MEMORANDUM

TO: Laura Krusinski, PE

FROM : Stefanie Bridges PE, Tulin Fuselier PE, Jim Wentworth PE

DATE : September 6, 2016

SUBJECT: Bridge #0181 – Bin Wall Replacement
Phase I Preliminary Design
Caribou Stream Bridge in Caribou, Maine
WIN 018984.00

Project No. 20161541.001A

The Maine Department of Transportation (MaineDOT) is proposing to stabilize or replace an existing steel bin retaining wall located along Caribou Stream and adjacent to Bridge No. 0181 in Caribou, Maine. Kleinfelder conducted geotechnical explorations to evaluate subsurface conditions, and to provide preliminary geotechnical recommendations to be used for design of the site improvements. The purpose of this Geotechnical Memorandum is to summarize our findings and preliminary geotechnical recommendations for various wall replacement and/or slope stabilization alternatives.

SITE AND PROJECT CONDITIONS

The existing wall retains Water Street, and abuts the northwest wing wall of MaineDOT Bridge No. 0181, which carries Bridge Road in a generally north-south direction over Caribou Stream in Caribou, ME (Site). The Site location is shown on Figure 1 – Site Location Plan.

Bridge No. 0181 is a single span concrete bridge constructed in the 1980s and is about 100 ft west of Bridge No. 6203, which carries U.S. Route 1 Caribou Bypass over Caribou Stream. Refer to Figure 2 – Existing Conditions and Boring Location Plan, for existing conditions at the site. The construction date of the retaining wall is unknown.

The existing retaining wall is about 70 feet in length and consists of stacked steel bins. It ranges in height from about 10 ft at the western end to about 20 ft at the eastern end of the wall, adjacent to the bridge abutment. The retaining wall has deteriorated, showing signs of rusting, buckling, and settlement. Large riprap and boulders exist at the toe of the wall, along the stream bank. Select photographs of the bin wall are provided in Attachment A.

Kleinfelder has reviewed the following documents for the preparation of this memorandum.

- Report titled "Substructure Investigation for U.S. Route 1 Caribou Bypass over Caribou Stream and Water Street" prepared by the Maine State Highway Commission, dated October 1965;
- Report titled "Subsurface Investigations for the Proposed Construction of a Structure to Cary Cross Street over Caribou Stream" prepared by the Maine Department of Transportation Materials & Research Division, dated September 1982;
- Design Plans for the Caribou Stream Bridge, dated March 1983;
- Right of Way Map, dated December 1982.

The October 1965 report suggests that the stream's banks were steepened by use of retaining walls. It refers to a short section of a metal bin type wall probably constructed to widen Bridge Street (previously Cross Street). The September 1982 report states that a bridge built in the 1960's was washed out during a flood event. The existing bridge was built in the 1980s following the washout of the old bridge; the March 1983 drawings for construction of the existing bridge indicate that the northwestern end of the wing wall is to be cast against an existing steel bin wall. Based on the subsurface information presented in the 1983 drawing set, subsurface conditions in the area consist of fill, underlain by dense to very dense till and rock.

Surface grades at the junction of Water Street and Bridge Street are generally flat across the project site, and slope gently downward from north to south across the bridge road surface from approximately Elevation (El.) 409 to El. 407 (refer to Figure 2). The top of the existing steel bin wall varies from approximately El. 400 to El. 407, generally increasing in elevation from west to east towards the existing bridge. Grades at the bottom of the existing steel bin wall range from approximately El. 385 to El. 389. Elevations referenced in this report and shown on Figure 2 are in feet, and are based on the North American Vertical Datum of 1988 (NAVD88).

SUBSURFACE CONDITIONS

LOCAL GEOLOGY

The Maine Geologic Survey (MGS) Surficial Geology of the Presque Isle 1° x 2° Quadrangle, Maine, open file no. 87-15 (1987) indicates the surficial soils in the vicinity of the project site are primarily till. Till within this area reportedly consists of a heterogeneous mixture of sand, silt, clay and stones, may include many boulders, generally massive, but in many places contains beds and lenses of variably washed and stratified sediments.

The Maine Geological Survey (MGS) Bedrock geologic map of Maine, Geologic Map Series BGMM (1985) indicates the bedrock at the site is the Silurian Spragueville Formation, consisting of limestone and mudstone, weakly metamorphosed, contains local occurances of prehnite and pumpellyite Protolith R - Interbedded pelite and limestone and/or dolostone.

FIELD EXPLORATIONS

Subsurface conditions at the site were explored on July 26 and 27, 2016 by advancing two (2) test borings (identified as RW-CAR-101 and RW-CAR-102). The two borings were advanced about 10 ft apart from each other and approximately perpendicular to the bin wall within the grassy area between the bin wall and Water Street. The approximate locations of the borings are shown on Figure 2. Boring locations were determined by measuring distances from existing features, and ground surface elevations were estimated by interpolating between contour lines on survey titled “Caribou Stream Bridge #0181 018984.00” dated June 29, 2016 received from MaineDOT per FTP on June 30, 2016. The boring locations and elevations should be considered accurate only to the degree implied by the method used.

New England Boring Contractors of Hermon, Maine advanced the borings with a Mobile truck-mounted B-53 drill rig. The borings were drilled using a combination of solid stem auger, hollow stem auger, and drive-and-wash drilling techniques. Boring RW-CAR-101 was advanced to a depth of about 37 feet, and RW-CAR-102 was advanced to a depth of about 24 feet below existing grade. The drillers performed Standard Penetration Tests (SPT) and obtained split spoon samples using a safety hammer. SPT samples were collected semi-continuously within the fill, and at five foot intervals thereafter in general accordance with American Association of State and Highway and Transportation Officials (AASHTO) Standard T206. Upon completion, the borings were backfilled with excavated soils.

Boring logs were maintained by a Kleinfelder geoprofessional and the soils were described in general accordance with the MaineDOT Key to Soil and Rock Descriptions and Terms dated January 2008. Descriptions of the soil encountered in the explorations are included in the boring logs provided in Attachment B. A soil description key is also provided in Attachment B.

SUBSURFACE CONDITIONS

The major soil groups encountered in the borings are described below, in general order of their occurrence. The strata boundaries shown in the boring logs are based on interpretations and the actual transition may be gradual. Refer to the test boring logs in Attachment B for detailed descriptions of the soil and rock samples collected.

