R.W. Gillespie & Associates, Inc.
Geotechnical Engineering • Environmental Consulting • Materials Testing Services

18 May 2018

Bruce Crawford
Kittery Port Authority
200 Rogers Road
Kittery, Maine 03904

Via email: brucecrawfordnco@aol.com

Subject: Report of Geotechnical Evaluation
Government Wharf Reconstruction
Kittery, Maine
RWG&A Project No. 1654-001

Dear Mr. Crawford:

R.W. Gillespie & Associates, Inc. (RWG&A) is pleased to present this report for the design of the reconstruction of Government Wharf in Kittery, Maine. The purpose of this geotechnical evaluation was to explore subsurface conditions and prepare recommendations for design and construction of the new pier and bulkhead wall. The evaluation was performed in general accordance with RWG&A's Proposal No. P-9766.GI, dated 02 February 2018.

Background

The pier is located about 400 feet southwest of Portsmouth Naval Shipyard Gate 1, as illustrated on Figure 1, *Locus Map*. RWG&A's understanding of the existing conditions is based on review of information in the email dated 19 January 2018; 1:05 PM, which included the report titled *Government Wharf Condition Assessment, Town of Kittery, ME* (The Report) prepared by Baker Design Consultants, Inc. and dated June 1, 2017.

The existing pier is about 36 feet long by 32 feet wide and is supported on several timber pile bents with each bent supported by 6 or 7 timber piles. The Report indicates the piles are generally in poor to fair condition. The landside end of the pier is supported on a quarried stone bulkhead wall, which The Report indicates is in fair condition and does not exhibit signs of distress from excessive settlement, overturning, or other instability. The wall reportedly shows signs of seepage during low tide indicating retained water within the wall backfill. The Report recommended a low load rating for the pier due to its deteriorated condition. It is understood the pier and bulkhead wall will be demolished and reconstructed in their entirety.

Scope of Services

As completed, RWG&A's scope of services included the following items:

1. Reviewed project information provided and readily available subsurface information from the project vicinity.

2. Marked test boring locations in the field by tape survey methods from features visible on the existing pier. Contacted DigSafe and OK-TO-DIG registered utility entities to locate public utilities as needed to conduct the borings. Retained a test boring drilling company as a subcontractor to RWG&A in order to conduct soil borings through the pier and bulkhead.

3. Completed a geotechnical subsurface exploration program under the direction of an RWG&A representative who observed the drilling activities, sampled the test borings, and logged the conditions encountered.

4. Excavated three test pits using hand tools at the bulkhead mudline.

5. Performed laboratory tests on soil samples recovered from the test borings to aid in soil description, and for determination of engineering properties needed for foundation design analysis.

6. Evaluated acquired field and engineering information with respect to supporting the pier on treated timber piles using Allowable Stress Design (ASD) design methods. Emphasis was placed on allowable pile capacity, pile type, and installation methods. Evaluations were conducted and recommendations prepared for one layout, pile type (i.e., treated timber piles).

7. Prepared this report of geotechnical evaluation presenting RWG&A's findings, conclusions, and recommendations.

Limitations

RWG&A's geotechnical evaluation scope of services for this project excluded the following services:

- An environmental site assessment relative to oil and hazardous materials or evidence of a potential release or threat of oil or hazardous materials on, below, or around the site;

- Use of AASHTO Load and Resistance Factor Design (LRFD) or similar methods;

- Evaluations of maximum storm surge or flood elevation, impact of sea level rise, wave forces, or wave action scour relative to the proposed pier;

- Preparation of contract drawings or technical specifications for construction.

Refer to Appendix A for additional limitations on the content and use of this report.

Subsurface Exploration

The subsurface exploration program consisted of three test pits dug on 06 April 2018 and two soil borings (designated B-1 and B-2) drilled on 17 April 2018. RWG&A representatives excavated test pits using hand tools at low tide near the base of the bulkhead wall. The test pits were extended to refusal surfaces at depths of about 7 inches to 1.2 feet below ground surface.

The soil borings were drilled by New England Boring Contractors, Inc. of Derry, New Hampshire using a track-mounted drill rig with cased washed boring drilling methods. Split-barrel sampling with standard penetration testing (*ASTM D1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*) was generally performed continuously through fill and at about 5-foot intervals thereafter.

Soil samples were described in general accordance with *ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. Logs of the test pits and borings prepared by RWG&A are included in Appendix B of this report. Stratification lines shown on the test boring logs represent the approximate boundaries between the different soil types encountered; the actual transitions will be more gradual and will vary over short distances.

Approximate locations of the test pits and borings are shown on Figure 2, *Exploration Location Plan*. RWG&A marked the locations for the proposed test borings in the field by taping and pacing from identifiable features. The exploration locations shown on Figure 2 should be considered accurate only to the degree implied by the method used to locate them.

Laboratory Testing

Laboratory testing consisted of three grain-size analyses with moisture content determinations performed on representative soil samples recovered from the subsurface explorations. Grain-size distribution curves are presented in Appendix C, *Laboratory Test Results*. Moisture content test results are shown on the exploration logs. The tests were performed in general accordance with the following methods and procedures:

- *ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.*
- *ASTM D2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

Tests were conducted at the RWG&A soils and materials testing laboratory in Biddeford, Maine, which is accredited by the American Association of State Highway and Transportation Officials (AASHTO) for the tests performed.

Subsurface Conditions

The following paragraphs summarize the subsurface conditions observed at the bulkhead wall and at the pier location. Refer to Appendix B for information about subsurface conditions at specific locations and depths.

Bulkhead: The exposed bulkhead wall is constructed of stack quarried boulders with smaller rock fragments chinked in open joints. It appears boulders had been dislodged from multiple locations, and the south bulkhead wall bulges outwards. Boring B-1 was performed on the land side of the existing stacked stone bulkhead wall. The soils encountered consisted of silty sand with gravel fill, which contained brick and cobbles at varying depths below ground surface. A refusal surface, interpreted to represent bedrock, was encountered at a depth of about 7.5 feet below ground surface. The refusal surfaces encountered might have occurred in dense soils or on cobbles, boulders or bedrock.

