevations (BFE) of 13 feet NAVD88.

Wave heights in the vicinity of the MMA waterfront structures and shoreline were estimated based on: 1) the results of the USACE NAACS study; and 2) wind-wave analytical calculations by GZA. The report “Heavy Weather Mooring, Maine Maritime Academy” also presented a wave height in the harbor area based on numerical SWAN modeling. GZA also reviewed deep water wave heights.

The USACE Wave Information Study (WIS) buoys and the NOAA National Data Buoy Center (NDBC), both have wave buoy points at the mouth of the Penobscot Bay, with NOAA having a physical buoy with real-time wave measurements. More details are provided in **Attachment 10**.

USACE NACCS save points in Castine Harbor were reviewed including significant wave heights (Hs) and their upper confidence intervals. The NACCS save points at the site indicated 100-year recurrence interval mean significant wave heights of 7.7 feet at the channel entrance, 5.1 feet in the harbor and 4.3 feet at the deep-water pier (with an upper confidence wave height at the pier of 8.5 feet). Although the NAACS study does not provide wave vectors, it is expected that the directions of the waves presented above are predominantly from the southwest.

A fetch limited analysis to determine nearshore waves was performed by GZA. Several different fetch directions were evaluated for nearshore wave heights and directions at the site. The analysis results predict wave heights of 5.1 feet associated with a southerly wind fetch and wind speeds consistent with a 100-year annual recurrence probability event. The analysis also indicated wave heights on the order of 3 feet from the northeast and southeast directions during a 100-year wind event.

Modeled wave heights presented in the report “Heavy Weather Mooring, Maine Maritime Academy” were 3.9 to 5.1 feet for the 10 and 100-year recurrence event, respectively.

Wave periods for the local wind-generated waves are on the order of 3 seconds. Wave periods of waves propagating from the Bay are on the order of 6 seconds.

Summary provided in **Tables 5 through 7** and in **Attachment 10**.

CURRENTS

Currents occur predominantly due to tidal circulation currents (tidal currents), wave-induced currents and wind-induced currents. The intensity and direction of these currents vary from prevailing conditions (e.g., tidal currents due to astronomical tides) to coastal storm conditions. There is limited observed current data in the project vicinity.

Attachment 5 presents an evaluation of tidal currents at Hosmer Ledge in Castine Harbor (near the project site). Normal tidal current velocities in the vicinity of the project site under typical tide and prevailing wind conditions are less than 1.8 knots. Tidal current vector directions range from about 50 degrees from true north (flood conditions) to about 240 degrees (ebb conditions). Extrapolation of NOAA predicted currents was performed to estimate tidal current velocities associated with coastal storm events and summarized in **Table 4** at a depth of 13 feet. See **Attachment 5** for tidal current velocities at other water depths.

Local wind-generated currents were estimated based on sustained wind speed. This occurs when wind forcing on the water's surface generates water movement. Approximately 3-5% of the 10-minute sustained wind speed can be used to estimate the wind-induced current at the water surface. For the site, 5% of the 10-minute sustained wind current equates to about 2.7, 2.9, 3.1, and 3.3 knots for the 10, 25, 50, and 100-year recurrence interval events, respectively. These values decrease with depth and are not representative of overall water movement. The wind-generated velocities at about 13 feet depth are about 80% of the water surface values.

The effects of wave-induced currents are included in typical hydrodynamic and wave load calculations based on wave height and period and are not calculated here.

EFFECTS OF CLIMATE CHANGE

Climate change is expected to affect the area tidal response, coastal flood water levels and frequency, wave heights and frequency and precipitation intensity and frequency. Climate change may also affect the relative influence of coastal storm types, with the contribution of tropical cyclones (hurricanes) increasing with higher probability.

The most significant and best documented of climate change factors is relative sea level rise which will change tidal elevations as well as increase antecedent water levels during coastal storms, both increasing the project site's flood hazard risk. Increases in precipitation intensity and frequency and an increase in rain precipitation versus snow will affect stormwater run-off and stormwater-related flooding.

The selection of an appropriate sea level rise projection is dependent upon the project risk tolerance, which is typically related to the site use and occupancy and the expected losses (physical damage, disruption of operations, etc.) due to coastal flooding. It is also based on the proposed service life and the ability of the facility to readily adapt to increasing sea levels. **Attachment 8** presents details relative to relative sea level rise. Recently updated NOAA projections (Intermediate to High projections) predict 1.5 feet to 3 feet by 2050 (relative to 2000).

SUMMARY OF ENVIRONMENTAL CONDITIONS

A summary table of the environmental condition results to be expected at the site under the 10-, 50-, and 100-year recurrence interval event is displayed in **Table 9**.

ATTACHMENTS

Figures
Attachment 1 – Limitations
Attachment 2 – Bathymetry and Topography
Attachment 3 – Wind Characteristics
Attachment 4 – Tidal Datums
Attachment 5 – Tidal Currents
Attachment 6 – Coastal Storm Typology
Attachment 7 – Extreme Water Levels
Attachment 8 – Projected Sea Level Rise
Attachment 9 – Deepwater and Nearshore Waves
Attachment 10 – Synthetic Hydrographs
Attachment 11 – Precipitation

Tables

Recurrence Interval Event	NOAA Bar Harbor Tide Station; Stillwater Elevation (ft, NAVD88)	NOAA Portland Tide Station; Stillwater Elevation (ft, NAVD88)	2012 USACE Report at Castine (ft, NAVD88)	Effective FEMA Stillwater Elevation (ft, NAVD88)	NACCS Mean Water Level Save Point 7194 (ft, NAVD88)	NACCS 95% Confidence Water Level Save Point 7194 (ft, NAVD88)
1-year	7.6	7.0	-	-	6.4	8.5
2-year	8.2	7.6	-	-	6.9	9.1
5-year	-	-	-	-	7.4	9.7
10-year	8.7	8.2	8.4	8.1	7.6	10.3
50-year	-	-	9.3	9.1	8.1	11.2
100-year	9.4	9.2	9.6	9.6	8.7	11.7
500-year	-	-	10.8	10.1	10.9	14.0

Table 1: Water Levels in Penobscot Bay

Datum	Height (ft, NAVD88)	Height (ft, MLLW)
MHHW	5.2	11.0
MHW	4.7	10.6
NAVD88	0.0	5.8
LMSL	-0.3	5.5
DTL	-0.3	5.5
MTL	-0.3	5.5
MLW	-5.4	0.4
MLLW	-5.8	0.0

Table 2: Castine, Maine Tidal Datums

Recurrence Interval Event	GZA Wind Evaluation (1-to-2-minute, mph)	ASCE 7-16 Transformed Winds (mph)	ASCE 7-16 Transformed Winds (10-minute, mph)	ASCE 7-16 Transformed Winds (30-second, mph)
10-year	53	57 (2-min) / 59 (1-min)	53	66
25-year	58	62 (2-min) / 64 (1-min)	58	72
50-year	60	66 (2-min) / 69 (1-min)	62	77
100-year	62	71 (2-min) / 74 (1-min)	67	83

Table 3: Wind Intensities for Different Recurrence Intervals - Castine, Maine

Recurrence Interval (years)	Current Velocity (knots)	Current Velocity (fps)	Tidal Condition
Annual High – Astronomical Tides	1.7	2.9	Both Ebb and Flood
10	2.0	3.4	Both Ebb and Flood
50	2.3	3.9	Both Ebb and Flood
100	2.6	4.4	Both Ebb and Flood
500	2.8	4.7	Both Ebb and Flood

Table 4: Hosmer Ledge Castine, ME Predicted Current Velocities at a Depth of 13 feet

Recurrence Interval Event	Wind (2-minute, mph)	Significant Wave Height (feet)	Peak Wave Period (s)
10-year	57	3.9	3.0
50-year	66	4.7	3.2
100-year	71	5.1	3.3

Table 5: Fetch-Limited Wave and Wave Period Results – Southwest Fetch (7.3 miles)

Recurrence Interval Event	Wind (2-minute, mph)	Significant Wave Height (feet)	Peak Wave Period (s)
10-year	57	2.1	2.0
50-year	66	2.5	2.1
100-year	71	2.8	2.2

Table 6: Fetch-Limited Wave and Wave Period Results – Southeast Fetch (2.1 miles)

Recurrence Interval Event	Wind (2-minute, mph)	Significant Wave Height (feet)	Peak Wave Period (s)
10-year	57	2.2	2.1
50-year	66	2.6	2.2
100-year	71	2.9	2.2

Table 7: Fetch-Limited Wave and Wave Period Results – Northeast Fetch (2.2 miles)

Recurrence Interval Event	NACCS Point 7031 (Height, ft)	NACCS Point 7194 (Height, ft)	NACCS Point 18336 (Height, ft)
1-year Mean	**3.1**	**2.4**	**2.6**
1-year Upper	7.2	6.6	6.8
10-year Mean	**5.5**	**3.3**	**3.9**
10-year Upper	9.6	7.5	8.0
50-year Mean	**7.0**	**4.0**	**4.7**
50-year Upper	10.9	8.1	8.7
100-year Mean	**7.7**	**4.3**	**5.1**
100-year Upper	11.6	8.5	9.0
500-year Mean	**9.1**	**5.2**	**5.8**
500-year Upper	12.8	9.3	9.7

Table 8: Summarizes Select, Representative NACCS Save Point Wave Heights, Including Upper Confidence Intervals

Recurrence Interval Event	ASCE 7-16 Transformed Winds – All Direction (30-second, mph)	GZA Analysis of Nearshore Wave and Wave Period – Southwest Direction	GZA Analysis of Nearshore Wave and Wave Period – Southeast Direction	Tidal Current Velocity at 13 feet (from 240° & 50°, knots)	Wind Current Velocity at Surface (SW Wind, knots)
10-year	66	3.9ft 3s to 6s	2.1/2s	2.0	2.7
50-year	77	4.7ft 3.2s to 6s	2.5/2.1s	2.3	3.1
100-year	83	5.1ft 3.3s to 6s	2.8/2.2s	2.6	3.3

Table 9: Environmental Condition Results – Summary Table

Figures

Figure 1 - Site Locus

Figure 2 - Site Location

Attachment 1
Limitations

USE OF REPORT

1. GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of the Client for the stated purpose(s) and location(s) identified in the Report. Use of this Report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).
3. The interpretations and conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of the described services. The work described in this report was carried out in accordance with the agreed upon Terms and Conditions of Engagement.
4. GZA's metocean data analysis and wave evaluation were performed in accordance with generally accepted practices of qualified professionals performing the same type of services at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.
5. Unless specifically stated otherwise, the evaluations performed by GZA and associated results and conclusions are based upon evaluation of historic data, trends, references, and guidance with respect to the current climate and sea level conditions. Future climate change may result in alterations to inputs which influence the environmental conditions at the site (e.g. rainfall totals, storm intensities, mean sea level, etc.). Such changes may have implications on the estimated flood elevations, wave heights, flood frequencies and/or other parameters contained in this report.

RELIANCE ON INFORMATION FROM OTHERS

6. In conducting our work, GZA has relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Any inconsistencies in this information which we have noted are discussed in the Report.

COMPLIANCE WITH CODES AND REGULATIONS

7. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations with codes and regulations by other parties are beyond our control.

ADDITIONAL INFORMATION

8. In the event that the Client or others authorized to use this report obtain information on conditions at the site(s) not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the opinions stated in this report.
9. The was performed using the SWAN 2D model, which does not include circulation and dynamic water level changes. Additional modeling would be required to refine the flood-frequency curves at the project site(s) and to include wave effects concurrent with flood hydrographs and flow velocities.

UNCERTAINTY

1. The prediction and statistical projection of metocean data includes several significant sources of uncertainty including: a) limited period of observation record; b) limited observation locations; and c) statistical uncertainty.
2. Numerical modeling of waves includes several significant sources of uncertainty including: a) model error; and b) model simplicity.
3. The report presents highly approximate information for current velocities, in particular under storm conditions.

The inherent uncertainties includes in GZA's study should be considered when interpreting and applying the results presented herein. GZA has not directly estimated uncertainty in this report. Quantitative estimates of uncertainty have been developed by USACE NAACS.

Attachment 2
Bathymetry and Topography

TOPOGRAPHIC AND BATHYMETRIC DATA

GZA developed a Digital Elevation Model of the site and vicinity topography and bathymetry. The topographic and bathymetric data sources used to create the DEMs include the following:

NOAA Data Access Viewer (DAV)

The NOAA DAV was used to access bathymetry and topography data for the project area. The NOAA DAV is a national repository for available elevation (LiDAR), imagery and land cover data for the coastal U.S. and its territories. The data, hosted by the NOAA Office for Coastal Management, is customized to a selected area and provided as a downloadable file. The specific data sources used:

- Continuously Updated Digital Elevation Model (CUDEM) - 1/9 Arc-Second Resolution Bathymetric-Topographic Tiles.) These data come from a continuous development of digital elevation models (DEMs) by NOAA's National Centers for Environmental Information (NCEI) for the U.S. coast. Database attributes include:
    - Data Source: Raster Digital Elevation Model
    - Note: The dataset as a whole was last modified 12/16/2021, however this does not necessarily mean the data at the project area is current as of that date.
    - Cell size (m): 3.00
    - Vertical Accuracy (cm): 50 - Not tested
    - Vertical Datum: NAVD88

NOAA Navigation Charts

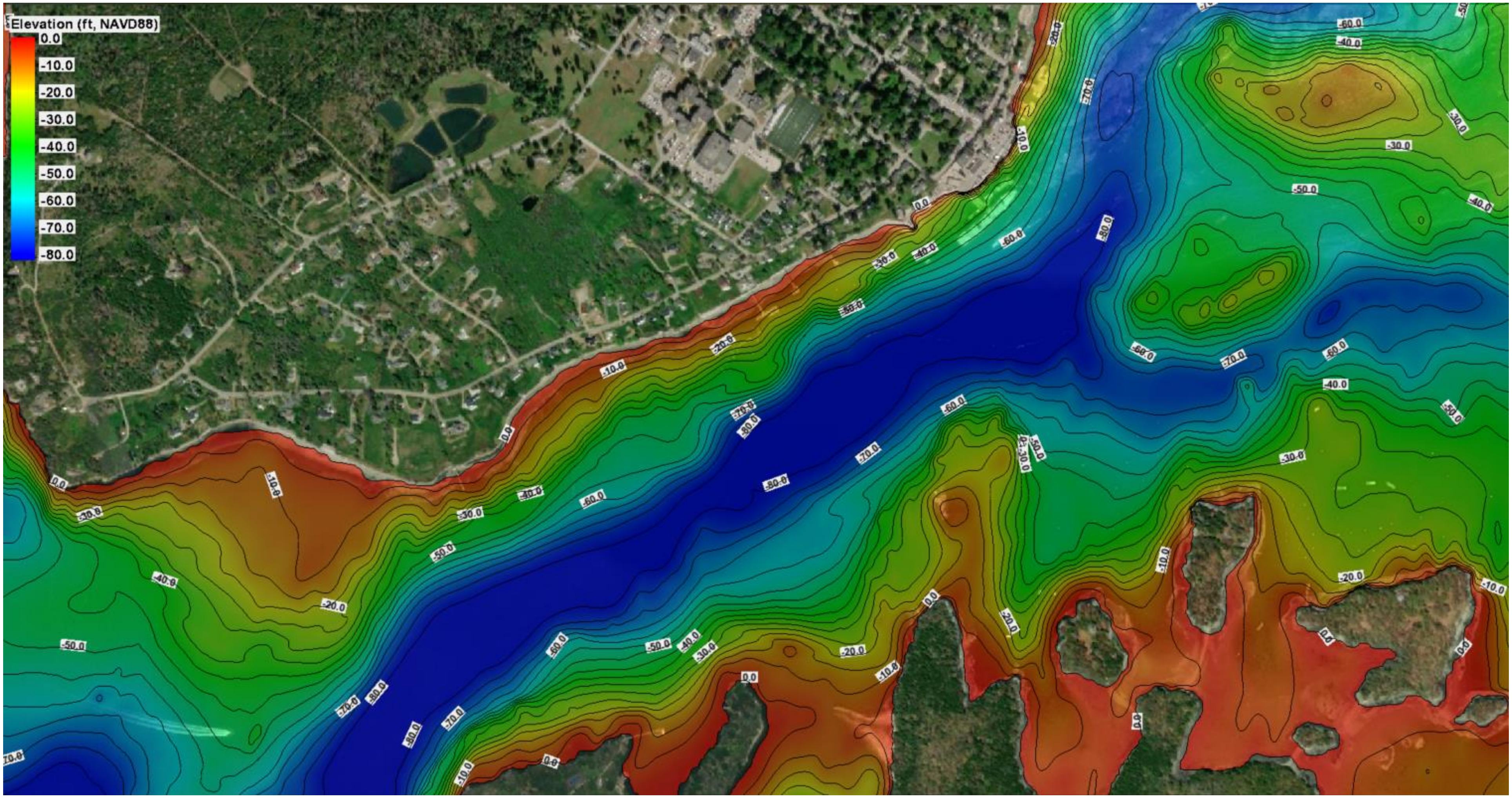
NOAA's Office of Coast Survey maintains the nation's nautical charts and publications for U.S. coasts and the Great Lakes. They use hydrographic surveys to collect depth measurements for nautical charts to provide safe and efficient navigation.

GZA also utilized NOAA's electronic navigation charts for purposes of: 1) evaluation of the coastal site setting; and 2) a visual check on the other bathymetric data sources. **Attachment 2 Figure 2** presents the NOAA Nautical Chart segment for the project area.

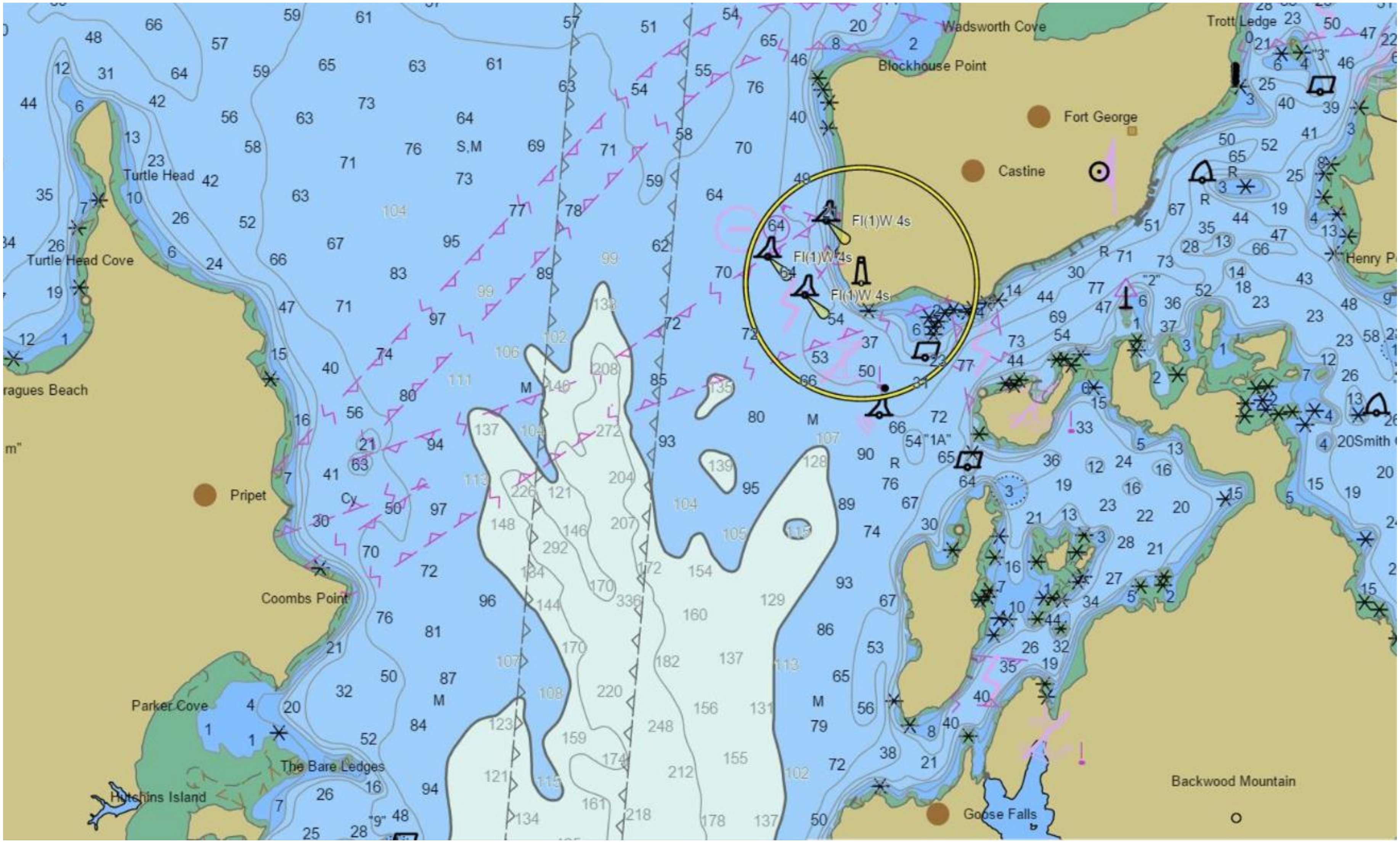
TOPOBAYTHMTRIC DIGITAL ELEVATION MODELS

GZA converted the data into a topobathymetric digital elevation models (TBDEM), expressing elevations relative to the NAVD88 vertical datum and NAD83 horizontal datum.

Attachment 2 Figure 1 presents a portion of the TBDEM in the vicinity of the project site.



Attachment 2 Figure 1 - Topobathymetric Digital Elevation Model (TBDEM) for the Project Area. Relative to NAVD88 datum in feet.



Attachment 2 Figure 2 - NOAA Nautical Chart for the Project Area. Relative to MLLW datum in feet

Note: NOAA electronic navigational chart (NOAA ENC®) data with "traditional paper chart" symbology

Attachment 3
Wind Characteristics

GZA WIND ANALYSIS

Wind Source Data

Hourly wind data at Bar Harbor Airport was downloaded from Iowa State University Environmental Mesonet. The record covers 1942 through 2021, a total of 79 years.

Station ID	Station Name	Lat (deg)	Long (deg)	Elevation (ft)	Archive Begins	IEM Network
BHB	BAR HARBOR (AWOS)	44.449	-68.362	26	Nov 02, 1942	ME_ASOS

GZA Evaluation (Updated 10/2022)

GZA compiled and analyzed wind data for the BHB airport from Iowa State University Environmental Mesonet. GZA conducted statistical analysis of the wind data representing both the prevailing and extreme conditions. The data source is NOAA's National Centers for Environmental Information (formerly the National Climatic Data Center (NCDC), data accessible at https://www.ncdc.noaa.gov/). The available wind record at Logan International Airport (BOS) includes a 77-year record (1942 – 2019) of hourly wind data of speed and direction (10-meter, 1 and 2-minute averaging duration).

The wind information includes:

- Prevailing Winds: The prevailing wind is the wind that blows most frequently across a particular region. Specifically, it is the dominant, non-storm wind that blows most frequently across a particular region. GZA's prevailing wind figure indicates the 1 and 2-minute, 10-meter sustained wind speed cumulative non-exceedance probability (in percent and miles per hour) of the complete wind dataset, analyzed by 22.5-degree directional bins and cumulatively for all directions. Directions are presented as clockwise from true north and indicate the direction from which the winds blow.
- Wind Roses: A wind rose is a graphic tool that presents a succinct view of how wind speed and direction are typically distributed at a particular location. Presented in a circular format, the wind rose shows the frequency of winds blowing from particular directions over a specified period. The length of each "spoke" around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each concentric circle represents a different frequency, emanating from zero at the center to increasing frequencies at the outer circles. Wind roses typically use 16 cardinal directions, such as north (N), NNE, NE, etc., although they may be subdivided into as many as 32 directions. In terms of angle measurement in degrees, North corresponds to 0°/360°, East to 90°, South to 180° and West to 270°. The information presented includes the entire annual wind data set over the 38-year period from 1974 to 2022. The results presented include the 1 and 2-minute, 10-meter sustained wind speed in mph.
- Extreme Winds: Extreme Winds include those wind events that exceed typical prevailing winds and are typically associated with tropical depressions and cyclones, extratropical cyclones such as Nor'easters and convective and non-convective events including tornados and thunderstorms. GZA performed statistical analysis of the observed 1 and 2-minute, 10-meter sustained monthly maximum wind data extracted from the data set, using the Generalized Extreme Value (GEV) distribution and the MathWorks© software (MATLAB). The three cases covered by the GEV distribution are often referred to as the Types I, II, and III. Each type corresponds to the limiting

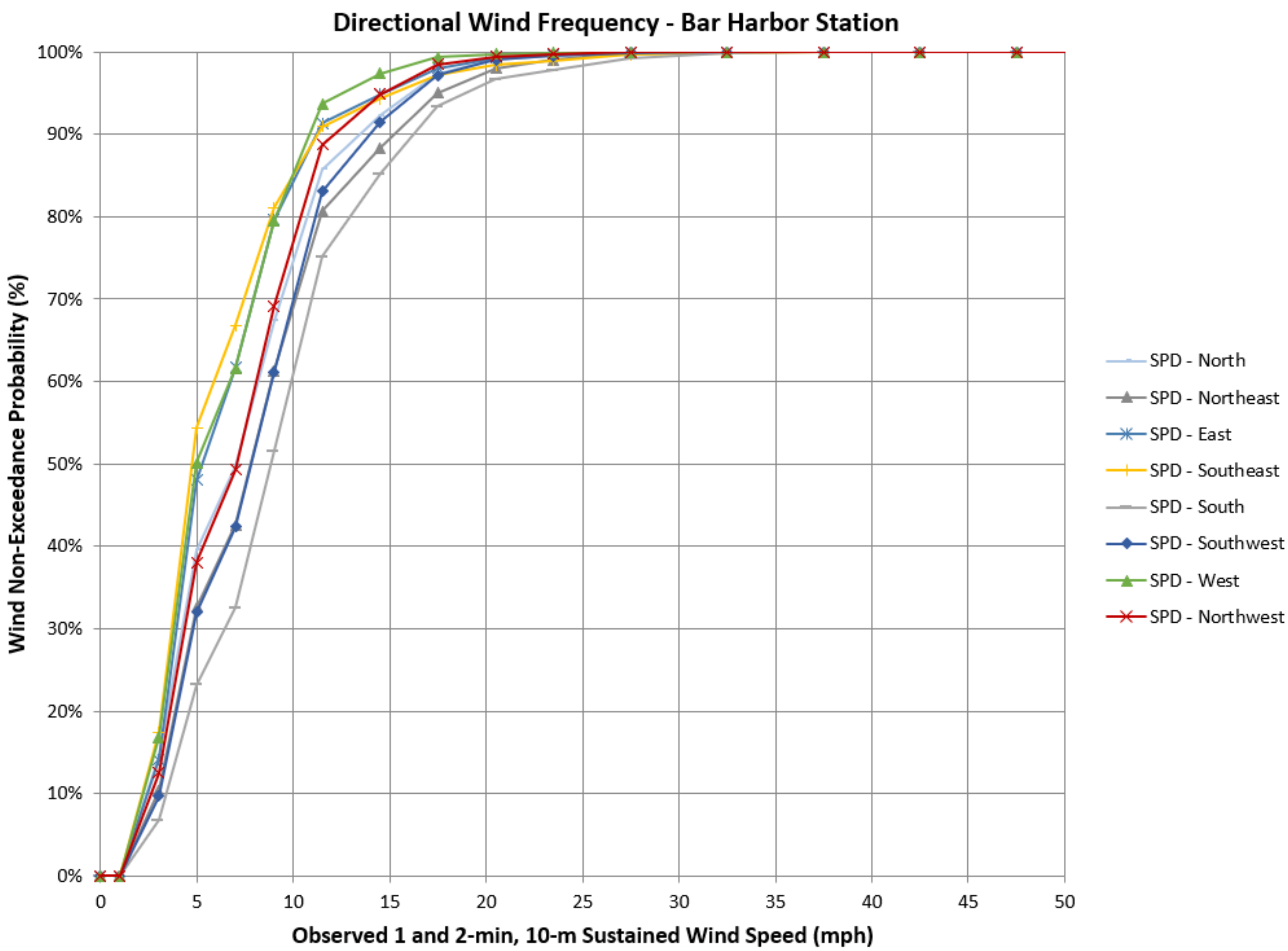
distribution of block maxima from a different class of underlying distributions. Statistical analyses were performed for the complete wind dataset for all-direction and for eight directional 45-degree data bins (i.e., North, Northeast, East, Southeast, South Southwest, West, and Northwest). GZA's Extreme Wind Frequency results include the Best Fit of the 1 and 2-minute, 10-meter sustained wind speed annual exceedance probability (in terms of recurrence interval in years and wind speed in miles per hour). Directions are presented as clockwise from true north and indicate the direction from which the winds blow.

ASCE 7-16

The predicted wind speeds (3-second gust at 10 meters; Exposure C) presented in ASCE 7-16 were transformed to 1,2-minut sustained wind speeds at 10-meters for comparison with the statistical analysis of observed airport wind data.