Fill: Fill material (or possible fill) was encountered below topsoil in both borings. Fill generally consisted of brown to grayish-brown sand and gravel, with varying amounts of silt. Root material, wood fragments, and asphalt pieces were noted in the fill in RW-CAR-101. SPT N-values in RW-CAR-101 ranged from 14 to 24 blows per foot (bpf), indicating medium dense material. SPT N-values in RW-CAR-102 ranged from 18 to 31 bpf, indicating medium dense to dense material.

The fill extended to approximately 22 feet depth in boring RW-CAR-101, which is closer to the bin wall, and to approximately 5 ft depth in boring RW-CAR-102, which is near the road.

Till: Brownish-gray to grayish-brown till deposits were encountered below the fill in both borings. The glacial deposits generally consisted of Gravel and Sand with varying amounts of Silt. Cobbles were encountered in boring RW-CAR-102. N-values within the glacial unit ranged from 23 to greater than 100 bpf, indicating medium dense to very dense material.

Bedrock: Bedrock was encountered in RW-CAR-101 at a depth of about 27 ft, or at approximate El. 382. Probable top of rock was encountered in RW-CAR-102 at a depth of about 24 ft, or at approximate El. 386.

Bedrock cores were retrieved from boring RW-CAR-101 from 27 to 37 feet (corresponding to approximate El. 382 to El. 372). The recovered cores were described as gray, fine-grained limestone, moderately severe weathering, steep dipping, calcite infilling, and some clay/silt infilling. The rock encountered appears to be generally consistent with the anticipated rock type based on the regional geologic map as described above. The calculated RQD values of the recovered rock core samples ranged from 0 to 27 percent indicating very poor to poor rock quality. Recovery in each run was 100 percent and the recovered fragments indicated that the bedding angle may have been quite steep relative to the drilling direction, which may have resulted in the low RQD values in the recovered samples.

Groundwater was not observed during drilling within the upper 10 feet at boring RW-CAR-101. Below 10 feet, the boring was advanced using the drive-and-wash drilling method, which introduces water into the borehole, obscuring the natural groundwater observation. At the end of the day on July 26, 4-inch casing had been advanced to a depth of 27 feet and was left in the ground overnight. The water level was measured at about 24 feet below ground surface elevation (corresponding to approximately EL. 385 ft) on the morning July 27.

Groundwater, interpreted by the presence of visible free water within the soil samples, was observed at a depth of about 22 feet (corresponding to approximately El. 388 ft) during drilling in boring RW-CAR-102.

The water elevation within the channel was measured on July 27, 2016. The measurement was estimated by taping from the road surface of the bridge spanning over the Caribou stream to the water surface below. The water elevation measured in the channel was approximately El. 383 at 2:00 PM.

It should be noted that water and groundwater levels fluctuate due to local and regional factors including, but not limited to, tidal influence, precipitation events, seasonal changes, and periods of wet or dry weather.

LABORATORY TESTING

Laboratory testing was performed on representative samples to substantiate field classifications and provide engineering parameters for geotechnical design. Laboratory testing consisted of four (4) Grain Size Analysis soil tests and one (1) Unconfined Compressive Strength Rock Test. The tests were performed by GeoTesting Express, Inc. of Acton, Massachusetts. The laboratory test results are summarized on the boring logs in Attachment B and the laboratory test reports are included in Attachment C.

PRELIMINARY GEOTECHNICAL ASSESSMENT

The subsurface conditions at the site generally ranged from medium dense to very dense materials. Although cobbles were encountered, boulders were not encountered in the two borings.

Even though the two borings were advanced only about 10 ft apart from each other, the fill thicknesses encountered in the two borings varied from 5 ft near the road to 22 ft near the retaining wall. The thickness and difference in thickness of the fill at these locations is consistent with the expected depth of the bottom of excavation that was likely required during installation of the steel bins. The depth of the steel bins into the slope is unknown.

Based on our discussions with you, and the observed subsurface conditions, we considered the following alternatives for replacement or repair of the steel bin wall.

- Replacement with a sloped embankment;
- Replacement with a combination of a sloped embankment and a sheet pile wall;
- Replacement with a full height sheet pile wall;
- Replacement with a full height pre-fabricated modular block wall.
- Repair with installation of soil nails through the existing bin wall.

We provide a brief overview and our preliminary geotechnical assessment of these options below. Once the alternatives are narrowed to a preferred solution geotechnical analyses should be conducted to obtain preliminary design solutions.

<u>Option 1 – Sloped Embankment</u>

This option consists of the removal of the steel bin wall in its entirety and re-grading the site to a slope extending from the edge of guardrail along Water Street to the banks of Caribou Stream.

Kleinfelder reviewed the steepness of the slope between Water Street and Caribou Stream, and found that a full sloped embankment will be as steep as 1.2 Horizontal to 1 Vertical (1.2H:1V) at the highest sections. While a global stability analysis has not been conducted, a 1.2H:1V is a steep slope that will at a minimum require surface treatment, such as the placement of riprap on the slope, or other solutions.

A global stability analysis will have to be conducted for this option to estimate the overall stability of the slope. If the global stability of the slope would need to be improved a slope stabilization method, such as a Mechanically Stabilized Earth (MSE) system could be used.

MSE is a soil slope or embankment that is reinforced with geosynthetic (or other) materials. The reinforcements are placed in lifts, and extend through the failure line of the slope. MSE systems are installed from the bottom up. Therefore, their installation would require the removal of the steel bin wall and excavation of the slope extending back to the analyzed failure surface. The depth of the excavation (into the slope) will vary based on the global stability analysis.

<u>Option 2 – Combination of Sloped Embankment and Sheet Pile Wall</u>

This option consists of supporting Water Street with a sheet pile wall driven from street level, the removal of the steel bin wall in its entirety and re-grading the site to a slope extending from the sheet pile wall near Water Street to the banks of Caribou Stream.

Kleinfelder conceptually placed a wall near Water Street, with the criteria that the slope above (extending to Water Street) would be as steep as 2H:1V, and the slope below would be as steep as 1.75H:1V at the highest sections. While a global stability analysis has not been conducted, these slopes will likely not require global slope stabilization.

Based on these conceptual slope configurations, the proposed sheet pile wall exposed height will range from 2 ft to 8 ft in height. Given the depth to rock at about 24 ft, the sheet piles wall will likely be able to be cantilevered. If loads on the sheet pile wall are such that it can not be cantilevered, a single row of tie-backs, or other wall systems that key in to the rock can be used.

Option 3 – Full Height Sheet Pile Wall

This option consists of supporting Water Street with a sheet pile wall driven from street level and installed immediately behind the existing steel bin wall, and the removal of the steel bin wall in its entirety following the installation of the sheet pile wall.