The test pits dug at the face of the bulkhead wall encountered refusal surfaces at depths ranging from about 7 inches to 1.2 feet below ground surface. Soils encountered in the test pits consisted of organic silt and fill consistent with the materials encountered in the pier boring. Bedrock was visible in the bottom of TP-3, and multiple bedrock outcrops were observed near test pit TP-3. The nature of refusal surfaces at test pits TP-1 and TP-2 could not be visibly determined due to rapid groundwater inflow into the test pits. Refusal might have been on cobbles, boulders or bedrock.

Pier: Boring B-2 was performed through the pier deck at the outboard end of the pier. The depth from the pier to the mudline was approximately 13 feet. Soil units, as encountered at test boring B-2, are described below proceeding downward from the intertidal ground surface.

Organic Sediments (OL): The initial soils at the mudline consisted of Organic Silt which contained shells, brick, glass, and other debris. The Organic Silt was loose to very loose and extended to a depth of about 3.5 feet below ground surface.

Sandy Silt (ML): The organic sediments are underlain by gray Sandy Silt described as very loose, wet, silt, with medium to fine sand, and gray. Encountered thickness of the unit was about 3 feet.

Silty Sand with Gravel (SM): Dense Silty Sand with Gravel was encountered below the sandy silt and was described as wet, coarse to fine sand, with silt, with gravel, and gray brown. The unit had an encountered thickness of about 3.5 feet.

Weathered Bedrock: Below the Silty Sand with Gravel, Weathered Bedrock was encountered and extended to apparent competent bedrock at a depth of about 16.5 feet below ground surface. The Weathered Bedrock was very dense.

Refusal was encountered in B-2 by rotary drilling with a tri-cone roller bit at about 16.5 feet below the mudline. The refusal surfaces encountered might have occurred in dense soils or on cobbles, boulders or bedrock.

Proposed Construction

The Report indicates that a large portion of the pier is in poor condition. It is understood, from a discussion with Bruce Crawford of the Kittery Port Authority, that the entire pier structure and bulkhead wall would be replaced in more-or-less the same footprint. Although design details are not available, it is understood the current plans call for the new pier to be a wooden structure, and the new bulkhead wall would be cast-in-place concrete. A land survey of the pier and

bulkhead were unavailable when this report was prepared. The Report indicates the existing pier deck elevation is below the FEMA base flood for the area. As such, Kittery Port Authority has indicated the reconstructed pier deck level would be at least 2 feet above the current elevation.

Engineering evaluations for this project are based on the test boring results and preliminary design information currently available to RWG&A. Should differing information become known prior to or during construction, these evaluations should be reviewed by RWG&A to confirm their continued applicability.

Recommendations

Based on the subsurface soil conditions and depth to refusal surfaces, the new pier may be supported on driven, treated timber piles that develop load-carrying capacity by end-bearing. It is anticipated that vertical and battered piles will be needed and that the pier structure would require bracing to resist lateral loads as timber piles would not penetrate the dense silty sand with gravel or weathered rock to a sufficient depth needed to develop lateral load resistance. The bulkhead wall foundation can consist of spread footings bearing on bedrock or on dense silty sand with gravel deposits below design scour depth as determined by the designers. Foundation requirements and construction considerations are significantly affected by the subsurface conditions present at the project site. RWG&A recommends that foundation construction be in accordance with applicable codes.

Site Preparation

1. Site preparation should include removal of obstructions before pile installation. Potential obstructions to pile installation that might be encountered include, but are not limited to, previously abandoned piles, remnants of foundations, mooring anchors, riprap, and utilities. Abandoned piles not in conflict with new piles should be cut off at least 1 foot below the finished ground elevation and left in place; piles in conflict with the new piles might need to be removed (i.e., pulled) and backfilled with sand. Alternately, where new pile locations conflict with existing piles, the abandoned piles should be cut off. The new piles may need to be relocated, and/or additional new piles may be needed.

2. It is anticipated that removal of obstructions near ground surface would be accomplished by pre-excavation with a hydraulic excavator, and that buried obstructions would be cleared by predrilling and/or spudding with the pile driving equipment. Voids caused by pile removal, pre-excavation, and predrilling should be backfilled with compacted granular fill.

3. Granular fill should consist of hard and durable sand and gravel particles free from vegetable matter, lumps or balls of clay and/or silt, frozen material and other deleterious substances. The gradation of granular fill should meet the requirements of *Maine Department of Transportation, Standard Specifications, Division 700, Subsection 703.19 Granular Borrow, Material for Underwater Backfill* and the following particle-size distribution:

Screen or Sieve Size	Percent Passing
3 inches	100
No. 40	0-70
No. 200	0-7

Based upon visual descriptions, the organic sediments are unsuitable for use as granular fill.

4. Granular fill used for backfill of removed obstructions and piles should be placed in uniform lifts not exceeding a couple of feet in thickness and be compacted with concrete vibrators and/or by manual rodding.

Treated Timber Piles

5. The pier may be supported on *ASTM D25, Standard Specification for Round Timber Piles,* Class B southern yellow pine timber piles driven to end-bearing capacity with an estimated maximum driven length of about 15 feet below mudline and 8-inch minimum tip diameter. The estimated range in embedment length excludes the part of the piles above ground surface/mudline needed to reach the pier.

6. Timber piles should be treated in accordance with the current American Wood Protection Association Standard U1-15, *Use Category System: User Specification for Treated Wood,* Use Category UC5A Marine Use Northern Waters.

7. Bottoms of abutment pile caps should be a minimum of 4 feet below the lowest adjacent ground surface exposed to freezing for frost protection.

8. The piles should be installed to develop their load carrying capacity in end-bearing. Recommended allowable geotechnical compressive pile capacity is 20 tons (40 kips) and 40 tons (80 kips) ultimate.

9. Lateral load capacity will need to be provided by battered piles; batter should not be flatter than 3 units horizontal to 12 units vertical (3H:1V). Other than vertical and battered pile bents, piles should be spaced a minimum of 24 inches center-to-center.