Limitations

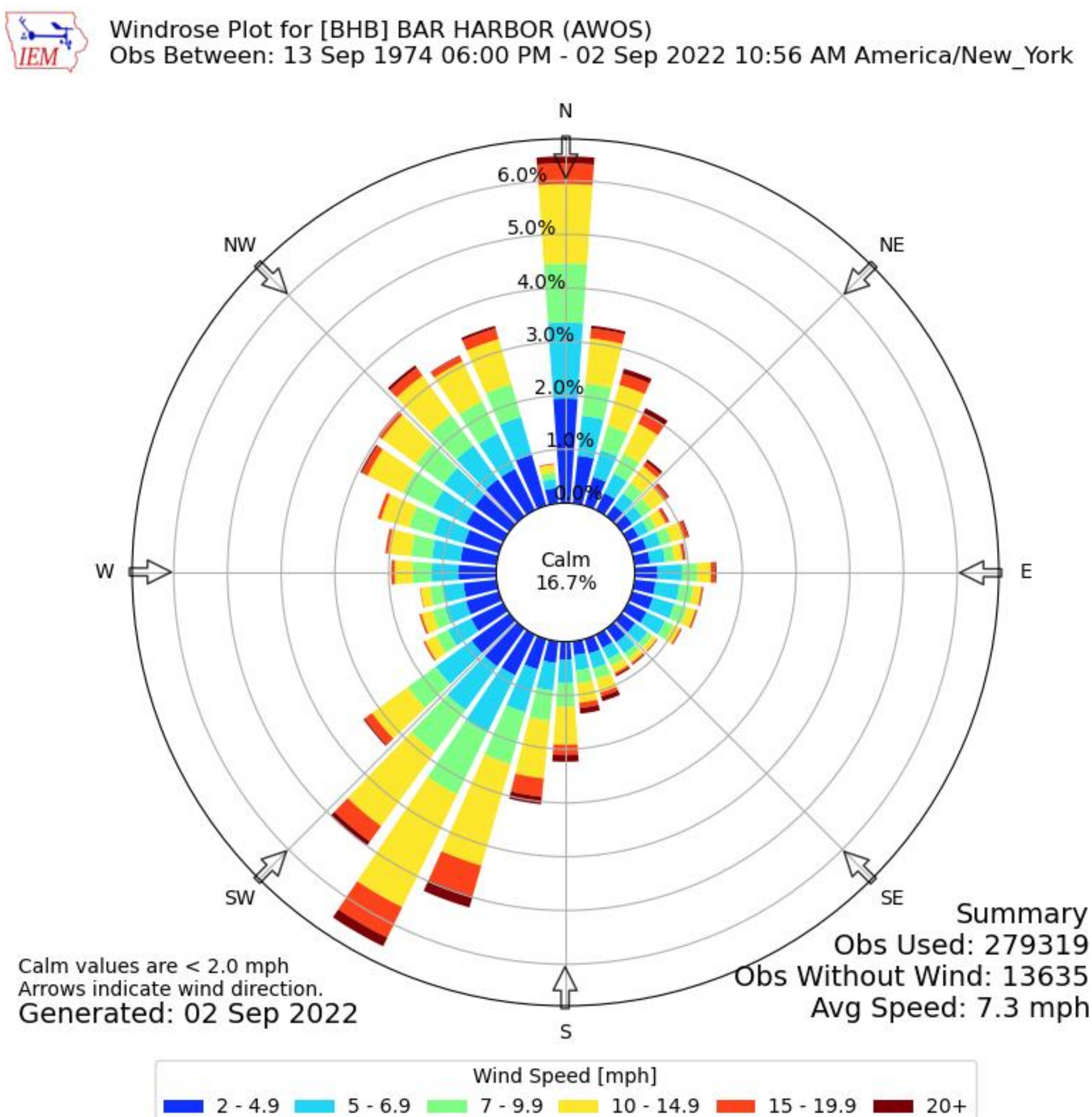
The period of record does not include significant wind events outside the period of record, which inclusion may influence the statistical analysis. Wind speed recommendations presented in ASCE 7-10 and 7-16 were reviewed and compared for consistency. The limited data set analyzed in the directional wind analysis may result in significant analysis uncertainty. The selection of wind speeds for design is based on available data and engineering judgement.



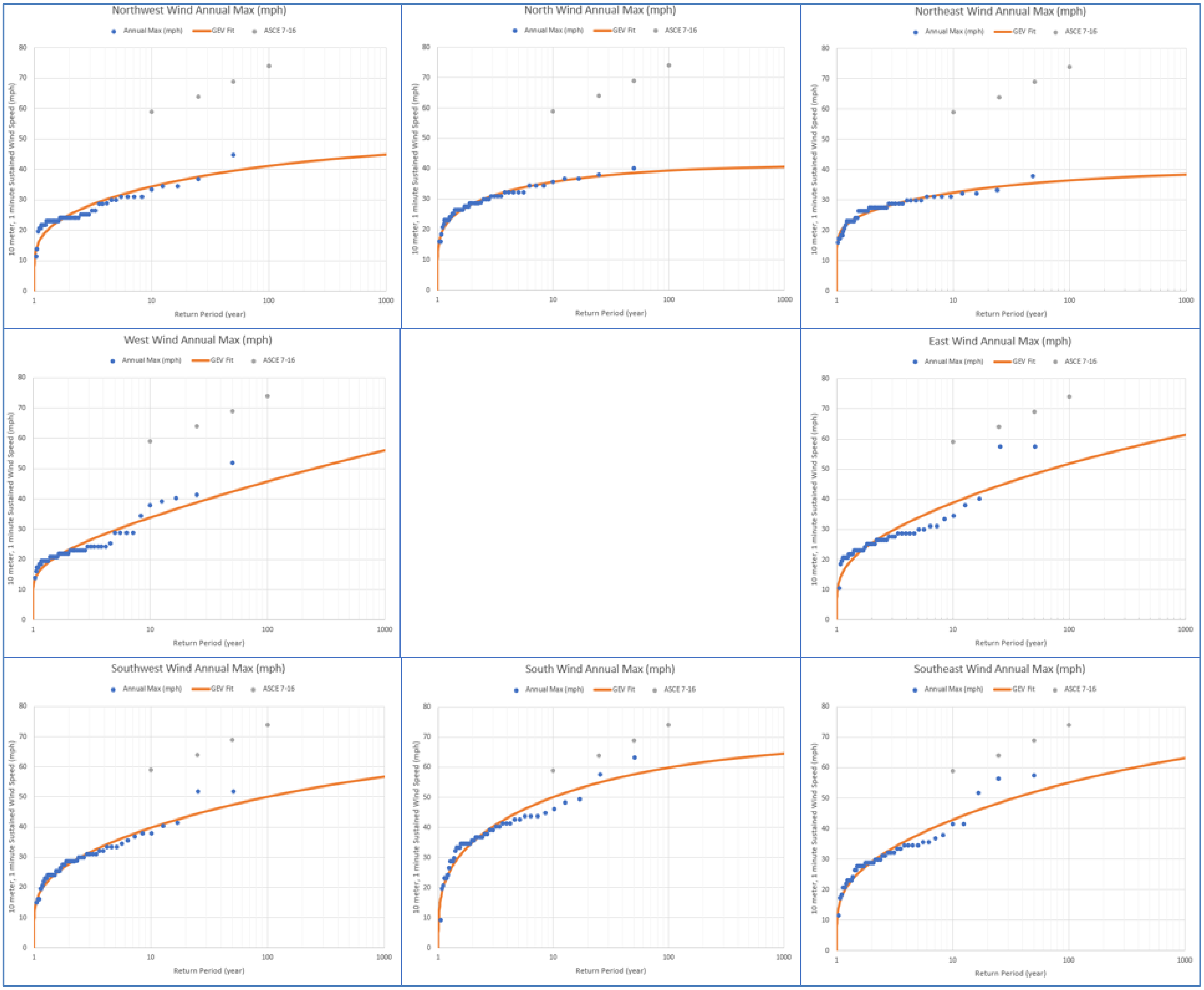
Attachment 3 Figure 1: Prevailing Winds based on GZA Statistical Analysis of Observed Wind Speeds at Bar Harbor Airport

Yearly Climatology:

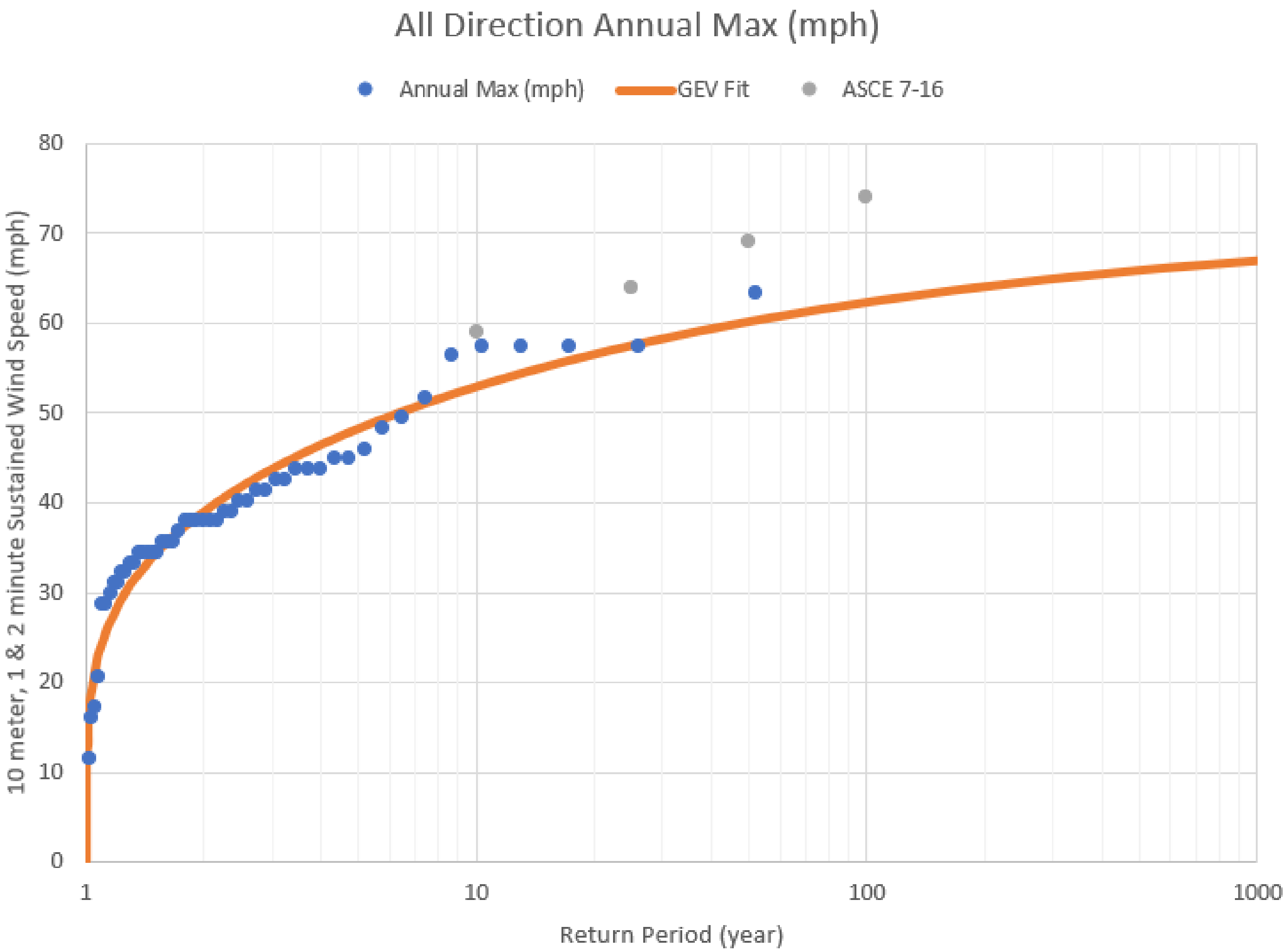
View raw data



Attachment 3 Figure 2: Wind Rose for Bar Harbor from Iowa State University Environmental Mesonet



Attachment 3 Figure 3: Directional Extreme Wind Intensity based on GZA Statistical Analysis



Attachment 3 Figure 3: All-Direction 1,2-Minute Sustained Wind Speeds at 10 meters. Intensity based on GZA Statistical Analysis

ASCE 7-16

ASCE 7-16 3-second gust wind speeds at 10 meters elevation were utilized as a comparison with GZA wind data to verify GZA's statistical wind analysis results. ASCE 7 winds represent the ultimate wind speed factored for allowable stress design over an ASCE Exposure C terrain scenario (roughly open terrain). The ASCE 7-16 3-second gust wind speed at 10 meters are summarized below:

Wind

Results:

Wind Speed	102 Vmph
10-year MRI	73 Vmph
25-year MRI	79 Vmph
50-year MRI	85 Vmph
100-year MRI	91 Vmph

Attachment 3 Table 1 - All-Direction 3-second gust speed, Exposure C, based on ASCE7-16

The site is not located in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2 (ASCE/SEI 7-16, Fig. 26.5-1A and Figs. CC.2-1–CC.2-4, and Section 26.5.2).

For comparison with the GZA airport wind analysis, the ASCE wind was converted using:

- the World Meteorological Organization (WMO) guidelines presented in " GUIDELINES FOR CONVERTING BETWEEN VARIOUS WIND AVERAGING PERIODS IN TROPICAL CYCLONE CONDITIONS ", dated August 2010

The ASCE 7-16 3-second gust was transformed for: 1) 1- and 2-minute reference period, on-shore wind at the coastline exposure to evaluate project site winds; and 2) 10-minute Open Water exposure.

The transformed ASCE 7-16 3-second wind gusts are summarized in **Attachment 3 Table 2**. For comparison with the GZA airport wind analysis, the ASCE wind was converted to the 1 and 2-minute wind using the World Meteorological Organization (WMO) guidelines for an Off-Sea, Onshore Winds at a Coastline exposure scenario. The ASCE 100-year wind for a 1- and 2-minute reference period is 74 and 71 mph, respectively. This is generally consistent with the observed wind speeds at the 100-year recurrence interval, analyzed from the airport data.

Recurrence Interval Event	GZA Wind Evaluation (1-to-2-minute, mph)	ASCE 7-16 Transformed Winds (mph)	ASCE 7-16 Transformed Winds (10-minute, mph)	ASCE 7-16 Transformed Winds (30-second, mph)
10-year	53	57 (2-min) / 59 (1-min)	53	66
25-year	58	62 (2-min) / 64 (1-min)	58	72
50-year	60	66 (2-min) / 69 (1-min)	62	77
100-year	62	71 (2-min) / 74 (1-min)	67	83

Attachment 3 Table 2: Transformed ASCE 7-16 3-Second Wind Gusts Comparison

Attachment 4
Tidal Datums

NOAA TIDAL STATION DATUMS

NOAA's Tides and Currents website is developed and supported by the Center for Operational Oceanographic Products and Services (CO-OPS).

NOAA tidal datums are local datums referenced to fixed base elevations and are established for National Tidal Datum Epochs (NTDE), which are updated to reflect periodic and apparent secular trends in sea level approximately every 20 to 25 years. The specific 19-year NTDE period was adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., Mean Lower Low Water) for tidal datums. Tidal datums in certain regions with anomalous sea level changes (Alaska, Gulf of Mexico) are calculated on a Modified 5-Year Epoch.

The present NTDE for the NOAA Bar Harbor tide gage and for Portland tide gauge is the current tidal epoch of 1983 through 2001.

Tidal datums that are applicable to the project area were developed for the following NOAA tide station:

Attachment 4 Figure 1 presents the NOAA Bar Harbor, ME tide station (8413320) and Portland, ME tide station (8418150) locations relative to Castine.

Attachment 4 Figure 2 presents NOAA VDATUM Conversion (MLLW to NAVD88) at Station 8413320, Bar Harbor, ME.

Attachment 4 Figure 3 presents NOAA VDATUM Conversion (NAVD88 to MHHW) at Castine, ME.

Attachment 4 Table 1 presents the NOAA tidal datums for Bar Harbor relative to Mean Lower Low Water (MLLW).

Attachment 4 Table 2 presents the NOAA tidal datums for Portland relative to NAVD88.

Attachment 4 Table 3 presents NOAA tidal datums for Bar Harbor converted from MLLW to NAVD88 using NOAA Vdatum.

Attachment 4 Table 4 presents NOAA Penobscot River Navigation Chart Tidal Datums.

Attachment 4 Table 5 presents NOAA tidal datums for Castine converted to MLLW using NOAA Vdatum.

NOAA tidal datums glossary of terms are presented below:

<u>Diurnal Tide Level (DTL):</u> The arithmetic mean of mean higher high water and mean lower low water.

<u>Great Diurnal Range (GT):</u> The difference in height between mean higher high water and mean lower low water.

<u>Greenwich High Water Interval (HWI)</u>: The average interval (in hours) between the moon's transit over the Greenwich meridian and the following high water at a location.

<u>Greenwich Low Water Interval (LWI):</u> The average interval (in hours) between the moon's transit over the Greenwich meridian and the following low water at a location.

<u>Highest Astronomical Tide (HAT):</u> The elevation of the highest predicted astronomical tide expected to occur at a specific tide station over the National Tidal Datum Epoch.

<u>Lowest Astronomical Tide (LAT):</u> The elevation of the lowest astronomical predicted tide expected to occur at a specific tide station over the National Tidal Datum Epoch.

<u>Max Tide: Highest Observed Tide.</u> The maximum height reached by a rising tide. The high water is due to the periodic tidal forces and the effects of meteorological, hydrologic, and/or oceanographic conditions.

<u>Mean Diurnal High Water Inequality (DHQ):</u> One-half the average difference between the two high waters of each tidal day observed over the National Tidal Datum Epoch. It is obtained by subtracting the mean of all the high waters from the mean of the higher high waters.

<u>Mean Diurnal Low Water Inequality (DLQ):</u> One-half the average difference between the two low waters of each tidal day observed over the National Tidal Datum Epoch. It is obtained by subtracting the mean of the lower low waters from the mean of all the low waters.

<u>Mean High Water (MHW):</u> The average of all the high-water heights observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

<u>Mean Higher High Water (MHHW):</u> The average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

<u>Mean Low Water (MLW):</u> The average of all the low water heights observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

<u>Mean Lower Low Water (MLLW):</u> The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

<u>Minimum Tide: Lowest Observed Tide</u>. The minimum height reached by a falling tide. The low water is due to the periodic tidal forces and the effects of meteorological, hydrologic, and/or oceanographic conditions.

<u>Mean Tide Level (MTL):</u> The arithmetic mean of mean high water and mean low water.

<u>Mean Sea Level (MSL):</u> The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; e.g. monthly mean sea level and yearly mean sea level.

<u>Mean Range of Tide (MN):</u> The difference in height between mean high water and mean low water.

<u>National Tidal Datum Epoch:</u> The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums. It is necessary for standardization because of periodic and apparent secular trends in sea level. The present NTDE is 1983 through 2001 and is actively considered for revision every 20-25 years. Tidal datums in certain regions with anomalous sea level changes (Alaska, Gulf of Mexico) are calculated on a Modified 5-Year Epoch.

<u>NOAA Tide Station Datum:</u> A fixed base elevation at a tide station to which all water level measurements are referred. The datum is unique to each station and is established at a lower elevation than the water is ever expected to reach. It is referenced to the primary benchmark at the station and is held constant regardless of changes to the water level gauge or tide staff. The datum of tabulation is most often at the zero of the first tide staff installed.

Datum Conversions

Tidal datums are indicated by NOAA in NAVD88 only for control stations (i.e., Portland). The Bar Harbor tidal datums were converted to NAVD88 datum using the NOAA VDATUM software **Attachment 4 Figure 2.** VDatum is a software tool developed jointly by NOAA's National Geodetic Survey (NGS), Office of Coast Survey (OCS), and Center for Operational Oceanographic Products and Services (CO-OPS). VDatum is designed to vertically transform geospatial data among a variety of tidal, orthometric and ellipsoidal vertical datums - allowing users to convert their data from different horizontal/vertical references into a common system and enabling the fusion of diverse geospatial data in desired reference levels.

The VDATUM conversion of MLLW to NAVD88 at Bar Harbor is -6.0 feet. **Attachment 4 Table 3** presents the NOAA tidal datums for Bar Harbor relative to NAVD88 using this conversion.

Elevations on Mean Lower Low Water

Station: 8413320, Bar Harbor, ME
Status: Accepted (Nov 2 2012)
Units: Feet
Control Station: 8418150 Portland, ME
T.M.: 0
Epoch: 1983-2001
Datum: MLLW

Datum	Value	Description
MHHW	11.37	Mean Higher-High Water
MHW	10.95	Mean High Water
MTL	5.66	Mean Tide Level
MSL	5.67	Mean Sea Level
DTL	5.69	Mean Diurnal Tide Level
MLW	0.38	Mean Low Water
MLLW	0.00	Mean Lower-Low Water
NAVD88		
STND	-3.47	Station Datum
GT	11.37	Great Diurnal Range
MN	10.56	Mean Range of Tide
DHQ	0.43	Mean Diurnal High Water Inequality
DLQ	0.38	Mean Diurnal Low Water Inequality
HWI	3.29	Greenwich High Water Interval (in hours)
LWI	9.51	Greenwich Low Water Interval (in hours)
Max Tide	16.21	Highest Observed Tide
Max Tide Date & Time	02/07/1978 05:00	Highest Observed Tide Date & Time
Min Tide	-2.91	Lowest Observed Tide
Min Tide Date & Time	03/21/2007 11:06	Lowest Observed Tide Date & Time
HAT	13.69	Highest Astronomical Tide
HAT Date & Time	11/15/2016 15:36	HAT Date and Time
LAT	-2.21	Lowest Astronomical Tide
LAT Date & Time	11/15/2016 22:00	LAT Date and Time

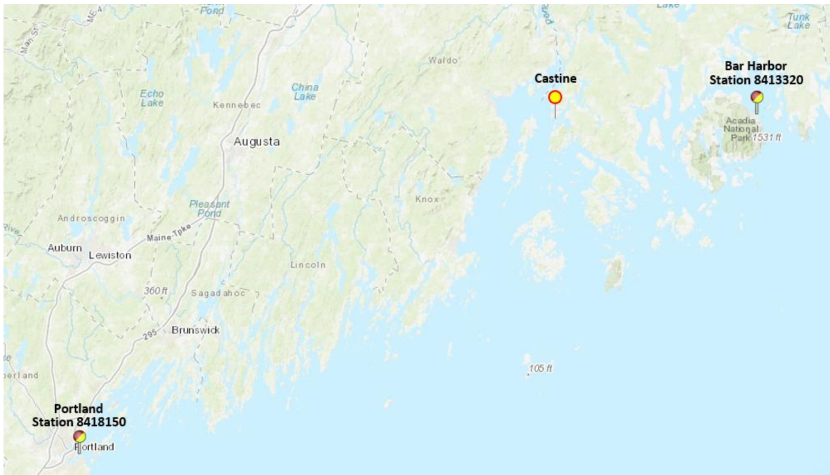
Attachment 4 Table 1: NOAA tidal datums for Bar Harbor relative to Mean Lower Low Water (MLLW)

Elevations on NAVD88

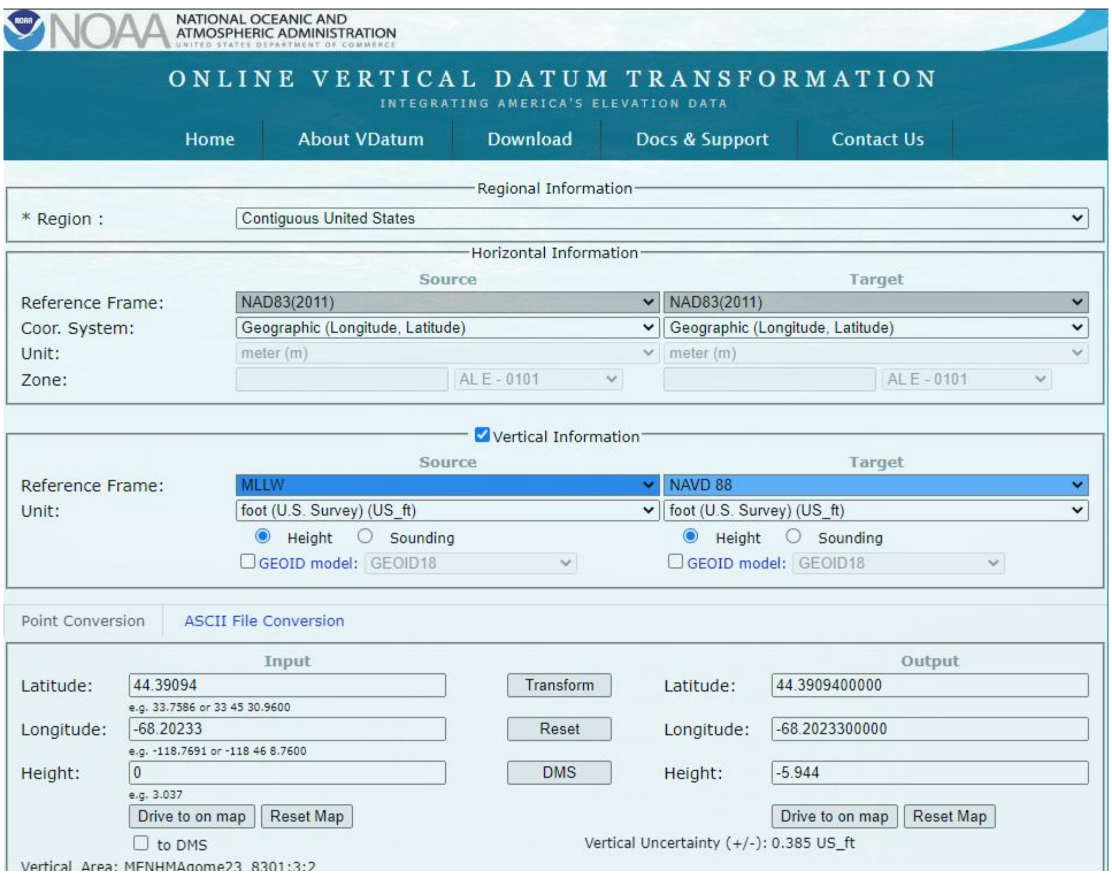
Station: 8418150, Portland, ME
Status: Accepted (Apr 17 2003)
Units: Feet
Control Station:
T.M.: 0
Epoch: 1983-2001
Datum: NAVD88

Datum	Value	Description
MHHW	4.65	Mean Higher-High Water
MHW	4.21	Mean High Water
MTL	-0.35	Mean Tide Level
MSL	-0.32	Mean Sea Level
DTL	-0.30	Mean Diurnal Tide Level
MLW	-4.91	Mean Low Water
MLLW	-5.26	Mean Lower-Low Water
NAVD88	0.00	North American Vertical Datum of 1988
STND	-13.81	Station Datum
GT	9.90	Great Diurnal Range
MN	9.12	Mean Range of Tide
DHQ	0.44	Mean Diurnal High Water Inequality
DLQ	0.34	Mean Diurnal Low Water Inequality
HWI	3.59	Greenwich High Water Interval (in hours)
LWI	9.75	Greenwich Low Water Interval (in hours)
Max Tide	8.87	Highest Observed Tide
Max Tide Date & Time	02/07/1978 10:30	Highest Observed Tide Date & Time
Min Tide	-8.71	Lowest Observed Tide
Min Tide Date & Time	11/30/1955 17:18	Lowest Observed Tide Date & Time
HAT	6.71	Highest Astronomical Tide
HAT Date & Time	05/19/2034 04:06	HAT Date and Time
LAT	-7.38	Lowest Astronomical Tide
LAT Date & Time	01/14/2036 22:42	LAT Date and Time

Attachment 4 Table 2: NOAA tidal datums for Portland relative to NAVD88



Attachment 4 Figure 1 - Tidal Datums - NOAA Station 8418150, Portland, ME & NOAA Station 8413320 Bar Harbor, ME



Attachment 4 Figure 2: NOAA VDATUM Conversion (MLLW to NAVD88) at Station 8413320, Bar Harbor, ME

Bar Harbor Water Elevations on NAVD88 in Feet

Datum	Value	Description
MHHW	5.4	Mean Higher-High Water
MHW	5.0	Mean High Water
MTL	-0.3	Mean Tide Level
MSL	-0.3	Mean Sea Level
DTL	-0.3	Mean Diurnal Tide Level
MLW	-5.6	Mean Low Water
MLLW	-6.0	Mean Lower-Low Water
NAVD88	0	North American Vertical Datum of 1988
STND	-9.4	Station Datum
GT	11.4	Great Diurnal Range
MN	10.6	Mean Range of Tide
DHQ	0.4	Mean Diurnal High Water Inequality
DLQ	0.4	Mean Diurnal Low Water Inequality
HWI	3.3	Greenwich High Water Interval (in hours)
LWI	9.5	Greenwich Low Water Interval (in hours)
HAT	7.8	Highest Astronomical Tide
LAT	-8.2	Lowest Astronomical Tide

Attachment 4 Table 3: NOAA tidal datums for Bar Harbor converted to NAVD88 using NOAA VDatum

PENOBSCOT RIVER

Mercator Projection
Scale 1:40,000 at Lat. 44°22'

North American Datum of 1983
(World Geodetic System 1984)

SOUNDINGS IN FEET
AT MEAN LOWER LOW WATER

Additional information can be obtained at nauticalcharts.noaa.gov.

SUPPLEMENTAL INFORMATION

Consult U.S. Coast Pilot 1 for important supplemental information.

RACING BUOYS

Racing buoys within the limits of this chart are not shown hereon. Information may be obtained from the U.S. Coast Guard District Offices as racing and other private buoys are

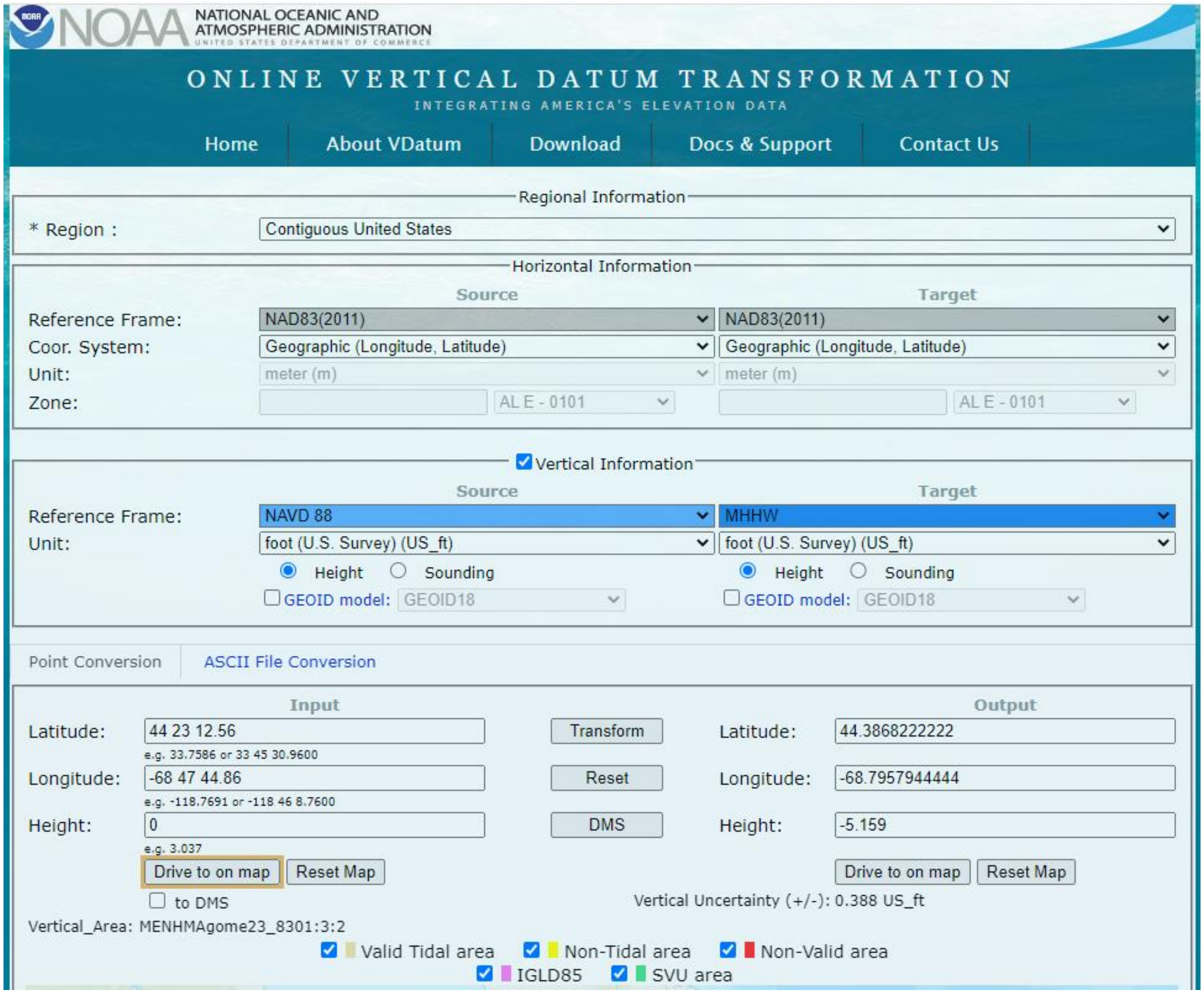
TIDAL INFORMATION

PLACE		Height referred to datum of soundings (MLLW)		
NAME	(LAT/LONG)	Mean Higher High Water	Mean High Water	Mean Low Water
		feet	feet	feet
Belfast	(44°26'N/69°00'W)	11.0	10.6	0.4
Castine	(44°23'N/68°48'W)	11.0	10.5	0.4
Fort Point	(44°28'N/68°49'W)	11.3	10.7	0.4
Bucksport	(44°34'N/68°48'W)	11.8	11.2	0.4
Hampden	(44°45'N/68°50'W)	13.9	13.3	0.5
Bangor	(44°48'N/68°46'W)	14.3	13.7	0.3

Dashes (- - -) located in datum columns indicate unavailable datum values for a tide station. Real-time water levels, tide predictions, and tidal current predictions are available on the Internet from http://tidesandcurrents.noaa.gov.