The proposed full-height sheet pile wall will be similar in height to that of the existing wall. The wall will likely require two to three levels of tie-backs, since it will have minimum toe before rock is encountered. The tie-back installation will need to be coordinated with the removal of the steel bin wall. While other wall systems that are installed from street level and that toe into the rock may be used, the need for tie-backs will likely not be eliminated for the taller sections of wall.

Option 4 – Full Height Pre-Fabricated Modular Block Wall

This option consists of supporting Water Street with a modular block wall installed in place of the existing steel bin wall, and the removal of the steel bin wall in its entirety.

Modular block walls are stacked concrete or other block sections that create a wall. They can be reinforced with geotextiles similar to an MSE system, or unreinforced (gravity wall system). The existing steel bin wall is a form of an unreinforced block wall.

Unreinforced retaining walls require a large base (about half the height of the wall). Similar to MSE systems, modular block retaining walls are installed from the bottom up, requiring a stable excavation of the site for placement of the geotextile materials or base materials. The depth of the excavation (into the slope) will vary based on the width of the block sections and the global stability analysis.

Option 5 – Installation of Soil Nails through The Existing Bin Wall

This option consists of stabilizing the existing steel bin wall with soil nails installed through the wall.

Soil nails are passive (not post-tensioned) reinforcing elements, usually consisting of a bar or rod ("nails") drilled into the soil mass. The soil nails are generally inserted at a 5 ft by 5 ft grid, and are typically grouted over their full length. The wall is supported at the face by reinforced shotcrete, and permanent walls are typically covered by an outer concrete facing which can provide an aesthetic finish. Drainage may consist of strip drains behind the facing and toe drains at the base of the wall.

It is our opinion that the existing wall is generally in poor condition and should be replaced. The use of shotcrete on a river bank is not preferred due to possible scouring from river floods. Therefore, this option is not a preferred alternative for this site.

ALTERNATIVES ANALYSIS

Of the above presented options, Option 2 appears to be the most feasible option based on its relative ease of installation, and higher design safety factors on proposed slopes. In this Option the existing bin wall can be removed from the top down as the slope is cut following the installation of the sheeting. We estimate that the costs on galvanized sheet pile wall is $50/square foot of sheet pile face.

While the other options are also feasible, they are less desirable due to the need for tie-backs, which will need a permanent easement, or the excavation of the entire slope for MSE applications, which can lead to road closures and additional cost for shoring and excavation.

Kleinfelder is ready to discuss these options, or a combination of these options, further upon request.

LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The scope of services for this geotechnical memorandum did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

REFERENCES

Lowell, Thomas V., (1987). Maine Geological Survey (MGS) Open-File No. 87-15, "Surficial Geology of the Presque Isle 1° X 2 ° Quadrangle, Maine."

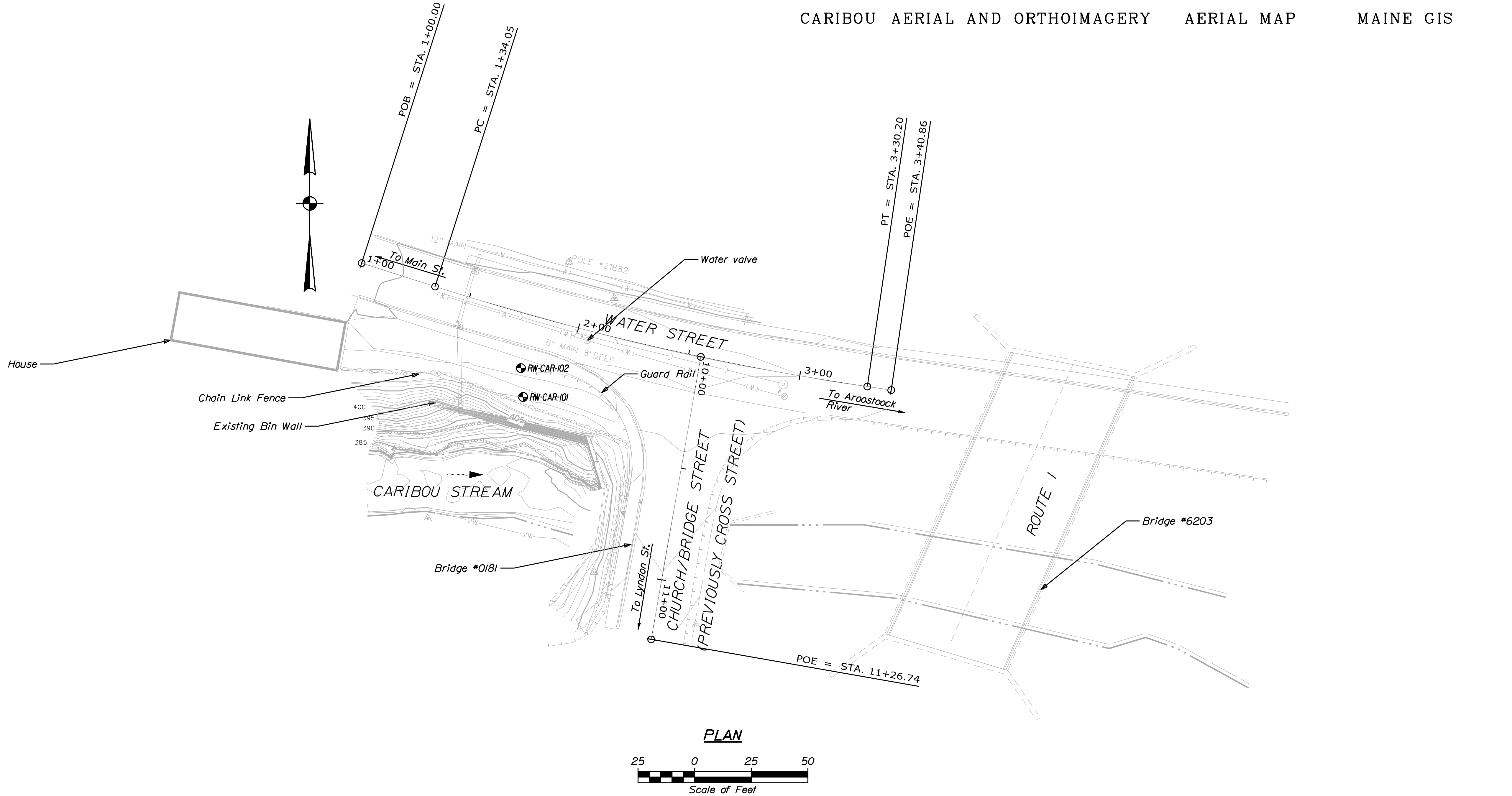
Osberg, P.H., Hussey, A.M., and Boone, G.M., (1985). Maine Geological Survey (MGS) Geologic Map Series BGMM, "Bedrock Geologic Map of Maine."

