FINAL GEOTECHNICAL EXPLORATION REPORT

WASTE WATER TREATMENT PLANT RECAPITALIZATION PROJECT

CONTRACT No. N40080-11-D-0496-0034

Naval Support Activity (NSA) Annapolis
Annapolis, Maryland

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1. EXECUTIVE SUMMARY

Patton Harris Rust & Associates – A Pennoni Company (PHR+A) has completed our geotechnical evaluation for the proposed new Wastewater Treatment Plant Recapitalization Project at the NSA Annapolis site within the U.S. Naval Academy in Annapolis, Maryland. The purpose of our evaluation was to: perform geotechnical field and laboratory testing; to classify the subsurface soils in the proposed building areas; and provide our conclusions and recommendations for foundation system construction.

The PHR+A team for this project are also providing architectural, structural, civil, and MEP engineering services. Based on information developed our team, the proposed construction consists of a new Denitrification Building; Electrical Building; Surge Basin; and Influent Pump Station. The new structures are located throughout the existing wastewater treatment plant and are predominately precast concrete construction. Additional miscellaneous construction includes: a concrete loading pad; an asphalt driveway; a culvert and stromwater pipe; and utility connections from the proposed structures to the existing infrastructure.

Currently, the site of the proposed structures consists of gravel lots, undeveloped area and an existing building which is to be demolished as part of this project. Existing site grades range from elevation 12 feet in the north to 20 feet in the south with raised clarifier tanks and surge basin centrally located within the project site graded to approximately 32 feet, NAVD88 datum. Based on existing and proposed grades, the new Denitrification Building, Electrical Building, and Influent Pump Station will require cuts and fills of less than 3 feet to achieve finished floor elevation. Wells within these structures will require excavations on the order of 10 to 23 feet to achieve proposed well bottoms. Site grading in the area of the proposed Surge Basin will require fills of up to 9 feet in order to achieve finished grade.

Three (3) Standard Penetration Test (SPT, ASTM D1586) borings were performed by Connelly Drilling & Associates on October 11, 2012 to depths of approximately 35 feet each below the existing ground surface. Subsurface stratigraphy encountered by the test borings indicate a surficial layer of topsoil or bituminous concrete underlain by loose to medium dense predominately granular soils with varying amounts of silt to the extent of the borings. A groundwater gradient sloping from the west towards Carrs Creek in the east was observed.

Based on the results of our field exploration, laboratory testing, and subsequent analysis, we conclude that construction of the proposed structures on a shallow foundation system consisting of strip and/or spread footings is feasible. In general, settlements for the proposed structures should be less than 1 inch with the exception of the Surge Basin which may result in a total settlement of up to 3 inches due to the fill and structure weight. Placement of fill in advance of basin construction and inclusion of flexible connections between the existing and proposed basins are recommended.

This report provides a summary of the proposed construction, our field and laboratory testing programs, and recommendations for the design and construction of the proposed structures.

2. INTRODUCTION

2.1. PROPOSED CONSTRUCTION

This project consists of upgrading the existing NSA Annapolis Wastewater Treatment Plant to meet regulatory discharge requirements by the January 1, 2015 deadline. To accomplish this, new construction will upgrade the capabilities of the existing plant. The proposed construction consists of the following:

- Denitrification Building. The Denitrification Building is to be located on the south east portion of the site near the existing chemical feed building and to the north of the wooded area surrounding the Recycling Center. The Denitrification Building is a single-story, "high bay" (approximately 30 feet tall), steel framed structure with an approximate plan area of 3,960 square feet and a finished floor elevation of 20.66 feet, NAVD88. The Denitrification Building is to contain two precast concrete surge tanks, each with an approximate plan area of 511.5 square feet and bottom elevation of approximately 10.66 feet, to be located on the east side of the proposed Denitrification Building. The Denitrification Building is also to contain two precast concrete wells, a mud well and clear well, each with an approximate plan area of 300 square feet and bottom elevation of approximately 10.66 feet, to be located on the west side of the proposed Denitrification Building.

- Electrical Building. The Electrical Building is located approximately 10 feet west of the new Denitrification Building and consists of a single story, precast concrete building bearing on cast-in-place concrete foundations and slab on grade. The building has a plan area of approximately 240 square feet and a finished floor elevation of 19.70 feet.

- New Surge Basin. The new Surge Basin is located adjacent to the existing surge basin on the southwest portion of the site near the intersection of Alder Rd. and Carrs Creek Rd. and consists of a square, open precast wall and base tank with a plan area of approximately 2,209 square feet (inside wall to wall) and a minimum top of slab elevation of 27.6 feet to match the existing basin. The wall to wall distance between the new and existing basin is to be approximately 4 feet.

- New Influent Pump Station. The new Influent Pump Station is located on the northwestern portion of the site in the general area of the existing influent pump station (which is to be demolished) and consists of a single story, slab on grade (no basement), partial cast-in-place and partial precast structure with a plan area of approximately 550 square feet and finished floor elevation of 17.50 feet. The pump station is to include a precast wet well which is to extend approximately 23 feet below the finished floor elevation.

Miscellaneous on-site construction includes: a proposed concrete loading pad to the north of the new Denitrification Building; a proposed asphalt driveway leading from Carrs Creek Rd to the new Denitrification Building; a new culvert and stromwater pipe leading from the entrance to the new Denitrification Building and discharging to the northeast of the new Denitrification Building; and miscellaneous utility connections from the proposed structures to the existing infrastructure.