10. Recommended maximum eccentricity is 2 inches from the design location. Vertical piles should be installed as plumb as is practicable unless the pile is designed with a batter for lateral load resistance. A pile should be considered out of plumb if the inclination is greater than 1/4 inch per foot from the design vertical or batter alignment. Pile leads should be fixed at two points to control pile alignment.

11. Project specifications should require the Contractor to submit information on their proposed pile driving system for review by the project Engineer and RWG&A prior to equipment mobilization. The pile driving system should be capable of installing the piles to the specified geotechnical capacity without damaging the piles. The Contractor's submittal should include a wave equation analysis of the proposed driving system to

evaluate driving stresses. Piles should be driven to their minimum embedment length with a single or double acting hammer. Driving stresses should be limited to a maximum compressive stress of 3,600 pounds per square inch.

12. Abrupt high driving resistance on the bearing soil layer should be expected. Predrilling and/or jetting may not be utilized to install or advance piles for this project. Vibratory hammers also should not be used.

13. To reduce damage to piles, the recommended maximum pile hammer energy is 12,000 foot-pounds. All piles should be installed in a continuous manner using the same equipment. Driving criteria should be reviewed by the Engineer and RWG&A based on the pile hammer proposed by the Contractor and the submitted wave equation analysis.

14. Pile driving should be stopped immediately if abrupt high resistance to penetration is encountered. Any sudden decrease in driving resistance should be investigated with regard to the possibility of damage. If the sudden decrease in driving resistance cannot be correlated to the depth of load bearing subsurface conditions, the pile should be removed for inspection or rejected.

Bulkhead Wall and Foundations

15. The proposed structure should be designed to withstand lateral, uplift, and overturning forces due to earthquakes. The in-place soils encountered in the explorations are not considered susceptible to liquefaction. The site is classified as Site Class C in accordance with the *2015 International Building Code*®.

16. The proposed bulkhead wall may be supported on spread and/or continuous footings bearing directly on prepared bedrock surfaces. The footings should be proportioned for an allowable contact pressure of 5,000 pounds per square foot. Total settlements of less than ½- inch should be expected. Minimum footing width should be in accordance with concrete design and building code requirements, and no less than 2 feet. For footings having a least lateral dimension less than 3 feet, the above allowable pressure should be taken as 1/3 of the above value times the least dimension in feet.

17. Prior to placement of concrete, care should be taken to limit disturbance of the bearing surfaces. Preparation of bedrock subgrades prior to placement of foundations or lean concrete fill should include removal of all loose, decomposed, disturbed, and/or dislodged rock. Bearing subgrades should then be cleansed with high pressure air or water. It is expected that the bedrock surface will be irregular and might extend below proposed bottom of footing elevations in some areas of the site. Bearing subgrades should be sloped no steeper than 4H:1V across the length or width of the foundation.

18. Lean concrete fill may be used to provide a level surface for placement of footings. Compressive strength of lean concrete fill should be equal to or greater than the compressive strength of concrete used in footings. Limits of concrete fill below footings should extend a minimum of 1 foot horizontally outside the outer edge of footings at

design footing subgrade elevation, and project down and away from the footing at a pitch no steeper than 1H:1V.

19. It is recommended that design bottom of footing level be a minimum of 2 feet below lowest adjacent ground surface exposed to freezing temperatures. Freezing of subgrade soils beneath footings and floor slabs might result in heaving and post-construction settlement. The Contractor should make every effort to prevent freezing of subgrade materials.

20. Lateral loads from wind and earthquake may be resisted by friction between the bottoms of footings and supporting subgrades, and by passive earth pressures below the maximum design scour depth against the sides of the foundation. Footings may be designed for friction coefficient of 0.5 and a lateral bearing pressure against sides of footings of 175 pounds per square foot per foot below design scour depth.

21. Bulkhead wall backfill within 10 feet of the back of the wall should be granular fill. Backfill should be placed in lifts not exceeding 8 inches in uncompacted thickness, and be compacted with vibratory plate compactors and/or walk behind rollers to achieve a minimum of 92 percent maximum dry density, as determined by ASTM D1557, *Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort* (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

22. French drains and weeper drains should be designed to prevent hydrostatic pressure buildup behind the abutment walls. The drains should be located near the bottom of the wall and above design sedimentation depth. French drains should be designed and constructed in accordance with *MaineDOT Standard Specifications Section 512 – French Drains.* Weeper drains should be designed and constructed to prevent migration or loss of material through the drain. Multiple drainage outlets should be provided so as not to be reliant upon a single flow path.

23. Walls that are not allowed to translate and rotate, such as walls restraining unbalanced earth pressure, should be designed to withstand an at-rest equivalent fluid unit weight of 65 pounds per square foot (K_o = 0.5). Below grade walls that are allowed to move may be designed to withstand an active equivalent fluid unit weight of 45 pounds per square foot (K_a = 0.33). Lateral load from vehicle surcharge can be accounted for by applying a uniform vertical pressure equal to 250 pounds per square foot multiplied by the active earth pressure coefficient. Unbalanced hydrostatic forces should be included in the design and taken as 50 percent of the maximum exposed wall height.

24. It is also recommended that retaining walls be designed with the resultant load within the middle third of the footing and that a maximum contact pressure at the toe of wall be no greater than 5,000 pounds per square foot.

Temporary Excavations

25. Excavations for the bulkhead retaining wall footing will be within, and potentially extend below, the intertidal water levels. Excavations should be sheeted or backfilled before they become inundated by rising tide levels. The Contractor should build, maintain, and

operate all cofferdams, sumps, and other temporary diversion and protection works needed to divert surface water through or around the construction. The cofferdam and dewatering system should be designed by a qualified Maine-licensed professional engineer engaged by the Contractor.

26. The Contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations, e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility Subcontractors could be liable for substantial penalties.

    As a safety measure, it is recommended that all earthwork equipment and spoil piles be kept a minimum lateral distance from the top of excavations equal to no less than 100 percent of the slope height.

