DUFFIELD ASSOCIATES
Consultants in the Geosciences

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August 3, 2010

Via Electronic Mail

Mr. Harry Magliente
Fidelis Design & Construction, LLC
700 East Main Street, 2nd Floor
Norristown, PA 19401

RE: Project No. 6772.GC
Geotechnical Evaluation
Wilmington VAMC
Repair and Replacement of Architectural Barriers – Phase II
Wilmington, Delaware

Dear Mr. Magliente:

Duffield Associates, Inc. (Duffield Associates) has completed our geotechnical evaluation for the proposed new entrance vestibule, pavilion, and restroom structures at the Veterans Administration Medical Center (VAMC) in Wilmington, Delaware, as part of the Repair and Replacement of Architectural Barriers – Phase II project. The following report summarizes the data obtained in the field and laboratory testing programs and includes recommendations for the design and construction of the proposed structures' foundations and slab-on-grades. These services were performed in general accordance with our subconsultant agreement, dated July 6, 2010 and authorized to proceed on July 7, 2010.

To assist with this evaluation, Duffield Associates utilized the following documentation:

- A geotechnical evaluation report titled "Report of Subsurface Exploration and Geotechnical Engineering Evaluation, Veterans Association Building Addition, 1601 Kirkwood Highway, Wilmington, Delaware, F&R project No.: 72L-0017," prepared by Froehling & Robertson, Inc., dated May 2009;

- A set of drawings, sheet Nos. 1 through 7 titled "Sediment & Stormwater Plans, Wilmington VAMC, 460-09-109 Repair and Replacement of Architectural Barriers – Phase II," prepared by Duffield Associates, dated June 25, 2010; and

- A "marked-up" foundation plan and section for the proposed vestibule indicating anticipated loading conditions and existing/proposed foundation elements prepared by Ring Consultant Group, P.C. provided to Duffield Associates, via electronic mail on July 16, 2010.

Based on the information provided, the following about the project is understood:

- A vestibule addition is proposed adjacent to the existing hospital with a footprint of 24 feet by 34 feet and proposed finished floor elevation of 90.5 feet, project datum. It is understood that the existing hospital is pile supported. The vestibule addition is to consist of slab-on-grade construction, structural steel framing, and brick and glass veneer. The new structure is anticipated to have a total of six (6) columns; three (3) supported by the pile caps of the existing structure and three (3) supported by a new foundation system. Maximum column loads of 25 kips and maximum wall loads of 0.8 kips per lineal foot are anticipated for the vestibule.

- A pre-fabricated pavilion structure is proposed to be located west of the main hospital building with a footprint of 44 feet by 60 feet. The structure is to consist of slab-on-grade and timber framing construction.

- A bathroom structure is to be located between the existing hospital and proposed pavilion. The bathroom structure is to have a footprint of 10 feet by 18 feet and is assumed to consist of slab-on-grade and load bearing masonry wall construction.

- Anticipated loading conditions for the pavilion and bathroom structures were not available at the time of this report, but are anticipated to be less than those of the vestibule addition.

SITE DESCRIPTION

The project site is located at the existing VAMC in Wilmington, Delaware. The area of the proposed vestibule addition is currently a relatively level bituminous concrete parking area. The proposed bathroom and pavilion structures are to be located in grass-covered areas west of the existing hospital and south of the western parking lots. The area of these structures is bound by Mill Creek to the west, with open grass-covered space to the south. Provided topographic information indicates that the existing site grades generally decrease from east-to-west within the area of the proposed bathroom and pavilion structures. To achieve the proposed finished floor elevations, minor regrading ("cuts" and "fills" on the order of less than 3 feet) will be required within the proposed structure areas.

FIELD AND LABORATORY TESTING PROGRAM

Three (3) Standard Penetration Test (SPT) borings (performed in general accordance with ASTM D 1586) were performed at the project site on July 14, 2010, at locations estimated by Duffield Associates' representative utilizing existing site features as a reference. One (1) boring was performed within the footprint of the proposed vestibule addition and two (2) borings were performed near the proposed pavilion and bathroom structures (see attached test boring location sketch for approximate locations). The test borings were performed to a depth of 20 feet below the existing ground surface. The test borings were performed by Feldmann Brothers, Inc., of Newark, Delaware, as a subcontractor to Duffield Associates, utilizing a truck-mounted Diedrich D-50 drill rig with hollow-stem augers. Duffield Associates' representative was present to review the performance of the test borings. Test boring logs prepared by Duffield Associates describing conditions observed are enclosed. Upon completion of the drilling, the boreholes were backfilled utilizing soil cuttings and the borehole near the proposed vestibule was capped with bituminous concrete "cold patch" level with the pavement surface. Excess soil cuttings were stockpiled above the test boring locations in non-paved areas. Additional settlement of the soil replaced in the boreholes may occur, resulting in a depression or hole in the ground surface. Consequently, future maintenance and restoration of the site may be required.