2.2. INFORMATION REVIEWED

To assist with our geotechnical evaluation, the following information was reviewed:

- A document titled "Statement of Work (SOW): Architect-Engineer Services – Denitrification Filter and Influent Pump Design at the Wastewater Treatment Plant (WWTP) Naval Support Activity Annapolis (NSAA) Annapolis, Maryland," developed by NAVFAC Washington District and dated January 18, 2012;

- Fifteen (15) Geotechnical Boring performed by Geo-Technology Associates, Inc. as part of Appendix B – Soil Boring and Well Logs of report titled "US Naval Academy Waste Water Treatment Plant & Water Treatment Plant Upgrades" and dated circa Spring 2011; and

- Technical Report TR-2308-ENV titled "Addendum to Cost and Performance Report of Electrical Resistance Heating (ERH) for Source Treatment" developed by Battelle Memorial Institute and dated September 2008.

2.3. EXISITNG SITE CONDITIONS

The project site is located within the existing NSA Annapolis wastewater treatment plant (WWTP) facility located at the U.S. Naval Academy in Annapolis, MD as shown on the Site Location Sketch included in Appendix A of this report. The existing WWTP is located off of Alder Road and Carrs Creek Rd in the North Severn area of the U.S. Naval Academy. The project site is bordered to the north and east by Carrs Creek, to the south by Alder Road and to the west by a wooded area. The site is approximately 3 acres not including the Recycling Center.

In general, site elevation ranges from elevation 12 feet in the north to 20 feet in the south with raised clarifier tanks and surge basin centrally located within the project site graded to approximately 32 feet (NAVD88 datum) based on a site survey provided by NAVFAC. Grades dropped off significantly moving north and east towards the creek. Site survey performed by Patton Harris Rust + Associates – A Pennoni Company (PHR+A) have been provided to NAVFAC under separate cover.

2.4. OBJECTIVES OF PRELIMINARY GEOTECHNICAL EXPLORATION PROGRAM

The objectives of our geotechnical evaluation were to determine subsurface conditions at the project site, evaluate these conditions with respect to the proposed construction, and present recommendations regarding:

- recommendations for foundation design, including discussion of alternate solutions if applicable;
- discussion of potential for consolidation and/or differential settlements of substrata encountered;
- construction of ground floor slab on-grade;
- "general procedure" soil Site Class based on applicable IBC requirements;
- ground water conditions with recommendations for waterproofing/hydrostatic design requirements including requirements for wall and/or under-slab drainage (if necessary);
- removal or treatment of objectionable material;
- use and treatment of in-situ materials for controlled fill; and
- quality assurance and field-testing and inspection during construction.

3. FIELD AND LABORATORY WORK

3.1. UTILITY DELINEATION

Prior to the performance of the of Standard Penetration Test borings, a private utility company visited the site and performed utility clearance at each of the proposed boring locations. None of the test boring locations were offset due to the presence of utilities.

3.2. STANDARD PENETRATION TEST BORINGS

Three (3) Standard Penetration Test (SPT) borings were performed at the site on October 11, 2012. SPT borings were performed in general accordance with ASTM D1586. The borings were performed at the general locations of the proposed structures: Denitrification & Electrical Buildings; Surge Basin; and Influent Pumping Station.. The three (3) test borings, labeled "B-1" through "B-3", were performed to a depth of approximately 35 feet each below the ground surface. Sampling was continuous in each boring to approximately 10 feet below existing grades and sampled in 5 foot increments after that to the termination depths.

Test boring "B-3" was offset approximately 50 feet south west from the south western edge of the proposed surge basin location. This offset was due to steep slopes along the existing surge basin and a heavily wooded area to the north and west preventing access of the drill rig. Therefore, test boring "B-3" was located on an access road running parallel along the wood line to the west, adjacent to the proposed surge basin and proposed construction entrance.

Test borings were performed by Connelly & Associates of Frederick, Maryland using an auger rig with 3¼ inch hollow stem augers. Our T. Thomson, Jr., PhD, PE, DGE, LEED AP directed the field work and Rebeka Van Derzee, EIT observed the test drilling. A Test Boring Location Sketch is provided in Appendix A. Logs of the test borings are provided in Appendix B.

3.3. GEOTECHNICAL LABORATORY TESTING

Following conclusion of the SPT drilling, the soil samples were delivered to our laboratory for visual classification and testing. The geotechnical laboratory program consisted of the following:

- Moisture Content (ASTM D 2216) 5 tests
- Sieve Analysis (ASTM D 422) 5 tests

Samples for testing were selected by Pennoni Associates' geotechnical engineer. Results of the laboratory testing and a list of testing procedures are provided in Appendix C of this report.

4. SUBSURFACE CHARACTERISTICS

4.1. GEOLOGY

According to the Geologic Map of Maryland prepared by the Maryland Geological Survey in 2001, the project site is located along the Western Shore Upland District, within the Coastal Plain Physiographic Province. Topography in this District is characterized by ravines, knolls and interfluves. It is underlain by a southeastwardly thickening sequence of sediments that consists of sand and gravel aquifers interlayered with silt and clay confining units.

A geologic report contained within the "Addendum to Cost and Performance Report of Electrical Resistance Heating (ERH) for Source Treatment Application at Site 1, U.S. Naval Station, Annapolis (USNA), Maryland," (Battelle Memorial Institute, 2008) indicates that the uppermost formation at the project site is called Aquia Formation, which is approximately 60 to 130 feet thick and is mainly comprised of medium to coarse grained, greenish to brown glauconitic quartz sand, interbedded with thin layers of silt and limonite or siderite cemented sandstone. Underlying the Aquia is the Brightseat Formation, which is described as an olive-gray to black glauconitic silt and clay. The Upper Cretaceous Severn, Matawan, and Magothy Formations underlie the Brightseat Formation.