Geotechnical Observation

27. Since the above geotechnical recommendations are based on limited numbers of observations and tests, the Owner, Contractor and Engineer should be particularly sensitive to the potential need for adjustments in the field. It would be in the best interest of the Owner and project to retain RWG&A to observe geotechnical aspects of the construction including general compliance with the design concepts, specifications, and recommendations, and to assist in development of design changes should subsurface conditions differ from those anticipated. Such observation increases the likelihood of the design intent being considered adequately during construction and will allow RWG&A to confirm its design recommendations. In particular, RWG&A should be engaged to:

    - review Contractor submittals,
    - observe backfilling associated with obstruction and pile removal,
    - monitor pile installation,
    - observe footing subgrade excavation,
    - monitor fill placement and compaction.

In addition to geotechnical observation, RWG&A can provide construction inspection and materials testing services. In addition to geotechnical observation, RWG&A can also provide full service construction inspection and materials testing. This would include soils, portland cement and asphaltic concrete, structural steel and welding inspections, destructive and non-destructive testing, and special inspection services in fulfillment of building code requirements.

Closure

This report has been prepared for specific application to the Reconstruction of Government Wharf in Kittery, Maine, and for the exclusive use of the Kittery Port Authority. This evaluation has been completed in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made. In the event that any changes are

made in the nature or design of the proposed construction, conclusions and recommendations of this report should be reviewed by RWG&A, verified and/or changed and documented writing.

The recommendations presented are based on the results of widely spaced explorations. The nature of variations between the explorations may not become evident until construction has begun. If variations are encountered, it will be necessary for RWG&A to re-evaluate the recommendations presented in this report. RWG&A requests an opportunity for a general review of the final design and specifications to determine that earthwork and foundation recommendations have been interpreted in the manner in which they were intended.

RWG&A looks forward to working with Kittery Port Authority during final design and construction of the project. Please do not hesitate to contact us if you have any questions about this report or if RWG&A may be of further service.

Sincerely,

R.W. GILLESPIE & ASSOCIATES, INC.

Marc R. Grenier, P.E.
Project Geotechnical Engineer

STATE OF MAINE
5/18/18
ERIK J. WIBERG
No. 8178
LICENSED PROFESSIONAL ENGINEER

Erik J. Wiberg, P.E.
Chief Geotechnical Engineer

MRG/EJW:md
In duplicate

Attachments:

- Figure 1, Locus Map
- Figure 2, Exploration Location Plan
- Appendix A, Use of Report
- Appendix B, Test Boring Logs
- Appendix C, Laboratory Test Results

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0 2000 3000 4000

SCALE, FEET

SOURCE:
USGS 7.5-MINUTE TOPOGRAPHIC QUADRANGLE OF KITTERY, ME, DATED 2015.

FIGURE 1
LOCUS MAP
GEOTECHNICAL EVALUATION
GOVERNMENT WHARF RECONSTRUCTION
KITTERY, MAINE

MAY 2018 PROJECT NO. 1654-001

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G:\Autocad\1600\1654-01\FIG 1, LOCUS MAP 1654-001.dwg, 5/14/2018 10:48:23 AM, Adobe PDF.pc3

LEGEND:

B-1 — APPROXIMATE LOCATION OF SOIL BORING DRILLED 17 APRIL 2018.

TP-1 — APPROXIMATE LOCATION OF TEST PIT DUG APRIL 2018.

SOURCE:
© GOOGLE EARTH 2017 IMAGE.

N

0 30 45 60
SCALE, FEET

FIGURE 2
EXPLORATION LOCATION PLAN
GEOTECHNICAL EVALUATION
GOVERNMENT WHARF RECONSTRUCTION
KITTERY, MAINE

MAY 2018 PROJECT NO. 1654-001

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APPENDIX A

USE OF REPORT

Geotechnical Evaluation
Reconstruction of Government Wharf
Kittery, Maine

USE OF REPORT

This geotechnical evaluation report has been limited to consideration of the soil and foundation aspects of the Government Wharf Reconstruction in Kittery, Maine. The primary purpose of RWG&A's services was to explore subsurface conditions and to make recommendations for design and construction of pier foundations and a bulkhead wall. This report also provides geotechnical parameters for design and identifies construction considerations solely intended to assist the engineers that will design the project and monitor its construction. This report is not a technical specification nor is it intended to be used as a specification for bidding or building the project. The report and the attached test boring logs and laboratory test results may be provided to others for informational purposes only.

This geotechnical evaluation report might also aid the Contractor responsible for construction, but reliance is not extended to the Contractor for the purposes of bidding and/or building the project. The construction considerations provided herein are not intended to be instructions or directives to the project Contractor. The project Contractor must evaluate construction issues encountered in the work on the basis of their experience with similar projects taking into account their own methods and procedures.

This report has not considered the construction from a worker safety perspective. Construction safety is the responsibility of the project Contractor, who is also solely responsible for the means, methods, and sequencing of construction operations. RWG&A is providing this information as a service to the Kittery Port Authority. Under no circumstances, should this information be interpreted to mean that RWG&A and/or the Kittery Port Authority are assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

RWG&A's scope of services excluded an environmental site assessment relative to oil and hazardous materials or evidence of a potential release or threat of oil or hazardous materials on, below, or around the site. Any statement in this report or on the test boring logs, regarding odors or unusual or suspicious conditions, is for informational purposes only and is not intended to constitute an environmental assessment.

APPENDIX B

TEST BORING LOGS

Geotechnical Evaluation
Reconstruction of Government Wharf
Kittery, Maine

RWG&A, Inc. soil descriptions are based on the following criteria. Descriptive terminology is used to denote the grain size and percentage of each component. The soil descriptions are based on visual-manual classification procedures, Standard Penetration Test results, and the results of laboratory testing on selected soil samples, where available. The Unified Soil Classification Group Symbol will be indicated in capital letters.