Attachments

Figure 1: Site Location Plan
Figure 2: Existing Conditions and Boring Location Plan
Attachment A: Site Photographs
Attachment B: Test Boring Logs
Attachment C: Laboratory Testing Results

REFERENCE FILES:

FILE NAME	FILE TYPE	BY	DATE
SURVEY	DGN	MAINE DOT	JUNE 30, 2016
CARIBOU AERIAL AND ORTHOIMAGERY	AERIAL MAP	MAINE GIS	2011



LEGEND

FIGURE 2

RW-CAR-10X Approximate location of borings drilled by Kleinfelder in July 2016

Datum: NAVD88

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

CARIBOU STREAM BRIDGE
RETAINING WALL

FIGURE 2 - EXISTING CONDITIONS
AND BORING LAYOUT PLAN

Filename: ...\GEOTECH\MSTA\001_GEOPLAN.dgn
Division: BRIDGE
Username: LFlanders
Date:9/6/2016

ATTACHMENT A

Site Photographs

Downstream portion of bin wall

Upstream portion of bin wall

Looking downstream at Bridge 0181

Drain pipe over bin wall

Roadside adjacent to bin wall looking west

Roadside adjacent to bin wall looking east

Deteriorated steel

Buckled portion of bin wall

ATTACHMENT B

Test Boring Logs

Maine Department of Transportation Soil/Rock Exploration Log US UNITS	**Project:** Retaining Wall Replacement, Adjacent to Bridge #0181 **Location:** Bridge St @ Water St Caribou, ME	**Boring No.:** RW-CAR-101 **PIN:** 018984.00

Driller:	N.E.B.C	**Elevation (ft.)**	408.05	**Auger ID/OD:**	4" Solid Stem
Operator:	Chris/Devon	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Madden	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140lbs/30"
Date Start/Finish:	7/26/2016-7/27/2016	**Drilling Method:**	Solid Stem Auger/Drive and Wash	**Core Barrel:**	NX Core
Boring Location:	1+84.44, 35.72R	**Casing ID/OD:**	4.5"/4"	**Water Level*:**	24'3"

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	S1	24/6	0.0 - 2.0	1-7-10-14	17	SSA			Top 2" grass/topsoil Brown, moist, medium dense SAND, some subangular gravel, trace silt, fine-coarse grained sand, fine-coarse grained gravel, non-plastic fines, SW-SM, trace root material and wood (FILL)	
5	S2	24/14	5.0 - 7.0	5-14-10-14	24				Brown, moist, medium dense SAND, some subangular gravel, trace silt, fine-coarse grained sand, fine-coarse grained gravel, non-plastic fines, SW-SM, asphalt pieces, wood (FILL)	
	S3	24/8	7.0 - 9.0	12-10-9-10	19				Greyish brown, moist, medium dense GRAVEL, trace sand, trace silt , angular to subangular, fine-coarse grained gravel, fine sand, non-plastic fines, GW, (FILL)	
10	S4	24/6	10.0 - 12.0	13-7-9-8	16	Wash			Greyish brown, moist, medium dense GRAVEL, trace silt, trace sand, angular to subangular, fine-coarse grained gravel, fine sand, non-plastic fines, GW, (FILL)	
15	S5	24/6	15.0 - 17.0	11-7-7-9	14				Greyish brown, wet, medium dense, sandy GRAVEL, little silt, angular to subangular, fine-coarse grained gravel, fine sand, non-plastic fines, GM, (FILL)	G#386514 A-1-b, GM
20	S6	24/6	20.0 - 22.0	7-13-9-9	22				Greyish brown, wet, medium dense GRAVEL, trace silt, trace sand, angular to subangular, fine grained gravel, non-plastic fines, GP, majority of sample is wood fragments, up to 3" long (FILL),	
							386.1		22.0	
	S7	24/3	22.0 - 24.0	19-19-21-20	40				Brownish grey, wet, dense, sandy GRAVEL, some silt, fine-coarse grained gravel, angular to subangular, fine-medium sand, non-plastic fines, GM (TILL)	
25										

Remarks:

Water level measured at 7:15 AM on 7/27/16 with casing installed to 27 feet.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation Soil/Rock Exploration Log US UNITS	**Project:** Retaining Wall Replacement, Adjacent to Bridge #0181 **Location:** Bridge St @ Water St Caribou, ME	**Boring No.:** RW-CAR-101 **PIN:** 018984.00

Driller:	N.E.B.C	**Elevation (ft.)**	408.05	**Auger ID/OD:**	4" Solid Stem
Operator:	Chris/Devon	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Madden	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140lbs/30"
Date Start/Finish:	7/26/2016-7/27/2016	**Drilling Method:**	Solid Stem Auger/Drive and Wash	**Core Barrel:**	NX Core
Boring Location:	1+84.44, 35.72R	**Casing ID/OD:**	4.5"/4"	**Water Level*:**	24'3"

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$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	S8	9/6	25.0 - 25.8	50-100/3"	>100				Brownish grey, wet, dense, sandy GRAVEL, some silt, fine-coarse grained gravel, angular to subangular, fine-medium sand, non-plastic fines, GM (TILL)	G#386515 A-1-b, GM
							381.1		27.0	
	R1	30/30	27.0 - 29.5	RQD = 0%		NX			R1: Grey, fine-grained, <1" to 8" fragments of fractured limestone, moderate to severe weathering, steep dipping (60°), calcite infilling, rock mass quality: very poor. 100% Recovery. R1: Core Times (min/ft) 1:45/4:43/3:56	
30	R2	18/18	29.5 - 31.0	RQD = 0%					R2: Grey, fine-grained, <1" to 5" fragments of fractured limestone, moderate to severe weathering, steep dipping (60°), calcite infilling, clay/silt infilling, rock mass quality: very poor. 100% Recovery. R2: Core Times (min/ft) 1:37/1:52	
	R3	18/18	31.0 - 32.5	RQD = 0%					R3: Grey, fine-grained, <1" to 9" fragments of fractured limestone, moderately severe weathering, steep dipping (60°), calcite infilling, clay/silt infilling, rock mass quality: very poor. 100% Recovery. R3: Core Times (min/ft) 3:14/2:05	
	R4	33/33	32.5 - 35.3	RQD = 27%					R4: Grey, fine-grained, <1" to 10" fragments of fractured limestone, moderate to severe weathering, steep dipping (60°), calcite infilling, rock mass quality: poor. 100% Recovery. R4: Core Times (min/ft) 4:42/3:35/2:12	qp = 1981.87 ksf
35	R5	21/21	35.3 - 37.0	RQD = 0%			371.1		R5: Grey, fine-grained, <1" to 8" fragments of fractured limestone, moderate to severe weathering, steep dipping (60°), calcite infilling, clay infilling, rock mass quality: very poor. 100% Recovery. R5: Core Times (min/ft) 2:14/2:52	
									37.0	
									Bottom of Exploration at 37.0 feet below ground surface.	
40										
45										
50										