Mapping by the United States Department of Agriculture Natural Resource Conservation Service (NRCS) for Anne Arundel County, Maryland indicates that this site is primarily comprised of soils classified as Annapolis fine sandy loam and Cumberstone-Mattaplex. These soils are indicated to be well to somewhat poorly drained, respectively. The Annapolis fine sandy loam has 15 to 25 percent slopes and the Cumberstone-Mattaplex has 0 to 2 percent slopes.

4.2. SUBSURFACE STRATIGRAPHY

Subsurface stratigraphy encountered by the test borings was generally consistent throughout the site and generally consisted of a surficial layer of topsoil or bituminous concrete and base course underlain by apparently natural silty sands (loose to medium density) to the extent of the test borings.

The soils composition encountered in the test borings performed herein varied from that performed by GTA in 2011 (as referenced above). In general, no predominately fine grained stratum was observed in the test borings performed herein. However, the coarse grained soils were observed to include a significant amount of fine grained soil.

For descriptive purposes the soil layers can be classified as follows:

Stratum	Approximate Thickness (ft)	Description	USCS Classification
T1	0.25	Topsoil [1]	---
T2	1.0	Bituminous concrete and graded aggregate base course [2]	---
A	34 - ---	Varicolored (orange brown to red brown to gray brown) SAND, trace to “and” silt (dry to saturated, non-plastic, loose to medium dense) [3]	SM

Notes:
[1] Stratum T1 not encountered in boring “B-3.”
[2] Stratum T2 only encountered in boring “B-3.”
[3] Stratum A not fully penetrated in borings “B-1”, “B-2” and “B-3.”

4.3. GROUNDWATER

Apparent ground water was encountered in each of the test borings at depths ranging from 12 to 18½ feet below existing ground surface corresponding to elevations ranging from approximately 6.4 to 0 feet, NAVD88. Previous test borings performed by GTA in 2011 (as referenced above) encountered apparent groundwater at a depth of approximately 22.5 feet below the ground surface in the area of the existing Tertiary Plant Control building.

As with previous studies performed at this site, the groundwater gradient appears to flow from higher elevations in the west towards the river.

5. ANALYSIS AND RECOMMENDATIONS

5.1. FOUNDATIONS

The structures proposed for construction as part of this project are relatively lightly loaded (i.e., single story, predominately precast construction, etc.) and will be require cuts and fills of less than 3 feet to achieve finished grade (with the exception of the surge basin which is discussed in the paragraphs below). Additionally, the subsurface stratigraphy disclosed by the test borings performed herein was relatively consistent throughout the site and consisted of predominately medium dense granular material to the extent of the test borings. The "loose" density granular material appeared to coincide with the elevation of the water table. Therefore, based on our field exploration, laboratory testing, and subsequent analysis, we conclude that the construction of the proposed structures on a shallow foundation system consisting of strip and/or spread footings and bearing on densified natural granular soils described herein as Stratum A or structural fill placed and compacted in accordance with the recommendations of this report is feasible. We recommend sizing the proposed foundations for a net allowable bearing capacity of 3,000 pounds per square foot. Strip and spread footings should be at least 2 feet wide and 3 feet in their smallest dimension, respectively, to prevent localized shear failure in soil. The subgrades of all exterior footings and any other foundation exposed to freezing temperatures during construction and/or the life of the structure should be established at least 32 inches below adjacent finished grades. Interior foundations in heated areas and foundations protected from frost heave can be founded a minimum of 18 inches below finished subgrade.

As the new Denitrification Building and Influent Pump Station will contain wells and depressed structures which are proposed to be below the base of the buildings foundations, we recommend that the deeper structures be constructed prior to the proposed building foundations in order to reduce the potential for undermining of the new building's foundations.

We understand that the foundation for the new Surge Basin will be a precast slab bearing on structural fill varying in thickness from approximately 1 foot (adjacent to the existing surge basin) to 9 feet. Additionally this structure will be constructed within 4 feet of the existing surge basin. We recommend that net contact pressures for the slab not exceed 3,000 pounds per square foot. Additionally, the slab may be designed assuming a modulus of vertical subgrade reaction (k_v) of 225 pounds per cubic inch. In order to reduce the transfer of stress on the existing basin as well as prevent the potential for undermining of the existing basin, we recommend founding the new basin at the elevation of the existing basin. We recommend that all connections from existing to new surge basins be designed as flexible and able to accommodate up to 2 inches of settlement.

5.2. ESTIMATED SETTLEMENT

Settlement of a soil mass is a function of the characteristics of the supporting materials and the stresses imposed on the soils by a structure/foundation. The soil profile at the site consists of predominately granular soils of Stratum A. Because of the granular soils, settlements should occur relatively rapidly and concurrently with load application. Settlements for foundations bearing on densified existing material and/or newly compacted load bearing fill and designed using an allowable net soil bearing capacity of 3,000 pounds per square foot are expected to be less than 1 inch for the new Denitrification Building, Electrical Building and Influent Pump Station.

Settlement for the new Surge Basin will result from a combination of fill induced settlement as well as structure induced settlement. Considering maximum fill height on the order of 9 feet and the weight of the new Surge Tank, we estimate total settlement on the order of 3 inches. Approximately half of this estimated settlement is due to the weight of the fill. Therefore, placement of the fill as far in advance of the basin construction will assist in allowing the fill induced settlement to occur. As the soil is predominately granular, this settlement should occur within one week of fill placement. Differential settlement for this structure and settlement of the existing surge basin due to the new construction are also considerations. We estimate settlement of the existing basin due to placement of the fill and new basin to be on the order of ½ inch. Similarly, differential settlement between the new and existing surge basin is anticipated to be on the order of 1½ inches.