COMPONENT DEFINITIONS BY GRADATION SIEVE LIMITS

Materials	Definitions	Fractions	Upper	Lower
Boulders	Material too large to pass through an opening 12 in. square.			
Cobbles	Material passing through a 12 in. opening and retained on the 3 in. sieve.			
Gravel	Material passing the 3 in. sieve and retained on 1/4" (No. 4 sieve).	Coarse Fine	3 in. 3/4 in.	3/4 in. 1/4 in.
Sand	Material passing the No. 4 sieve and retained on the No. 200 sieve.	Coarse Medium Fine	No. 4 (1/4") No. 10 (1/8") No. 40 (1/32")	No. 10 (1/8") No. 40 (1/32") No. 200
Silt	Material passing the No. 200 sieve which is usually non-plastic in character and exhibits little or no strength when air dried.		No. 200	
Clay	Material passing the No. 200 sieve which can also be made to exhibit plasticity within a certain range of moisture contents and which exhibits considerable strength when air dried.		No. 200	

SOIL DESCRIPTION

General

Soils are described as to the Unified Soil Classification Systems Group Symbol, density or consistency, color, grain size distribution and other pertinent properties such as plasticity and dry strength. The RWG&A order of descriptors is as follows:

1. USCS Group Name and Symbol, or Fill
2. Density or Consistency
3. Moisture
4. Grain Size & Constituent percentages
5. Other pertinent descriptors
6. Color

DESCRIPTIVE TERMINOLOGY DENOTING COMPONENT PROPORTIONS

Descriptive Terms	Range of Proportions
Noun (major component)	≥50%
Adjective (secondary component)	20 - 50%
Some (third component)	25 - 45%
Little (second or third component)	15 - 25%
Few (second or third component)	5 - 15%
Trace	0 - 5%
With	Amount of component not determined. Used as a conjunction only. Does not indicate component percentile

OTHER DESCRIPTIVE TERMS

Where appropriate, geological classifications are also used (Glacial Till, etc.)

TYPICAL DESCRIPTIONS

SAND WITH SILT (SP-SM): Medium dense, moist, coarse to medium sand, few silt, brown.
FILL; Loose, dry, fine sand, some gravel and silt, with brick and concrete fragments, dark brown.
SILTY CLAY (CL); Very stiff, moist, silty clay, olive-brown.

DENSITY OR CONSISTENCY OF SOILS

COHESIVE SOILS

Consistency of Cohesive Soils	Standard Penetration Test (Blows Per Foot) (N)	Undrained Shear Strength (TSF)
Very Soft	0 - 2	Below 0.13 (250 psf)
Soft	2 - 4	0.13 to 0.25 (to 500 psf)
Medium	4 - 8	0.25 to 0.5 (to 1,000 psf)
Stiff	8 - 15	0.5 to 1.0 (to 2,000 psf)
Very Stiff	15 - 30	1.0 to 2.0 (to 4,000 psf)
Hard	Over 30	over 2.0 (over 4,000 psf)

Consistency of cohesive soils is based upon field vane shear, torvane, or pocket penetrometer, or laboratory vane shear or Unconsolidated-Undrained Triaxial Compression tests. Consistency of cohesive soils is based upon the Standard Penetration test when no other data is available.

COHESIONLESS SOILS

Density of Cohesionless Soils	Standard Penetration Test (Blows per Foot) (in)
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	over 50

PENETRATION RESISTANCE

STANDARD PENETRATION TEST (ASTM D1586) - a 2.0-inch diameter, 1-3/8 inch inside diameter split barrel sample is driven into soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The total number of blows required for penetration from 6 to 18 inches is the Standard Penetration Resistance (N).

COBBLES AND BOULDERS

The percentage of cobbles and boulders is estimated visually where possible.

Descriptive Term	Estimated Percentage
Very Few	0 - 10%
Few	10 - 25%
Common	25 - 40%
Numerous	40 - 50%

If the percentage cannot be determined, as in a typical test boring, then use “with” to indicate the presence of cobbles and/or boulders. (i.e., gravelly sand with cobbles and boulders).

FILLS

The following terminology is used to denote size range of man-made materials within fill deposits:

Size Range	Comparative Soil Terms
<No. 200 Sieve	Silt - size
No. 200 to 1/4 in.	Sand - size
1/4 in. to 3 in.	Gravel - size
3 in. to 12 in.	Cobble - size
>12 in.	Boulder - size

SUPPLEMENTAL SOIL DESCRIPTION TERMINOLOGY

Term	Example	
Seam	Typically 1/16 to 1/2 inch thick	1/4 inch sand seams
Layer	Greater than 1/2 inch thick	2-inch sand layers
Occasional	One or less per foot of thickness	
Frequent	More than one per foot of thickness	
Interbedded	Alternating soil layers of different composition	
Varved	Alternating thin seams of silt and clay	
Mottled	Variations in color	

R.W. Gillespie & Associates
- Geotechnical Engineering
- Environmental Consulting
- Materials Testing Services

Boring Log: B-1

Total Depth (ft): 8.3

Sheet 1 of 1

Project Name: Government Wharf Reconstruction
RWG&A Project No. 1654-001
Location: Kittery, Maine
Client: Kittery Port Authority
RWG&A Representative: M. Grenier
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfill with cuttings
Observed Water Depth: Not Obs.

Drilling Contractor: N.E. Boring Contractors
Drill Rig: Scout Rig
Driller Rep.: B. Raiche
Date Started: 04/17/2018
Date Completed: 04/17/2018
Surface Elevation: N/A
Drilling Method: Drive + Wash
Casing Type: 4" Steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (4 inches).	14	8 7 8	15		
				FILL; Silty sand with gravel, coarse to fine sand, little silt, little gravel, brown gray.					
			S-2		6	8 7 6	11	11	GS NM
5			S-3	Little brick at 4'.	6	5 4 15	13	8	GS NM
				Cobbles from 6.5' to 7.5'.		8 9			
				Top of rock, advanced with roller cone to 8.3'.					
				Bottom of Exploration at 8.3', terminated 0.8' below top of rock.					
10									
15									
20									
25									
30									

Notes:

R.W. Gillespie & Associates
- Geotechnical Engineering
- Environmental Consulting
- Materials Testing Services

Boring Log: B-2

Total Depth (ft): 16.5

Sheet 1 of 1

Project Name: Government Wharf Reconstruction
RWG&A Project No. 1654-001
Location: Kittery, Maine
Client: Kittery Port Authority
RWG&A Representative: M. Grenier
Boring Location: See Exploration Location Plan
Boring Abandonment Method:
Observed Water Depth: 0'