Following completion of the field program, soil samples were returned to Duffield Associates' office. Two (2) moisture contents (ASTM D 2216) and percents finer than a No. 200 sieve (ASTM D 1140) were performed on selected samples. Additionally, one (1) Atterberg Limits (ASTM D 4318) was performed on sample No. S-2 from boring TB-3. A liquid limit of 54 and plasticity index of 31, classifying the sample as a Unified Soil Classification System (USCS) high plasticity clay (CH) soil, was determined. Results of laboratory testing are indicated on the enclosed test boring logs.

GENERALIZED SITE GEOLOGY

Geologically, the site is mapped by the Delaware Geologic Survey (DGS) as within the Wilmington Complex of the Piedmont Physiographic Province. In general, this province is characterized by rolling sedimentary topography underlain by crystalline metamorphic rock categorized as gabbroic gneiss (locally known as "Brandywine Blue Granite"). This rock is considered relatively hard and is known for its variable fracture spacing. This rock may often be highly weathered, particularly at the locations of joints or fractures within the rock. Since this rock typically weathers along joint surfaces, the result can be boulder-like "joint blocks" of essentially fresh bedrock totally surrounded by weathered rock. The presence of boulders in the overlying soils may potentially exist. Available information indicates that the depth to rock is on the order of 200 feet or less.

SUBSURFACE CONDITIONS

The subsurface conditions observed at the site can generally be described as surficial layers of topsoil or bituminous concrete overlying predominately fine-grained soils consisting of medium to very stiff consistency clay and silt to the extent of the test borings. In the area of the proposed pavilion and bathroom (i.e., TB-2 and TB-3), the surficial layer of topsoil was underlain by apparent fill material consisting of soft to medium consistency silt. A layer of medium density silty sand approximately 4.0 to 6.5 feet in thickness was encountered at a depth of approximately 8 feet and within the fine-grained strata near the proposed pavilion and bathroom. For discussion purposes, subsurface conditions encountered can be further described as follows:

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Stratum	Approximate Thickness (feet)	Generalized Description[1]
A1[2]	0.4	TOPSOIL (approximately 5 inches)
A2[3]	0.9	BITUMINOUS CONCRETE (approximately 11 inches)
B[2]	1.6 – 2.6	FILL: Gray, dark brown clayey-silt, trace to little fine sand, trace organics (e.g., roots), trace gravel (moist to wet)
C	2.0 – 5.0	Orange-brown, green-brown, gray CLAY (mottled), trace to little fine sand, trace silt trace organics (e.g., roots) (medium to stiff consistency, moist); USCS: CL/CH
D[2]	4.0 – 6.5	Brown, orange-brown, yellow fine SAND, trace to little silt, trace medium to coarse sand, trace to little gravel (medium dense, wet); USCS: SM
E	1.0 – --[4]	Varicolored (Gray, orange-brown, green) clayey-SILT, trace to and fine to medium sand (micaceous) (medium to very stiff, moist); USCS: ML

Notes:
1. The soil descriptions utilized herein and on the test boring logs are defined in the General Notes within Appendix C.
2. Stratum not encountered within test boring TB-1.
3. Stratum only encountered within test boring TB-1.
4. Stratum not fully penetrated in any test borings.

Groundwater observations during the performance of the test borings are indicated on the test boring logs. Groundwater was encountered in all three (3) of the test borings and was observed to range between 6.2 to 13.5 feet below the existing ground surface. However, due to the presence of predominately fine-grained soils, localized or "perched" groundwater could be encountered. Recommendations for groundwater control during construction are provided further below.

Based on the information contained on Flood Insurance Rate Map (FIRM) No. 10003C0151J prepared by the Federal Emergency Management Agency (FEMA), the project site is located in a Special Flood Hazard Area characterized as Zone "AE," with a 100-year flood, or base flood elevation, of 84 feet (NAVD 1988). These maps indicate that this flood hazard area is not subjected to high velocity wave action, but is considered a "General Floodplain Area." Therefore, groundwater conditions corresponding to flood elevations may be encountered during extreme conditions and could be experienced.

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DISCUSSION

FOUNDATIONS

Two (2) foundation options were reviewed in our analysis: shallow, spread footing type foundations and a helical "screw" anchor foundation system. Based on the subsurface data obtained during this evaluation, it is Duffield Associates' opinion that the "natural" site clay soil of Stratum C encountered beneath the existing pavement, topsoil, and fill is generally suitable for supporting the proposed structures on a shallow foundation system and slab-on-grade. Structural fill, placed and compacted as recommended in this report, is also considered suitable for supporting a shallow foundation system. Analysis indicates that the foundations bearing on the natural soils or on compacted structural fill could be sized for a maximum allowable bearing pressure of 2,000 pounds per square foot (psf). This analysis has assumed a shallow foundation system with a minimum width of 3 feet for isolated footings, 2 feet for continuous footings, and a minimum burial depth of 32 inches.