Remarks:

Water level measured at 7:15 AM on 7/27/16 with casing installed to 27 feet.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US UNITS

Project: Retaining Wall Replacement, Adjacent to Bridge #0181
Location: Bridge St @ Water St Caribou, ME

Boring No.: RW-CAR-102
PIN: 018984.00

Driller:	N.E.B.C	**Elevation (ft.)**	409.30	**Auger ID/OD:**	2.25"/5.625"
Operator:	Chris/Devon	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Madden	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140lbs/30"
Date Start/Finish:	7/27/2016	**Drilling Method:**	Hollow Stem Auger	**Core Barrel:**	N/A
Boring Location:	1+80.20, 23.69R	**Casing ID/OD:**	N/A	**Water Level*:**	22'

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Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	S1	24/12	0.0 - 2.0	1-6-12-11	18	HSA			Top 3" grass/topsoil Greyish brown, moist, medium dense SAND, little silt, little subrounded gravel, fine-coarse grained sand, fine grained gravel, slightly plastic fines, SM, (POSSIBLE FILL)	
	S2	24/14	2.0 - 4.0	15-14-17-22	31				Greyish brown, moist, dense SAND, little silt, trace subrounded gravel, fine-coarse grained sand, fine gravel, slightly plastic fine, SM, (POSSIBLE FILL)	
5	S3	24/11	5.0 - 7.0	30-19-18-12	37		404.3		5.0 Greyish brown, moist, dense, sandy GRAVEL, little silt, fine subrounded gravel, fine-coarse sand, non-plastic fines, GM, (TILL), broken cobbles fragments at 5 feet	G#386516 A-1-b, GM
	S4	24/NR	7.0 - 9.0	10-11-12-12	23				Recovered only broken cobble fragments (also in sampler tip)	
10	S5	24/6	10.0 - 12.0	12-14-20-20	34		399.3		10.0 Greyish brown, moist, dense SAND, some subrounded gravel, trace silt, fine-coarse sand, fine-coarse gravel, non-plastic to slightly plastic fines, SW-SM, (TILL)	
15	S6	24/6	15.0 - 17.0	9-12-14-16	26		394.3		15.0 Light brownish grey, moist, medium dense, clayey SAND, some gravel, fine-coarse grained sand, fine-coarse grained gravel, slightly plastic fines, SC (TILL)	
20	S7	24/14	20.0 - 22.0	19-21-32-49	53				Greyish brown, moist, wet, very dense, clayey SAND, little subangular to subrounded gravel, fine-coarse sand, fine-coarse gravel, slightly plastic fines, SC (TILL)	G#386517 A-4, SC
25	S8	0/0	24.0 - 24.0	N/A			385.3		24.0 **Bottom of Exploration at 24.0 feet below ground surface.** Split spoon bouncing on possible bedrock at 24 feet	

Remarks:

Water level measured on 7/27/16 following auger refusal at 24 feet.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

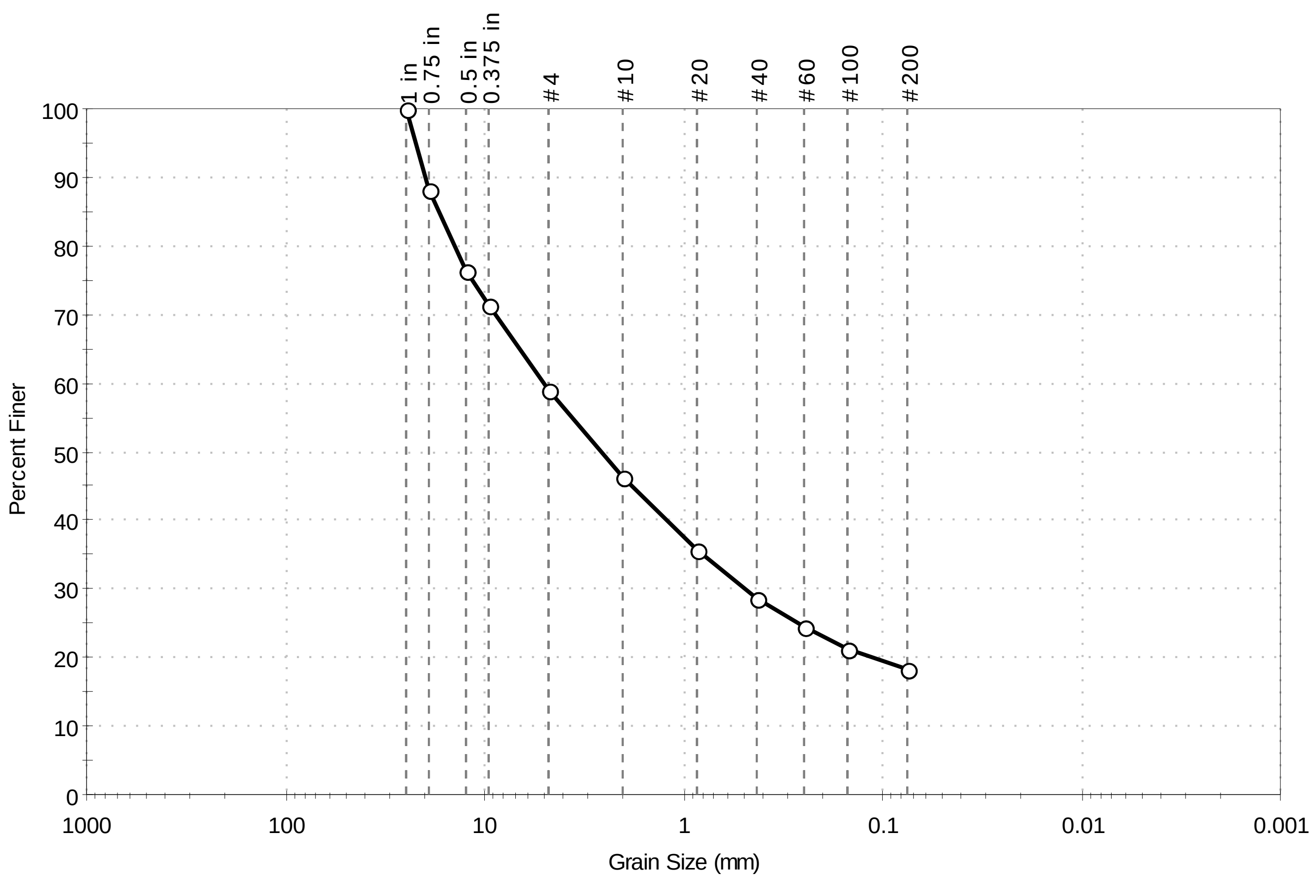
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

