

James Wilson
Bristol Bay Borough
#1 Main Street
Naknek, AK 99633

SAVEC Facility, RFP 25-01: Site 12

October 20, 2022

Subject: Bristol Bay Task 2 Public Facilities Master Plan Geotechnical Site Assessment - rev1

Dear Mr. Wilson,

PND Engineers, Inc. (PND), with Bristol Bay Borough, performed a limited geotechnical investigation at four locations along the Alaska Peninsula Highway between King Salmon and Naknek, Alaska (Figure 1). The purpose of the investigation was to evaluate the subsurface conditions and provide an overview of the sites to eventually determine a suitable location for a proposed fire station, emergency medical service building, police station, and public works facility. The following paragraphs summarize the geotechnical investigation, surface, and subsurface characterization to evaluate each site's potential for further development.



Figure 1. Vicinity Map

INVESTIGATION DESCRIPTION

Between September 8 and 9, 2022, PND and Bristol Bay Borough, advanced 13 test pits (TPs) at four locations (Figure 2). Test pits at Section 9 and three TPs at Section 12 (TP12-01, -02, and -04) were excavated using a Hitachi 225 backhoe excavator with a 4-foot-wide bucket. Due to mechanical issues, the TPs at Section 4, Section 10, and two TPs from Section 12 (TP12-03 and TP12-05) were advanced by a Bobcat E35 with a 2-foot-wide bucket. During the investigation, grab samples (GR) were collected where a visual change occurred in the soil profile. The recovered samples were field-classified following the ASTM D2488 Visual Manual Procedure and ASTM D4083 Frozen Soil Classification. Graticular coordinates (surveyed with hand-held GPS) and depth of the test pits are shown in Table 1. Aerial maps with as-built test pit locations at each site are shown in Appendix A.



Figure 2. Map overview of site 9, 10, 4 and 12.

Table 1. As-Built Test-Pit Locations

Site	Test-Pit ID	Latitude	Longitude	Depth (ft)
4	TP04-01	N 58.728104	W 156.814548	10
4	TP04-02	N 58.728784	W 156.814365	10
9	TP09-01	N 58.747450	W 156.913912	19
9	TP09-02	N 58.746978	W 156.913026	19
9	TP09-03	N 58.747645	W 156.912943	18
9	TP09-04	N 58.747240	W 156.911440	19
10	TP10-01	N 58.733487	W 156.855672	10
10	TP10-02	N 58.734259	W 156.855327	10
12	TP12-01	N 58.725509	W 156.785440	19
12	TP12-02	N 58.726112	W 156.785710	19
12	TP12-03	N 58.727283	W 156.786754	10
12	TP12-04	N 58.727510	W 156.784615	19
12	TP12-05	N 58.727187	W 156.783312	9.5

*Horizontal datum: NAD83, Alaska State Plane Zone 6

Representative grab samples were collected and sealed in freezer bags to maintain in-situ moisture content. The samples were transported to PND’s Soil Material Laboratory in Anchorage for testing. All tests were performed to ASTM standards where applicable. A total of 65 lab tests were performed (Table 2). The test pit logs and laboratory test results (Particle Size Analysis, Moisture Content, and Atterberg Limits) are provided in Appendix B and Appendix C, respectively.

Lab characterizations included the following tests:

- Moisture Content/Classification (*ASTM D2216*)
- *Classification of Soils (ASTM D2487)*
- Description and Identification of Soils (*ASTM D2488*)
- Standard Practice for Description of Frozen Soils (Visual-Manual Procedure) (*ASTM D4083-07*)
- Particle Size Analysis (*ASTM D6913*)
- Atterberg Limits (*ASTM D4318*)
- Fines Wash (*ASTM D1140*)

Table 2. Lab Test Summary

Test Type	Quantity
Moisture Content with Classification (<i>ASTM D2487 / D2488 / D2216</i>)	59
Gradation of Soils (<i>ASTM D6913</i>)	2
Atterberg Limits (<i>ASTM D4318</i>)	2
Fines Wash (<i>ASTM D1140</i>)	2
Total Lab Tests	65

SURFACE AND SUBSURFACE CHARACTERIZATION BY SITE

This section summarizes the surface and subsurface characterization of the four sites investigated. The soil and ice characterizations are based on PND field logging observations - Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock (*ASTM D5434-03*) and Standard Practice for Description of Frozen Soils (Visual-Manual Procedure) (*ASTM D4083-07*). See Figure 3 for a visual graphic of soil stratigraphy for Site 4 and Site 9 (TP09-01 and -03) and Figure 4 for Sites 9 (TP09-04), 10, and 12.