Drilling Contractor: N.E. Boring Contractors
Drill Rig: Scout Rig
Driller Rep.: B. Raiche
Date Started: 04/17/2018
Date Completed: 04/17/2018
Surface Elevation:
Drilling Method: Drive + Wash
Casing Type: 4" Steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	Organic Sediments; Organic Silt; soft, wet, silt, with sand, few shells, black.	10	3 3 2	5		
			S-2		6	2 1 1/18"	1		
5			S-3	Organic Sediments; Sandy Silt; very soft, silt, with medium to fine sand, gray.	2	WOH/ 12"	1		
			S-4	SILTY SAND WITH GRAVEL (SM); Dense, coarse to fine sand, with silt, with gravel, gray brown.	12	1 12 16 20 50/5"	70+	14	GS NM
10				Weathered rock.					
			S-5		6	25 50/5"	100+		
15			S-6		1	52/2"	100+		
				Bottom of Exploration at 16.5'; Roller cone refusal, possible bedrock.					
20									
25									
30									

Notes: Depths refer to depth below mud line. Boring performed through the deck which was 13' above mud line.

R.W. Gillespie & Associates

- Geotechnical Engineering
- Environmental Consulting
- Materials Testing Services

TEST PIT LOG

Test Pit No. TP-1

PROJECT	Government Wharf Reconstruction	PROJECT NO.	1654-001
CLIENT	Kittery Port Authority	DATE	04/06/2018
LOCATION	Kittery	ELEV.	
EXCAVATION METHOD	Hand tools	LOGGER	David Walker
EXCAVATION LOCATION	See Exploration Location Plan		
DEPTH TO - Water: 0'	When checked:	Caving:	

DEPTH	SYMBOL	SAMPLES SAMPLE NUMBER	DESCRIPTION	LAB TESTS	MOISTURE %
0			ORGANIC SILT (OL)		
			SILTY SAND WITH GRAVEL (SM)		
1					
			Bottom of Exploration at 1.2'; Refusal, possible bedrock or boulder.		
2					
3					
4					
5					
6					

Notes:

R.W. Gillespie & Associates

- Geotechnical Engineering
- Environmental Consulting
- Materials Testing Services

TEST PIT LOG

Test Pit No. TP-2

PROJECT	Government Wharf Reconstruction	PROJECT NO.	1654-001
CLIENT	Kittery Port Authority	DATE	04/06/2018
LOCATION	Kittery	ELEV.	
EXCAVATION METHOD	Hand tools	LOGGER	David Walker
EXCAVATION LOCATION	See Exploration Location Plan		
DEPTH TO - Water: 0'	When checked:	Caving:	

DEPTH	SYMBOL	SAMPLES SAMPLE NUMBER	DESCRIPTION	LAB TESTS	MOISTURE %
0			ORGANIC SILT (OL)		
			SILTY SAND WITH GRAVEL (SM)		
1					
2			Bottom of Exploration at 1.9'; Refusal, possible bedrock or boulder.		
3					
4					
5					
6					

Notes:

R.W. Gillespie & Associates

- Geotechnical Engineering
- Environmental Consulting
- Materials Testing Services

TEST PIT LOG

Test Pit No. TP-3

PROJECT	Government Wharf Reconstruction	PROJECT NO.	1654-001
CLIENT	Kittery Port Authority	DATE	04/06/2018
LOCATION	Kittery	ELEV.	
EXCAVATION METHOD	Hand tools	LOGGER	David Walker
EXCAVATION LOCATION	See Exploration Location Plan		
DEPTH TO - Water: Not Obs.	When checked:	Caving:	

DEPTH	SYMBOL	SAMPLES SAMPLE NUMBER	DESCRIPTION	LAB TESTS	MOISTURE %
0			ORGANIC SILT (OL)		
			Bottom of Exploration at 7"; Refusal, bedrock.		
1					
2					
3					
4					
5					
6					

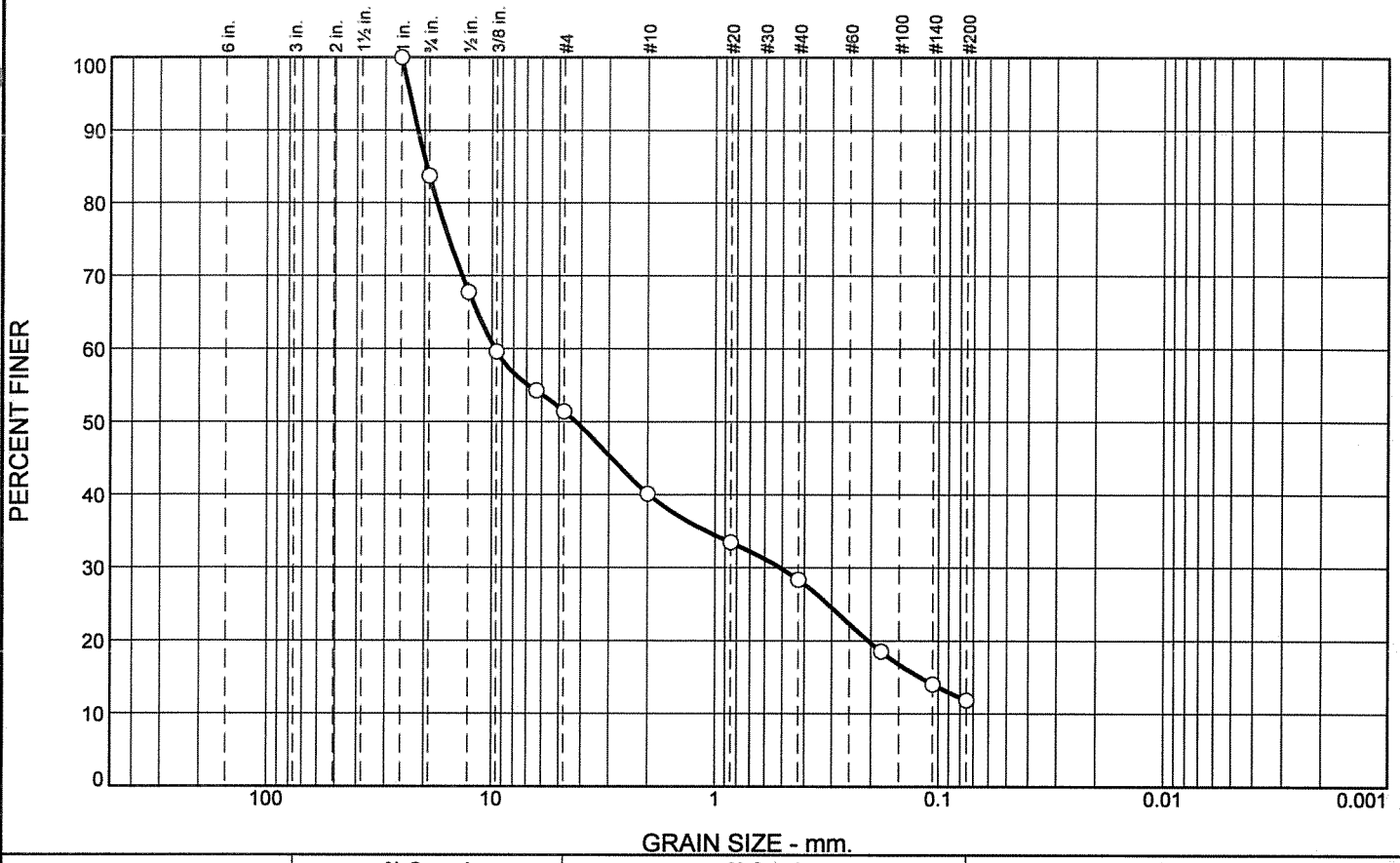
Notes:

APPENDIX C

LABORATORY TEST RESULTS

Geotechnical Evaluation
Reconstruction of Government Wharf
Kittery, Maine

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.2	32.4	11.3	11.7	16.5	11.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	83.8		
1/2"	67.8		
3/8"	59.6		
1/4"	54.3		
#4	51.4		
#10	40.1		
#20	33.5		
#40	28.4		
#80	18.6		
#140	14.1		
#200	11.9		

* (no specification provided)

Soil Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 21.4165 D_{85}= 19.5229 D_{60}= 9.7010
D_{50}= 4.2176 D_{30}= 0.5107 D_{15}= 0.1204
D_{10}= C_u= C_c=

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Moisture Content: 10.8%

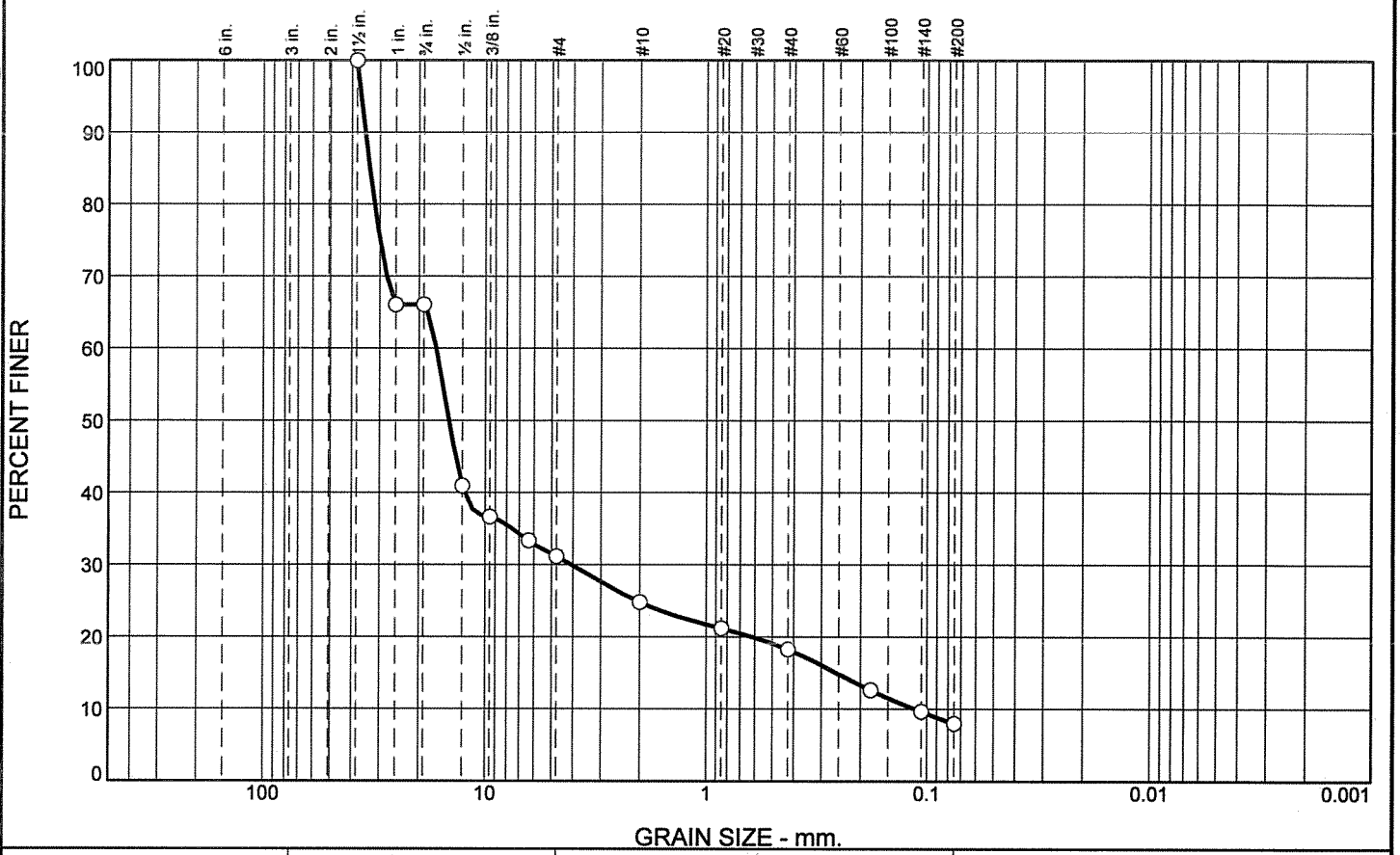
Location: Boring: B-1
Sample Number: S-2 **Depth:** 2.3'-4.3' **Date:** 4/30/18