(Jan 2016)

Attachment 4 Table 4: NOAA Penobscot River Navigation Chart Tidal Datums



Attachment 4 Figure 3: NOAA VDATUM Conversion (NAVD88 to MHHW) at Castine, ME

	Per VDatum		
Datum	Height (ft, NAVD88)	Height (ft, MLLW)	NOAA Navigation Chart (ft, MLLW)
MHHW	5.2	11.0	11.0
MHW	4.7	10.6	10.5
NAVD88	0.0	5.8	
LMSL	-0.3	5.5	
DTL	-0.3	5.5	
MTL	-0.3	5.5	
MLW	-5.4	0.4	0.5
MLLW	-5.8	0.0	

Attachment 4 Table 5: NOAA tidal datums for Castine converted to NAVD88 using NOAA VDatum

Attachment 5
Tidal Currents

TIDAL CURRENTS

NOAA Current Predictions and current measurements from NOAA Tides and Currents. NOAA Current Predictions were used to infer the currents at the project site. Specifically, the current station at Hosmer Ledge in Castine Harbor (PEB0611), with a current prediction water depth at 13 feet was used.

https://tidesandcurrents.noaa.gov/noaacurrents/Stations?g=454

Available Hosmer Ledge monthly current prediction tables are available for the years 2020 through 2024. Observed current data for an 11-day period in 2006 is also available.

Observed Current Velocities:

A Hosmer Ledge (PEB0611) current probe was deployed in the late summer of 2006, where current measurements were taken at a range of depths. Observed data of current speed and direct can be viewed at each measurement depth (6.4 feet to 52.4 feet) between August 22 and September 28, 2006. An example of this data is shown in **Attachment 5, Figure 2** (13 feet depth). As indicated on **Figure 2**, the vector direction of the tidal currents is 240 and 50 degrees (from true north) with the flood and ebb tide, respectively. These flow vectors are consistent with the channel orientation between the peninsula at Castine and Nautilus Island, Cape Rosier (see DEM in **Attachment 2**).

Predicted Current Velocities

GZA also reviewed the Hosmer Ledge predicted daily annual current data for the years available. Currents associated with coastal storm tides were inferred from the daily predicted current velocities. The range of extreme predicted ebb and flow velocities were identified (annual extremes). Coincident water levels were developed based on NOAA tidal station water level observations (extrapolated to Castine). A statistical interpolation of tidal velocities versus water level was performed for ebb and flow conditions. The statistical extrapolation was advanced to water level elevations predicted at Castine for coastal storm flood conditions (stillwater elevations) for the 10-year to 500-year recurrence interval flood. The extrapolated current speeds at a depth of 13 feet are summarized below. The approximate flood direction is 50 degrees from true north.

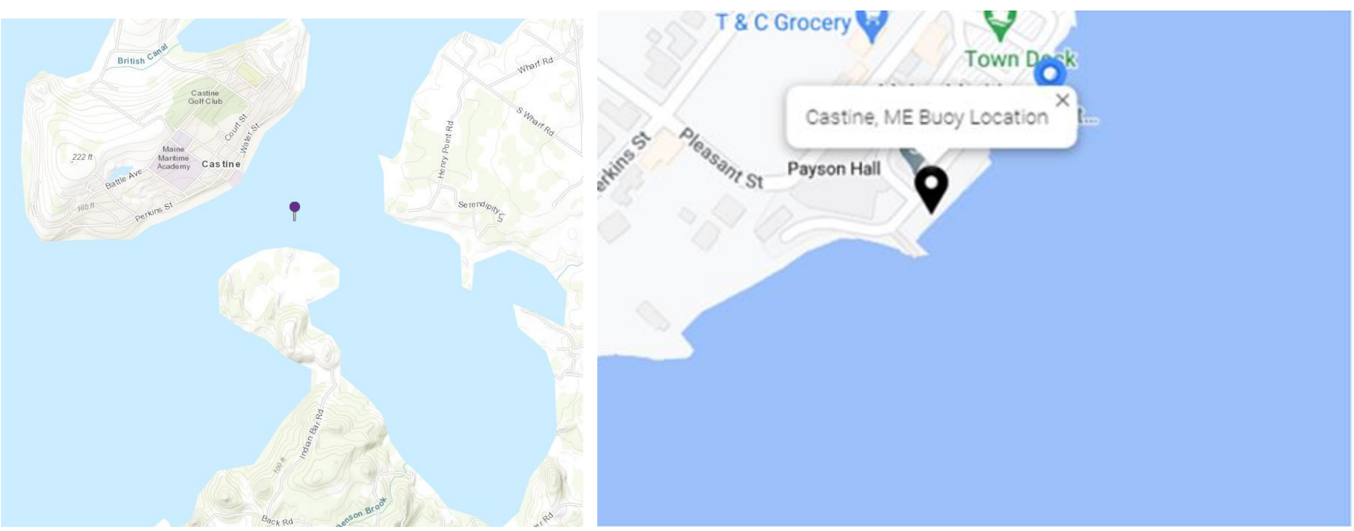
Recurrence Interval (years)	Current Velocity (knots)	Current Velocity (fps)	Tidal Condition
Annual High – Astronomical Tides	1.7	2.9	Both Ebb and Flood
10	2.0	3.4	Both Ebb and Flood
50	2.3	3.9	Both Ebb and Flood
100	2.6	4.4	Both Ebb and Flood
500	2.8	4.7	Both Ebb and Flood

Attachment 5 Table 1: Hosmer Ledge Castine, ME Predicted Current Velocities at a Depth of 13 feet

Based on the 2006 observed current measurements at different depths GZA determined the ratios to current speeds at all other depths measured. These ratios are presented in **Attachment 5, Table 2,** relative to a depth of 13 feet.

Measured Depth	Ratio of Current Speed to Speed at 13 feet
6.4	1.01
13	1.00
19.6	0.99
26.1	1.02
32.7	1.01
39.2	0.98
45.8	0.95
52.4	0.91

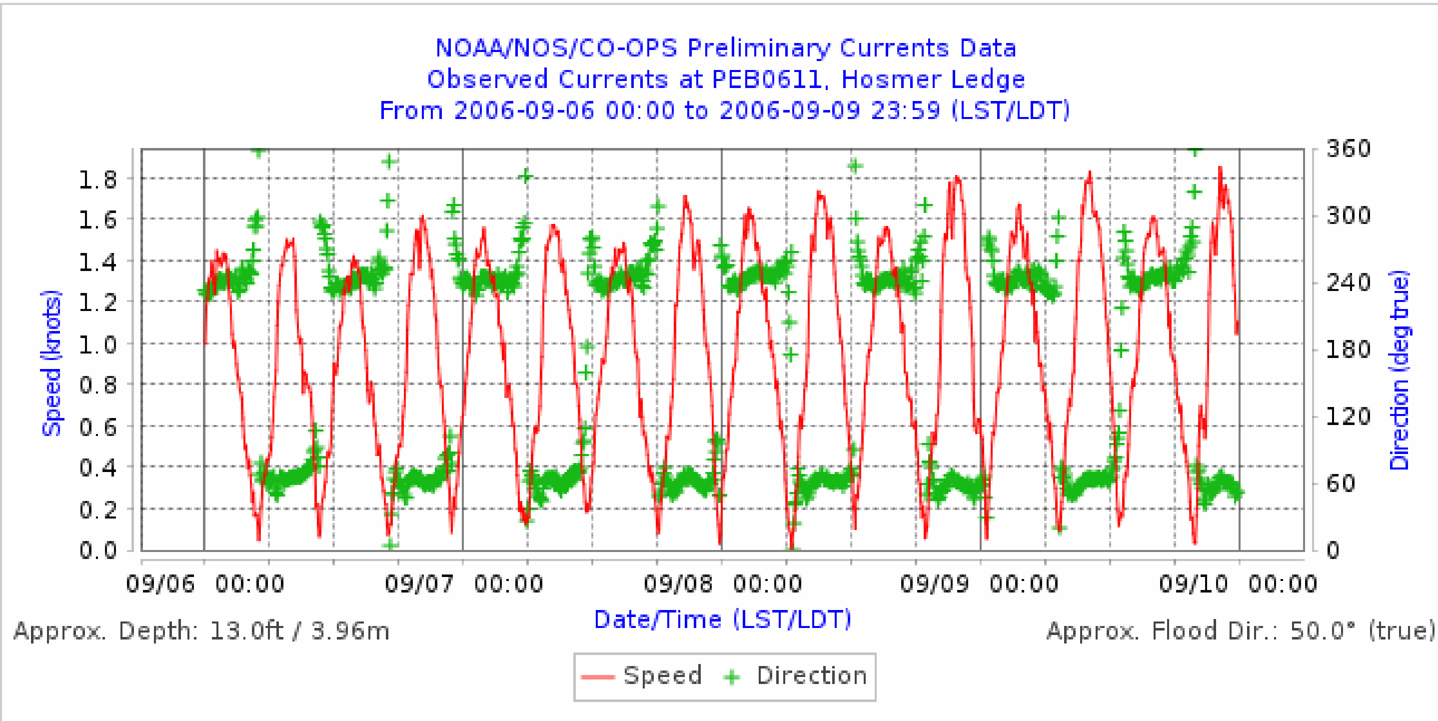
Attachment 5 Table 2: Hosmer Ledge Castine, ME Current Speed Ratios with Depth



Attachment 5 Figure 1: Hosmer Ledge (Left) and Castine (right), ME Tidal Buoy Location

Hosmer Ledge (PEB0611)

Deployed (UTC): 2006-08-22 20:04:00 to 2006-09-28 18:30:00



Attachment 5 Figure 1: Observed Current Data 9/6/2006 through 9/9/2006 at Hosmer Ledge in Castine, ME

Attachment 6
Coastal Storm Typology

COASTAL STORM TYPOLOGY

The region of Maine where the project site is located is exposed to extra-tropical coastal storms (ETCs) called Nor'easters, which can result in high wind, storm surge, large waves and higher velocity currents. Tropical cyclones (TCs), including hurricanes occur occasionally in Maine and can produce greater wind speeds and storm surges, but they do not occur nearly as frequently as Nor'easters. The area is also exposed to tropical cyclones that transform to become extratropical (post-tropical) (ETs), retaining some meteorological characteristics of both tropical and extratropical systems. In addition to extratropical and tropical cyclones, convective storms which can result in intense wind (e.g., thunderstorms) can occur but do not result in a coastal flood event.

Tropical Cyclones

Tropical cyclones include the following storm types, based on wind intensity:

Tropical Depression: A tropical cyclone with maximum sustained winds of 38 mph (33 knots) or less.

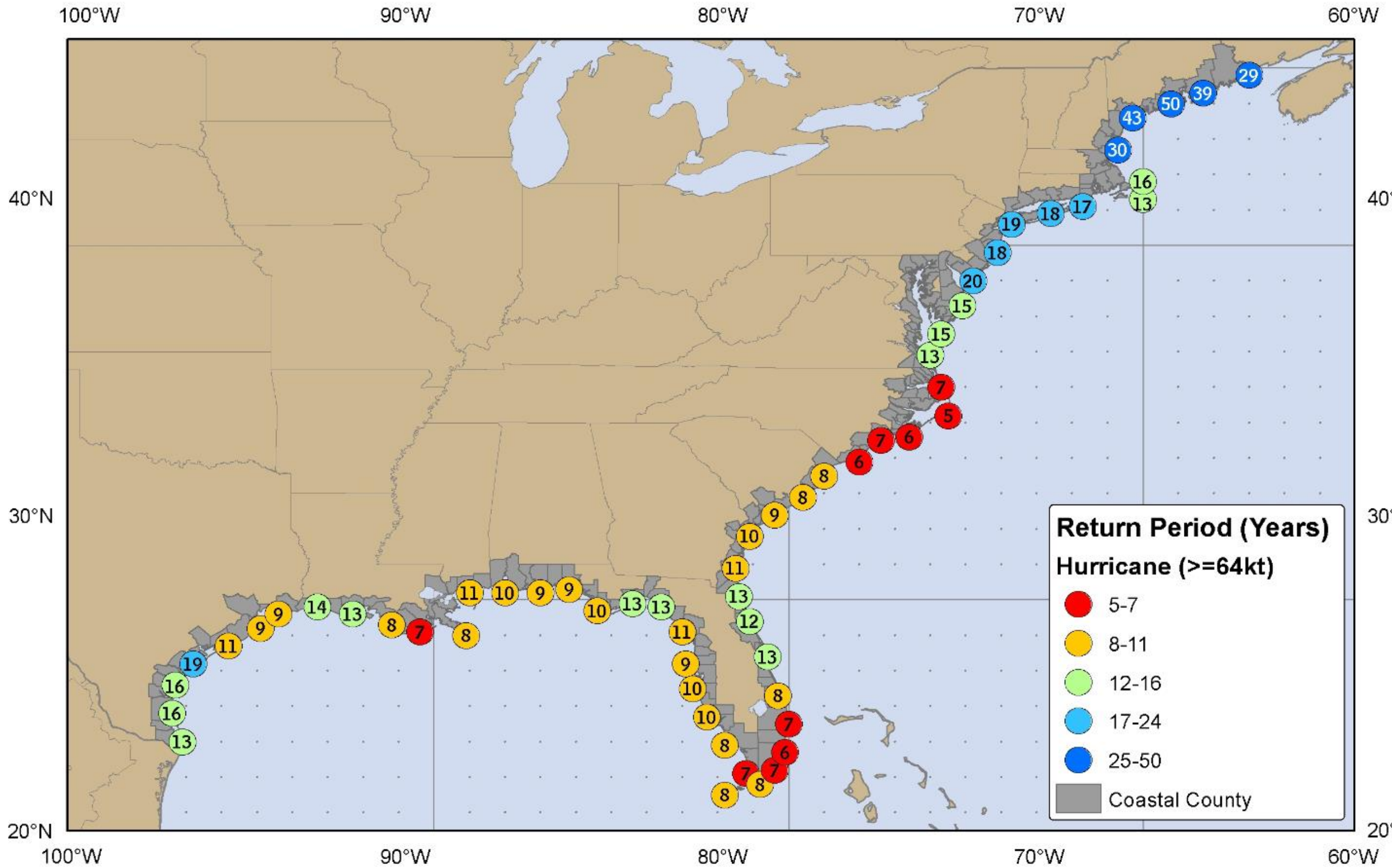
Tropical Storm: A tropical cyclone with maximum sustained winds of 39 to 73 mph (34 to 63 knots).

Hurricane: A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher. In the western North Pacific, hurricanes are called typhoons; similar storms in the Indian Ocean and South Pacific Ocean are called cyclones.

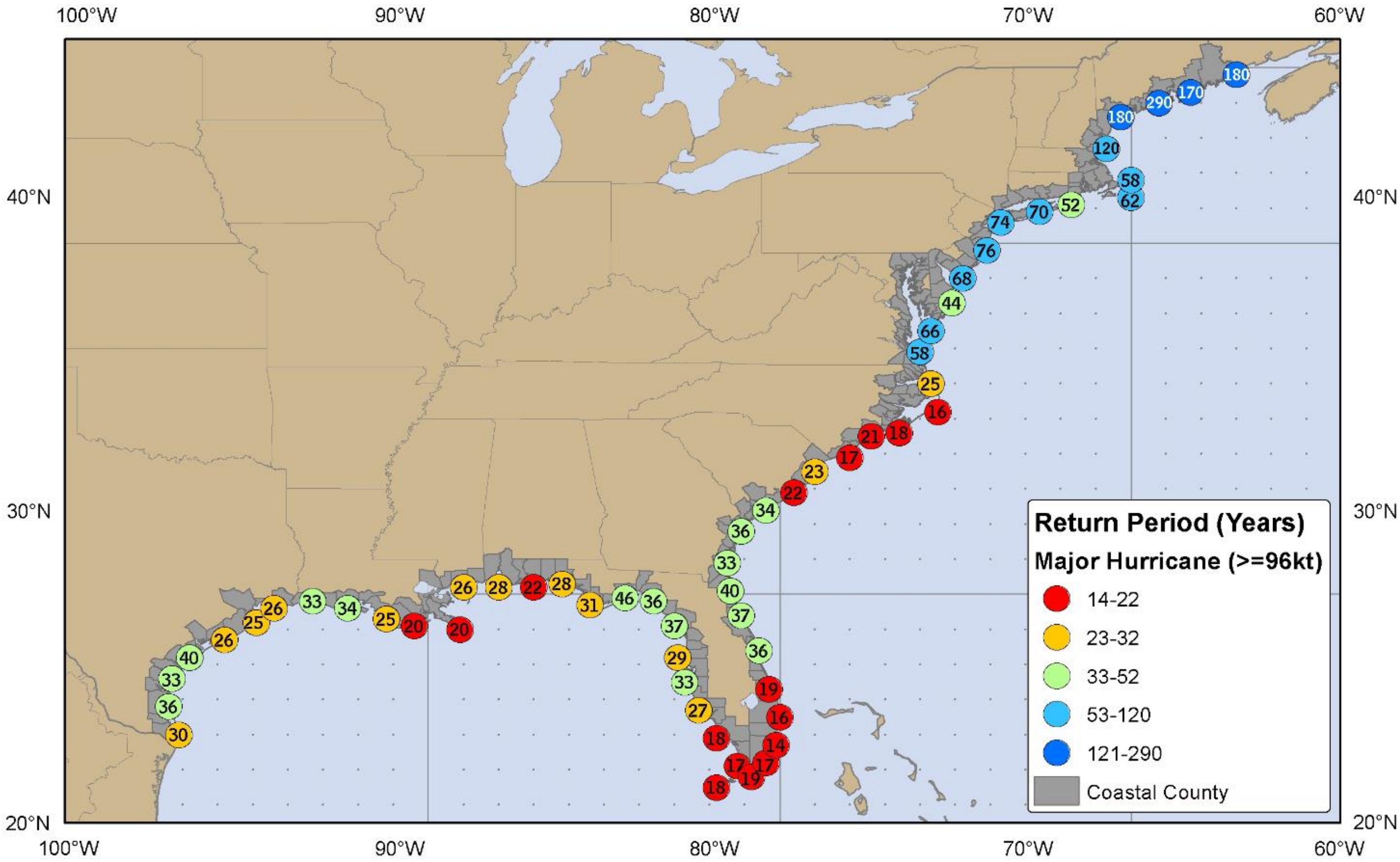
Major Hurricane: A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher, corresponding to a Category 3, 4 or 5 on the Saffir-Simpson Hurricane Wind Scale.

Hurricane return periods are the frequency at which a certain intensity of hurricane can be expected within a given distance of a given location (for the figures shown below, 50 nm or 58 statute miles). In simpler terms, a return period of 20 years for a major hurricane means that on average during the previous 100 years, a Category 3 or greater hurricane passed within 50 nm (58 miles) of that location about five times. As indicated in **Attachment 6 Figure 1**, the estimated return period for a hurricane of any intensity in the vicinity of Castine is 50 years. As indicated in **Attachment 6 Figure 2**, the estimated return period for a major hurricane in the vicinity of Castine is 290 years (reference National Hurricane Center Tropical Cyclone Climatology; https://www.nhc.noaa.gov/climo/#bac)

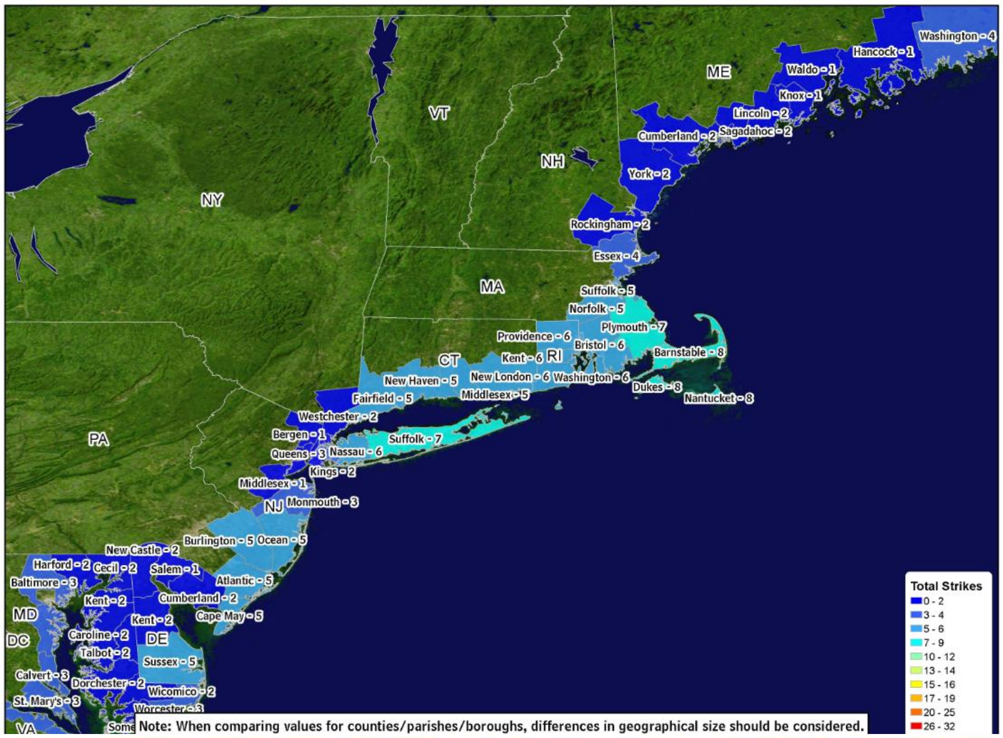
Hurricane strikes include landfalls and areas with overland wind speeds of hurricane intensity. As indicated in **Attachment 6 Figure 3**, there has been one (1) hurricane strike and 0 major hurricane strikes within Hancock County between 1900 and 2010. Historic tropical cyclone tracks with 60 nautical miles of Castine, Maine are indicated in in **Attachment 6 Figure 4.**

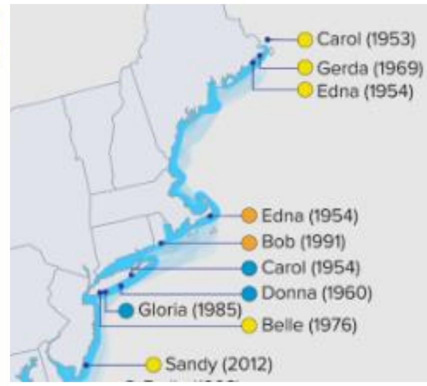


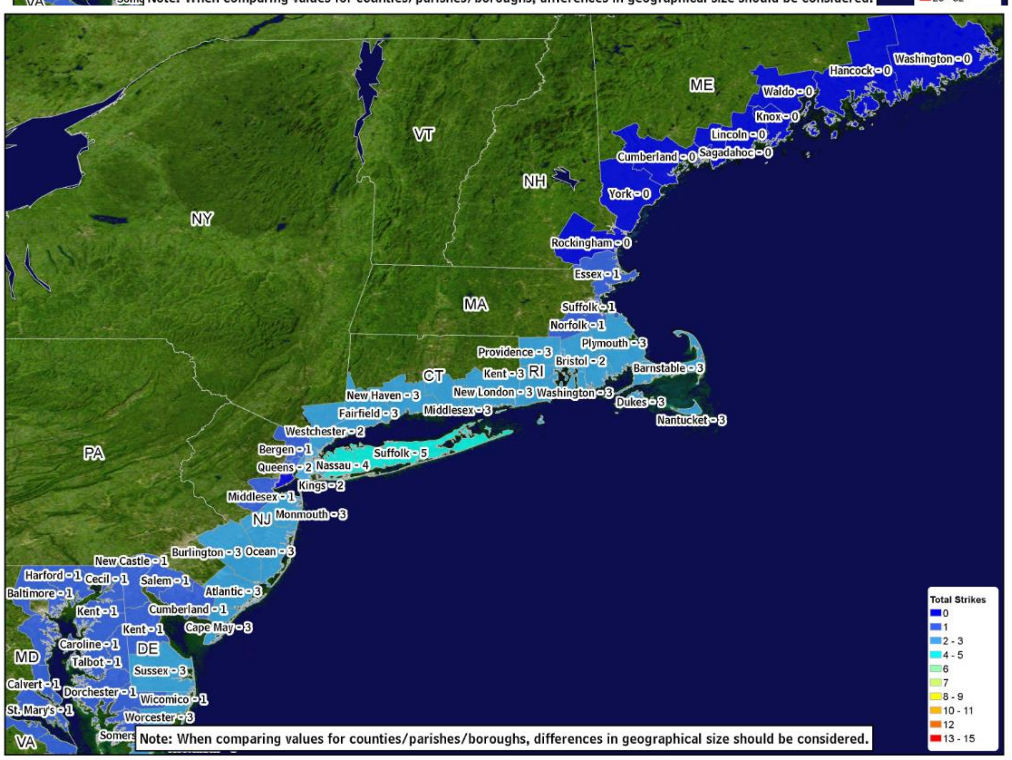
Attachment 6 Figure 1: Estimated return period in years for hurricanes passing within 50 nautical miles of various locations on the U.S. Coast



Attachment 6 Figure 2: Estimated return period in years for major hurricanes passing within 50 nautical miles of various locations on the U.S. Coast



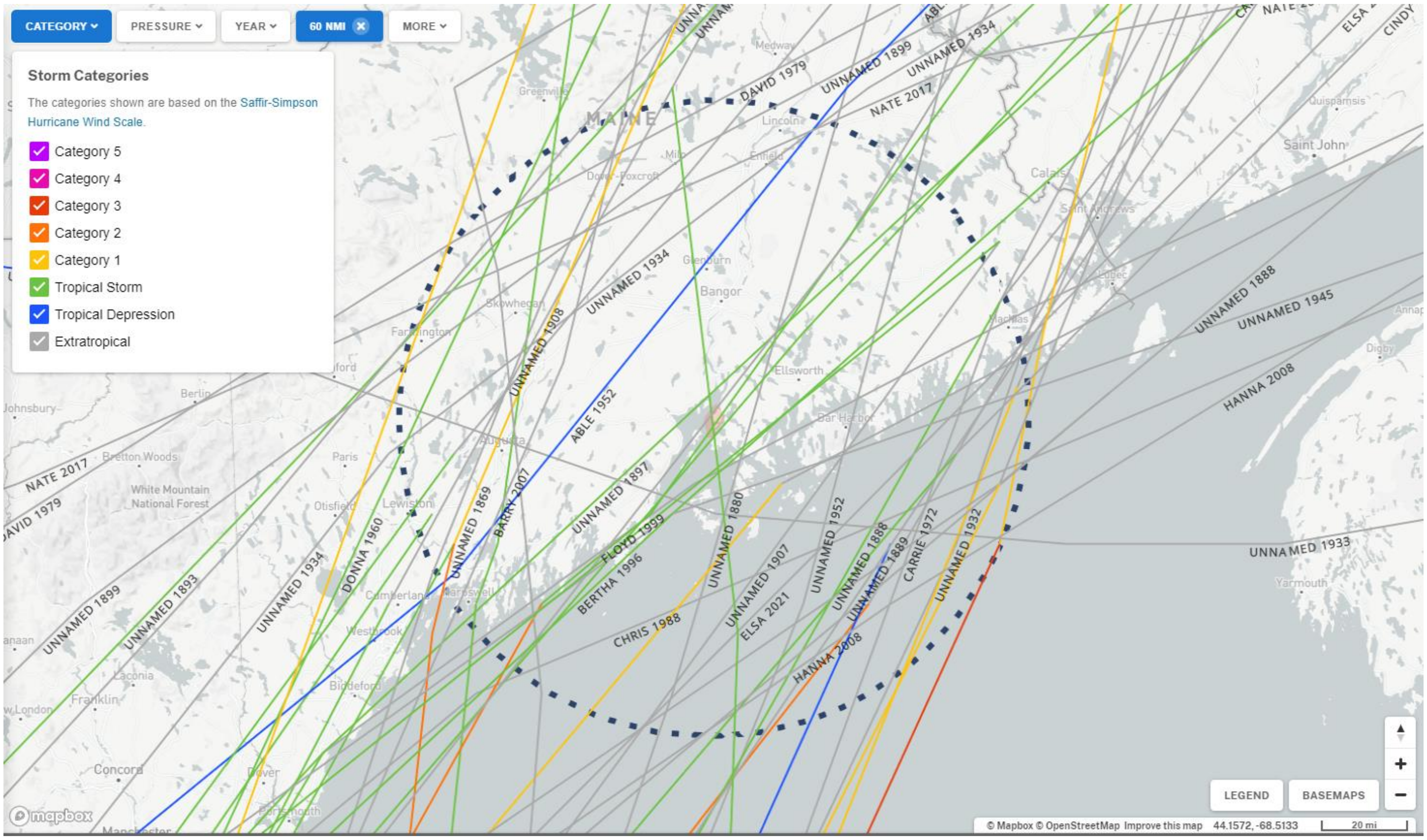




Total number of major hurricane strikes by counties/parishes/boroughs, 1900-2010

Data from NWS NHC 46: Hurricane Experience Levels of Coastal County Populations from Texas to Maine. Jerry D. Jarrell, Paul J. Hebert, and Max Mayfield. August, 1992, with updates.

Attachment 6 Figure 3: Total number of hurricane strikes (including incidents on hurricane force wind over land); Total Hurricanes (top) Major Hurricanes (bottom); Specific Hurricanes (top right)



Attachment 6 Figure 4: Historical Tropical Cyclone Tracks with 60 nautical miles of Castine, Maine.