SITE 4

Site 4 was located 350 ft. east of the Bay Cablevision Station building on flat, moist tundra, with dwarf shrub ground cover. Two test pits were excavated at Site 4 (TP04-01 and TP04-02, 150 ft and 450 ft. from the Alaska Peninsula Hwy, respectively) to a depth of 10 feet below ground surface (bgs). Sporadic permafrost was identified at this location below an approximate 1.5-foot saturated vegetative layer. Well-bonded stratified ice lenses (1/4-inch layers) (Vs) were found in TP04-01 from (2-2.5 ft). No groundwater was encountered. The soil profile at Site 4 can be generally described as:

- (0-1.5 ft) Peat (PT)
- (1.5-2 ft) organic Silt (OL)
- (2-2.5 ft) organic Silt (OL) with stratified ice lenses (Vs with 1/4- inch layers of ice)
- (2.5-3 ft) Silt with sand (MLs)
- (3-5 ft) Clay (CL).
- (5-10 ft) silty gravelly Sand (gSM) to gravelly Silt with sand (gMLs).

SITE 9

Site 9 was located at the Bayview Subdivision in lot H27. Four test pits were excavated at Site 9 to a depth of 19 feet bgs. Groundcover varied across the site with TP09-02 located on a sand pit and TP09-01, -03, and -04 located on moist tundra with dwarf shrubs and few scattered trees. Groundwater was not encountered at the site. Soil lithology varied at the site and three separate profiles are presented. At TP09-02, the soil column consisted of poorly graded sand from ground surface to 19 feet bgs.

TP09-01 and TP09-03 can be generally described as:

- (0-1.5 ft) Peat (PT)
- (1.5-3 ft) Silt with sand (MLs) to silty Sand (SM)
- (3-4 ft) poorly graded Sand with silt (SP-SM)
- (4-12 ft) Clay (CL) to sandy lean Clay with gravel (sCLg)
- (12-19 ft) sandy Lean Clay with gravel (sCLg)

TP09-04 can be generally described as:

- (0-1 ft) Peat (PT)
- (1-2 ft) organic Silt (OL)
- (2-2.5 ft) Silt (ML)
- (2.5-5 ft) silty Gravel with sand (GMs)
- (5-20 ft) silty Sand with gravel (SMg)

SITE 10

Site 10 was located 0.3 miles east of the local cemetery. Two test-pits were excavated at Site 10, TP10-01 and TP10-02, 150 ft. and 440 ft. from the road, respectively, to a depth of 10 feet bgs. Ground cover consisted of an approximate 1-foot layer of moist tundra with sporadic dwarf shrubs. No groundwater was encountered. The soil profile at Site 10 can be generally described as:

- (0-1 ft) Peat (PT)
- (1-2 ft) organic Silt (OL)
- (2-3 ft) Clay (CL)
- (3-6 ft) Clay with sand (CLs)
- (6-10 ft) clayey gravelly Sand (gSC) to sandy Lean Clay w/gravel (sCLg)

SITE 12

Site 12 was located on Government Lot 4, roughly 500 ft. west of Paul's Creek. Five test pits were excavated at Site 12 (TP12-01 to -05) to a depth ranging from 9.5 to 19 feet bgs. TP12-04 was located on a commercial sand pit with the remaining four TPs located on highly vegetated land with high brush and tree groundcover. No groundwater was encountered at the site. The soil profile for site 12 can be generally described as:

- (0-2 ft) poorly graded Sand with silt (SP-SM)
- (2-2.5 ft) Silt (ML)
- (2.5-11 ft) poorly graded Sand (SP) to silty Sand (SM)
- (11-20 ft) poorly graded Sand (SP)