5.3.GROUND SUPPORTED FLOOR SLABS & LOADING PAD

Based on the proposed finished floor elevations of approximately 20.66 feet and 17.5 feet for the Denitrification Building and Influent Pump Station, respectively, it is not anticipated that significant cuts or fills will be required. Therefore, proposed subgrade is anticipated to consist of the predominately granular soils of Stratum A. Provided the

subgrade is prepared as discussed in Section 5.6 below, the concrete slabs on grade and loading pad can be designed using a modulus of vertical subgrade reaction (k_v) of 200 pci (densified Stratum A) and/or 240 pci (new select granular fill). We recommend that the slab be designed as "fully floating" (not connected to the structural elements of the building) in order to reduce potential cracking due to differential settlement between the building's structural elements and slab on grade. A 4 to 6 inch thick free-draining granular base course should be placed beneath the slab to provide a uniform bearing surface and to aid in the proper curing of the concrete.

5.4. SEISMIC SITE CLASS

Based on the 2009 International Building Code, Table 1613.5.2, Site Class Definitions as well as our experience within this general site area, we recommend classifying the site as Site Class D – stiff soil profile.

5.5. GROUND AND SURFACE WATER MANAGEMENT

The ground water observations made in the borings suggests that free-standing groundwater is not anticipated in shallow excavations for the proposed structures. However, perched and/or trapped water conditions are considered possible. In the event that wet condition and/or seepage are encountered due to perched water, sumps and pumps should be adequate to maintain stable conditions during foundation construction. The foundation excavations should not be used as a detention basin or sump. During construction surface runoff should be prevented from entering the excavations by creating soil berms or diversion swales along the perimeter if the excavation is expected to be open for a long period of time. Where ponding does occur, the water should be pumped immediately and grades should then be established to prevent further ponding.

Observations made in the borings and our review of available data indicate that free-standing groundwater and caving conditions are anticipated in the excavation for the Influent Pump Station wet well, with approximate bottom of well elevation of -7 feet, NAVD88. Groundwater in boring "B-2" (performed in the general area of the proposed Influent Pumping Station) was observed at an elevation of approximately 3.4 feet. We recommend that this wet well be designed for a groundwater table elevation of at least 5 feet including waterproofing measures.

5.6. EARTHWORK

Prior to placing any new fill, and before the construction of the proposed foundations and the floor slabs, any demolition debris, bituminous concrete pavement, vegetation and associated topsoil must be removed from within the areas of proposed construction. These materials can remain in proposed landscaped areas provided that future plans do not include building in those areas. Any existing utility line abandoned in-place should be grouted or the line should be removed and the trench appropriately backfilled.

Exposed subgrades should be thoroughly proofrolled using a minimum 10-ton vibratory roller operated in static mode or a fully loaded dump truck in an attempt to identify unstable (soft, yielding, etc.) surface areas. During proofrolling, any unstable area found should be stabilized by excavating and replacing those soils with suitable soil (adequately compacted), by lowering the moisture content of the subgrade soils and compacting them, or by other methods (placing a geotextile and stone layer, etc.). Due to the variable amount of silt within the silty sand soils, these soils are considered highly susceptible to damage from construction equipment and/or precipitation. To reduce the potential for damage to the subgrade, we recommend that construction traffic over the subgrade be kept to a minimum. Also, concrete for the foundation and/or slab on grade should be placed as soon as possible following the subgrade preparation.

Our experience and laboratory test results indicate that the on-site, near surface soils of Stratum A can be reused for the construction. Laboratory testing indicates that the near surface soils of Stratum A contain varying amounts of silt upwards to 40%. Our laboratory test results also indicate that the present moisture content (13.1% to 26.8%) of these soils may be above the optimum moisture content normally associated with these soils to achieve desired degree of compaction and/or stability. Adjusting the moisture contents of these on-site soils before use in subgrade preparation should be expected. This may be difficult during periods of relatively high precipitation or cooler temperatures. Therefore, contract provisions should account for importing structural fill material, if necessary. Granular fill should consist of well-graded material with a maximum particle size less than 3 inches and not more than 20 percent passing the No. 200 sieve and have a plasticity index (PI) not greater than 8 percent.

New fills consisting of granular soil should be placed in layers not exceeding 12 in. loose measure. This criterion might be adjusted by the geotechnical engineer in the field depending on the conditions present at the time of construction, on the compaction equipment used, and on the fill material selected. Fills for support of foundations/slabs and pavement should be compacted to at least 98 percent of the laboratory determined maximum dry density, ASTM D 698, when small hand operated compaction equipment is used and to at least 95 percent of the laboratory determined dry density, ASTM D 1557, when self-propelled, heavy duty compaction equipment is used. Fills should extend a minimum of 5 feet beyond the exterior edge of a loaded area and have side slopes not steeper than 2 horizontal to 1 vertical.

Specifications should indicate that the percentage of maximum dry density attained in the field is not the only criteria to be used for assessing fill compaction. Observation of the behavior of the fill under the loads of construction equipment should be used. If the test results indicate that the percentage of compaction is being achieved, but the soil mass is moving under the equipment, placement of additional fill should not be continued until the movement is stabilized. Otherwise, settlement of the fill may occur.