Extratropical Cyclones

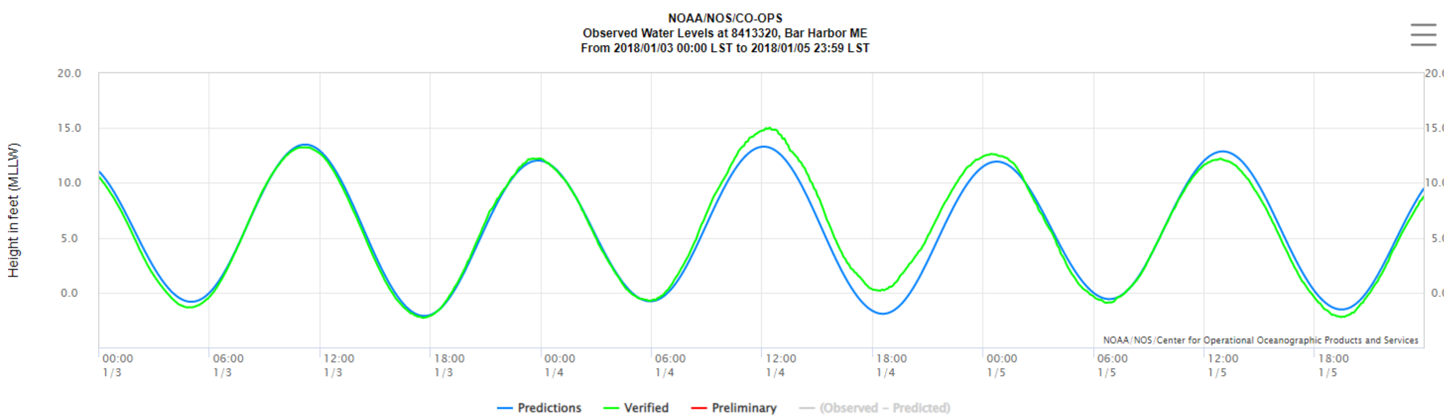
Extratropical cyclones are typically a large counterclockwise wind circulation around a low pressure. This storm type is often as much as 1,000 miles wide, and the storm speed is approximately 25 mph as it travels up the eastern coast of the United States. Sustained wind speeds of 10-40 mph are common, with short-term wind speeds of up to 70 mph. Extratropical cyclones can approach the northeastern United States from the west, from the southwest, and from the south, the latter of which are referred to as nor'easters.

January and March 2018 resulted in 5 large nor'easters which impacted Castine, ME including:

- January 4, 2018
- March 1-3, 2018
- March 6 -8, 2018
- March 12-14, 2018
- March 20-22, 2018

January 4, 2018: This storm had the highest recorded water levels for Bar Harbor and third highest for Portland, ME.

Attachment 6 Figure 5 presents the observed water level time series at the Bar Harbor tidal station between January 3-5, 2018. Elevated water levels due to storm surge were observed for 2 high tide cycles. The maximum observed water level was about Elevation 9.67 feet NAVD88 (approximately the 100-year recurrence interval water level).



Attachment 6 Figure 5: Water Level Time Series at Bar Harbor Tide Station January 3 - 5, 2018

Convective Storms

In addition to extratropical and tropical cyclones, the area is also susceptible to convective storms, which generally occur during the summer, where strong surface heating combined with moist unstable airmasses can result in isolated thunderstorms or organized systems, such as mesoscale convective complexes and squall lines. In addition to lightning, hail, and torrential rains, these systems can also generate extreme winds such as derechos (intense and widespread straight-line winds). Convective activity can also occur within other storm types (TCs, ETCs, and ETs).

Maximum Observed Water Levels at the Bar Harbor and Portland, ME Tide Stations

The top ten highest water levels observed as of April 2018 at the Bar Harbor and Portland, ME tidal stations are shown in **Attachment 6 Table 1.** All top 10 events are extratropical storms.

Top Ten Highest Water Levels for long-term stations in feet above MHHW (as of 4/2018)

* --- Inferred Level & --- Last Recorded Level # --- High Water Mark

Station Number	Station Name	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	Tenth
8413320	Bar Harbor, ME	1/4/2018	12/29/1959	2/7/1978	1/27/1963	1/9/1978	1/28/1979	1/21/2011	4/8/2016	1/2/2010	12/22/1995
	(since 1947)	3.57	3.56	3.53	3.46	3.41	3.35	3.18	3.16	3.12	3.11
8418150	Portland, ME	2/7/1978	1/9/1978	1/4/2018	3/16/1976	12/4/1990	11/20/1945	11/30/1944	3/2/2018	4/16/2007	1/2/1987
	(since 1912)	4.22	4.03	3.61	3.36	3.35	3.34	3.34	3.26	3.26	3.23

Attachment 6 Table 1 - Top Ten Highest Water Levels at NOAA Bar Harbor and Portland, ME Tide Stations

Summary of Coastal Storm Typologies

Due to its geographic location, Hancock County is susceptible to flooding from northeasters, post-tropical storms, and hurricanes. Nor'easters are high frequency events, although with variable intensity. Nor-easters are the storm typology resulting in the top 10 flood high water levels at the NOAA Bar Harbor and Portland tidal stations. Review of the historical hurricane record indicates that the coastline of Hancock County is also vulnerable to flooding due to hurricanes. The frequency of hurricanes, in particular major hurricanes in the area is low (50-year and 290-year recurrence intervals respectively). The effect of historical hurricanes in the area is also diminished due to: 1) colder waters north of Cape Cod and in the Gulf of Maine; and 2) most potentially impactful hurricanes make landfall in Long Island, Connecticut, Rhode Island and Cape Cod, with overland decrease in intensity before they track near Maine. For these reasons, hurricanes have not contributed much to the observational wind and water level records, which have a limited period of record (less than 100-years).

Based on the historical record and engineering judgement, it is expected that the central Maine area coastal flood-frequency relationship is dominated by extratropical (nor'easters) flood events from the 1-year to 100-year recurrence intervals. Hurricanes may contribute to the flood-frequency at around 50-year recurrence intervals but are not expected to significantly contribute to the 100-year recurrence interval (and more frequent) flood risk. At lower probabilities (greater than 100-year recurrence intervals), hurricanes may begin to have a contribution.

These historical relationships may change in the future due to climate change and its effects on hurricane frequency, intensity and storm tracks.

Convective storms can result in significant wind and precipitation events but are not expected to contribute to the greater coastal flood risk.

Attachment 7
Extreme Water Levels

NOAA TIDAL STATION EXTREME WATER LEVELS

NOAA provides exceedance probability statistics based on observed extreme water levels, including annual and monthly exceedance probability levels for select CO-OPS water level stations with at least 30 years of data. When used in conjunction with real time station data, exceedance probability levels can be used to evaluate current conditions and determine whether a rare event is occurring. This information may also be instrumental in planning for the possibility of dangerously high or low water events at a local level. The NOAA Technical Report, "Extreme Water Levels of the United States 1893-2010" describes the methods and data used in the calculation of the exceedance probability levels.

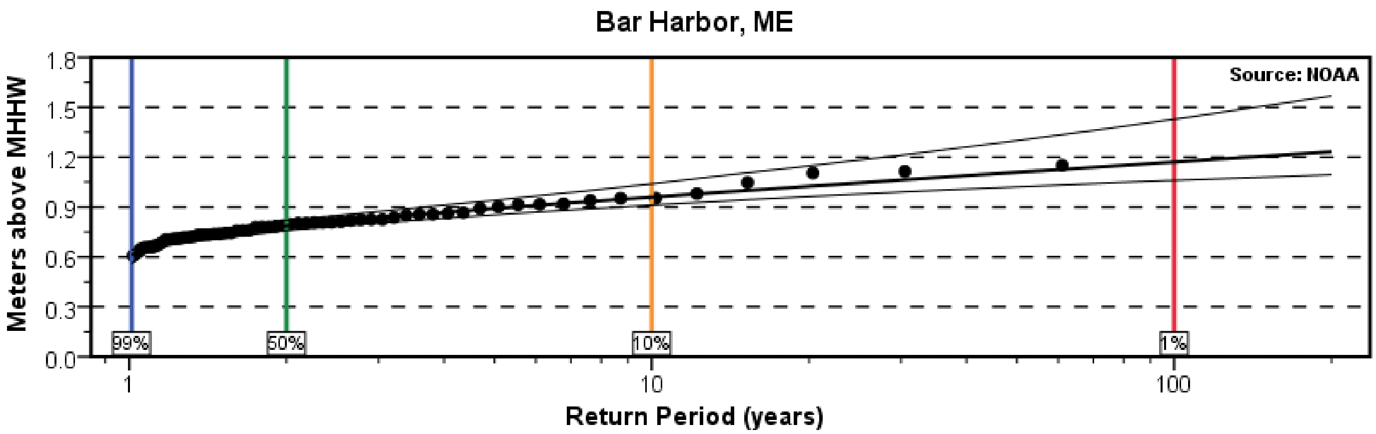
The extreme levels measured by the CO-OPS tide gauges during storms are called storm tides, which are a combination of the astronomical tide, the storm surge, and (dependent upon the gage location) limited wave setup. They do not include wave runup, the movement of water up a slope. Therefore, the 1% annual exceedance probability levels shown here do not necessarily correspond to the Base Flood Elevations (BFE) defined by the Federal Emergency Management Administration (FEMA). The 1% annual exceedance probability levels on this website more closely correspond to stillwater elevations (SWEL) developed by FEMA and the USACE NACCS. The peak levels from tsunamis, which can cause high-frequency fluctuations at some locations, have not been included in this statistical analysis due to their infrequency during the periods of historic record.

Attachment 7 Figures 1 through 4 present NOAA annual exceedance probability curves with 95% confidence intervals indicating the highest water levels as a function of return period in years. The dots indicate the annual highest water levels after the Mean Sea Level trend was removed, which were used to calculate the curves. The levels are in meters relative to the MHHW datums established by CO-OPS (1 foot = 0.3 meters). The horizontal position of the rightmost dot indicates the number of years of data used in the calculation. **Figures 1 and 2** presents data for the NOAA Bar Harbor tide station, the closest control station to the project site. **Figures 3 and 4** presents data for the NOAA Portland tide station, the 2nd closest control station to the project site.

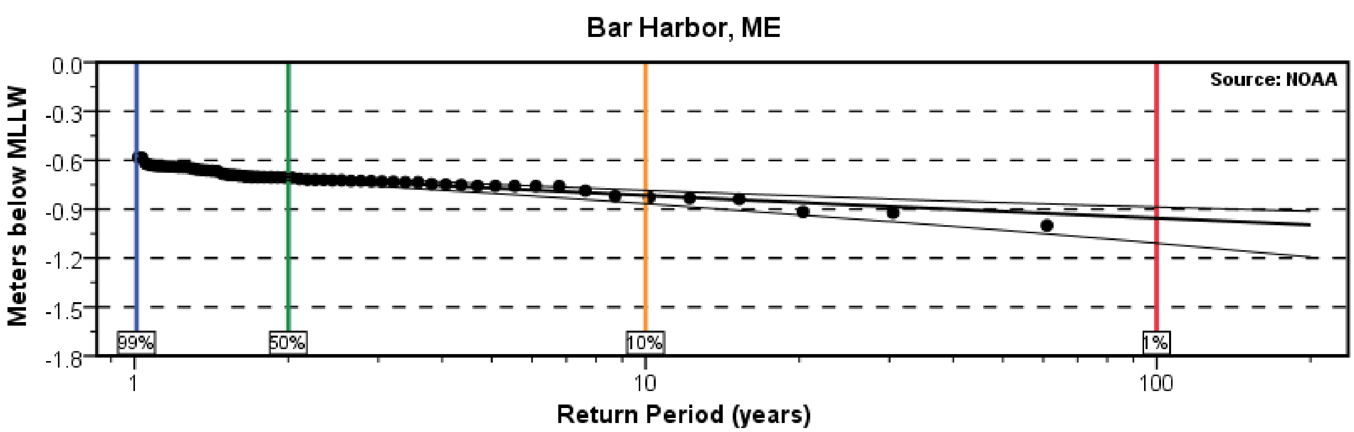
Attachment 7 Figures 5 and 6 present NOAA annual exceedance probability curves with 95% confidence intervals indicating the lowest water levels as a function of return period in years. The dots indicate the annual lowest water levels after the Mean Sea Level trend was removed, which were used to calculate the curves. The levels are in meters relative to the MLLW datums established by CO-OPS (1 foot = 0.3 meters). The horizontal position of the rightmost dot indicates the number of years of data used in the calculation. **Figure 2** presents data for the NOAA Bar Harbor tide station, the closest control station to the project site. **Figure 4** presents data for the NOAA Portland tide station, the 2nd closest control station to the project site.

Attachment 7 Figure 7 presents plots showing the monthly highest and lowest water levels with the 1%, 10%, 50%, and 99% annual exceedance probability levels in red, orange, green, and blue for the Bar Harbor tidal station. The plotted values are in meters relative to the MHHW datum established by CO-OPS (1 foot = 0.3 meters). On average, the 1% level (red) will be exceeded in only one year per century, the 10% level (orange) will be exceeded in ten years per century, and the 50% level (green) will be exceeded in fifty years per century. The 99% level (blue) will be exceeded in all but one year per century, although it could be exceeded more than once in other years. These correspond to recurrence intervals of 100-years, 10-years, 2-years and 1-yaers, respectively.

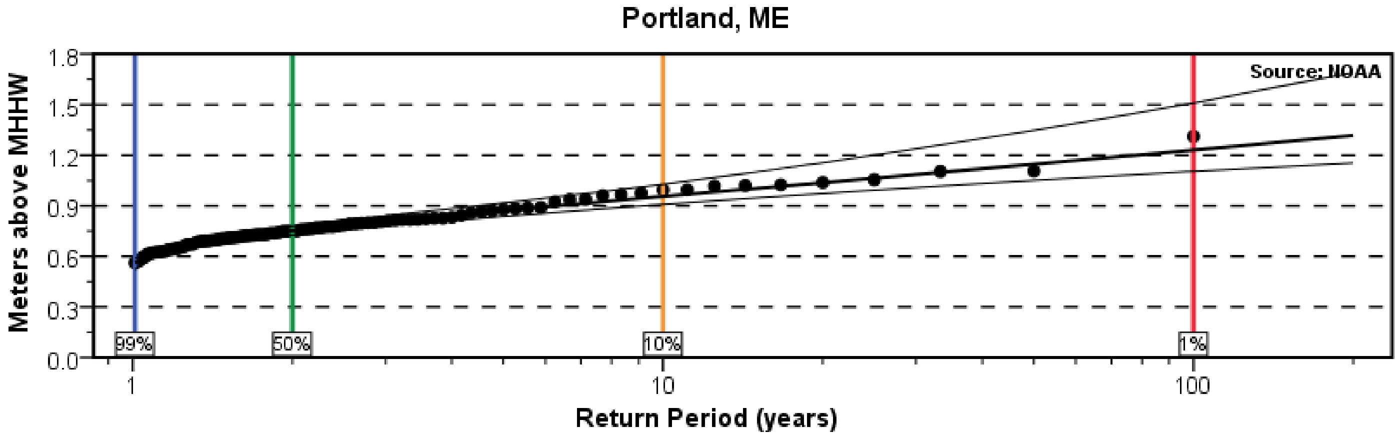
NOAA also provides a listing of the Top Ten Highest Water Levels at 110 long-term stations as a table in meters or a table in feet above MHHW. No adjustment has been made for the rates of sea level rise or fall at each station. An inferred level indicates that missing data at the peak water level were filled in. A high-water mark is a physical mark near the station that can indicate the maximum elevation of a storm event. See **Attachment 7 Table 1.**



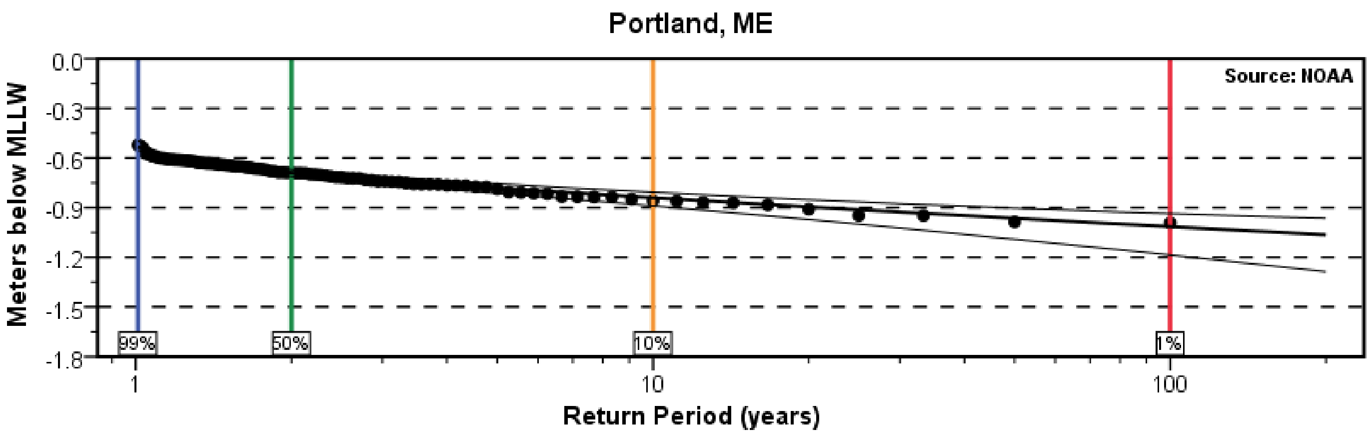
Attachment 7 Figure 1 - NOAA annual exceedance probability curves with 95% confidence intervals; High Water Levels relative to MHHW for Station 8413320 at Bar Harbor, ME



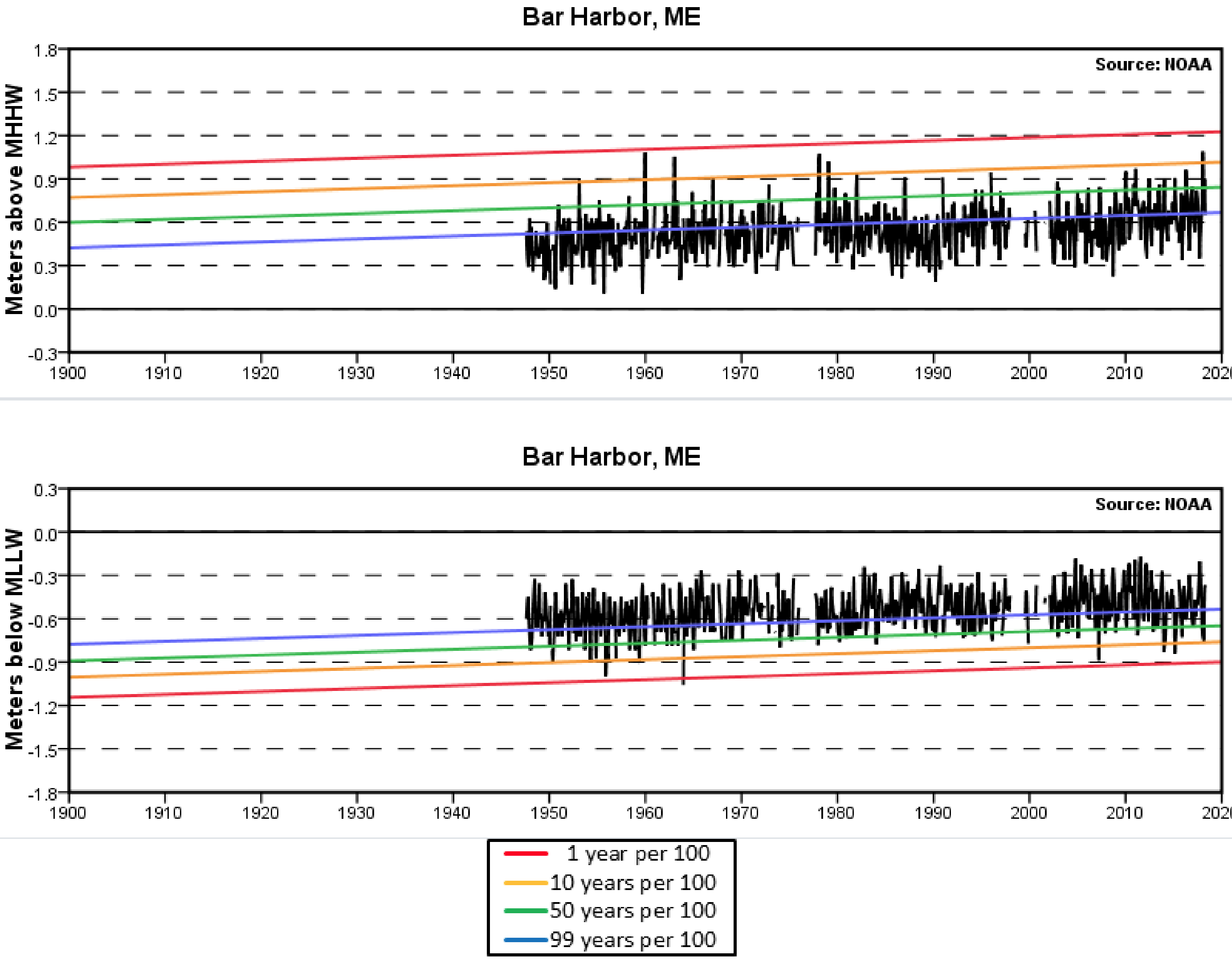
Attachment 7 Figure 2 - NOAA annual exceedance probability curves with 95% confidence intervals; Low Water Levels Relative to MLLW for Station 8413320 at Bar Harbor, ME



Attachment 7 Figure 3 - NOAA annual exceedance probability curves with 95% confidence intervals; High Water Levels relative to MHHW for Station 8418150 at Portland, ME

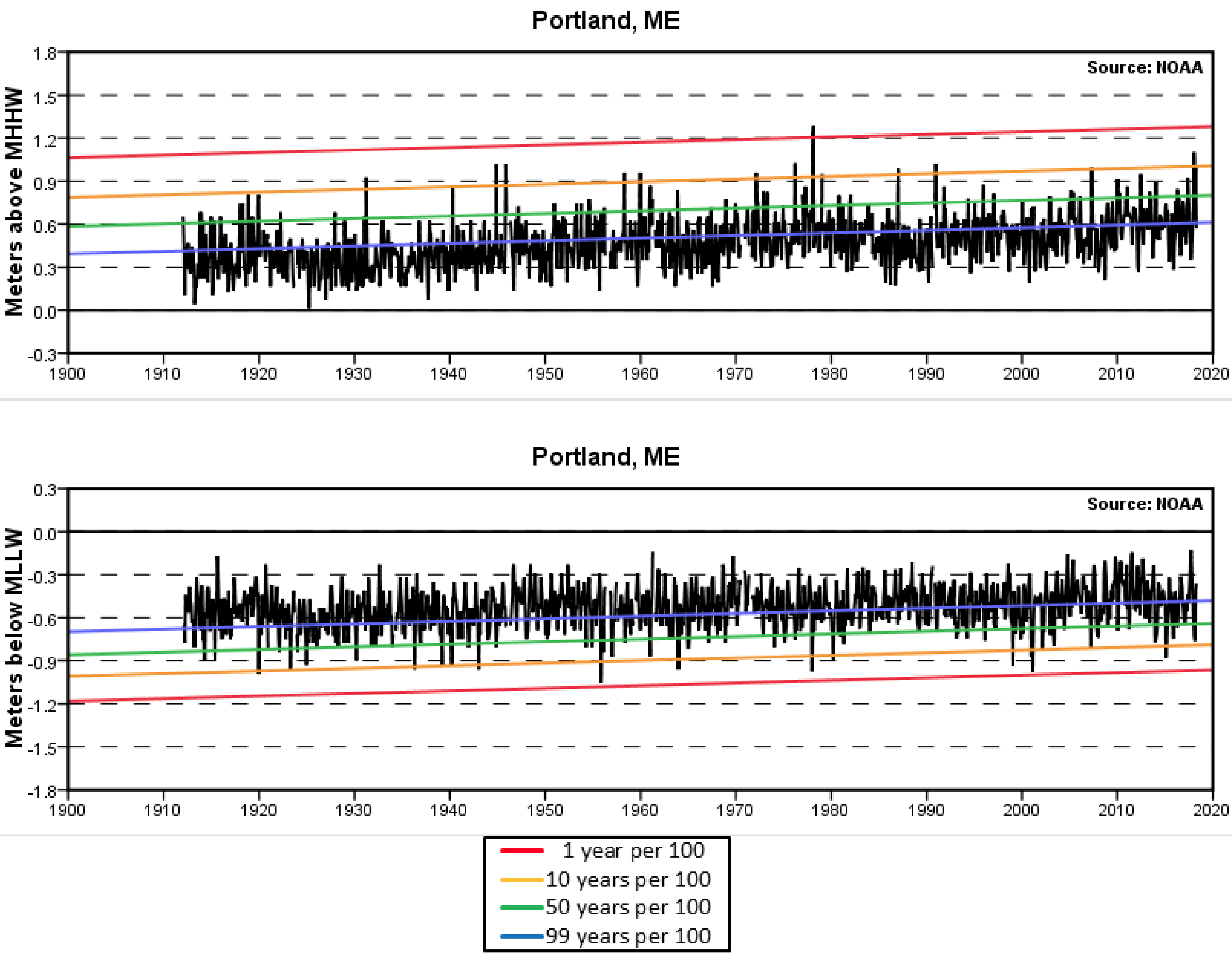


Attachment 7 Figure 4 - NOAA annual exceedance probability curves with 95% confidence intervals; Low Water Levels Relative to MLLW for Station 8418150 at Portland, ME



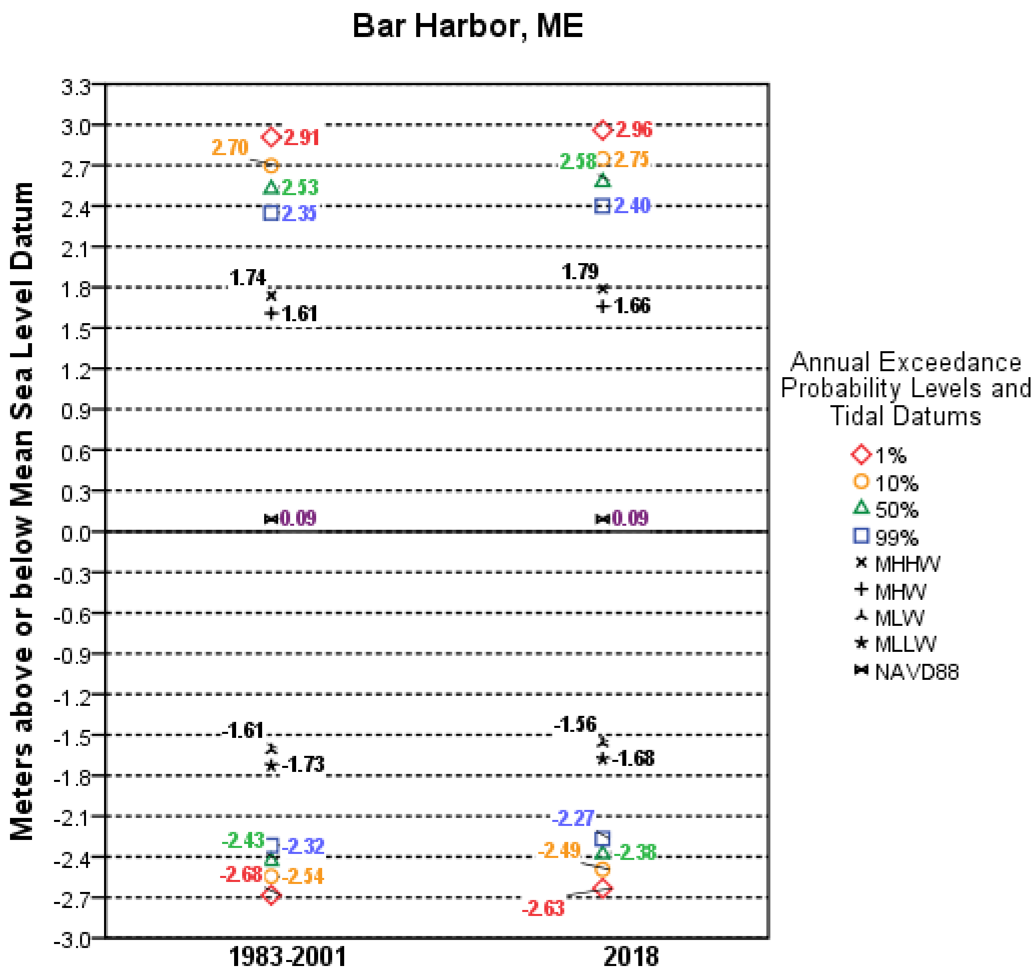
Attachment 7 Figure 5 - NOAA annual exceedance probability curves with 95% confidence intervals Station 8413320 at Bar Harbor, ME

Note: The monthly extreme water levels include a Mean Sea Level (MSL) trend of 2.04 millimeters/year with a 95% confidence interval of +/- 0.26 millimeters/year based on monthly MSL data from 1947 to 2006 which is equivalent to a change of 0.67 feet in 100 years.



Attachment 7 Figure 6 - NOAA annual exceedance probability curves with 95% confidence intervals Station 8418150 at Portland, ME

Note: The monthly extreme water levels include a Mean Sea Level (MSL) trend 1.82 millimeters/year with a 95% confidence interval of +/- 0.17 millimeters/year based on monthly MSL data from 1912 to 2006 which is equivalent to a change of 0.6 feet in 100 years.



Attachment 7 Figure 7 - NOAA monthly highest and lowest water levels with the 1%, 10%, 50%, and 99% annual exceedance probability levels for Bar Harbor

"UPDATED TIDAL PROFILES FOR THE NEW ENGLAND COASTLINE; 2012"

In 1988, the U.S. Army Corps of Engineers (USACE) developed coastal flood frequency curves for the New England coastline from Long Island Sound to the Maine-Canada border. The New England Tidal Flood Profiles, from Bergen Point, New York, to the Maine border with Canada, were updated by conducting new flood frequency analyses of long-term tide gage records supplemented by highwater mark data from significant events in the record. Tide gage records were available from NOS and USACE, while highwater mark data was retrieved from the USACE 1988 report. Parametric probability distributions were fit to the tide gage data using the method of L moments. The suite of probability distributions included the original Pearson Type III distribution to enable comparisons between the old tidal flood profiles and the results from the new analyses. The tidal flood profiles were updated using the best fitting probability distribution, as determined by goodness-of-fit criteria. Data for 16 tide stations were obtained from the NOAA/NOS Center for Operational Oceanographic Products and Services (CO-OPS) data base (http://co-ops.nos.noaa.gov/). Data for two tide stations were obtained from the USACE, New England District. Only those stations with more than 20 years of record were used for the frequency analysis.

FEMA FLOOD INSURANCE STUDY AND FLOOD INSURANCE RATE MAP

FEMA Flood Insurance Rate Maps (FIRMS) and Flood Insurance Studies (FIS) present flood-frequency information for the shoreline and onshore project area. The effective FIS and FIRM applicable to this study include:

- FEMA Flood Insurance Study, Hancock County, Maine; FIS Number 23009CV002A; Revised July 20, 2016
- FEMA Flood Insurance Rate Map Panels 23009C0883D, 23009C0884D, 23009C0887D, 23009C0889D, 23009C0891D and 23009C1102D; effective date 7/20/2016

For the areas of Hancock County that are impacted by coastal flooding processes, coastal flood hazard analyses were performed to provide estimates of coastal Base Flood Elevations (BFEs). Coastal BFEs reflect the increase in water levels during a flood event due to extreme tides and storm surge as well as overland wave effects.