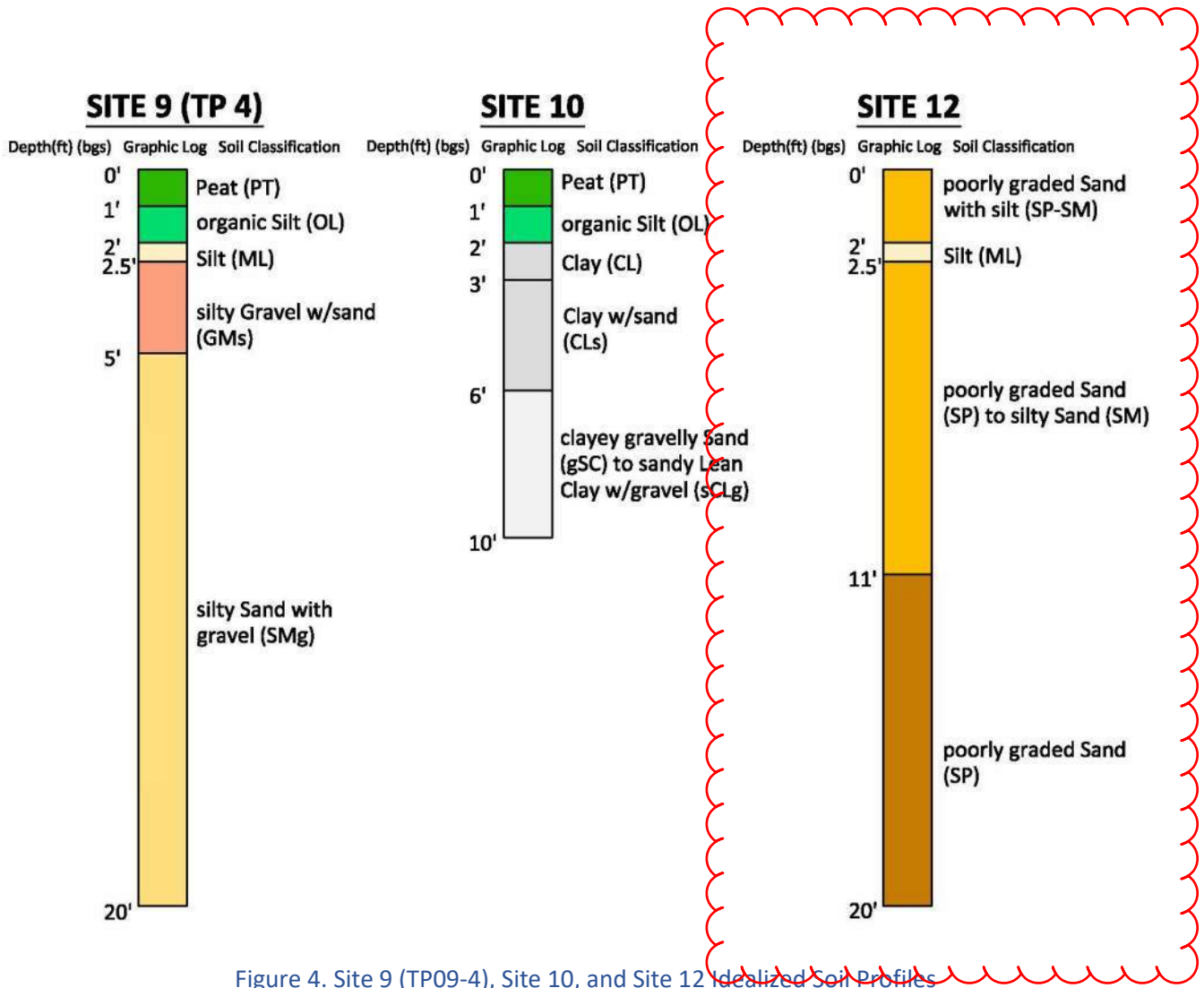


Figure 4. Site 9 (TP09-4), Site 10, and Site 12 Idealized Soil Profiles

SITE FINDINGS

The following is an assessment of each site as to the potential for conventional concrete foundation construction:

- Site 4 is suitable for a conventional concrete foundation. Although sporadic permafrost was encountered at this site, the ice was within the excavation depths required for a conventional concrete foundation. Excavation at this location would extend to below the clay layer at approximately 5 feet bgs. This site is on a higher elevation that gently slopes allowing for adequate drainage around future development.
- Site 9 consists of various soil profiles that have the potential to support a conventional concrete foundation. Lean clay is more prevalent at this site along the northern extent. Although helical piles would be suggested for areas constructed on clays, clay stiffness determined by a full geotechnical investigation would confirm whether a conventional concrete foundation would be suitable. With the presence of clay comes the concern for a greater rate of settlement experienced by the structure. Separately, TP09-02 is located in a natural sand pit. It is likely that this natural sand material would extend northeast to encompass TP09-04. Together, these test pits located in a sandy to silty sand area could support a conventional concrete foundation, requiring typical excavation to account for NFS fill material to support the foundation. Overall, the site sits higher in elevation relative to the surrounding landmarks with a gradual downward slope in all directions with scattered brush cover throughout.
- Site 10 has potential to support a conventional concrete foundation. Both TPs excavated revealed lean clay throughout. Dependent on clay stiffness, the use of helical piles could be necessary. High rate of settlement of a structure is of concern. A thorough geotechnical investigation would determine if this site can support a conventional concrete foundation. Site is on a gradual slope that dips toward the major drainage pathway located approximately 715 feet to the east.
- Site 12 is suitable for a conventional concrete foundation. No permafrost was encountered at this site. Material consisted of sand with silt to silty sand. No excess excavation of material would be required beyond typical excavations to account for NFS fill material below conventional concrete foundations. The site is at a higher elevation relative to nearby water bodies and gradually slopes to the east towards the creek.

If any of the four sites are selected for development, PND recommends a full geotechnical investigation including borehole drilling using a Standard Penetration Test (SPT) split spoon sampler at the proposed structure locations. A full investigation will provide samples and blow counts that correlate to soil properties used in bearing capacity and settlement calculations, in addition to a seismic analysis to determine liquefaction potential.

Sincerely,

PND Engineers, Inc.



Torsten Mayrberger, PhD, PE
Principal



Dominic Russo, EIT
Staff Engineer II



Figure A-3. Site 10 Aerial Map

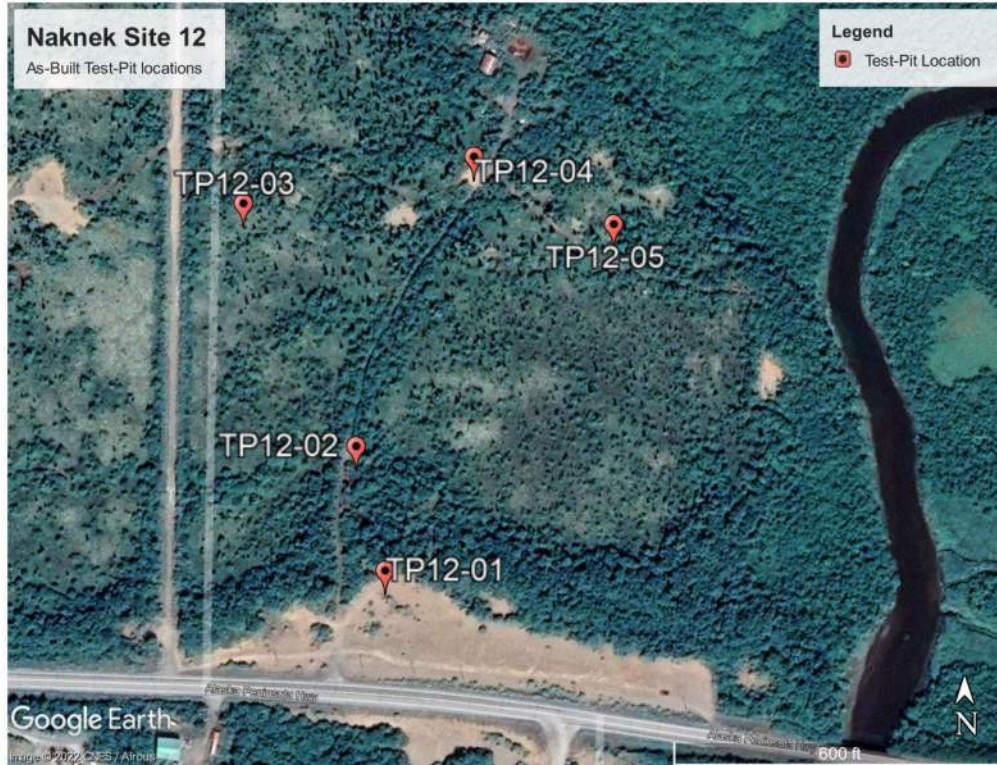


Figure A-4. Site 12 Aerial Map

LOG OF TEST-PIT TP10-01

Project: Bristol Bay Pub. Facil. Master Plan
 Project Number: 211098
 Project Phase: Task 2