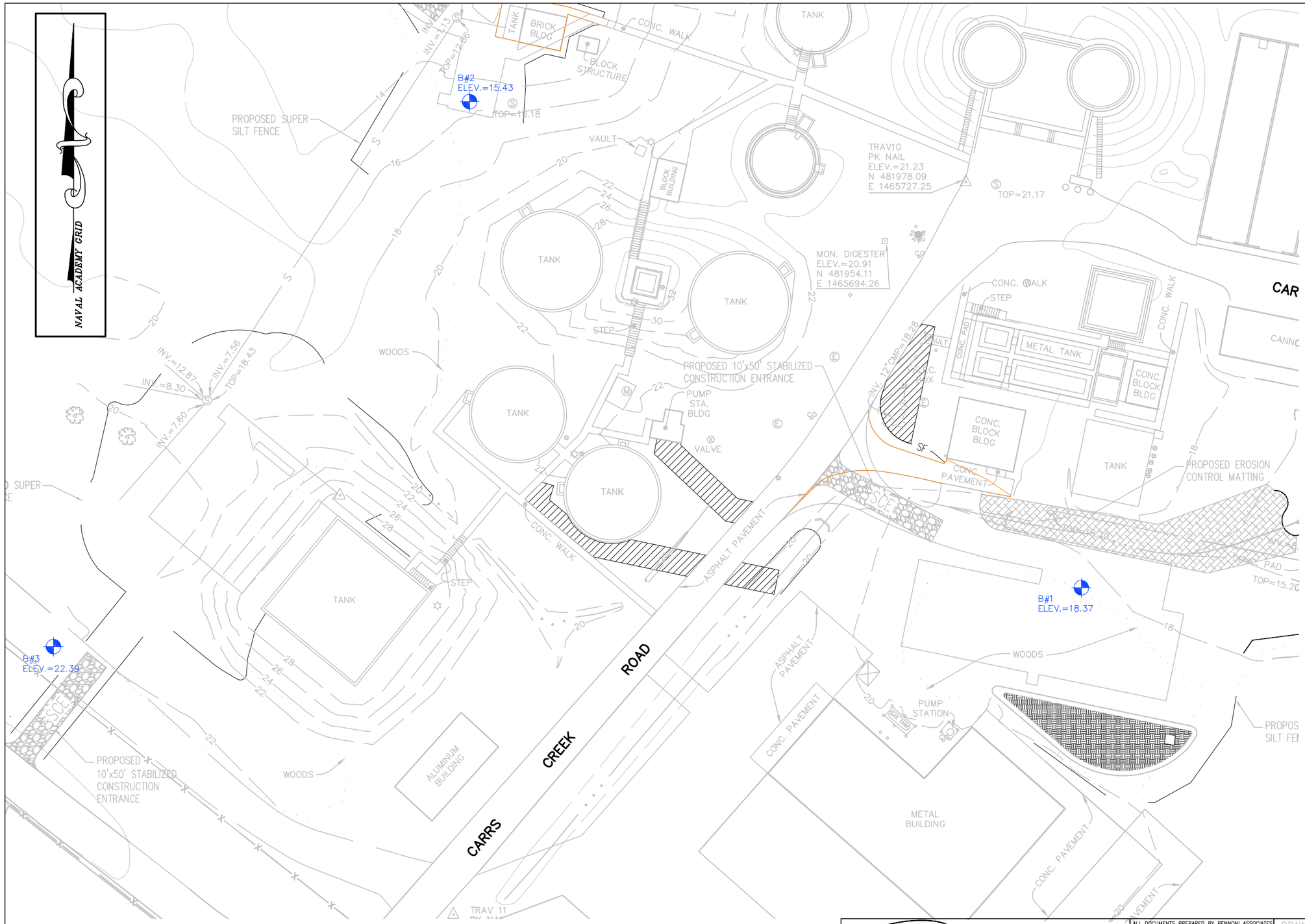
6. LIMITATIONS

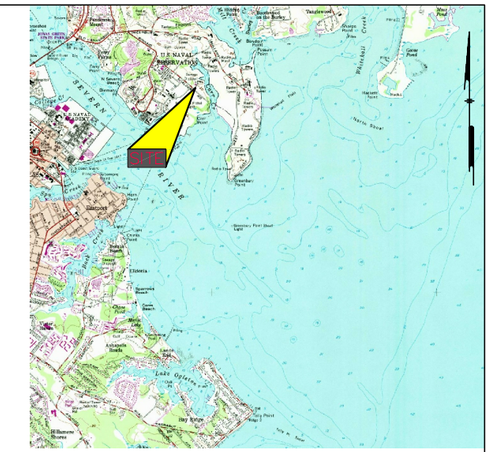
This work has been done in accordance with our authorized scope of work and in accordance with generally accepted professional practice in the fields of geotechnical and foundation engineering. This warranty is in lieu of all other warranties either expressed or implied. Our conclusions and recommendations are based on the data revealed by this exploration. We are not responsible for any conclusions or opinions drawn from the data included herein, other than those specifically stated, nor are the recommendations presented in this report intended for direct use as construction specifications. This report is intended for use with regard to the specific project described herein; any changes in loads, structures, or locations should be brought to our attention so that we may determine how they may affect our conclusions. An attempt has been made to provide for normal contingencies but the possibility remains that unexpected conditions may be encountered during construction. If this should occur, or if additional or contradictory data are revealed in the future, we should be notified so that modifications to this report can be made, if necessary. If we do not review relevant construction documents and witness the relevant construction operations, then we cannot be responsible for any problems that may result from misinterpretation or misunderstanding of this report or failure to comply with our recommendations.

APPENDICES

APPENDIX A

SITE AND TEST BORING LOCATION SKETCH





LOCATION MAP

ANNAPOLIS QUAD
N.T.S.

LEGEND

B–1 TEST BORING LOCATION

BORINGS B–1 THRU B–3 PERFORMED ON 10/11/12.

GENERAL NOTES

THE SUBSURFACE CONDITIONS REVEALED BY THIS STUDY REPRESENT CURRENT CONDITIONS AT THE SPECIFIED TEST LOCATIONS ONLY AND MAY NOT BE INDICATIVE OF CONDITIONS AT OTHER LOCATIONS.