ATTACHMENT C

Laboratory Testing Results

Client:	Kleinfelder		
Project:	Caribou Retaining Wall Replacement		
Location:	Caribou, ME	Project No:	GTX-305151
Boring ID: RW-CAR-101	Sample Type: bag	Tested By:	jbr
Sample ID: S5	Test Date: 08/11/16	Checked By:	jsc
Depth : 15-17 ft	Test Id: 386514		
Test Comment:	---		
Visual Description:	Moist, olive brown silty gravel with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	41.0	40.7	18.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	88		
0.5 in	12.50	76		
0.375 in	9.50	71		
#4	4.75	59		
#10	2.00	46		
#20	0.85	36		
#40	0.42	29		
#60	0.25	24		
#100	0.15	21		
#200	0.075	18		

Coefficients

D_{85} = 16.9233 mm

D_{30} = 0.4833 mm

D_{60} = 5.0277 mm

D_{15} = N/A

D_{50} = 2.5853 mm

D_{10} = N/A

C_u = N/A

C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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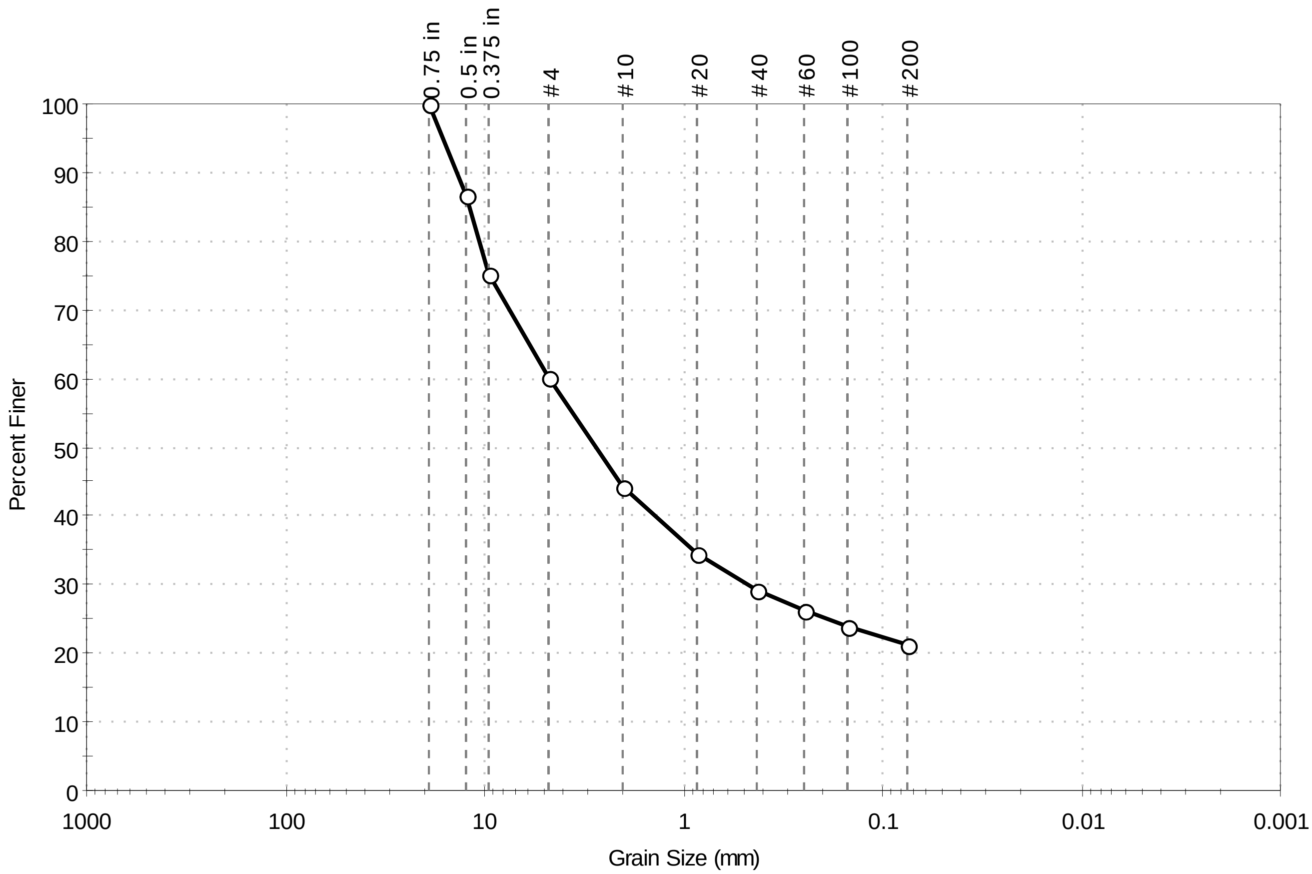
Client:	Kleinfelder				
Project:	Caribou Retaining Wall Replacement				
Location:	Caribou, ME			Project No:	GTX-305151
Boring ID:	RW-CAR-101	Sample Type:	bag	Tested By:	jbr
Sample ID:	S8	Test Date:	08/11/16	Checked By:	jsc
Depth :	25-25.8 ft	Test Id:	386515		
Test Comment:	---				
Visual Description:	Moist, olive silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	39.7	39.1	21.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	87		
0.375 in	9.50	75		
#4	4.75	60		
#10	2.00	44		
#20	0.85	35		
#40	0.42	29		
#60	0.25	26		
#100	0.15	24		
#200	0.075	21		