Elevation:
 Horizontal Datum: NAD83 AKSP Zone 6
 Latitude: 58.73349 °N Longitude: 156.85567 °W

Logged By: JBR, DJR
 Reviewed By: FVM
 Review Date: 09/20/22

Depth (10 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Graphic Log	Blows/ 6 in.	♦ Blows per foot ▲ Salinity ppt ● Moisture %	Other Tests	Size Distribution
0	TP				Dark brown PEAT; PT.	PT					
		GR		1	Brown organic SILT; OL.	OL					
	TP				Brownish gray lean CLAY; CL.	CL					
		GR		2							
	TP				Gray lean CLAY with SAND; CLs. Sub-rounded gravel (max. 1/2"-inch).	CLs					
		GR		3							
5	TP				Gray SANDY lean CLAY with GRAVEL; sCLg. Sub-rounded gravel (max. 1/2"-inch).	sCLg					
		GR		4							
	TP										
		GR		5							
10	TP										



Borehole terminated at 10 ft
 Client: Bristol Bay Borough
 Drill Start: 9/8/2022

Drilling Contractor: MP
 Drill Equipment: Bobcat E35 Excavator
 Driller: DM

LOG OF TEST-PIT TP10-02

Project: Bristol Bay Pub. Facil. Master Plan
 Project Number: 211098
 Project Phase: Task 2

Elevation:
 Horizontal Datum: NAD83 AKSP Zone 6
 Latitude: 58.73426 °N Longitude: 156.85533 °W

Logged By: JBR,DJR
 Reviewed By: FVM
 Review Date: 09/20/22

Depth (10 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Graphic Log	Blows/ 6 in.	♦ Blows per foot ▲ Salinity ppt ● Moisture %	Other Tests	Size Distribution
0					Brown PEAT ; PT .						
	TP				Dark brown PEAT ; PT .	PT					
		GR		1							
	TP				Brownish gray lean CLAY ; CL . Sub-rounded gravel (max. 1/2"-inch).	CL					
		GR		2							
	TP				Tan lean CLAY with SAND ; CLs . Trace of COBBLES @4'.	CLs					
		GR		3							
	TP				Gray CLAYEY, GRAVELLY SAND ; gSC . Sub-rounded gravel (max. 3"-inch).	gSC					
		GR		4							
10	TP										



Borehole terminated at 10 ft
 Client: Bristol Bay Borough
 Drill Start: 9/8/2022

Drilling Contractor: MP
 Drill Equipment: Bobcat E35 Excavator
 Driller: DM

LOG OF TEST-PIT TP12-01

Project: Bristol Bay Pub. Facil. Master Plan
 Project Number: 211098
 Project Phase: Task 2

Elevation:
 Horizontal Datum: NAD83 AKSP Zone 6
 Latitude: 58.72551 °N Longitude: 156.78544 °W

Logged By: JBR,DJR
 Reviewed By: FVM
 Review Date: 09/20/22

Depth (19 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Graphic Log	Blows/ 6 in.	Moisture %				Other Tests	Size Distribution
									10	20	30	40		
0		GR		1	Brown poorly graded SAND; SP.				●					
	TP													
		GR		2	Brownish gray poorly graded SAND; SP.				●					
	TP													
5					Orange poorly graded SAND; SP.									
	TP													
						SP								
10					Gray poorly graded SAND; SP.									
	TP													
		GR		3					●					
	TP													



Borehole terminated at 19 ft
 Client: Bristol Bay Borough
 Drill Start: 9/7/2022

Drilling Contractor: MP
 Drill Equipment: Hitachi 225 Excavator
 Driller: DM

LOG OF TEST-PIT TP12-03

Project: Bristol Bay Pub. Facil. Master Plan
 Project Number: 211098
 Project Phase: Task 2

Elevation:
 Horizontal Datum: NAD83 AKSP Zone 6
 Latitude: 58.72728 °N Longitude: 156.78675 °W