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DRAWN BY: TJQ	SCALE: N.T.S.	DATE: 10/25/12
CHECKED BY:	SKETCH No.	
JOB No. NAVY 1234	TL-1	

BORING LOCATION PLAN

APPENDIX B

TEST BORING LOGS (3)

PROJECT: US Naval Academy (North Severn) WWTP **PROJECT NO.:** NAVY1234
PROJECT LOCATION: Annapolis, MD
DRILLING FIRM: Connelly & Associates **ELEVATION:** 18.37 ft NAVD88
FOREMAN: Curtis Wolfe **LOGGED BY:** R. Van Derzee
DRILLING METHOD: Hollow Stem Auger (3-1/4" ID)
DATE STARTED: 10/11/12 **DATE COMPLETED:** 10/11/12
DEPTH TO WATER> INITIAL: ▽ 18.5 ft **AFTER 24 HOURS:** ▼ NM **CAVING>** ⌒ 16.0 ft

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LOG OF BORING No. B-1

Depth (feet)	Description	Graphic	Stratum	Sample No.	Recovery (in.)	Blow Counts	Remarks
0							
	3" TOPSOIL: Brown fine to medium sand, some silt, trace organics 0.25		T1	S-1	16	3-7-7	
	Orange fine to medium to coarse SAND, trace silt, trace organics			S-2	17	4-7-8	
	Light tan to light gray SILT and fine SAND, trace organics Light orange brown fine SAND and SILT, little medium sand, moist			S-3	17	3-5-7	
	Orange brown to gray brown fine to medium SAND, little silt, moist						
10	Red brown to gray brown fine SAND, some silt, little medium sand, trace coarse sand, moist			S-4	17	5-6-8	
	Red brown to orange brown to gray brown fine to medium to coarse SAND, some silt, wet			S-5	18	2-4-4	
			A				
20	Red brown to gray brown fine to medium SAND, some silt, saturated			S-6	18	3-4-6	
	SAME			S-7	21	4-8-11	
30	Gray brown fine to medium SAND, little silt, dark red brown fine to medium sand mottles, saturated			S-8	21	5-6-8	
	Gray brown to red brown fine to medium SAND, little silt, saturated			S-9	21	3-10-11	
	Boring terminated at 35 ft.						
40							
50							
60							
70							

Coordinates: 481813.19 North, 1465774.12 East
Elevation and coordinates taken from survey performed by PHR&A.

PROJECT: US Naval Academy (North Severn) WWTP **PROJECT NO.:** NAVY1234
PROJECT LOCATION: Annapolis, MD
DRILLING FIRM: Connelly & Associates **ELEVATION:** 15.43 ft NAVD88
FOREMAN: Curtis Wolfe **LOGGED BY:** R. Van Derzee
DRILLING METHOD: Hollow Stem Auger (3-1/4" ID)
DATE STARTED: 10/11/12 **DATE COMPLETED:** 10/11/12
DEPTH TO WATER> INITIAL: ▽ 12.0 ft **AFTER 24 HOURS:** ▼ NM **CAVING>** C 18.0 ft

Pennoni

LOG OF BORING No. B-2

Depth (feet)	Description	Graphic	Stratum	Sample No.	Recovery (in.)	Blow Counts	Remarks
0							
	3" TOPSOIL: Brown silt and fine sand, trace organics (0.25)		T1	S-1	13	3-4-4	
	Brown to gray brown fine SAND and SILT			S-2	21	4-5-8	
	Brown to gray brown fine SAND, some silt, trace medium sand, moist			S-3	21	4-5-7	
	Orange brown fine to medium SAND, little silt, moist						
10	Red brown fine to medium SAND, little silt, moist			S-4	16	5-7-6	
	▽ Red brown to gray brown fine to medium SAND, some silt, saturated			S-5	15	3-3-4	
	C		A				
20	Gray brown fine SAND, little medium sand, little silt, orange brown and red brown fine sand mottles, saturated			S-6	21	5-6-9	
	Gray brown to red brown fine SAND, little silt, trace medium sand saturated			S-7	13	5-9-11	
30	Gray brown to orange brown fine to medium SAND, little silt, red brown fine sand and silt mottles, saturated			S-8	18	8-9-11	
	Red brown to gray brown to orange brown fine to medium SAND, some silt, saturated			S-9	14	3-12-16	
	Boring terminated at 35 ft.						
40							
50							
60							
70							

Coordinates: 482010.80 North, 1465525.43 East
Elevation and coordinates taken from survey performed by PHR&A.

PROJECT: US Naval Academy (North Severn) WWTP **PROJECT NO.:** NAVY1234
PROJECT LOCATION: Annapolis, MD
DRILLING FIRM: Connelly & Associates **ELEVATION:** 22.39 ft NAVD88
FOREMAN: Curtis Wolfe **LOGGED BY:** R. Van Derzee
DRILLING METHOD: Hollow Stem Auger (3-1/4" ID)
DATE STARTED: 10/11/12 **DATE COMPLETED:** 10/11/12
DEPTH TO WATER> INITIAL: ▽ 16.0 ft **AFTER 24 HOURS:** ▼ NM **CAVING>** C 25.0 ft

Pennoni

LOG OF BORING No. B-3

Depth (feet)	Description	Graphic	Stratum	Sample No.	Recovery (in.)	Blow Counts	Remarks
0							
	12" BITUMINOUS CONCRETE and BASE		T2	S-1	12	18-14-6	
	Orange brown fine SAND and SILT			S-2	6	6-8-9	
	SAME Light orange brown to tan SILT, some fine sand			S-3	17	4-5-5	
10	Orange to orange brown fine to medium SAND, little silt, moist			S-4	16	6-6-7	
	SAME Orange brown to red brown to gray brown fine to medium to coarse SAND, little silt, moist			S-5	18	3-6-6	
20	Dark orange brown to red brown fine to medium to coarse SAND, little silt, saturated		A	S-6	21	3-3-5	
	C Red brown fine SAND, some silt, orange brown to gray brown fine to medium sand mottles, saturated			S-7	18	3-5-7	
30	Red brown to dark gray brown fine to medium SAND, little silt, saturated			S-8	17	9-10-14	
	Gray brown to dark orange brown fine to medium to coarse SAND, trace silt, saturated			S-9	21	3-6-5	
	Boring terminated at 35 ft.						
40							
50							
60							
70							

Coordinates: 481789.23 North, 1465356.24 East
Elevation and coordinates taken from survey performed by PHR&A.