R.W. Gillespie & Associates, Inc.
Saco, Maine

Client: Kittery Port Authority
Project: Government Wharf Reconstruction
Kittery, ME
Project No: 1654-001 **Lab No.** 14945a

Tested By: JJB **Checked By:** MRG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	33.9	34.9	6.4	6.5	10.3	8.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	66.1		
3/4"	66.1		
1/2"	41.0		
3/8"	36.7		
1/4"	33.3		
#4	31.2		
#10	24.8		
#20	21.2		
#40	18.3		
#80	12.6		
#140	9.7		
#200	8.0		

* (no specification provided)

Soil Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 34.8798 D_{85}= 33.2956 D_{60}= 16.7475
D_{50}= 14.6241 D_{30}= 4.0577 D_{15}= 0.2555
D_{10}= 0.1129 C_u= 148.36 C_c= 8.71

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Moisture Content: 8.0%

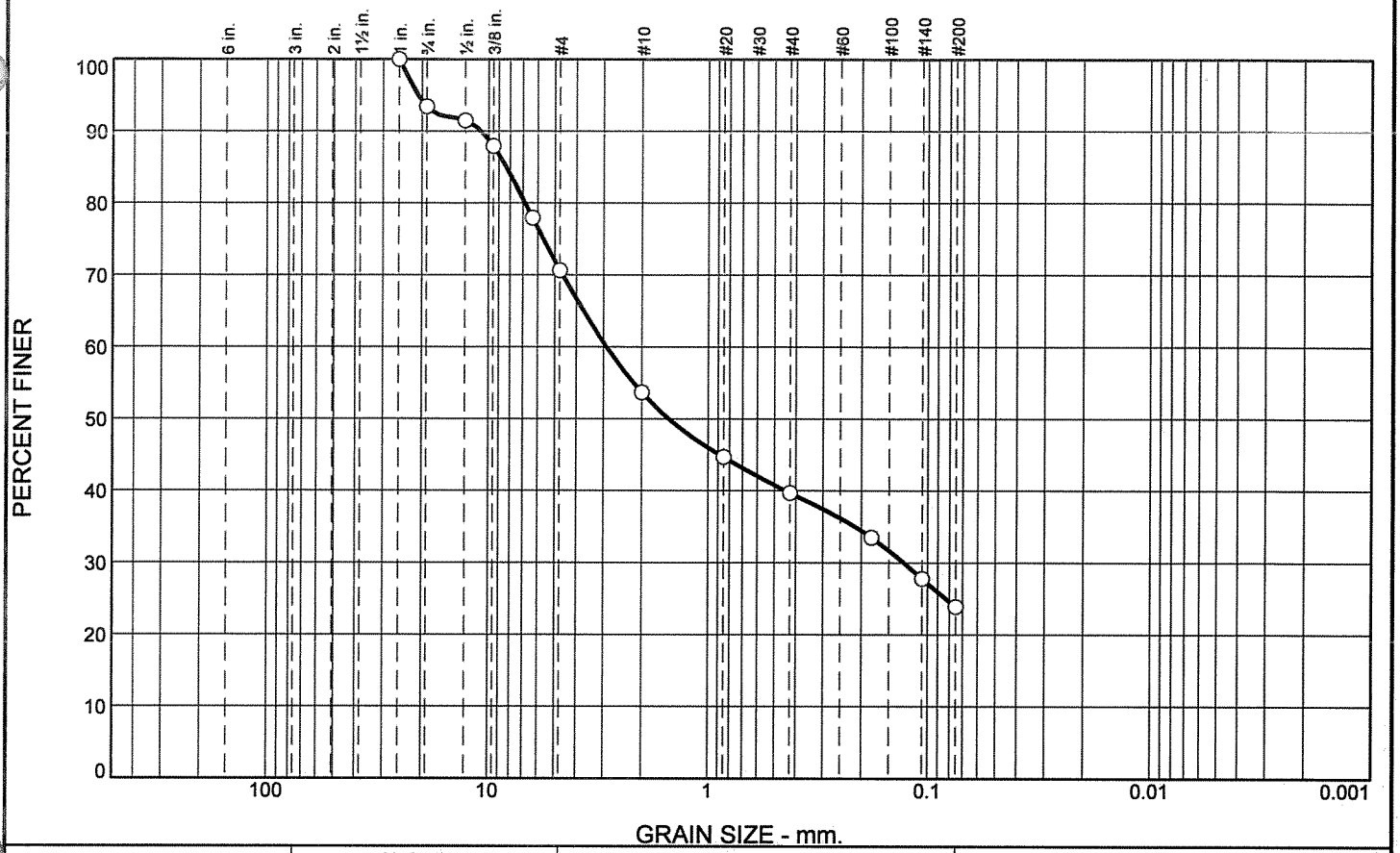
Location: Boring: B-1
Sample Number: S-3 **Depth:** 4.3'-6.3' **Date:** 4/30/18

R.W. Gillespie & Associates, Inc.
Saco, Maine

Client: Kittery Port Authority
Project: Government Wharf Reconstruction
Kittery, ME
Project No: 1654-001 **Lab No.** 14945b

Tested By: JJB **Checked By:** MRG MRG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.6	22.7	17.0	14.0	15.8	23.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	93.4		
1/2"	91.5		
3/8"	87.9		
1/4"	77.9		
#4	70.7		
#10	53.7		
#20	44.7		
#40	39.7		
#80	33.5		
#140	27.8		
#200	23.9		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 10.8315 D_{85}= 8.3345 D_{60}= 2.9032
D_{50}= 1.5068 D_{30}= 0.1284 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Moisture Content: 14.1%

Location: Boring: B-2
Sample Number: S-4 **Depth:** 7'-9' **Date:** 4/30/18

R.W. Gillespie & Associates, Inc.
Saco, Maine

Client: Kittery Port Authority
Project: Government Wharf Reconstruction
Kittery, ME
Project No: 1654-001 **Lab No.** 14945c

Tested By: JJB **Checked By:** MRG