Effective FEMA FIRM Special Flood Hazard Areas

Attachment 7 Figures 8 and **9** present the effective FEMA flood hazard zones at the project site and vicinity using the FEMA Digital Viewer.

The FEMA Base Flood Elevation (BFE) along the project shoreline ranges from VE13 (along the outer piers) to AE10 (floodwaters occurring along the Maine Maritime Academy Waterfront Campus towards Water Street). The VE classification indicates wave heights equal to or greater than 3 feet. The FEMA BFE within landside flood areas is generally AE10 except along the shoreline to the south of the pier, which includes both AE10 and VE12 zones. The closest FEMA coastal transect, applicable to the project site, is transect 10.

The methodologies used for development of the effective stillwater elevations, wave heights and periods, wave setup, wave run-up and overland wave propagation used by FEMA to establish the effective BFE are summarized below.

<u>Stillwater Elevation (SWEL)</u>:

The stillwater elevations (SWELs) for different recurrence intervals were derived by statistical analysis of tide gauge records in New England. The results of the analysis at the tide gauge stations were used to develop flood profiles along the New England coastline. Regional frequency analysis was performed using L-moments with interpolation to establish stillwater flood-frequency (reference STARR, Updating tidal profiles for the New England coastline, 2012). The 10- percent, 2-percent, 1-percent, and 0.2-percent-annual-chance SWELs for this Study were obtained from the updated STARR flood frequency profiles. Stillwater elevations were linearly interpolated to all coastal transects throughout Hancock County and are included in the digital data files compiled for the coastal submittal.

<u>Wave Height and Period:</u>

At each station, the USACE has conducted return period analysis from which wave heights for different return periods were obtained. The corresponding wave periods were determined by considering wave steepness values typical of North Atlantic hurricanes as described in FEMA guidance (references Guidelines and Specifications for Flood Hazard Mapping Partners Appendix D: Guidance for Coastal Flooding Analyses and Mapping and the Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update, February 2007). The wave conditions were de-shoaled to deep water to obtain the equivalent deep water wave conditions. The wave heights were averaged to provide a single wave height and wave period for the open coast transects.

Between Castine and the open Gulf of Maine/ Atlantic Ocean, there are areas where islands and peninsulas cause parts of the shoreline to be largely sheltered from wind waves generated in the Atlantic Ocean. Wave conditions for transects along these coastlines were derived using the methodology prescribed by the USACE for computing wave growth in fetch-restricted water bodies. The approach is implemented in the ACES software package, which was used for this work. For each transect, the geometry of the basin was defined by wind fetches parallel to the transect direction. As recommended in the Coastal Engineering Manual (CEM) and FEMA guidance, the deep-water wave growth option was used in all cases irrespective of the average depth of the wind basin. The ACES technical report notes that the shallow-water forms of the wave growth equations attempt to incorporate the effects of bottom friction and percolation but that the formulations are still largely experimental and unverified. The CEM instead recommends that the computed wave height be capped by depth-limited wave breaking considerations and the wave period (Tp) be capped by a limiting wave period. For a given effective wind fetch, the wind duration for which waves attain a fully-developed sea state is found by marching through a range (zero to six hours) of wind speed averaging intervals.

Wave Set-Up:

Wave setup was computed at each transect using the Direct Integration Method (DIM).

Coastal Transects

Transects (profiles) were located for coastal hydrologic and hydraulic analyses perpendicular to the average shoreline along areas subject to coastal flooding extending off-shore to areas representative of deep water conditions and extending inland to a point where wave action ceased. On low-lying transects inundated by storm surge, the propagation of waves overland was modeled using the Wave Height Analysis for Flood Insurance Studies (WHAFIS 4.0) tool. On steep transects where wave runup, rather than storm surge inundation is the dominant source of flooding, wave runup was computed using the RUNUP 2.0 tool or the Technical Advisory Committee for Water Retaining Structures (TAW) method.

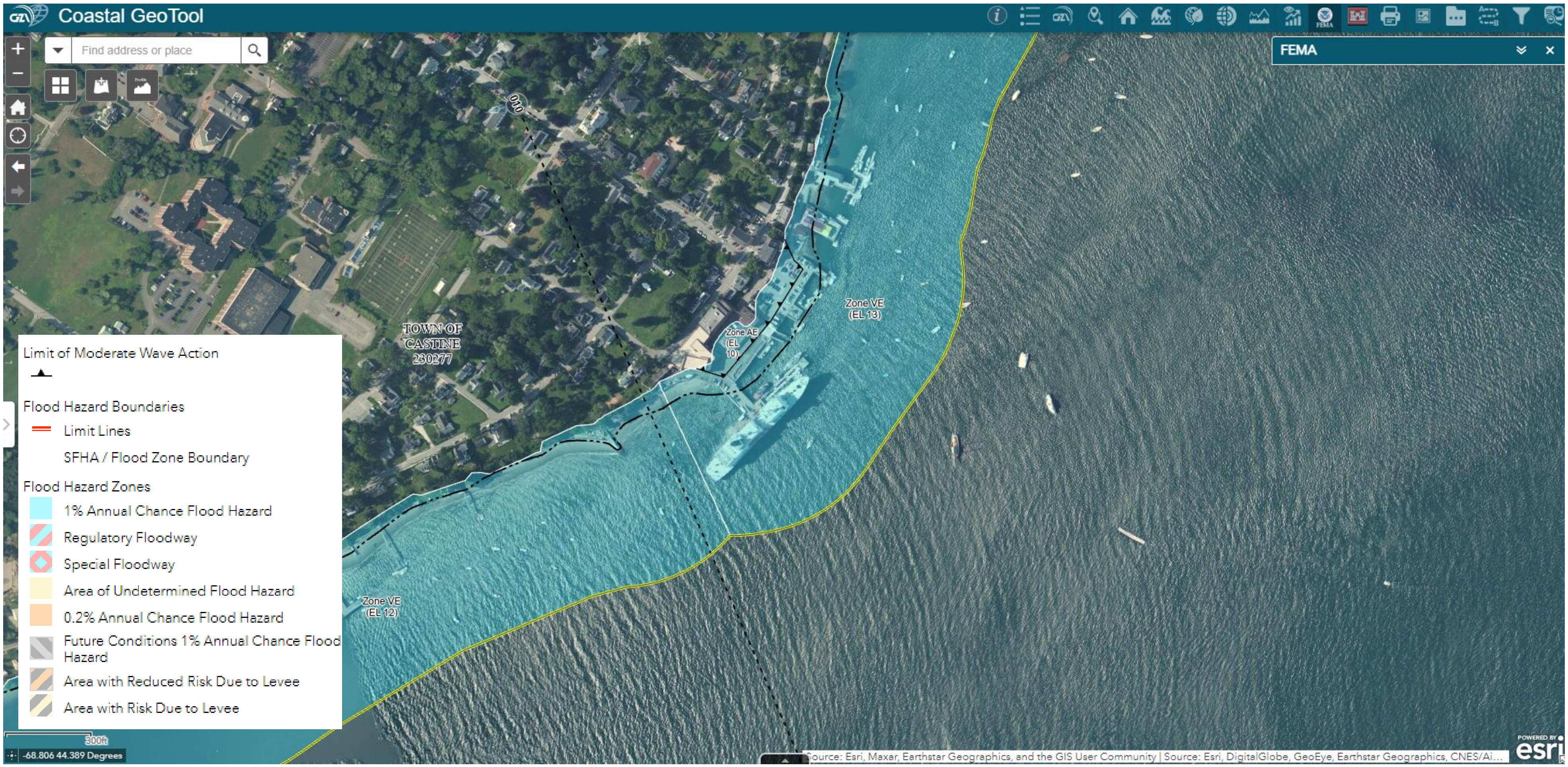
Effective Stillwater Elevations

The effective stillwater elevations developed by FEMA for coastal transect 10 is summarized in **Attachment 7 Table 1,** which was extracted from Table 17 of the effective FIS. The 1-percent annual chance stillwater elevation including wave set-up at transect 10 is 9.6 feet NAVD88.

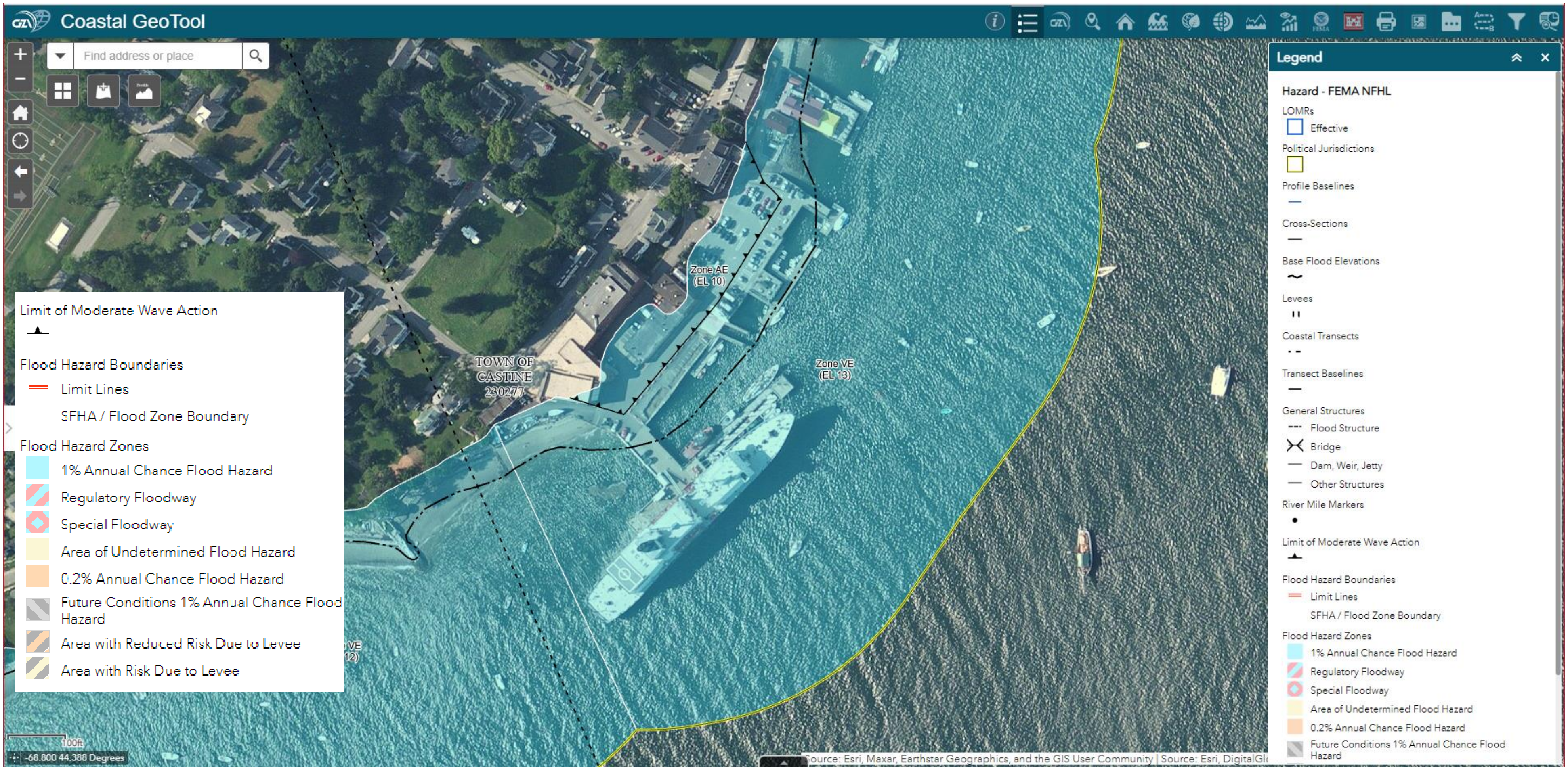
Table 17: Coastal Transect Parameters

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	HC-010	2	3.4	8.1	*	9.1	9.6	10.1

Attachment 7 Table 1 - Stillwater Elevations Developed by FEMA for Coastal Transect HC-010



Attachment 7 Figure 8: Effective FEMA Flood Zones within Project Site Vicinity Using FEMA Digital Viewer



Attachment 7 Figure 9: Effective FEMA Flood Zones within Project Site Using FEMA Digital Viewer

USACE NORTH ATLANTIC COAST COMPREHENSIVE STUDY (NACCS)

The North Atlantic Coast Comprehensive Study (NACCS) was completed by the US Army Corps of Engineers (USACE) after Hurricane Sandy to address coastal storm and flood risk to vulnerable populations, property, ecosystems, and infrastructure. The study was conducted to provide information for computing the joint probability of coastal storm environmental forcing parameters for the U.S. North Atlantic Coast (NAC) coastal regions from Virginia to Maine.

The NACCS wave and water level modeling goals included simulating an efficient number of storms representing a sufficient range of storm characteristics in order to accurately describe the statistical nature of coastal storm response over the entire region. NACCS included the application of a suite of high-fidelity numerical models within the Coastal Storm Modeling System (CSTORM-MS). Representative synthetic tropical and historical extratropical storms were strategically selected to characterize the regional storm hazard. CSTORM-MS was then applied with the wave generation and propagation model WAM, providing offshore, deep-water waves to apply as boundary conditions to the nearshore steady-state wave model STWAVE. The circulation model ADCIRC was used to simulate the surge and circulation response to the storms. STWAVE to provide nearshore wave conditions including local wind -generated waves.

The statistical analysis of the response of the 1,150 simulated storms (1,050 tropical cyclones and 100 extra-tropical cyclones) was conducted at nearly 19,000 save point locations to produce response statistics including AEP and average recurrence interval (ARI). In addition, epistemic uncertainty was quantified and represented as confidence limits (CLs).

The NACCS JPA model employs the joint probability method with optimal sampling (JPM-OS) scheme for the statistical analysis of tropical cyclones. The JPM considers all possible combinations of tropical cyclone meteorological parameters (i.e., track location, heading direction, translational speed, central pressure deficit, and radius of maximum winds) along with their associated probabilities and the storm responses generated by each combination of parameters. Each of these combinations constitutes a synthetic tropical cyclone. The probabilities of the tropical cyclones are combined by means of the JPM multidimensional integral in order to compute the AEP of each storm response.

For analysis of extratropical cyclones, NACCS utilized the following general methodology. The most significant historical extratropical cyclones were sampled from water level stations throughout the study area using the Peak Over Thresholds (POT) statistical method. The selected storms were simulated using climatological and hydrodynamic numerical simulation. Hindcast wind and pressure fields were used to drive high-fidelity storm surge and wave hydrodynamic models. The simulated water level responses were fitted with a parametric distribution model (typically the Generalized Pareto Distribution (GPD)). The best estimates of the distribution parameters can be obtained using fitting approaches such as using the maximum likelihood method (MLM).

Storm Set Simulations: Four sets of storm simulations were performed within NACCS:

- The first set of extratropical and tropical simulations (TCS1, XCS1) represents the base condition, modeled on mean sea level with wave effects but without astronomical tides or long-term SLC.
- The second set of extratropical and tropical simulations (TCS2, XCS2) consisted of the same base condition as in the first set but with each storm modeled on a unique, randomly selected tide phase.
- The third set of extratropical and tropical simulations (TCS3, XCS3) was the same as the second set except that it was modeled with a static water level adjustment of 1.0 m to simulate a future GSLC scenario of the same magnitude.

- A tide-only suite of 96 simulations was also run where each simulation had a random phase selected from historical tides occurring in September 2010.
- A fourth tropical cyclone set (TCS4) of results was developed by linear superposition of 96 tide-only simulations with the base condition set (TSC1).

Data access is provided via the USACE Coastal Hazards System (CHS), a national, coastal, storm-hazard data storage and mining system.

NACCS Save Point Data at Project Site

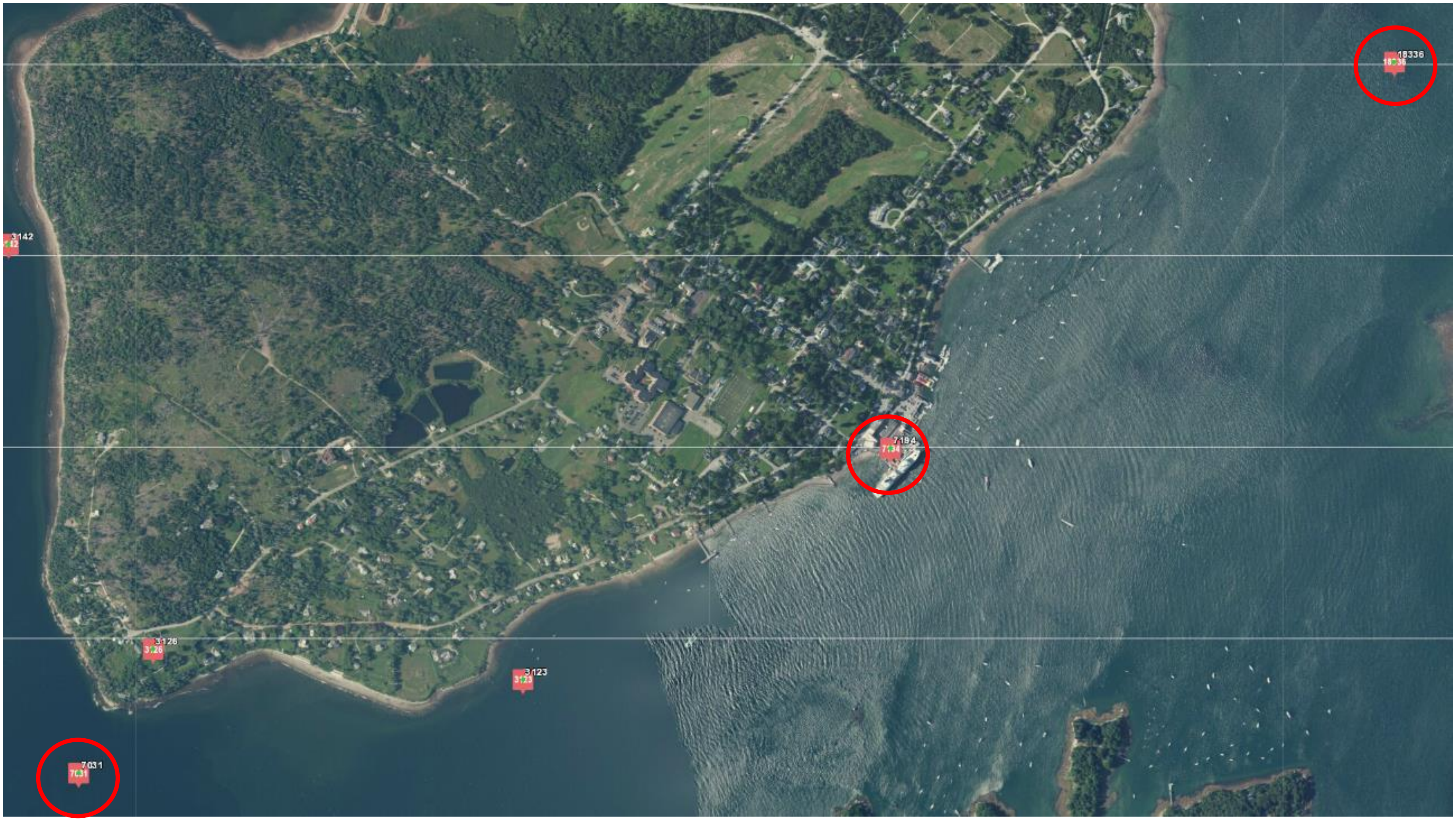
GZA has utilized the results of USACE NACCS study output (NACCS save point data) that are applicable to this project. The data utilized includes:

- Flood-Frequency Relationships:
  - Response statistics representing the total water level flood frequency including 13 ARI values representing 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, and 10000 years
  - Uncertainty: expected value, 68%, 90%, 95% confidence intervals
- Nearshore Wave Height Frequency Relationships:
  - Response statistics representing the significant wave height (Hs) frequency including 13 ARI values representing 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, and 10000 years
  - Uncertainty: expected value, 68%, 90%, 95% confidence intervals

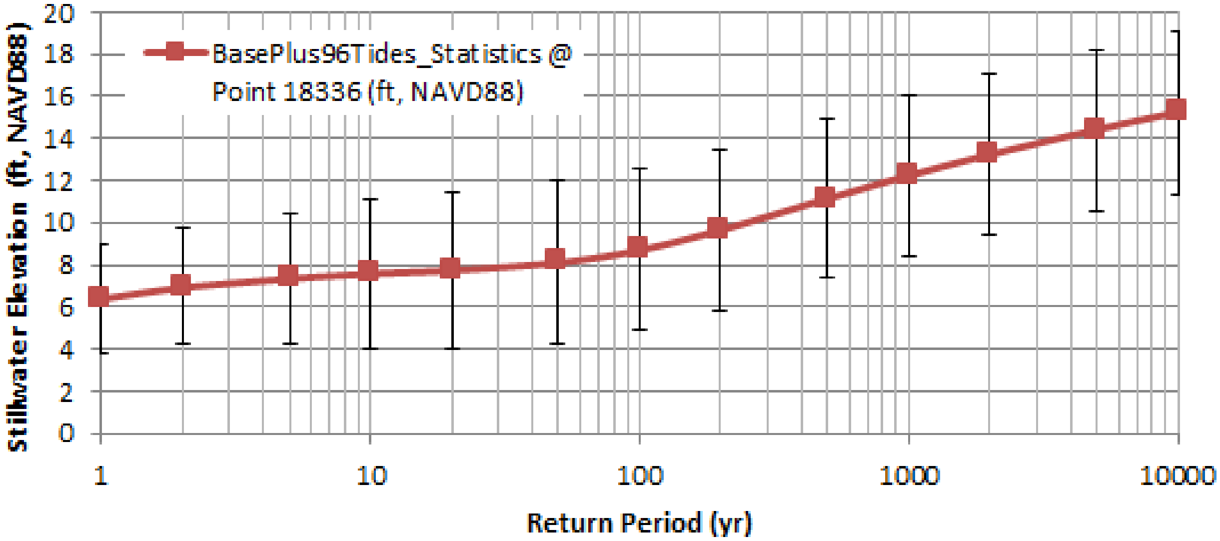
NACCS save points 18336, 7194 and 7031 were utilized to understand and develop representative water level flood frequency and wave frequency conditions for the project site. **Attachment 7 Figure 10** presents the NACCS save point locations.

Attachment 7 Figure 11, 12 and **13** presents flood-frequency relationships for save points 18336, 7194 and 7031, respectively.

Attachment Table 2, 3 and **4** presents flood-frequency relationships for save points 18336, 7194 and 7031, respectively.



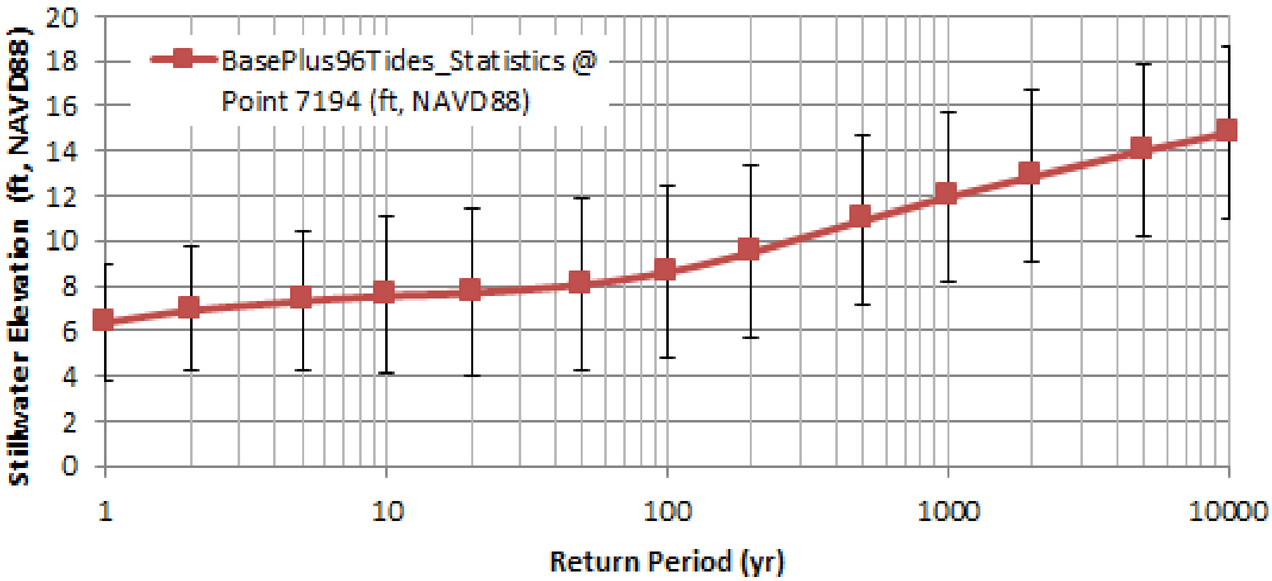
Attachment 7 Figure 10 - USACE NACCS Save Points at Project Site



Attachment 7 Figure 11: USACE NACCS Save Point 18336 Flood Frequency Relationship at Project Site

Table: NACCS Storm Surge Frequency Curves with 95% Confidence Interval				
Recurrence Interval (yr)	SurgeOnly @ Point 18336 (ft, NAVD88)	95% CI (ft)	BasePlus96Tides @ Point 18336 (ft, NAVD88)	95% CI (ft)
1	1.6	± 2.8	6.4	± 2.6
2	2.2	± 2.8	6.9	± 2.8
5	2.9	± 2.7	7.4	± 3.1
10	3.2	± 2.6	7.6	± 3.5
20	3.4	± 3	7.8	± 3.7
50	4.1	± 3.8	8.1	± 3.8
100	5.3	± 3.8	8.7	± 3.8
200	6.7	± 3.8	9.7	± 3.8
500	8.0	± 3.8	11.1	± 3.8
1,000	8.8	± 3.8	12.2	± 3.8
2,000	9.5	± 3.8	13.2	± 3.8
5,000	10.7	± 3.8	14.4	± 3.8
10,000	11.7	± 3.8	15.2	± 3.8

Attachment 7 Table 2: USACE NACCS Save Point 18336 Flood Frequency Relationship at Project Site

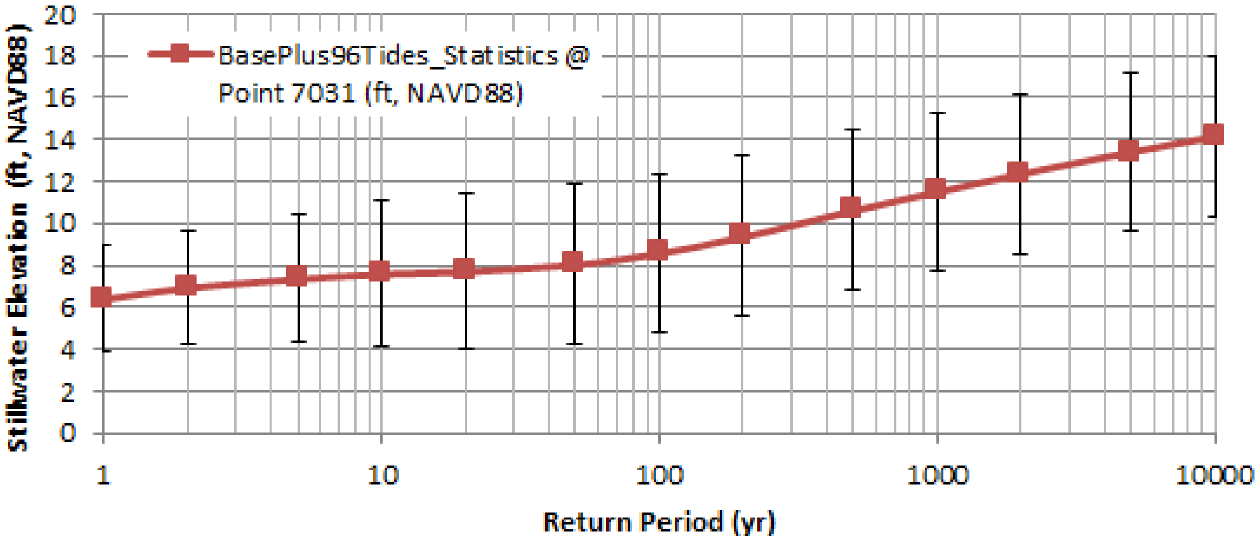


Attachment 7 Figure 12: USACE NACCS Save Point 7194 Flood Frequency Relationship at Project Site

Table: NACCS Storm Surge Frequency Curves with 95% Confidence Interval

Recurrence Interval (yr)	SurgeOnly @ Point 7194 (ft, NAVD88)	95% CI (ft)	BasePlus96Tides @ Point 7194 (ft, NAVD88)	95% CI (ft)
1	1.6	± 2.8	6.4	± 2.6
2	2.2	± 2.8	6.9	± 2.8
5	2.9	± 2.7	7.4	± 3.1
10	3.2	± 2.6	7.6	± 3.5
20	3.4	± 3	7.7	± 3.7
50	4.1	± 3.8	8.1	± 3.8
100	5.2	± 3.8	8.7	± 3.8
200	6.5	± 3.8	9.5	± 3.8
500	7.7	± 3.8	10.9	± 3.8
1,000	8.4	± 3.8	12.0	± 3.8
2,000	9.1	± 3.8	12.9	± 3.8
5,000	10.3	± 3.8	14.0	± 3.8
10,000	11.2	± 3.8	14.8	± 3.8

Attachment 7 Table 3: USACE NACCS Save Point 7194 Flood Frequency Relationship at Project Site



Attachment 7 Figure 13: USACE NACCS Save Point 7031 Flood Frequency Relationship at Project Site

Table: NACCS Storm Surge Frequency Curves with 95% Confidence Interval				
Recurrence Interval (yr)	SurgeOnly @ Point 7031 (ft, NAVD88)	95% CI (ft)	BasePlus96Tides @ Point 7031 (ft, NAVD88)	95% CI (ft)
1	1.6	± 2.8	6.4	± 2.6
2	2.3	± 2.8	6.9	± 2.7
5	2.9	± 2.7	7.4	± 3.1
10	3.2	± 2.6	7.6	± 3.5
20	3.4	± 3	7.7	± 3.7
50	4.0	± 3.8	8.1	± 3.8
100	5.0	± 3.8	8.6	± 3.8
200	6.1	± 3.8	9.4	± 3.8
500	7.1	± 3.8	10.6	± 3.8
1,000	7.8	± 3.8	11.5	± 3.8
2,000	8.5	± 3.8	12.4	± 3.8
5,000	9.5	± 3.8	13.4	± 3.8
10,000	10.4	± 3.8	14.1	± 3.8

Attachment 7 Table 4: USACE NACCS Save Point 7031 Flood Frequency Relationship at Project Site

SUMMARY OF WATER LEVEL DATA

Extreme water level data, applicable to the project site, has been developed from multiple data sources including NOAA Tidal Station; the USACE Report "Updated Tidal Profiles for the New England Coastline", 2012; FEMA Flood Insurance Study; and the USACE North Atlantic Coast Comprehensive Study (NAACS).