APPENDIX C

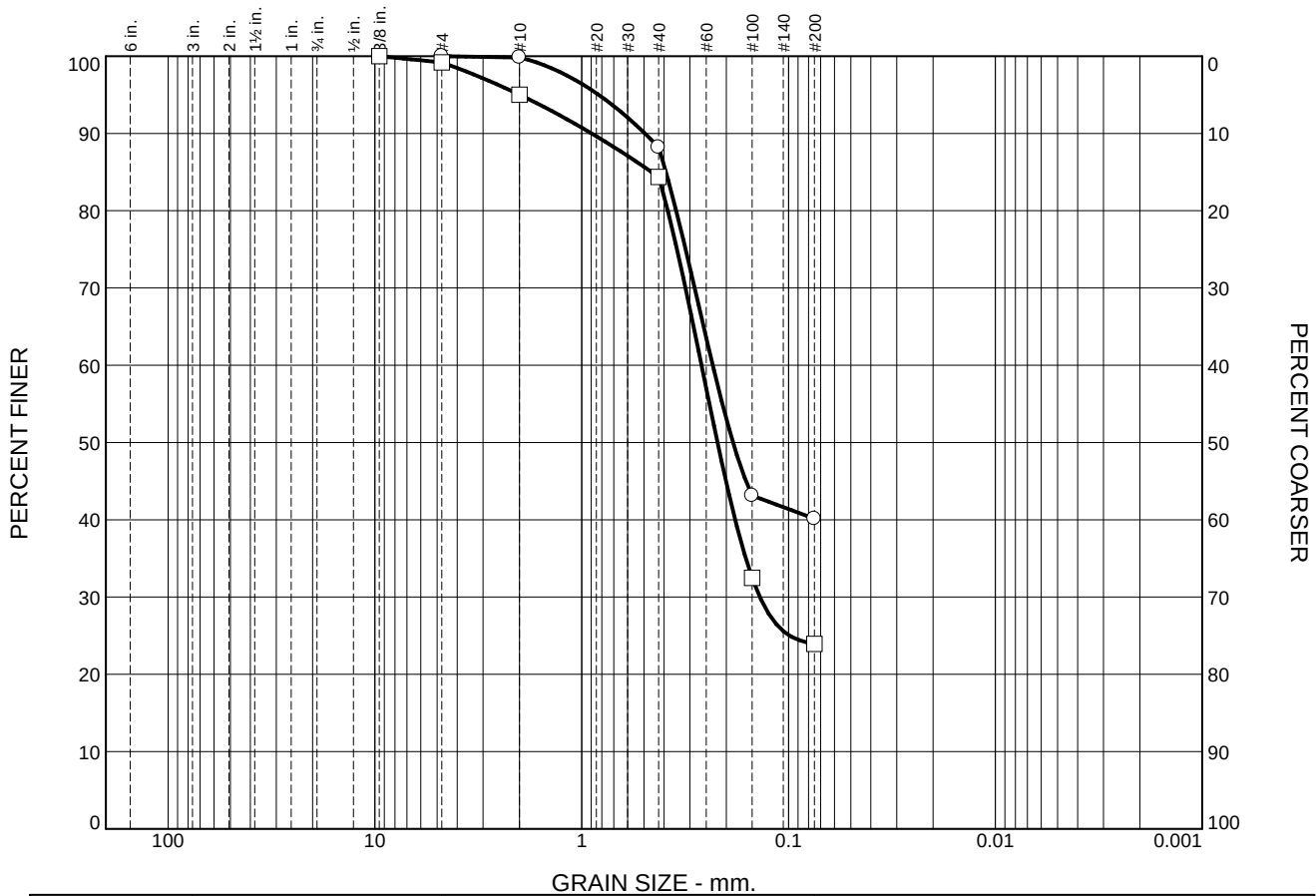
GEOTECHNICAL LABORATORY TEST RESULTS

SUMMARY OF LABORATORY DATA

BORING NUMBER	SAMPLE NUMBER	DEPTH (ft)	SOIL GROUP SYMBOL	GRAIN SIZE DISTRIBUTION			PLASTICITY				MOISTURE CONTENT w %	VOLUMETRIC				COMPACTION DATA			PERMEABILITY (E-6 CM/SEC)	FALLING/CONSTANT HEAD	CALIFORNIA BEARING RATIO (CBR) %	SHEAR STRENGTH		
				GRAVEL %	SAND %	SILT/CLAY %	LIQUID LIMIT w_l	PLASTIC LIMIT wp	PLASTICITY INDEX I_P	LIQUIDITY INDEX I_L		SPECIFIC GRAVITY (G)	DRY UNIT WEIGHT (pcf)	VOID RATIO (e)	DEGREE OF SATURATION %	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT %	STANDARD/MODIFIED				UNCONFINED COMPRESSIVE STRENGTH (tsf)	COHESION (tsf)	AXIAL STRAIN (%)
B-1	S-2	2.5-4 ft	SM	0	60	40					13.1													
B-1	S-4	8.5-10 ft	SM	1	75	24					17.0													
B-2	S-2	2.5-4 ft	SM	0	68	32					18.9													
B-2	S-6	18.5-20 ft	SM	0	84	16					25.9													
B-2	S-7	23.5-25 ft	SP-SM	0	88	12					26.8													