Coefficients

D_{85} = 11.9728 mm
D_{30} = 0.4644 mm
D_{60} = 4.6884 mm
D_{15} = N/A
D_{50} = 2.7371 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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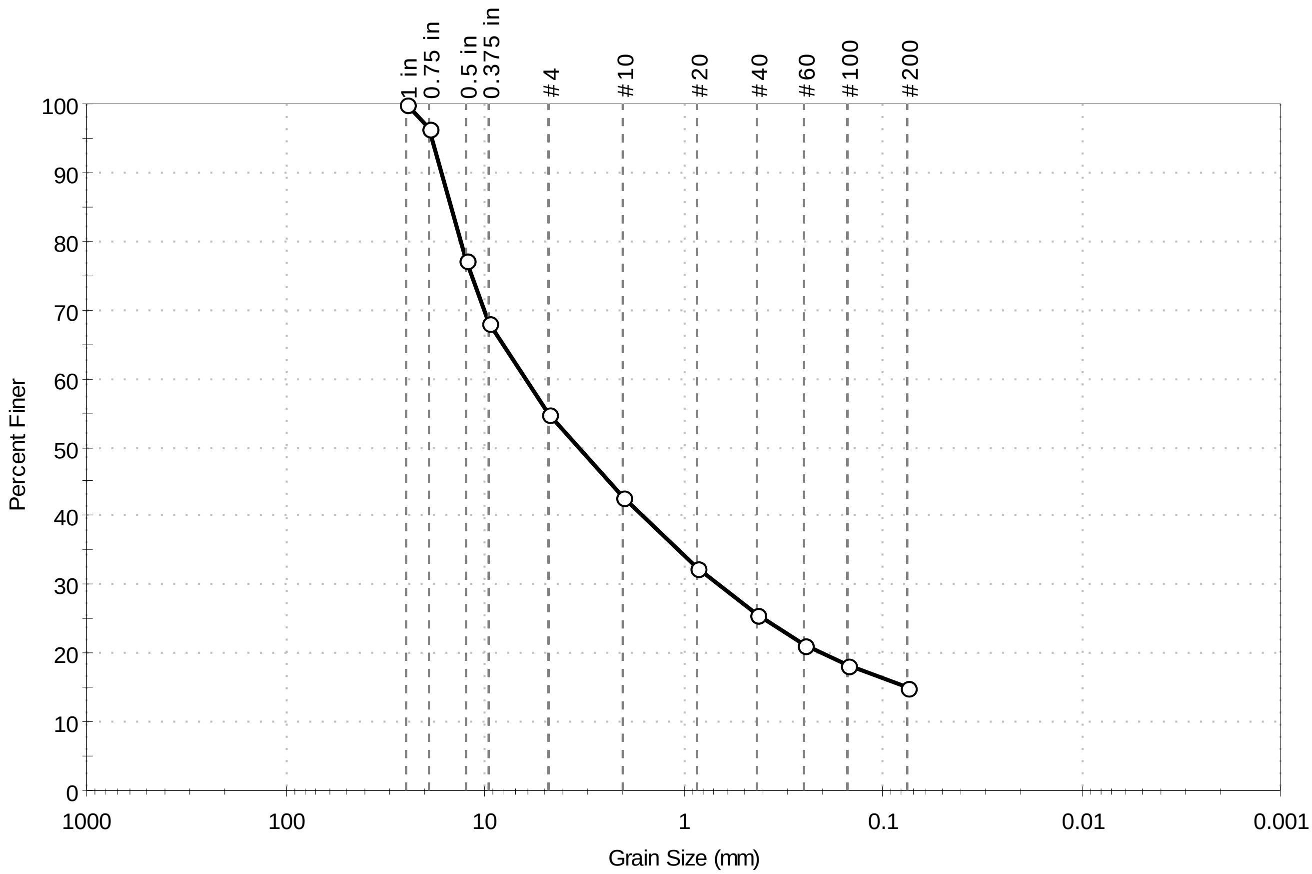
Client: Kleinfelder			
Project: Caribou Retaining Wall Replacement			
Location: Caribou, ME		Project No:	GTX-305151
Boring ID: RW-CAR-102	Sample Type: bag	Tested By:	jbr
Sample ID: S3	Test Date: 08/11/16	Checked By:	jsc
Depth : 5-7 ft	Test Id: 386516		
Test Comment: ---			
Visual Description: Moist, olive silty gravel with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	45.3	39.7	15.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	77		
0.375 in	9.50	68		
#4	4.75	55		
#10	2.00	43		
#20	0.85	32		
#40	0.42	26		
#60	0.25	21		
#100	0.15	18		
#200	0.075	15		

Coefficients

D_{85} = 14.7803 mm | D_{30} = 0.6697 mm

D_{60} = 6.2393 mm | D_{15} = N/A

D_{50} = 3.3827 mm | D_{10} = N/A

C_u = N/A | C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

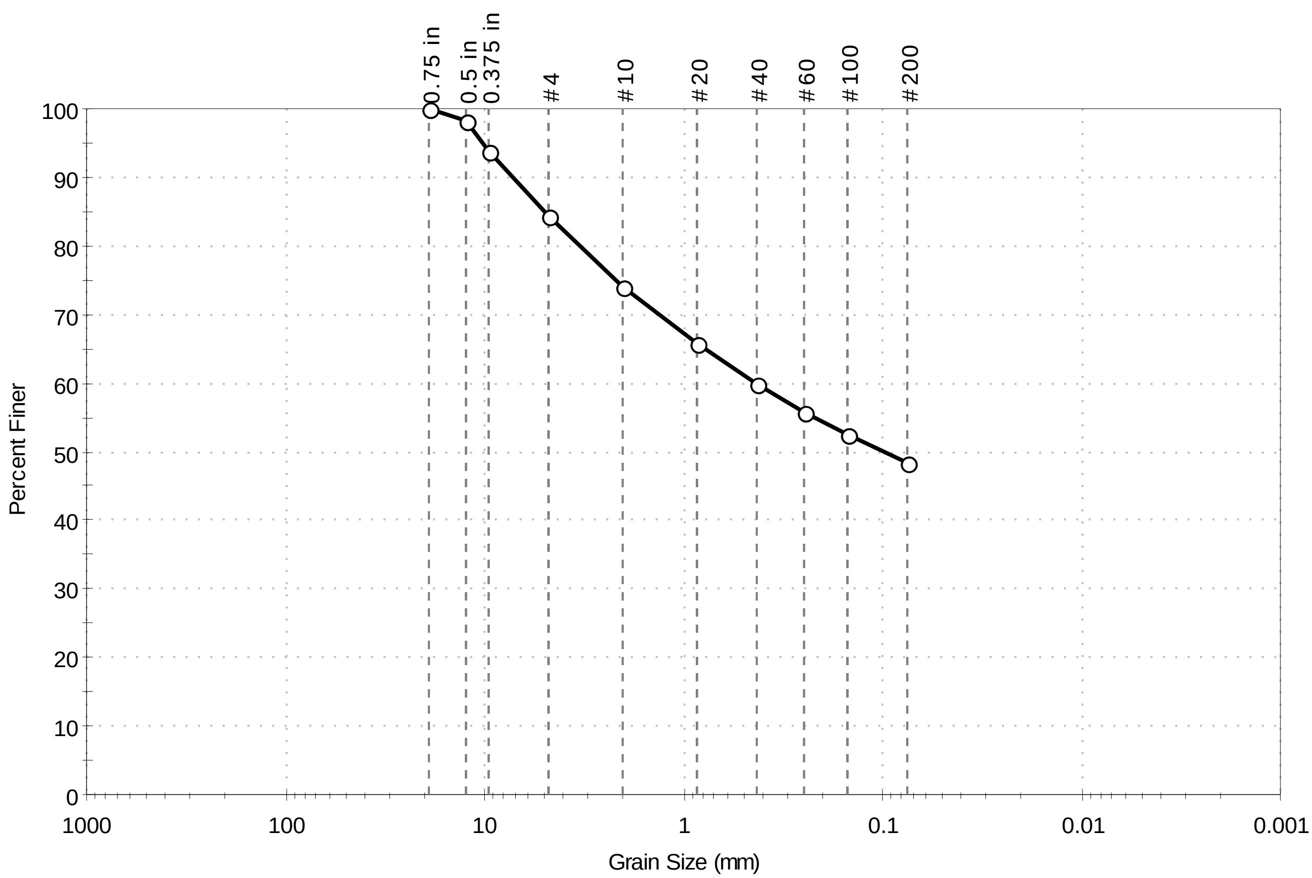
Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