Logged By: JBR,DJR
 Reviewed By: FVM
 Review Date: 09/20/22

Depth (10 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Graphic Log	Blows/ 6 in.	◆ Blows per foot ▲ Salinity ppt ● Moisture % 10 20 30 40	Other Tests	Size Distribution
0					Dark brown organic SILT; OL.	OL					
	TP				Brown poorly graded SAND with SILT; SP-SM.	SP-SM					
		GR		1					●		
	TP				Dark brown poorly graded SAND; SP.						
		GR		2					●	68%	
	TP										
		GR		3					●		
	TP					SP					
5	TP										
		GR		4	Brown SILTY SAND; SM.	SM				●	
	TP										
		GR			Orange-brown poorly graded SAND with SILT; SP-SM.	SP-SM					
	TP										
		GR		5					●		
10	TP										Fines = 9.1%



Borehole terminated at 10 ft
 Client: Bristol Bay Borough
 Drill Start: 9/8/2022

Drilling Contractor: MP
 Drill Equipment: Bobcat E35 Excavator
 Driller: DM

Summary of Sample Characteristics

Client: Bristol Bay Borough
Project: Bristol Bay Pub. Facil. Master Plan
Project #: 211098



Borehole	Sample #	From	To	Sample Method	Liquid Limit (%)	Plastic Limit (%)	Gradation (%)			Max Particle Size (in)	Laboratory Classification*	Salinity (ppt)	Moisture (%)	Particle Shape	Angularity	Other Tests**
							Gravel	Sand	Fines*							
TP10-01	1	1	1.5	GR						OL		35				
TP10-01	2	2.5	3	GR						CL		16				
TP10-01	3	3.5	4	GR						CLs		12				
TP10-01	4	7.5	8	GR					3/8	SC		14		SR		
TP10-01	5	9.5	10	GR					1	sCLg		14		SR		
TP10-02	1	1	1.5	GR						PT		186				
TP10-02	2	1.5	2	GR						CL		19				
TP10-02	3	2.5	3	GR						CLs		14				
TP10-02	4	9	9.5	GR					1	gSC		13		R		
TP12-01	1	0	1	GR						SP		6				
TP12-01	2	2	4	GR						SP		7				
TP12-01	3	17	18	GR						SP		7				
TP12-02	1	0.5	1	GR						SP-SM		11				
TP12-02	2	2	2.5	GR						SP		8				
TP12-02	3	4	5	GR						SM		19				
TP12-02	4	15	15.5	GR					2.9	SP		7				
TP12-03	1	1	1.5	GR						SP-SM		15				
TP12-03	2	1.5	2	GR						SP		68				
TP12-03	3	3	3.5	GR						SP		7				
TP12-03	4	6	6.5	GR						SM		15				
TP12-03	5	9.5	10	GR					9.1	SP-SM		9				
TP12-04	1	2	2.5	GR						SP-SM		21				
TP12-04	2	4.5	5	GR						SM		26				
TP12-04	3	12.5	13	GR						SP		10				
TP12-04	4	16	16.5	GR						SP		7				
TP12-05	1	1	1.5	GR						PT		36				
TP12-05	2	1.5	2	GR						SP-SM		12				
TP12-05	3	2	2.5	GR						ML		66				
TP12-05	4	4	4.5	GR						SP		8				

*Fines type and content estimated with ASTM D2488 when ASTM D422 or D4318 were not performed

**Other tests: DEN = Bulk Density, SPG = Specific Gravity, HYD = Hydrometer, CONS = Consolidation, UCS = Unconfined Compression Strength, TRIAX = Triaxial

Summary of Sample Characteristics

Client: Bristol Bay Borough
Project: Bristol Bay Pub. Facil. Master Plan
Project #: 211098



Borehole	Sample #	From	To	Sample Method	Liquid Limit (%)	Plastic Limit (%)	Gradation (%)			Max Particle Size (in)	Laboratory Classification *	Salinity (ppt)	Moisture (%)	Particle Shape	Angularity	Other Tests**
							Gravel	Sand	Fines*							
TP12-05	5	9	9.5	GR							SP	6				

59 samples

*Fines type and content estimated with ASTM D2488 when ASTM D422 or D4318 were not performed
 **Other tests: DEN = Bulk Density, SPG = Specific Gravity, HYD = Hydrometer, CONS = Consolidation, UCS = Unconfined Compression Strength, TRIAX = Triaxial
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