<u>High Water Levels Due to Coastal Storm Surge</u>

Attachment 7 Table 5 summarizes stillwater elevation data in the site vicinity based on these data sources. The NOAA, Stars and FEMA water levels were developed based on statistical extrapolation of observed water level data at NOAA tide stations. The principal limitation of this approach is its dependence upon observed data which have a limited period of record. The USACE NAACS study utilized a completely different methodology which included modeling of synthetic storm tracks and statistical interpolation of the model output. The storm tracks were developed using observed meteorological parameters that are representative of the current climate.

Each of the methods used include statistical uncertainty (and model uncertainty - USACE NAACS). Statistical uncertainty developed by NOAA is on the order of 2 feet. Uncertainty presented by NAACS indicates 95% uncertainty of about +/- 2.8 to 3.5 feet around the mean.

None of the methodologies used reflect the potential effects of climate change, including sea level rise, changes in storm typologies, storm frequency and storm intensity.

<u>Low Water Levels</u>

Low water levels have been developed by NOAA based on statistical extrapolation of observed data. The 100-year recurrence interval low water level (upper bound) projected at the Bar Harbor and Portland tidal stations is about -1.2 meters MLLW (about -4 feet MLLW). This corresponds to a 100-year recurrence interval low water at Castine of about 10 feet NAVD88. This is lower than the Lowest Astronomical Tide and likely is due in part to atmospheric low-pressure conditions that can occur during coastal storm events.

Recurrence Interval Event	NOAA Bar Harbor Tide Station; Stillwater Elevation (ft, NAVD88)	NOAA Portland Tide Station; Stillwater Elevation (ft, NAVD88)	2012 USACE Report at Castine (ft, NAVD88)	Effective FEMA Stillwater Elevation (ft, NAVD88)	NACCS Mean Water Level Save Point 7194 (ft, NAVD88)	NACCS 95% Confidence Water Level Save Point 7194 (ft, NAVD88)
1-year	7.6	7.0	-	-	6.4	8.5
2-year	8.2	7.6	-	-	6.9	9.1
5-year	-	-	-	-	7.4	9.7
10-year	8.7	8.2	8.4	8.1	7.6	10.3
50-year	-	-	9.3	9.1	8.1	11.2
100-year	9.4	9.2	9.6	9.6	8.7	11.7
500-year	-	-	10.8	10.1	10.9	14.0

Attachment 7 Table 5: Summary of Stillwater Elevation Data in Salem Harbor from Multiple Data Sources

Attachment 8
Projected Sea Level Rise

RELATIVE SEA LEVEL RISE

Observed Relative Sea Level Rise

NOAA has observed and recorded the rate of mean sea level rise and fall for 117 long-term water level stations. Monthly mean sea level data were used to obtain the linear trend, the average seasonal cycle, and the interannual variations. The linear trend at a coastal location is primarily a combination of the global sea-level rise and any local vertical land movement. The seasonal cycle and interannual variations are caused by fluctuations in coastal ocean temperatures, salinities, winds, atmospheric pressures, and currents. Observed RSLR from the following NOAA tide station is applicable to the project area:

- NOAA Bar Harbor tidal station gage (Station ID 8413320)
- NOAA Portland tidal station gage (Station ID 8418150)

The observed RSLR is presented in **Attachment 8 Figure 1 and 2**. The NOAA Bar Harbor gage (Station ID 8413320) and NOAA Portland gage (Station ID 8418150) are the closest long-term gages to the project site. The gages provide observed sea level trends based on historical data. For NOAA Bar Harbor gage, the current observed sea level rise rate was estimated to be 2.30 millimeters per year (mm/yr) with a 95% confidence interval of +/- 0.19 mm/yr. For NOAA Portland gage, the current observed sea level rise rate was estimated to be 1.90 millimeters per year (mm/yr) with a 95% confidence interval of +/- 0.14 mm/yr. Over the most recent 25 years, the measured water level data indicates that the mean rate of sea level rise is increasing. The observed rate indicates that the mean sea level is expected to rise at a rate of approximately 0.7 to 0.9 inch per decade at the Portland and Bar Harbor stations, respectively. The projected total SLR is approximately 4 inches (or 0.33 foot) in 2070 and 6.4 inches (or 0.53 foot) by 2100 based on a linear extrapolation of the observed SLR rate, from the present (Year 2022).

Projected Future Relative Sea Level Rise

The National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) developed global and regional sea level rise scenarios, presented in NOAA Technical Report NOS CO-OPS 083 " Global and Regional Sea Level Rise Scenarios for the United States". The report articulates the linkages between scenario-based and probabilistic projections of future sea levels for coastal-risk planning and management of long-lived critical infrastructure.

During 2015 to 2018, the Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Interagency Task Force, jointly convened by the U.S. Global Change Research Program (USGCRP) and the National Ocean Council (NOC): 1) updated scenarios of global mean sea level (GMSL) rise; 2) integrated the global scenarios with regional factors contributing to sea level change for the entire U.S. coastline; and 3) incorporated these regionally appropriate scenarios within coastal risk management tools and capabilities deployed by individual agencies in support of the needs of specific stakeholder groups and user communities. Gridded relative sea level (RSLR), which includes both ocean-level change and vertical land motion) projections for the United States associated with an updated set of GMSL scenarios were produced.

GMSL rise and associated RSL change were quantified from the year 2000 through the year 2200 (on a decadal basis to 2100 and with lower temporal frequency between 2100 and 2200). The 0.3 m-2.5 m GMSL range for 2100 was discretized by 0.5-m increments and aligned with emissions-based, conditional probabilistic storylines and global model projections into six GMSL rise scenarios: a Low, Intermediate-Low, Intermediate, Intermediate-High, High, and Extreme, which correspond to GMSL rise of 0.3 m, 0.5 m, 1.0 m, 1.5 m, 2.0 m and 2.5 m, respectively. These GMSL rise scenarios were used to derive regional RSL responses on a 1-degree grid covering the coastlines of the U.S. mainland, Alaska, Hawaii, the Caribbean, and the Pacific Island territories, as well as at the precise locations of tide gauges along these coastlines. GMSL was adjusted to account for key factors important at regional scales, including: 1) shifts in oceanographic factors such as circulation patterns; 2) changes in the Earth's gravitational field and rotation, and the flexure of the crust and upper mantle, due to melting of land-based ice; and 3) vertical land movement (VLM; subsidence or uplift) due to glacial isostatic adjustment (GIA, which also changes Earth's gravitational field and rotation, as well as the overall shape of the ocean basin), sediment compaction, groundwater and fossil fuel withdrawals, and other non-climatic factors.

The "2017 US Global Change Research Program" RSLR projections (NOAA 2017) are available for NOAA tide stations using the USACE Sea Level Calculator. The Sea Level Rise Calculator provides a way to visualize the USACE and other authoritative sea level rise scenarios for any tide gauge that is part of the NOAA National Water Level Observation Network (NWLON).

RSLR projections were developed for the project using the USACE Sea Level Rise Calculator and NOAA 2017 projections for the following NOAA tide station:

- NOAA Bar Harbor tidal station gage (Station ID 8413320)
- NOAA Portland tidal station gage (Station ID 8418150)

RSLR projections from the USACE and NOAA 2017 are graphically presented in **Attachment 8 Figures 3 and 4**.

Attachment 8 Figure 5 and 6 also includes six SLR projection scenarios updated in 2022 by NOAA[1], ranging from Low to High. Similarly, the NOAA sea level rise projections at selected time horizons are summarized in **Attachment 8 Table 1.** In 2022, NOAA released an updated global SLR report[2] and revised their 2017 SLR estimates, those values are presented in this report under **Attachment 8 Figure 5** and **Attachment 8 Figure 6**. The six NOAA projections (global sea level rise) are also associated with estimated exceedance probabilities, under three Representative Concentration Pathway (RCP) scenarios (Kopp et al., 2014). RCP 8.5 assumes that greenhouse gas emissions will remain unmitigated in the future (i.e., continue at the current rate).

Following the approach in the 2017 National Climate Assessment and the National Oceanic and Atmospheric Administration's Global and Regional Sea Level Rise Scenarios for the United States, conditional probability distributions for sea level rise projections can be integrated into different scenarios to support planning and decision-making, given uncertainty and future risks. This approach allows for the many different probabilistic projections (i.e., two models each using two greenhouse gas concentration pathways for multiple time series and several probabilities groups) to be filtered into four scenarios. Under this approach, each of the scenarios—Intermediate, Intermediate-High, High, and Extreme—is cross-walked with two or three probabilistic model outputs. On their own, while they are not site-specific projections of mean higher high-water levels, these projections provide insight to overall trends in rising sea levels along the coastline, to help coastal municipal officials identify future hazards exacerbated by rising seas.

The State of Maine along with the EPA has worked with the Maine Climate Council and has recommended that the State of Maine "manage" for 1.5 feet of relative sea level rise (SLR) by 2050 and 3.9 feet by 2100[4]. The State has recommended these based on a "Commit to Manage" and "Prepare to Manage" scenarios. The "Commit to Manage" scenario accounts for the NOAA Intermediate SLR projection of 1.5 feet by 2050 and 3.9 feet by 2100. The "Prepare to Manage" scenario accounts for a NOAA High SLR projection of 3.0 feet by 2050 and 8.8 feet by 2100. **Attachment 8 Figure 7** displays the projections shown on the Maine SLR dashboard.

SUMMARY

While there are several appropriate, different sources of relative sea level rise projections for the Hancock County area, they are all based on global modeling of different greenhouse gas emission scenario (Representative Concentration

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[1] NOAA, 2017. NOAA Technical Report NOS CO-OPS 083 Global and Regional Sea Level Rise Scenarios for the United States.
[2] NOAA, 2022. Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines.
[4] Maine Climate Science Dashboard, 2022. https://climatecouncil.maine.gov/maine-climate-science-dashboard

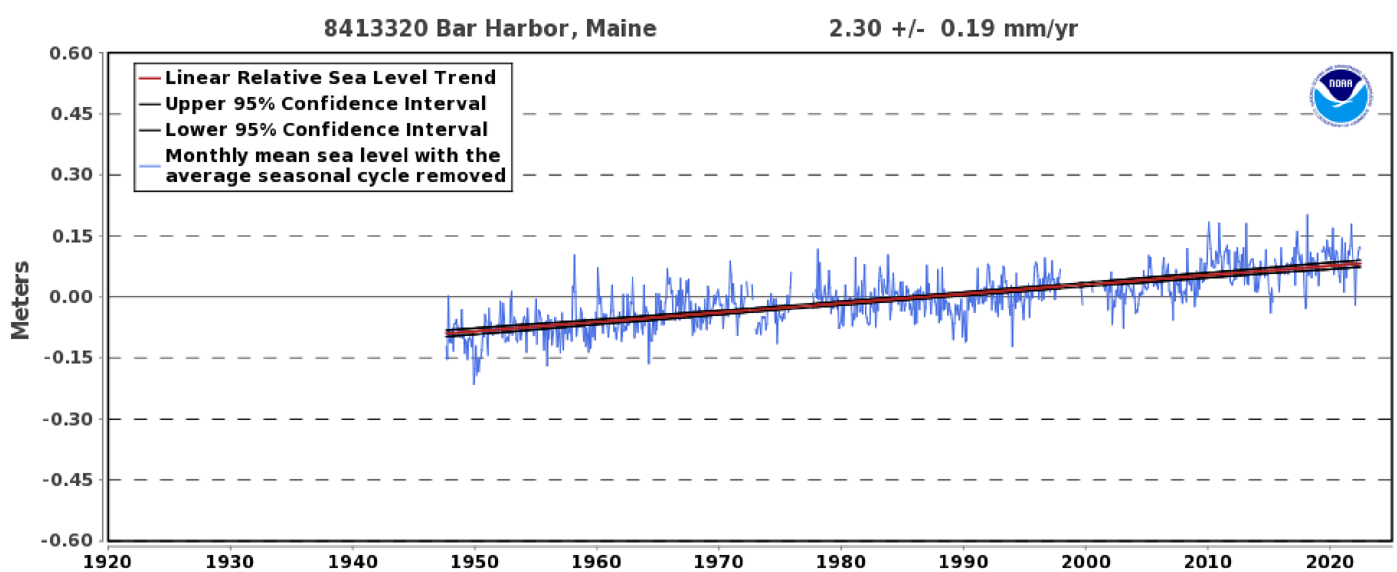
Pathways) and inclusion of local oceanographic effects and vertical land movement and are generally consistent. Similar to selection of an appropriate coastal flood recurrence interval, the selection of an appropriate sea level rise projection should be based on risk tolerance - specifically the acceptable risk based on consideration of flood consequences and facility criticality.

Sea level rise, coastal storm surge and astronomical tide are all independent variables. The joint probability of coastal storm surge and astronomical tide is captured in the flood-frequency data included in this report. Within open water areas, it is reasonable to linearly superimpose sea level rise to the current flood frequency data to estimate future flood frequency inclusive of the effects of sea level rise. In sheltered waters such as estuaries, embayments and harbors hydrodynamics may result in non-linear storm surge responses when sea level rise is added.

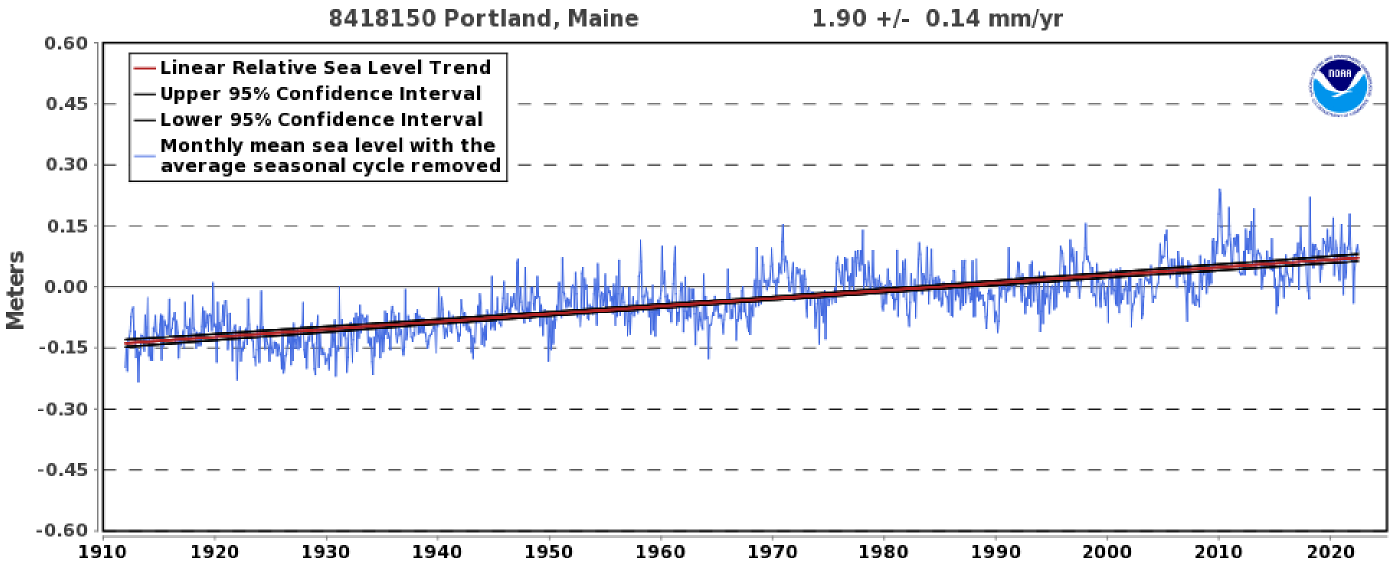
YEAR	NOAA (LOW)	NOAA (INT- LOW)	NOAA (INTERMEDIATE)	NOAA (INT-HIGH)	NOAA (HIGH)	NOAA (EXTREME)
2050	0.62	0.82	1.48	2.17	2.95	3.38
2070	0.89	1.18	2.33	3.48	4.92	5.91
2100	1.12	1.54	3.84	6.00	8.73	10.79

Attachment 8 Table 1 - NOAA 2017 Sea Level Rise Projections (in feet) at the Portland NOAA Gauge, 8418150 (feet NAVD88)

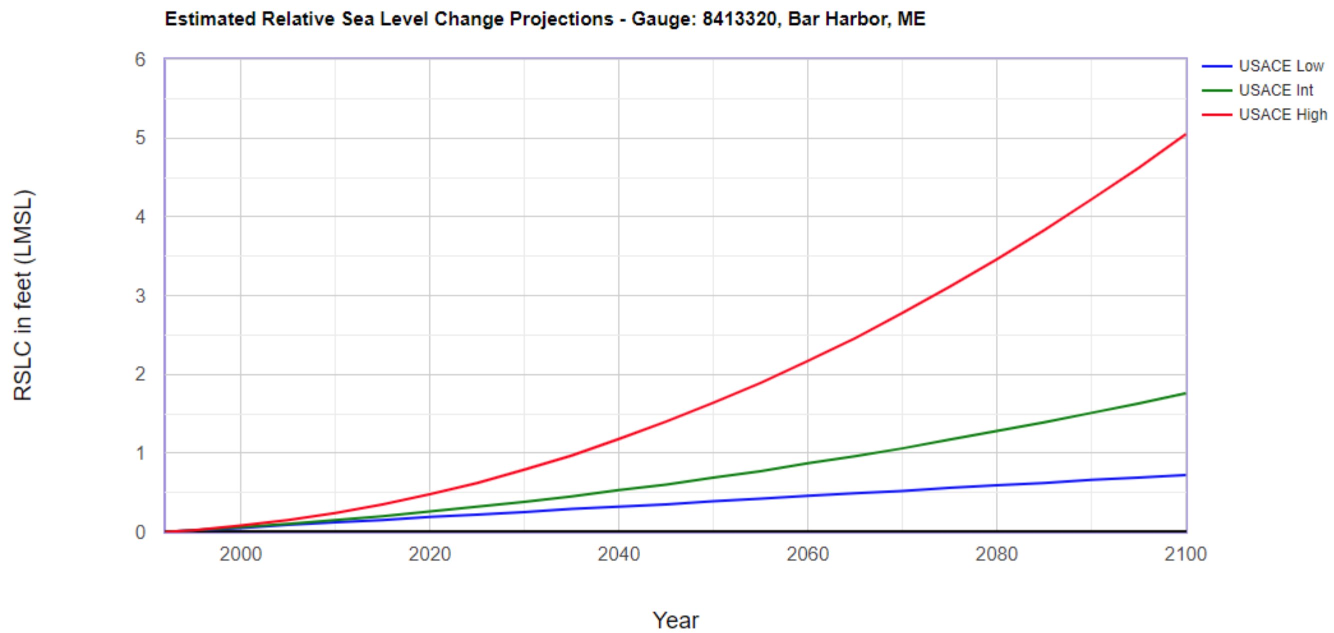
Note: Per USACE SLR calculator, starting year 2000.

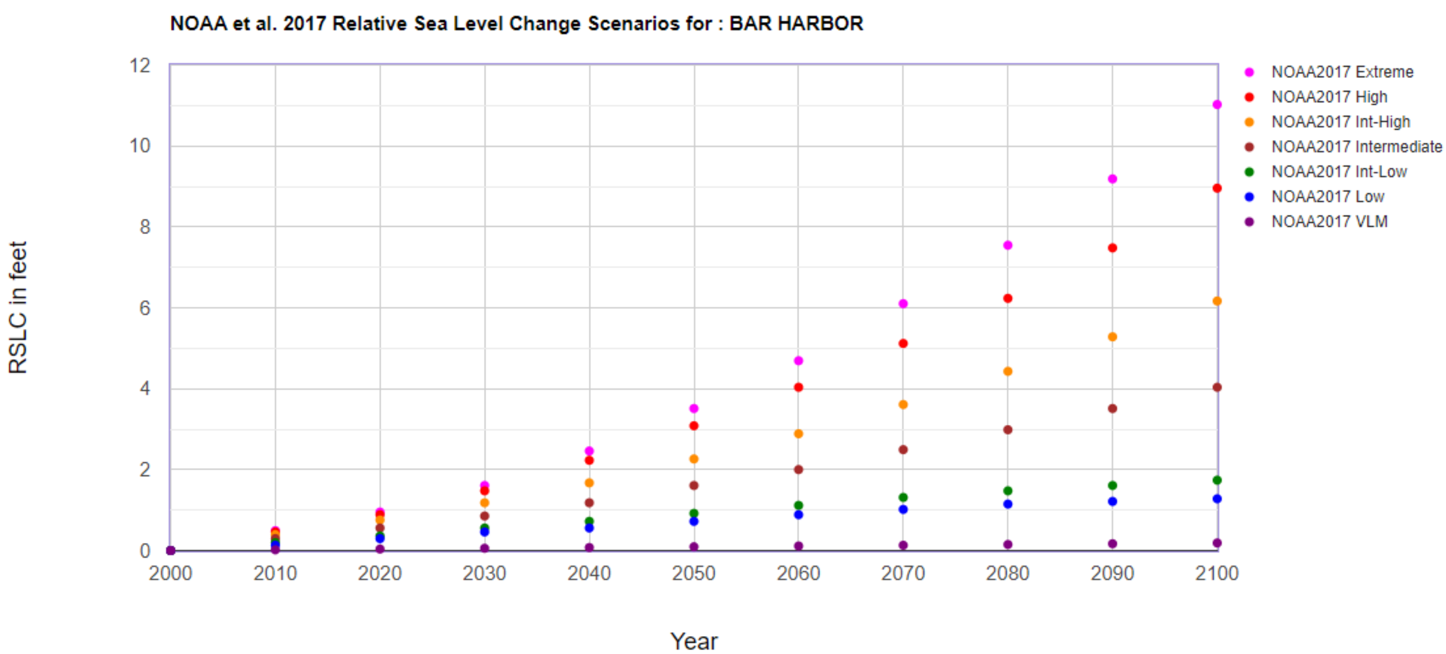


Attachment 8 Figure 1 - Observed Sea Level Trend at Bar Harbor Tide Gage 8413320

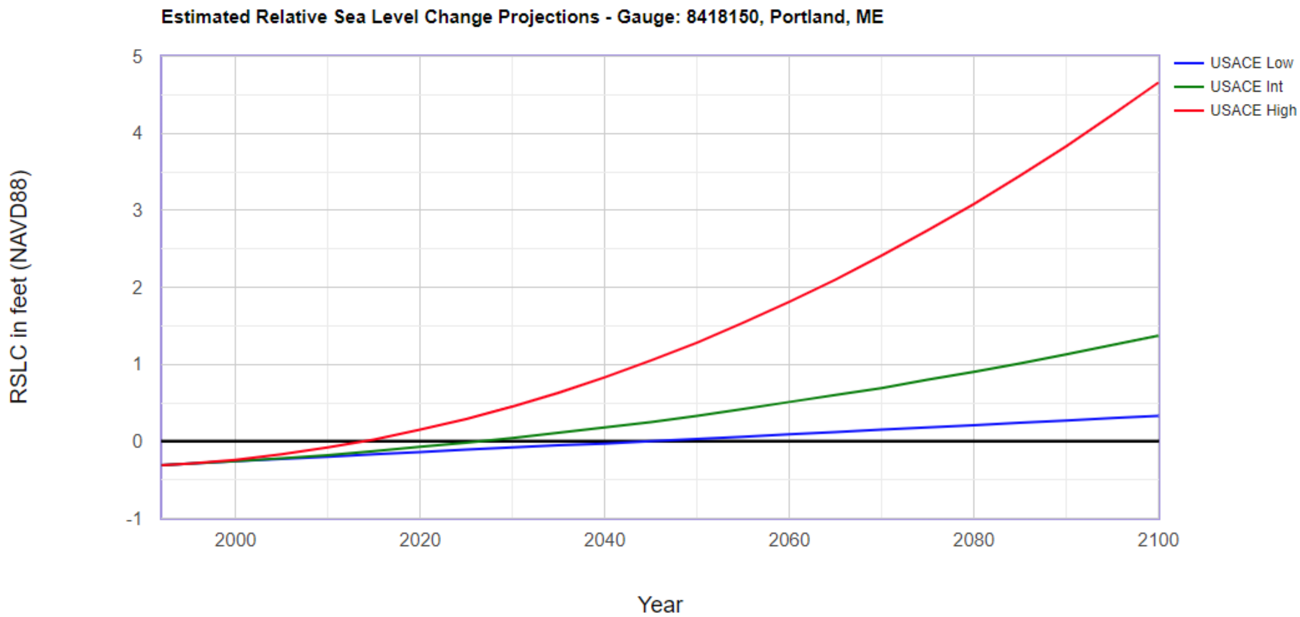


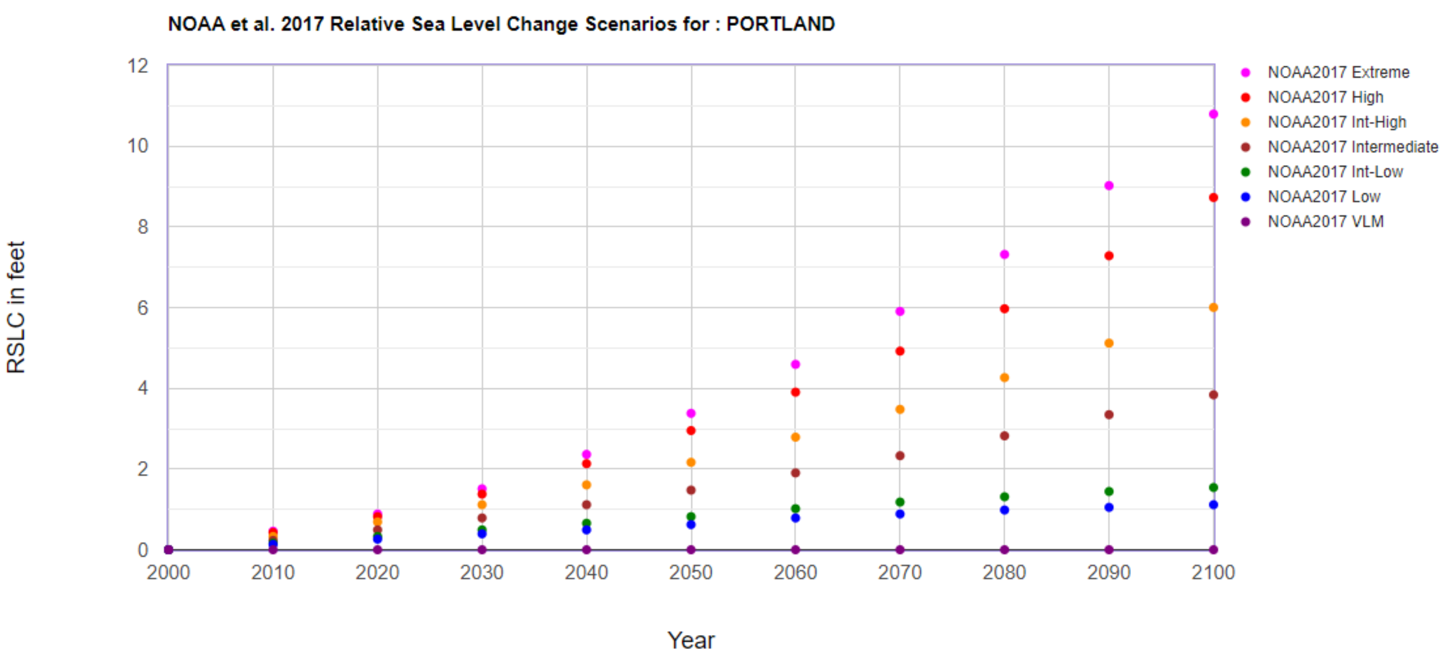
Attachment 8 Figure 2 - Observed Sea Level Trend at Portland Tide Gage 8418150



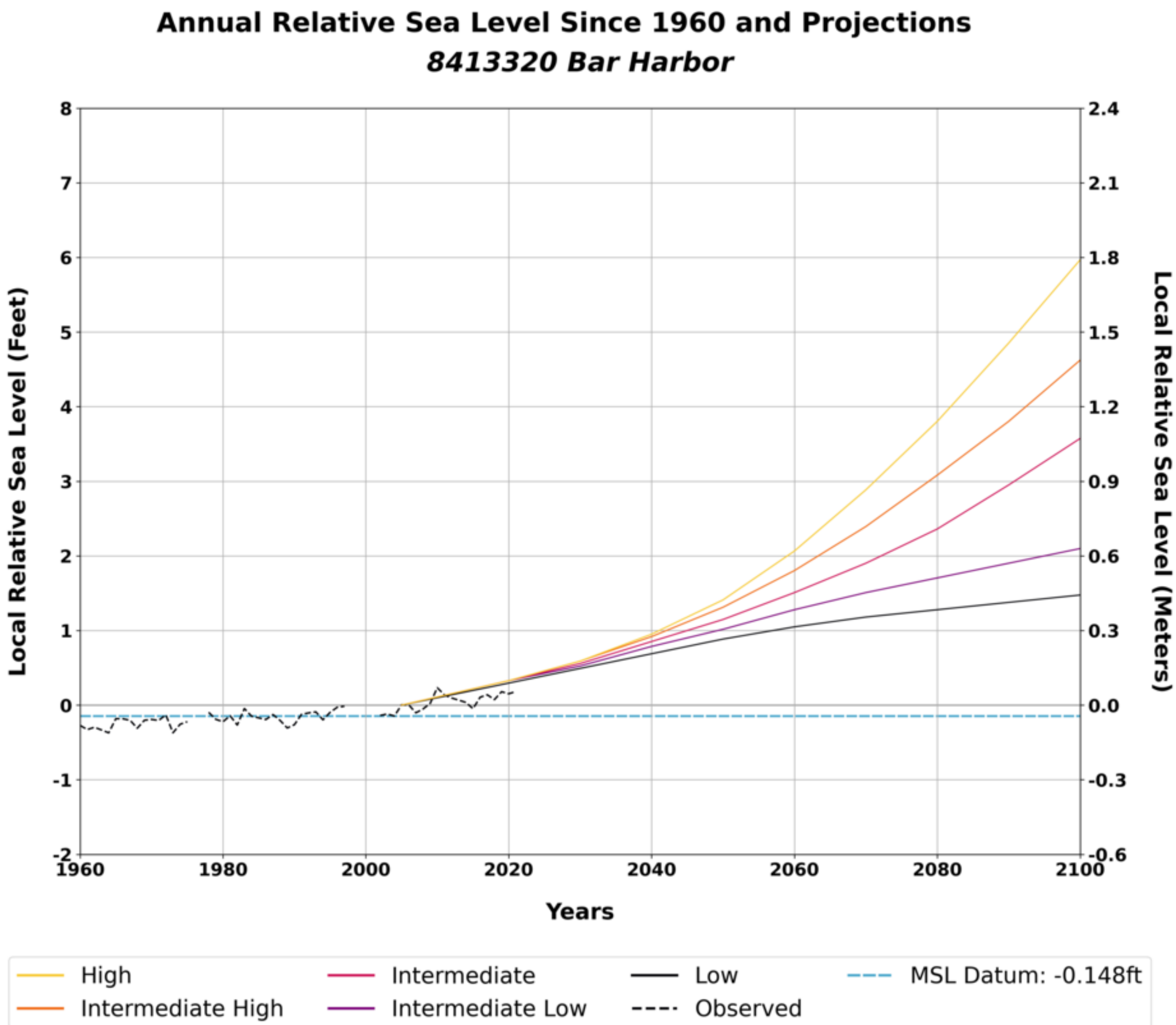


Attachment 8 Figure 3 – Bar Harbor 8413320 Sea Level Projection using USACE and NOAA 2017 Sea Level Rise Calculator