Client: Kleinfelder			
Project: Caribou Retaining Wall Replacement			
Location: Caribou, ME		Project No:	GTX-305151
Boring ID: RW-CAR-102	Sample Type: bag	Tested By:	jbr
Sample ID: S7	Test Date: 08/11/16	Checked By:	jsc
Depth : 20-22 ft	Test Id: 386517		
Test Comment: ---			
Visual Description: Moist, olive clayey sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	15.6	35.9	48.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	98		
0.375 in	9.50	94		
#4	4.75	84		
#10	2.00	74		
#20	0.85	66		
#40	0.42	60		
#60	0.25	56		
#100	0.15	52		
#200	0.075	49		

Coefficients

D_{85} = 4.9616 mm　　D_{30} = N/A

D_{60} = 0.4266 mm　　D_{15} = N/A

D_{50} = 0.0977 mm　　D_{10} = N/A

C_u = N/A　　C_c = N/A

Classification

ASTM　N/A

AASHTO　Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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Client:	Kleinfelder				
Project:	Caribou Retaining Wall Replacement				
Location:	Caribou, ME			Project No:	GTX-305151
Boring ID:	RW-CAR-101	Sample Type:	cylinder	Tested By:	daa/rlc
Sample ID:	R4	Test Date:	08/12/16	Checked By:	jsc
Depth :	33'9"-34'8"	Test Id:	386490		
Test Comment:	---				
Visual Description:	See photograph(s)				
Sample Comment:	---				

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
RW-CAR-101	R4	33'9"-34'8"	170	13,763	1	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure
(See attached photographs)

Client:	Kleinfelder	Test Date:	8/10/2016
Project Name:	Caribou Retaining Wall Replacement	Tested By:	daa/rlc
Project Location:	Caribou, ME	Checked By:	jsc
GTX #:	305151		
Boring ID:	RW-CAR-101		
Sample ID:	R4		
Depth:	33'9"-34'8"		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.25	4.25	4.25		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	590.82				
Bulk Density, lb/ft^3	170			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.1			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00040
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010

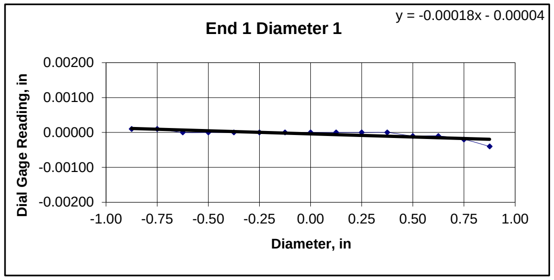
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00010

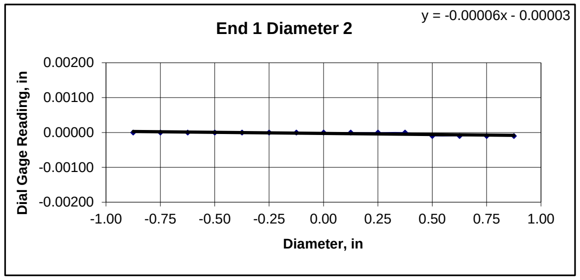
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

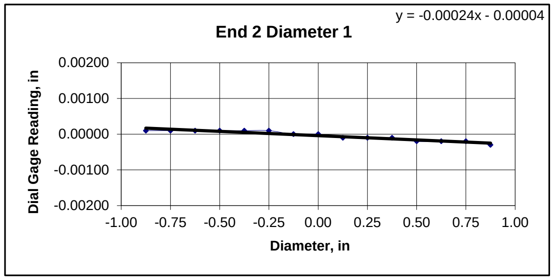
Difference between max and min readings, in:
0° = 0.0004 90° = 0

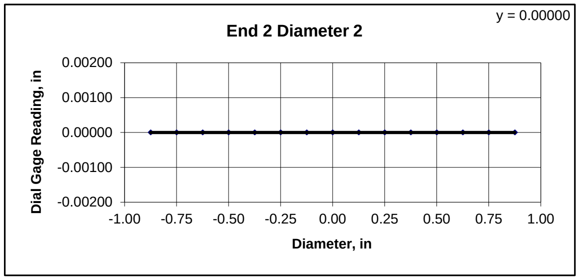
Maximum difference must be < 0.0020 in. Difference = ± 0.00025

Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00018
Angle of Best Fit Line: -0.01031

End 2:
Slope of Best Fit Line -0.00024
Angle of Best Fit Line: -0.01375

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00006
Angle of Best Fit Line: -0.00344

End 2:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	1.990	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00010	1.990	0.00005	0.003	YES
END 2					
Diameter 1, in	0.00040	1.990	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00000	1.990	0.00000	0.000	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Kleinfelder
Project Name:	Caribou Retaining Wall Replacement
Project Location:	Caribou, ME
GTX #:	305151
Test Date:	8/12/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	RW-CAR-101
Sample ID:	R4
Depth:	33'9"-34'8"

After cutting and grinding

After break