PENNONI ASSOCIATES INC.	DRAWN BY: JM CHECKED BY: RLV	DATE: 10/25/2012 DATE: 10/26/2012	PROJECT: **WWTP-NSA Annapolis** LOCATION: **US Naval Academy (North Severn) - Annapolis, MD**	JOB No.: **NAVY1234** TABLE No.: **L-1**

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.2	11.6	48.1	40.1	
□	0.0	0.0	0.8	4.2	10.6	60.5	23.9	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-1	S-2	2.5-4 ft	MC SAND AND FINES	SM
□	B-1	S-4	8.5-10 ft	FMC SAND, SOME FINES	SM

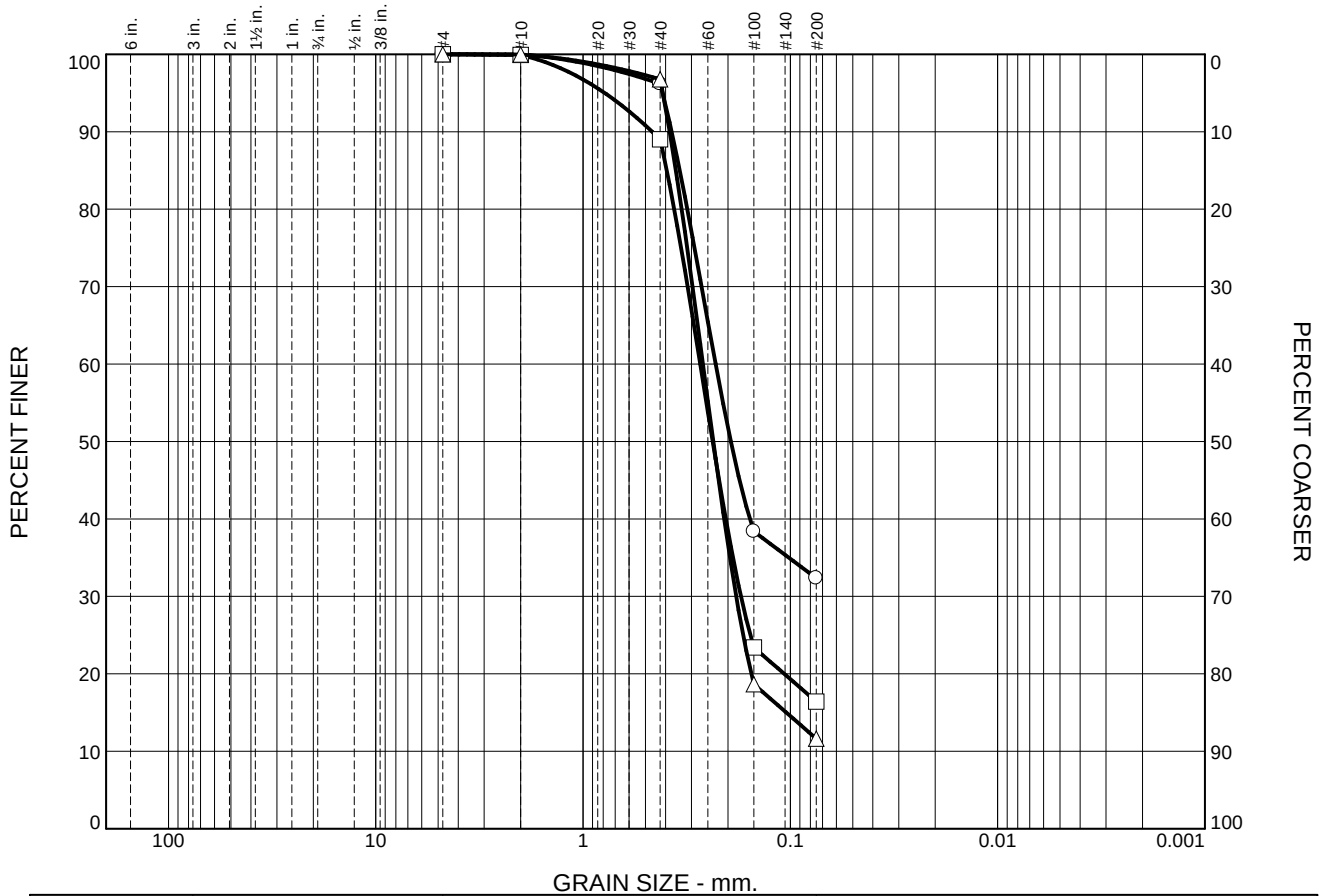
PENNONI ASSOCIATES INC.

Bethlehem, PA

Client: NAVFAC WASHINGTON
Project: WWTP - NSA ANNAPOLIS

Project No.: NAVY-1234.00 **Figure** S-1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	3.8	63.8	32.4	
□	0.0	0.0	0.0	0.1	10.9	72.6	16.4	
△	0.0	0.0	0.0	0.0	3.2	85.2	11.6	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-2	S-2	2.5-4 ft	FM SAND, SOME FINES	SM
□	B-2	S-6	18.5-20 ft	FM SAND, LITTLE FINES	SM
△	B-2	S-7	23.5-25 ft	FM SAND, LITTLE FINES	SP-SM

PENNONI ASSOCIATES INC.

Bethlehem, PA

Client: NAVFAC WASHINGTON
Project: WWTP - NSA ANNAPOLIS

Project No.: NAVY-1234.00 **Figure** S-2