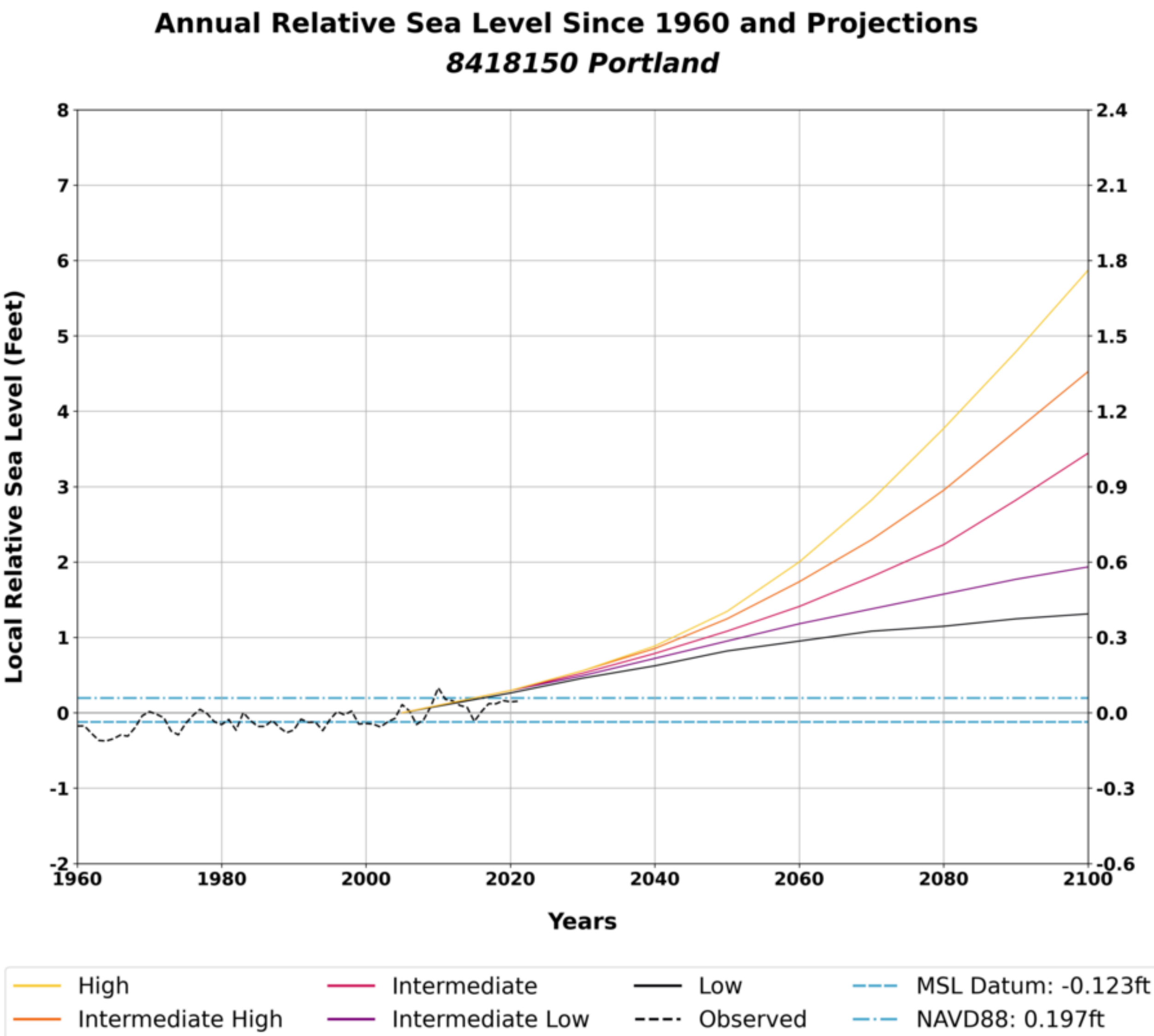




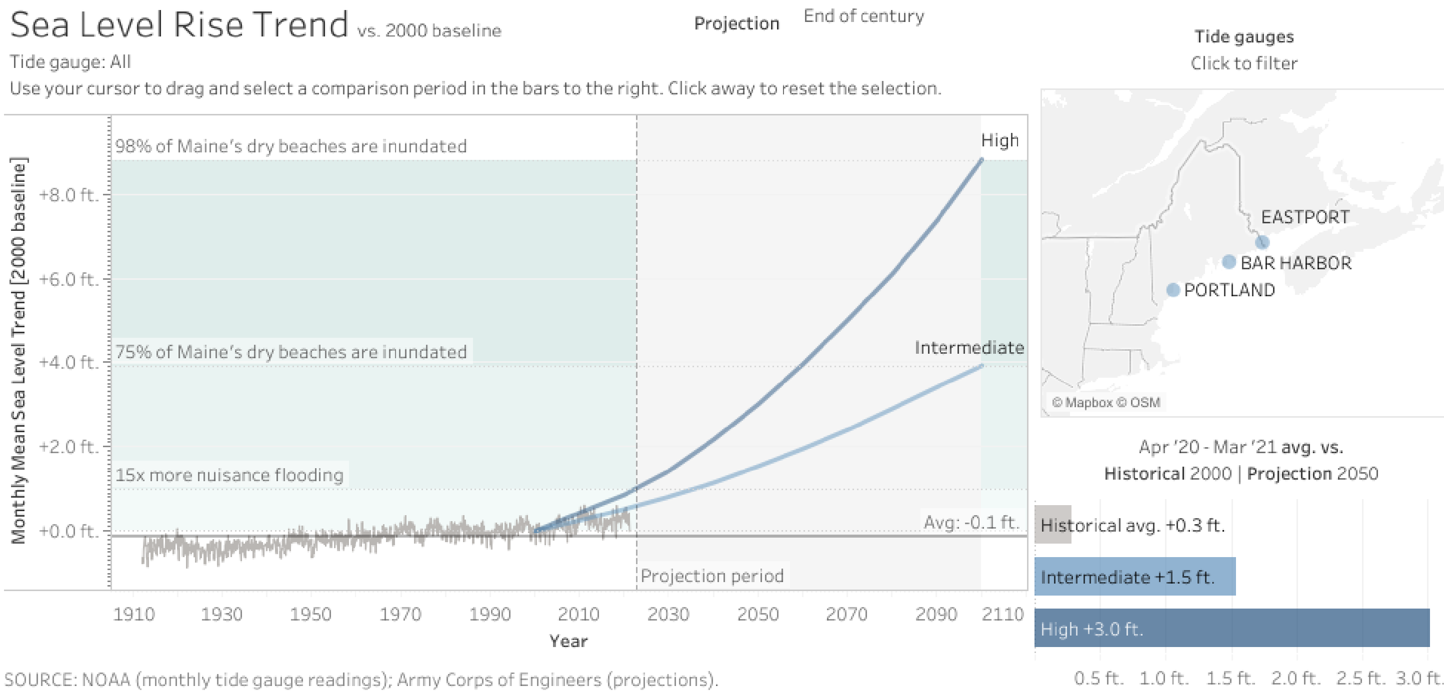
Attachment 8 Figure 4 – Portland 8418150 Sea Level Projection using USACE and NOAA 2017 Sea Level Rise Calculator



Attachment 8 Figure 5 – NOAA 2022 Annual Mean Relative Sea Level Rise Scenario Estimates for Bar Harbor, ME



Attachment 8 Figure 6 - NOAA 2022 Annual Mean Relative Sea Level Rise Scenario Estimates for Portland, ME



Attachment 8 Figure 7 - Maine Climate Council Relative Sea Level Rise Scenario Estimates

Attachment 9
Deepwater and Nearshore Waves

DEEPWATER WAVES

USACE Wave Information Study (WIS)

The Wave Information Study (WIS) is a digital database of hindcast wave conditions archived in the National Climatic Data Center (NCDC). The WIS was initiated in 1976 and is managed as part of the field data collection program by the U.S. Army Coastal Engineering Research Center. Parameters used in the data include significant wave height, dominant period, direction, sea swell height, sea swell period, and sea swell direction as well as input wind direction and speed.

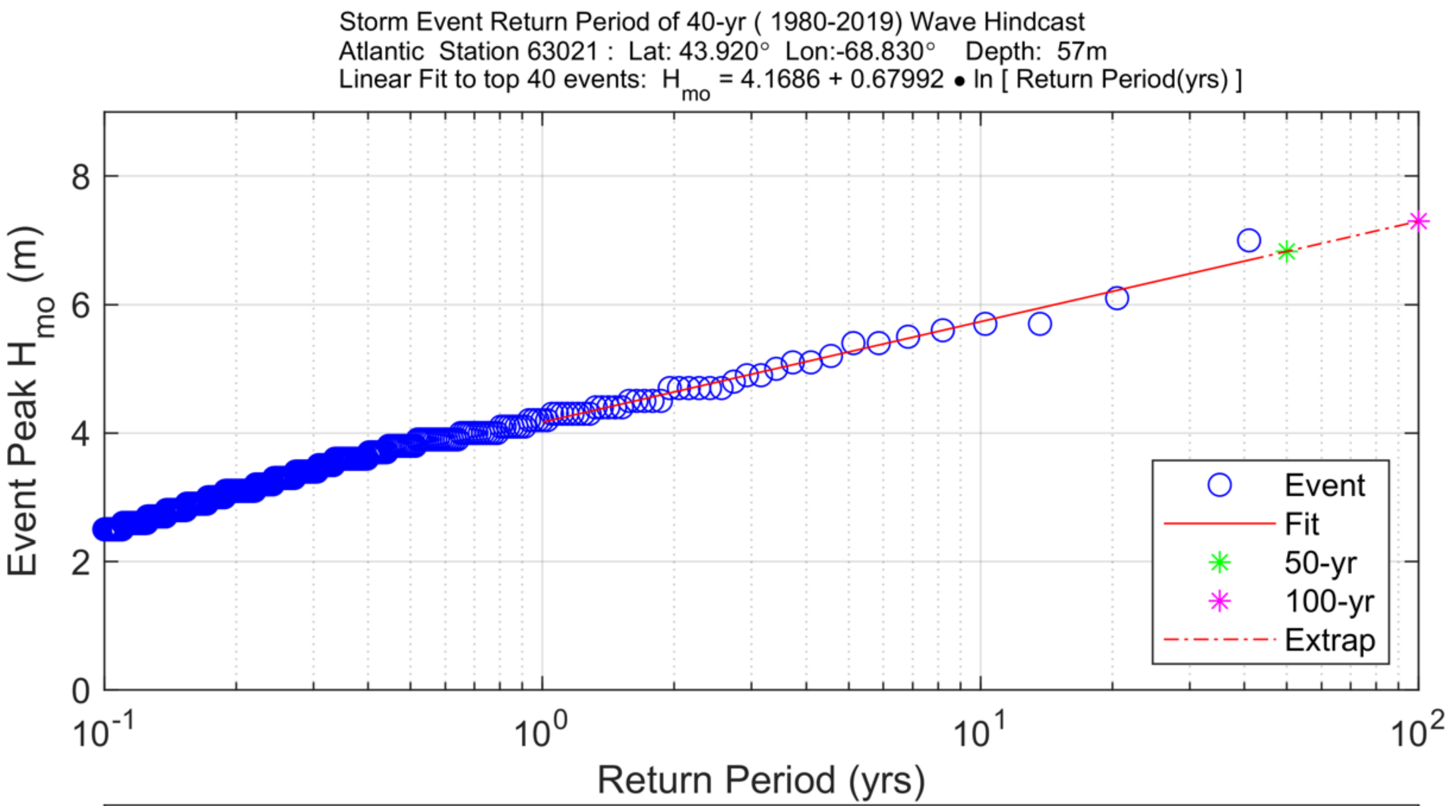
The hindcast wave event peaks plotted against their predicted return period as well as the top 10 wave events at WIS Station 63021, 63021 and 63023 are displayed in **Attachment 9 Figure 1** through **Attachment 9 Figure 3.** The location of the WIS station is shown in **Attachment 9 Figure 5.**

Wave climatology including height, period and direction was analyzed from this data for extreme wave events. A logarithmic fit has been applied to the event peaks and extrapolated out to the 100-year recurrence interval event. The average wave direction of the top 10 events is 139.7°, 110.1°, and 152.4° for Station 63021, 63021 and 63023, respectively. This corresponds to an East-Southeast direction. The top 10 event most in line with the project fetch arrived from 175.2°, 172.1°, and 187.0° for Station 63021, 63021 and 63023, respectively, suggesting that extreme waves can approach from South at the Hindcast buoy locations. Of the top 10 events, all other than the top event are the product of extratropical storm events. The top storm event corresponds to Hurricane Bob in 1991.

Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS)

The Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) is a digital database of oceanographic data in operation with the national Integrated Ocean Observing System (IOOS). Its purpose is to provide data to grow the ocean observation system and provide data to users.

The NDBC (National Data Buoy Center), controlled by NOAA, has data that is contained within the NERACOOS database. The NDBC is a source of buoy observations throughout the world that are placed to support the understanding of metocean information. Wave height, wave period, wind speed and wind direction are displayed in **Attachment 9 Figure 6** for the nearest NDBC point, Station 44033 (Buoy F01) in Penobscot Bay**.** The location of the station is shown in **Attachment 9 Figure 4.**

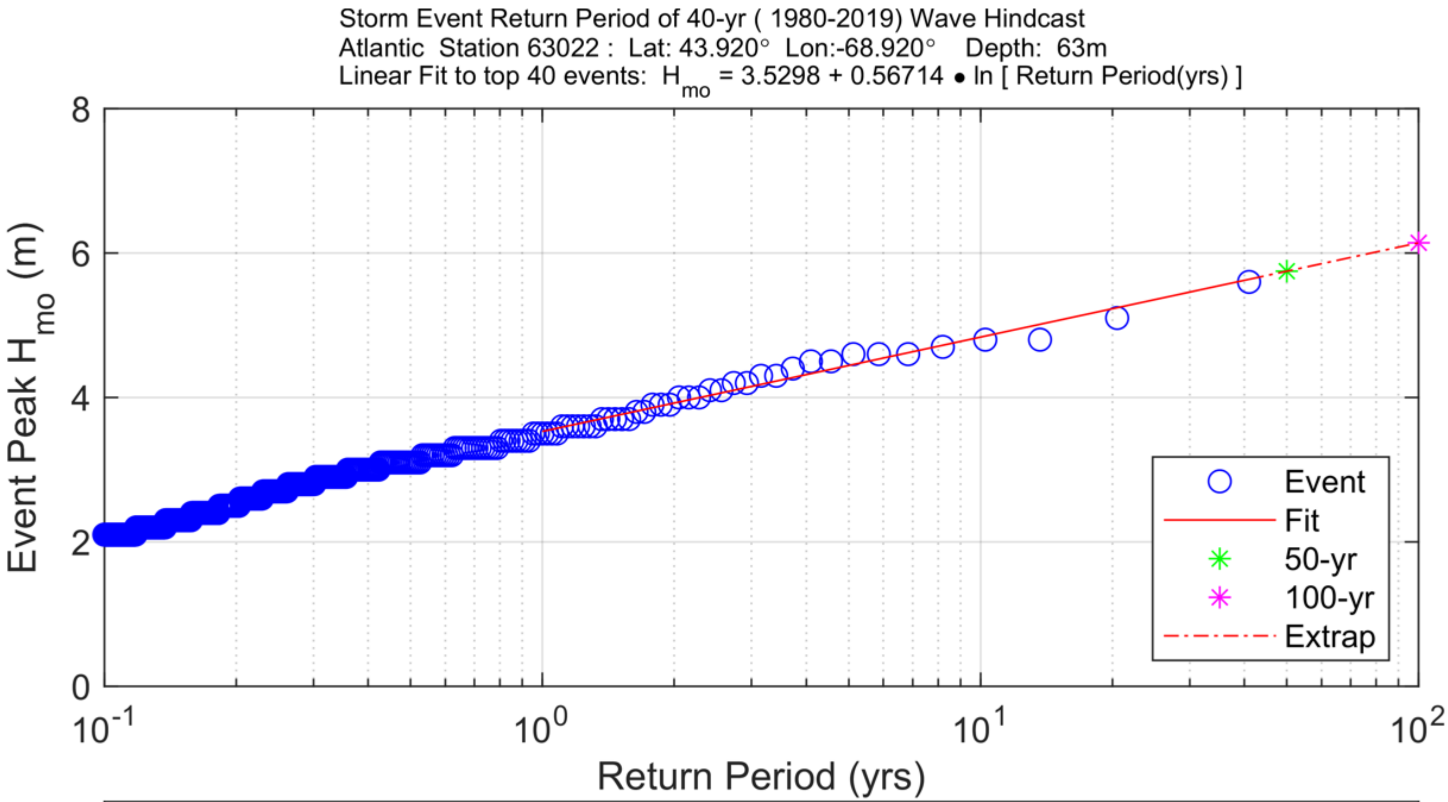


Top 10 events based on Peak H_{mo}

Event	Date/Time(UTC)	H_{mo}	T_{pp}	θ_{wave}	Event	Date/Time(UTC)	H_{mo}	T_{pp}	θ_{wave}
1	1991/08/20 01:00	7.00	10.50	171.0	6	2012/12/22 00:00	5.50	9.90	121.8
2	2012/10/30 05:00	6.10	12.80	128.4	7	2010/02/26 06:00	5.40	10.30	108.6
3	2017/10/30 13:00	5.70	10.10	139.3	8	2017/03/15 07:00	5.40	11.30	160.5
4	1993/03/14 12:00	5.70	12.50	147.0	9	2001/03/23 01:00	5.20	11.60	110.4
5	2011/04/17 12:00	5.60	9.80	134.8	10	2000/12/18 07:00	5.10	10.00	175.2

An event is defined as any period when $H_{mo} > 2.03$m θ_{wave} is direction that waves are arriving from

Attachment 9 Figure 1: WIS Station 63021 Hindcast Information

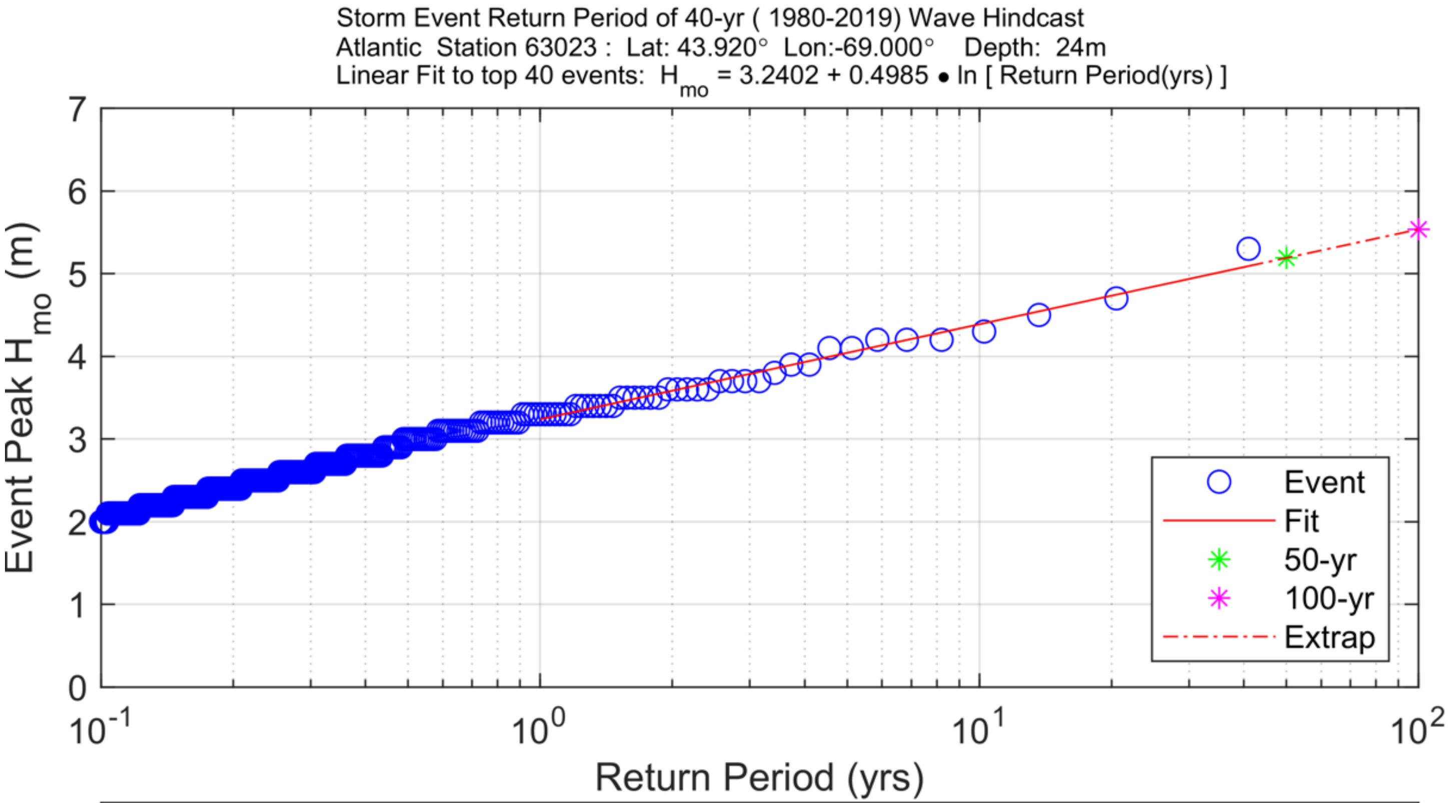


Top 10 events based on Peak H_{mo}

Event	Date/Time(UTC)	H_{mo}	T_{pp}	θ_{wave}	Event	Date/Time(UTC)	H_{mo}	T_{pp}	θ_{wave}
1	1991/08/20 01:00	5.60	10.20	172.1	6	2011/04/17 12:00	4.60	9.80	126.8
2	2012/10/30 05:00	5.10	12.10	120.3	7	2017/10/30 13:00	4.60	9.90	131.0
3	2012/12/22 00:00	4.80	9.90	116.0	8	2013/02/09 12:00	4.60	11.00	62.3
4	2010/02/26 06:00	4.80	10.20	104.3	9	2001/03/23 01:00	4.50	11.40	103.8
5	2015/01/27 19:00	4.70	11.60	70.5	10	1980/01/16 13:00	4.50	11.60	93.6

An event is defined as any period when H_{mo} > 1.66m θ_{wave} is direction that waves are arriving from

Attachment 9 Figure 2: WIS Stations 63022 Hindcast Information



Top 10 events based on Peak H_{mo}

Event	Date/Time(UTC)	H_{mo}	T_{pp}	θ_{wave}	Event	Date/Time(UTC)	H_{mo}	T_{pp}	θ_{wave}
1	1991/08/20 01:00	5.30	11.80	187.0	6	2011/04/17 12:00	4.20	10.00	136.5
2	2012/10/30 04:00	4.70	14.50	135.8	7	2017/03/15 07:00	4.20	11.90	168.1
3	1993/03/14 14:00	4.50	13.40	165.2	8	2011/08/29 02:00	4.10	10.90	173.4
4	2017/10/30 13:00	4.30	10.70	145.8	9	2012/12/22 00:00	4.10	10.00	122.9
5	2000/12/18 07:00	4.20	10.30	179.7	10	2010/02/26 06:00	3.90	10.50	109.5

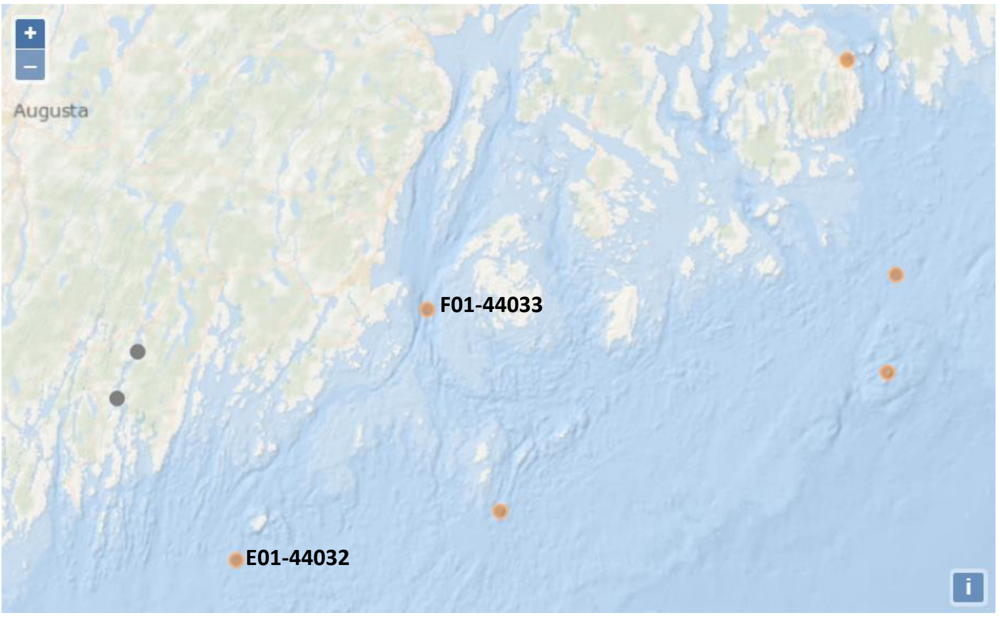
An event is defined as any period when H_{mo} > 1.63m

θ_{wave} is direction that waves are arriving from

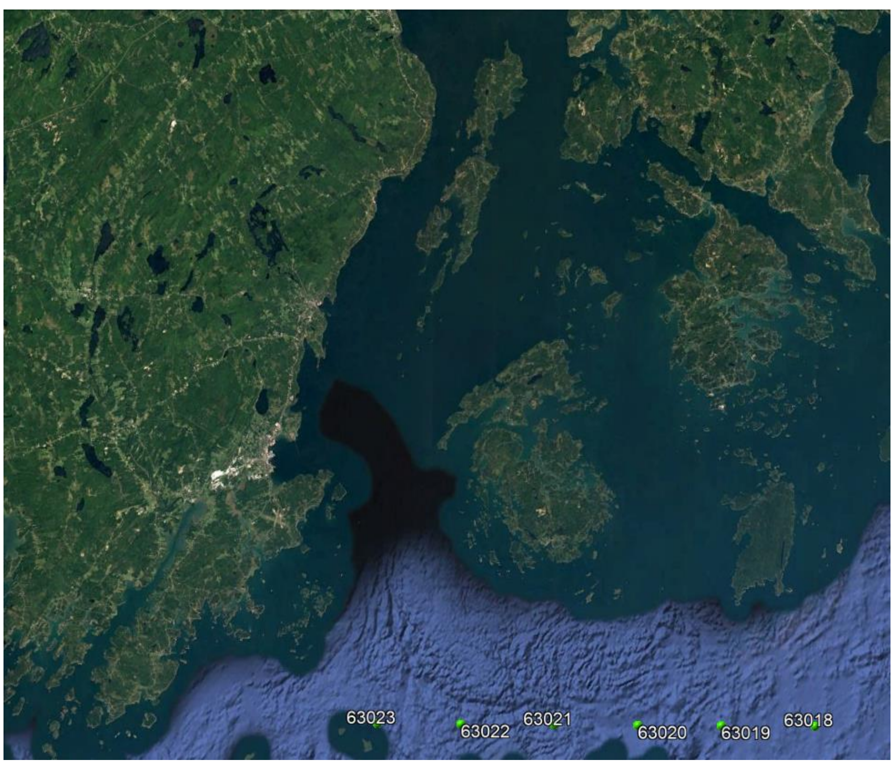
Attachment 9 Figure 3: WIS Stations 63023 Hindcast Information

NDCB (NERACOOS) Buoys

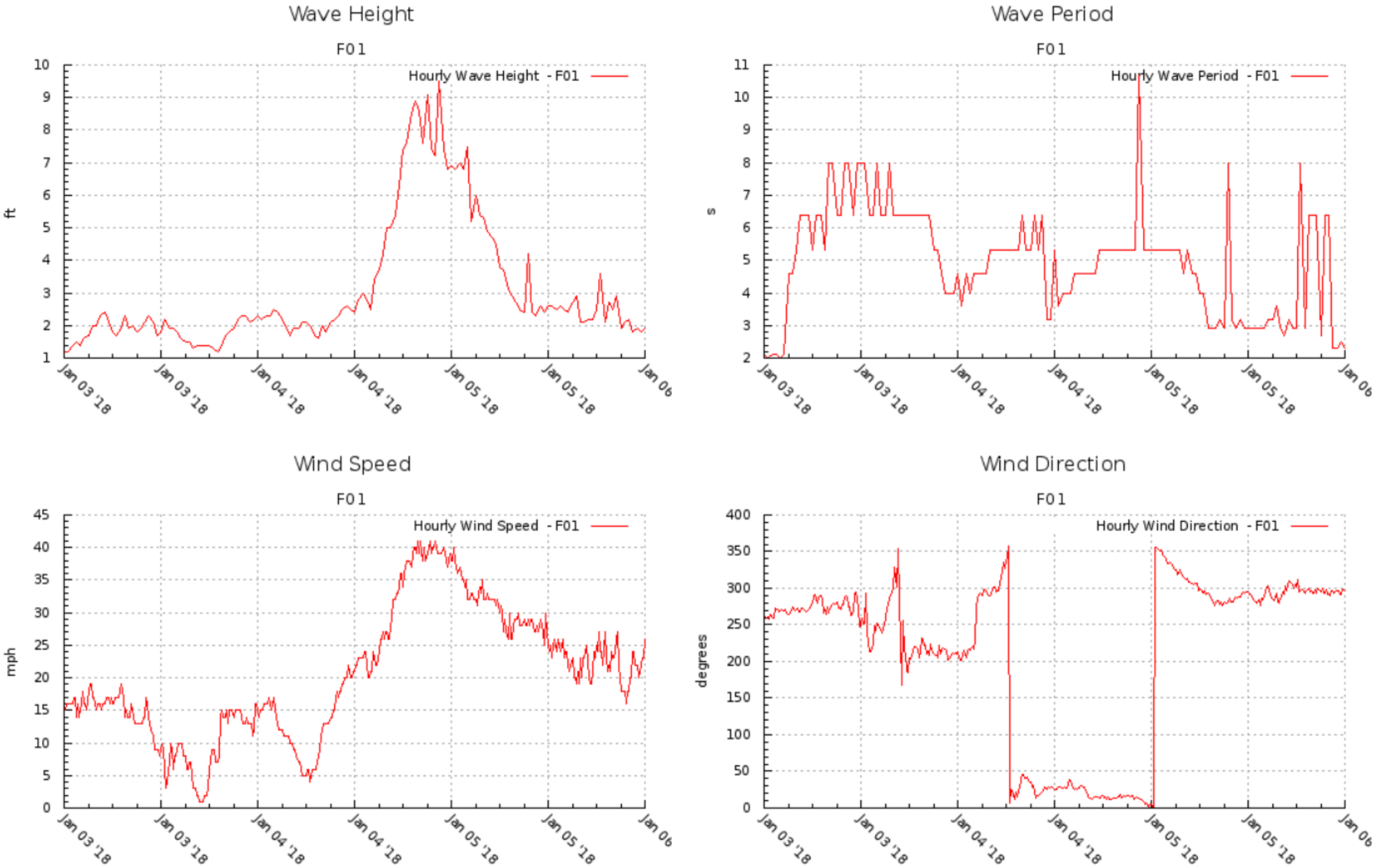
Observed wave heights and periods for several major 2018 extratropical storms are **Attachment 9 Figure 2**.



Attachment 9 Figure 4: NDCB (NERACOOS) Buoy Locations



Attachment 9 Figure 5: USACE WIS Hindcasting Buoy Locations

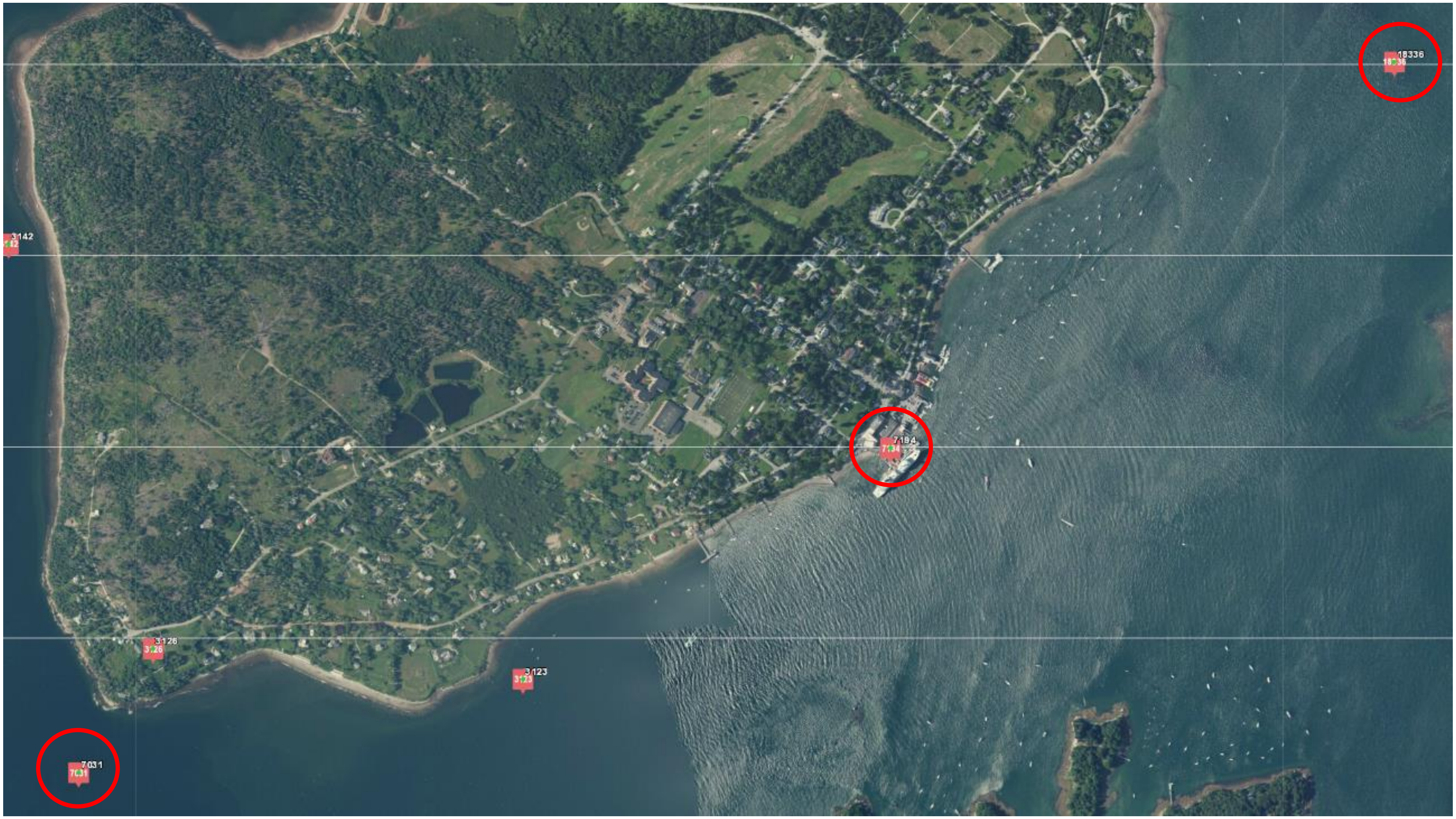


Attachment 9 Figure 6: NDBC (NERACOOS) Buoy Data (F01 44033) (Coastal Storm January 3-6, 2018 UTC Time)

USACE North Atlantic Coast Comprehensive Study (NACCS)

GZA has utilized the results of study output (NACCS save point data) that are applicable to this project. The data utilized includes:

- Nearshore Wave Height Frequency Relationships:
    - Response statistics representing the significant wave height (Hs) frequency including 13 ARI values representing 1, 2, 5, 10, 20, 50, 100, 200, 500 years
    - Uncertainty: expected value, 95% confidence intervals



Attachment 9 Figure 5: USACE NAACS Save Point Locations

Recurrence Interval Event	NACCS Point 7031 (Height, ft)	NACCS Point 7194 (Height, ft)	NACCS Point 18336 (Height, ft)
1-year Mean	**3.1**	**2.4**	**2.6**
1-year Upper	7.2	6.6	6.8
10-year Mean	**5.5**	**3.3**	**3.9**
10-year Upper	9.6	7.5	8.0
50-year Mean	**7.0**	**4.0**	**4.7**
50-year Upper	10.9	8.1	8.7
100-year Mean	**7.7**	**4.3**	**5.1**
100-year Upper	11.6	8.5	9.0
500-year Mean	**9.1**	**5.2**	**5.8**
500-year Upper	12.8	9.3	9.7

Attachment 9 Table 1: Summarizes Select, Representative NACCS Save Point Wave Heights, Including Upper Confidence Intervals.

A fetch limited analysis to determine nearshore waves was competed. The analysis looked at a south-westerly, south-easterly, and north-easterly fetch (**Attachment 9 Figure 5**). The longest exposure for the site was the southwest fetch, which determined the largest nearshore wave conditions at the site during a 10, 50 and 100-year annual recurrence probability event. The fetch length used was 7.3 miles.

The other fetch lengths (fetches 2 and 3) were analyzed to determine wave conditions approaching the site from different directions. For example, the analysis of fetch 2 from the southeast, indicates that during a 100-year recurrence interval event waves of 2.8 feet at a 2.2 second period could approach the current ship orientation broadside. A summary of the wave conditions is presented in **Attachment 9 Table 2.**

Recurrence Interval Event	Wind (2-minute, mph)	Significant Wave Height (feet)	Peak Wave Period (s)
10-year	57	3.9	3.0
50-year	66	4.7	3.2
100-year	71	5.1	3.3

Attachment 9 Table 2: Fetch-Limited Wave and Wave Period Results – Southwest Fetch (7.3 miles)

Recurrence Interval Event	Wind (2-minute, mph)	Significant Wave Height (feet)	Peak Wave Period (s)
10-year	57	2.1	2.0
50-year	66	2.5	2.1
100-year	71	2.8	2.2

Attachment 9 Table 3: Fetch-Limited Wave and Wave Period Results – Southeast Fetch (2.1 miles)

Recurrence Interval Event	Wind (2-minute, mph)	Significant Wave Height (feet)	Peak Wave Period (s)
10-year	57	2.2	2.1
50-year	66	2.6	2.2
100-year	71	2.9	2.2

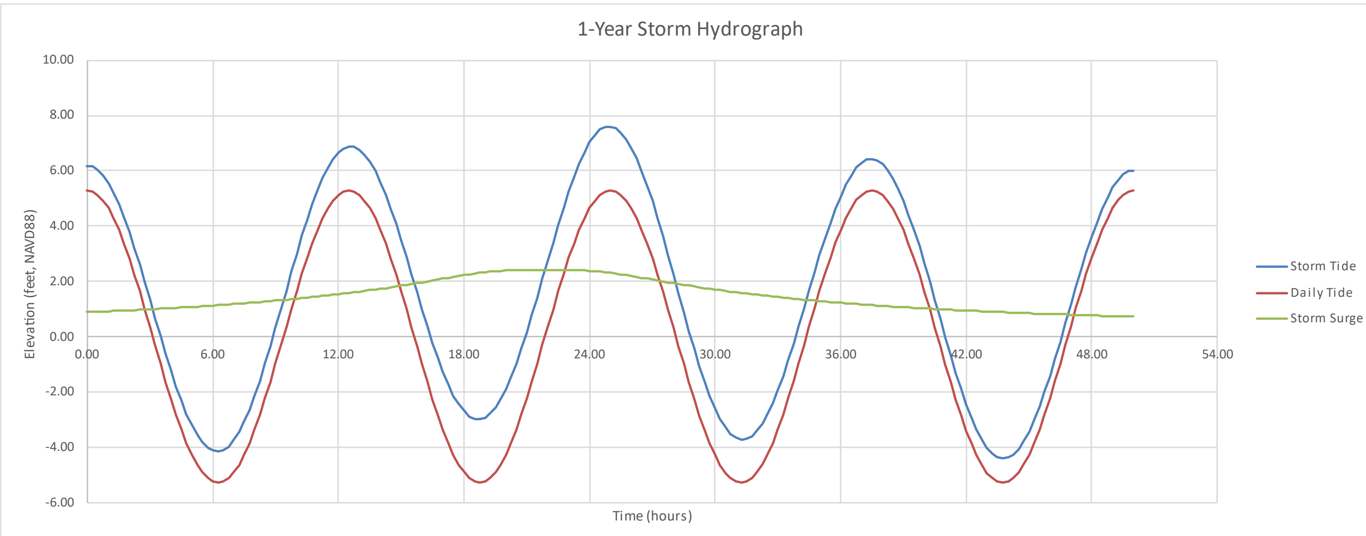
Attachment 9 Table 4: Fetch-Limited Wave and Wave Period Results – Northeast Fetch (2.2 miles)

Attachment 9 Figure 5: Fetch Lines Used in Fetch Limited Wave Calculations

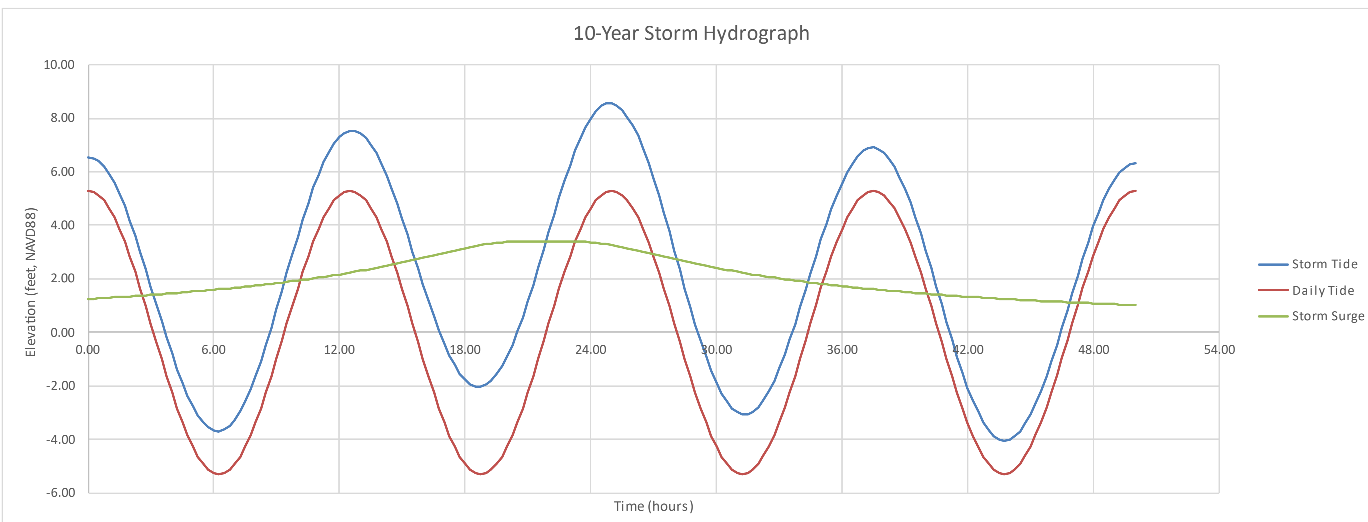
Attachment 10
Synthetic Hydrographs

SYNTHETIC HYDROGRAPHS

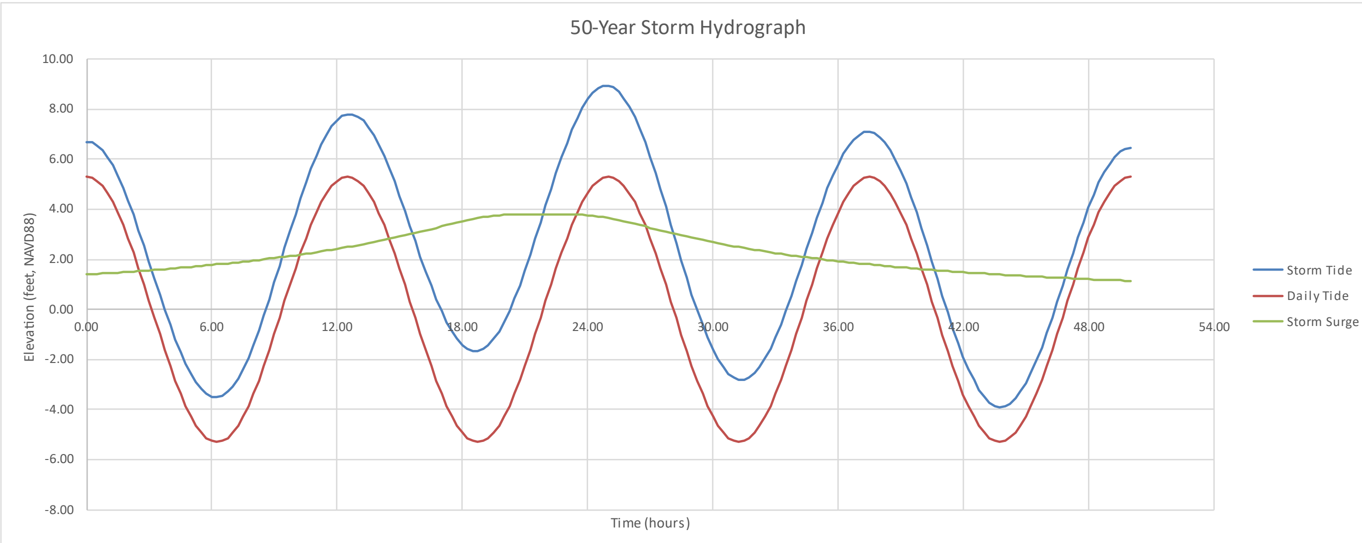
Synthetic hydrographs for extratropical storms were created by GZA (**Attachment 10 Figure 1** through **Attachment 10 Figure 4**) through analysis of past top flood events recorded at the NOAA Bar Harbor Tide gauge staion. The synthetic storm events were estimated to have a high wind radius of 200 miles with a moving speed of 20 miles per hour, aligning with a coastal storm that remains through multiple tide cycles. This is typical of an extratropical event in the region.



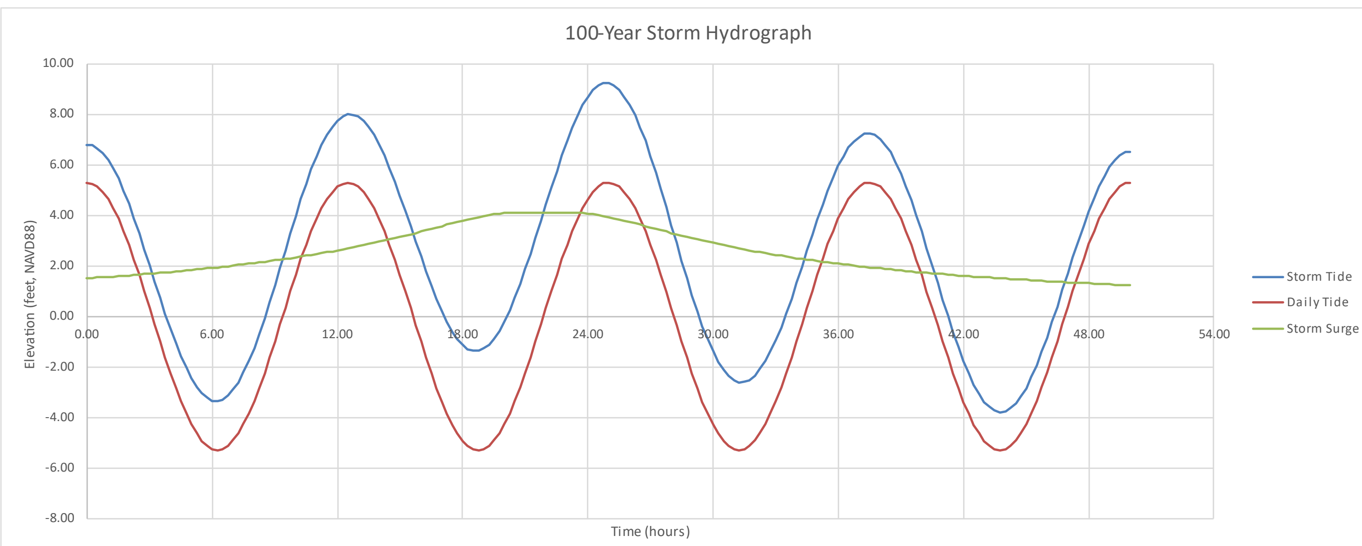
Attachment 10 Figure 1: 1-Year Storm Synthetic Hydrograph



Attachment 10 Figure 2: 10-Year Storm Synthetic Hydrograph



Attachment 10 Figure 3: 50-Year Storm Synthetic Hydrograph



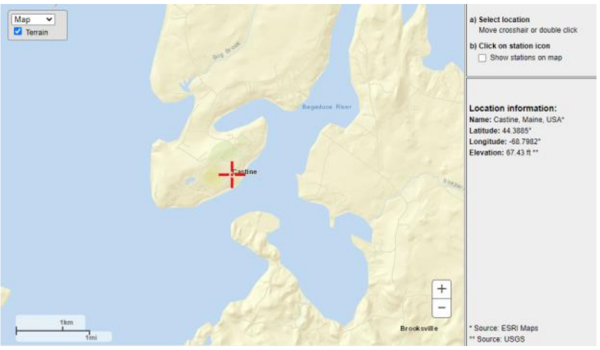
Attachment 10 Figure 4: 100-Year Storm Synthetic Hydrograph

Attachment 11
Precipitation

PRECIPITATION

The NWS-OWP Hydrometeorological Design Studies Center provides precipitation frequency (PF) estimates for various areas of the U.S. as volumes of NOAA Atlas 14. Estimates in a variety of formats with supplementary information and documentation are available from the PF Data Server (PFDS). Publications for states not covered by Atlas 14 are also available. Rainfall frequency estimates. NOAA Atlas 14 precipitation frequency estimates represent precipitation magnitudes regardless of the type of precipitation. For some areas the contribution of snowfall to the total yearly precipitation amount is significant. Precipitation frequency results are based on data from a variety of sources, but largely from the National Centers for Environmental Information - NCEI (formerly National Climatic Data Center - NCDC).

Atlas 14 precipitation frequency are tabulated and graphed below for the project area. Climate change will result in increase in precipitation intensity and frequency.



PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

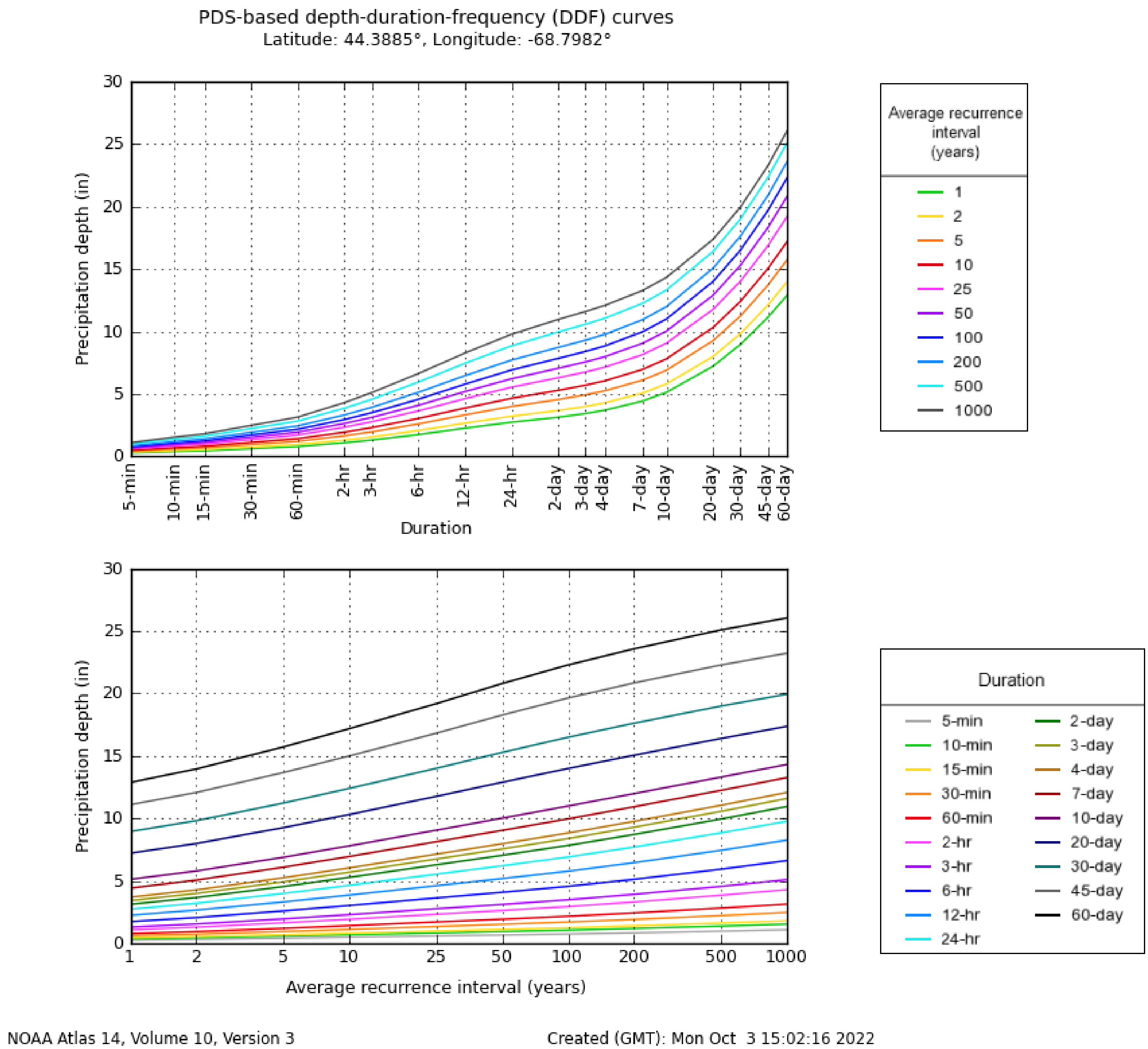
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.266 (0.216-0.325)	0.321 (0.261-0.392)	0.411 (0.333-0.504)	0.486 (0.390-0.599)	0.589 (0.455-0.756)	0.666 (0.502-0.872)	0.747 (0.543-1.01)	0.839 (0.572-1.16)	0.973 (0.634-1.39)	1.08 (0.686-1.57)
10-min	0.377 (0.306-0.460)	0.455 (0.369-0.556)	0.583 (0.471-0.715)	0.688 (0.553-0.848)	0.834 (0.644-1.07)	0.944 (0.711-1.24)	1.06 (0.770-1.44)	1.19 (0.812-1.64)	1.38 (0.898-1.96)	1.54 (0.972-2.23)
15-min	0.443 (0.360-0.541)	0.535 (0.435-0.654)	0.685 (0.554-0.840)	0.810 (0.651-0.998)	0.981 (0.758-1.26)	1.11 (0.836-1.45)	1.25 (0.906-1.69)	1.40 (0.954-1.93)	1.62 (1.06-2.31)	1.81 (1.14-2.62)
30-min	0.611 (0.498-0.747)	0.737 (0.599-0.901)	0.942 (0.762-1.16)	1.11 (0.894-1.37)	1.35 (1.04-1.73)	1.52 (1.15-1.99)	1.71 (1.24-2.31)	1.92 (1.31-2.65)	2.22 (1.45-3.16)	2.47 (1.57-3.59)
60-min	0.780 (0.635-0.953)	0.939 (0.763-1.15)	1.20 (0.970-1.47)	1.41 (1.14-1.75)	1.71 (1.32-2.20)	1.93 (1.46-2.53)	2.17 (1.58-2.94)	2.44 (1.66-3.36)	2.82 (1.84-4.01)	3.14 (1.99-4.55)
2-hr	1.08 (0.885-1.31)	1.29 (1.06-1.57)	1.64 (1.34-2.00)	1.93 (1.56-2.37)	2.33 (1.81-2.97)	2.63 (2.00-3.42)	2.94 (2.16-3.97)	3.31 (2.27-4.53)	3.85 (2.53-5.43)	4.30 (2.74-6.18)
3-hr	1.30 (1.07-1.57)	1.55 (1.27-1.87)	1.96 (1.60-2.38)	2.30 (1.87-2.80)	2.77 (2.16-3.52)	3.12 (2.38-4.04)	3.49 (2.57-4.68)	3.92 (2.70-5.34)	4.56 (3.00-6.41)	5.10 (3.27-7.29)
6-hr	1.74 (1.44-2.09)	2.06 (1.71-2.48)	2.59 (2.13-3.12)	3.03 (2.48-3.67)	3.63 (2.86-4.58)	4.08 (3.14-5.25)	4.56 (3.39-6.08)	5.12 (3.56-6.92)	5.94 (3.94-8.27)	6.62 (4.28-9.39)
12-hr	2.25 (1.88-2.69)	2.66 (2.21-3.17)	3.32 (2.75-3.97)	3.86 (3.18-4.65)	4.61 (3.66-5.77)	5.18 (4.00-6.60)	5.78 (4.31-7.61)	6.46 (4.52-8.65)	7.45 (4.98-10.3)	8.27 (5.38-11.6)
24-hr	2.73 (2.29-3.23)	3.21 (2.69-3.80)	3.99 (3.33-4.75)	4.64 (3.84-5.55)	5.54 (4.41-6.87)	6.21 (4.83-7.84)	6.91 (5.19-9.02)	7.71 (5.44-10.2)	8.84 (5.97-12.1)	9.77 (6.41-13.6)
2-day	3.13 (2.64-3.68)	3.66 (3.09-4.32)	4.55 (3.82-5.37)	5.28 (4.40-6.27)	6.29 (5.04-7.74)	7.05 (5.52-8.83)	7.84 (5.92-10.1)	8.72 (6.20-11.5)	9.95 (6.77-13.5)	11.0 (7.25-15.1)
3-day	3.42 (2.90-4.01)	3.99 (3.38-4.68)	4.92 (4.15-5.79)	5.69 (4.77-6.73)	6.75 (5.44-8.27)	7.56 (5.94-9.41)	8.39 (6.35-10.8)	9.30 (6.65-12.2)	10.6 (7.23-14.3)	11.6 (7.70-15.9)
4-day	3.69 (3.14-4.32)	4.28 (3.63-5.01)	5.24 (4.43-6.15)	6.04 (5.07-7.12)	7.14 (5.76-8.71)	7.98 (6.28-9.89)	8.83 (6.70-11.3)	9.76 (7.00-12.8)	11.1 (7.58-14.9)	12.1 (8.05-16.5)
7-day	4.42 (3.78-5.14)	5.06 (4.31-5.88)	6.09 (5.18-7.11)	6.95 (5.87-8.15)	8.14 (6.61-9.85)	9.05 (7.15-11.1)	9.97 (7.59-12.6)	10.9 (7.90-14.2)	12.2 (8.46-16.4)	13.3 (8.91-18.0)
10-day	5.12 (4.39-5.93)	5.79 (4.96-6.71)	6.89 (5.88-8.01)	7.80 (6.61-9.11)	9.06 (7.37-10.9)	10.0 (7.95-12.3)	11.0 (8.38-13.8)	12.0 (8.70-15.5)	13.3 (9.24-17.7)	14.3 (9.65-19.4)
20-day	7.22 (6.23-8.30)	7.99 (6.89-9.20)	9.26 (7.95-10.7)	10.3 (8.80-12.0)	11.8 (9.64-14.0)	12.9 (10.3-15.6)	14.0 (10.7-17.3)	15.1 (11.0-19.3)	16.4 (11.5-21.6)	17.4 (11.8-23.3)
30-day	8.95 (7.76-10.3)	9.82 (8.49-11.3)	11.2 (9.68-12.9)	12.4 (10.6-14.3)	14.0 (11.5-16.6)	15.3 (12.2-18.4)	16.5 (12.7-20.3)	17.6 (13.0-22.4)	19.0 (13.4-24.9)	19.9 (13.6-26.6)
45-day	11.1 (9.65-12.7)	12.1 (10.5-13.8)	13.7 (11.8-15.7)	15.0 (12.9-17.3)	16.8 (13.9-19.8)	18.3 (14.7-21.8)	19.6 (15.1-23.9)	20.8 (15.4-26.4)	22.3 (15.8-29.0)	23.2 (15.9-30.8)
60-day	12.9 (11.2-14.7)	14.0 (12.2-15.9)	15.7 (13.6-17.9)	17.2 (14.8-19.7)	19.2 (15.9-22.5)	20.8 (16.8-24.7)	22.3 (17.2-27.1)	23.6 (17.5-29.7)	25.1 (17.8-32.6)	26.1 (17.9-34.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Attachment 11 Figure 1: NOAA Atlas 14 Precipitation Frequency Estimates at the Site in Castine, ME



Attachment 11 Figure 2: NOAA Atlas 14 Precipitation Depth, Duration and Frequency at the Site in Castine, ME