Estimates of foundation settlement were also performed to aid in evaluating the effects of the anticipated loads on the subsurface conditions. Based on this analysis, it is estimated that maximum total foundation settlement for the proposed vestibule, bathroom, and pavilion structures should be on the order of 1½ inches or less, with differential settlement estimated to be 1 inch or less between new footings with an approximately 20-foot spacing. These magnitudes of total and differential settlement are generally considered to be within tolerable limits for steel and timber-framed structures. For the vestibule structure partially supported on the piles of the existing hospital, differential settlement of as much as 1 ½ inches in 20 feet are estimated. The actual settlement tolerance of the structure should be verified with the project's structural engineer.

Although it is possible to utilize a shallow foundation system for support of the proposed structures, several conditions exist which favor the utilization of a deep foundation system. As you are aware, deep foundation systems including helical "screw" anchor foundation systems have previously been recommended for other structures at the project site (i.e., emergency room addition). You have indicated that the proposed vestibule addition is to have approximately half of the proposed columns supported on the pile caps of the existing structure and the remaining half supported by a new foundation system. Utilizing a deep foundation system for the proposed vestibule addition would reduce the risk of differential settlement across the footprint of the structure, as we estimate that deep foundation system would experience less total settlement under the proposed loads. Further, it is understood that the proposed pavilion and bathroom structures are to be located with the mapped 100-year flood hazard area. Therefore, as discussed further below, it is recommended that the foundation elements of these structures (i.e., slab-on-grade and foundations) be designed to accommodate for buoyant or "uplift" conditions resulting from anticipated flood events. For these structures a deep foundation system would provide greater "uplift" resistance than a shallow foundation system. Additionally, structures supported on deep foundation systems are less susceptible to displacement and possible damage resulting from cyclical flooding events.

The capacity of the helical or "screw" anchor foundations generally increases with the embedment depth into competent bearing materials as the resistance to vertical compression or uplift loads is based on soil bearing against the helical plates. The capacity of the anchors can be empirically evaluated based on the torque required for installation, or can be determined by "pullout" testing following installation. Due to the presence of predominately fine-grained clay and silt soils located within the project site Duffield Associates recommends the performance of a helical anchor testing program, particularly for "pullout" or uplift resistance in order to confirm the anticipated helical anchor capacities within the different bearing strata. These foundation support systems (e.g., Chance Anchors, RamJack, etc.) are typically installed by experienced specialty foundation system contractors, who can be contacted directly for design and cost-estimating assistance. It is noted that many helix options can be evaluated for different loading conditions; however, for the purposes of this evaluation, a typical three (3) helix per shaft system consisting of 10-inch, 12-inch, and 14-inch-diameter helixes was evaluated to estimated compression and uplift capacities.

Based on the subsurface data obtained during this evaluation and static analysis, it is Duffield Associates' opinion that a typical three (3) helix per shaft system consisting of 10-inch, 12-inch, and 14-inch-diameter helixes should be capable of developing the following allowable capacities with the embedment depths indicated in the following table:

Table 1: Summary of Helical Anchor Analysis

Location	Depth of Bottom Helix	Allowable Compression Capacity	Allowable Tension Capacity
Vestibule Addition	15 feet	10 kips	7 kips
	20 feet	20 kips	14 kips
Pavilion and Bathroom Structure	10 feet	7 kips	5 kips
	15 to 20 feet	12 kips	8 kips

NOTE: Estimated allowable capacities are based on static analysis and a factor of safety of 2.0 for compression and 3.0 for tension.

Total foundation settlement for a helical foundation system is estimate to be on the order of a ½ inch or less for all three of the aforementioned structures.

SLAB-ON-GRADE

The apparent previously placed fill soils (Stratum B) were observed to be soil materials with no deleterious miscellaneous materials observed. Construction records documenting that the apparent fill was placed and compacted in controlled lifts were not provided at the time of this evaluation; therefore, it is unknown how uniform these soils are throughout the site. There is an increased risk associated with placing a slab-on-grade over uncontrolled fill material versus construction over natural soils or compacted fill. These risks include increased potential for differential movement resulting in possible slab cracking and settlement. The following options should be considered for construction of the slab-on-grade.

- Option 1 - Complete Removal of Previously Placed Fill. This option provides a "least-risk" alternative in terms of potential settlement and involves completely removing the previously placed fill where encountered in the proposed slab areas and replacement with structural fill, placed and compacted in accordance with the recommendations of this report. This approach would require over excavation of the proposed pavilion and bathroom slab areas to an estimated depth of up to 3 feet below existing grade. The actual depths would need to be field determined during construction.

- Option 2 - Subgrade Review and Construction Over Previously Placed Fill. As an alternative to complete removal of previously placed material (Stratum B), it may be feasible to allow the previously placed fill to remain in place underneath the slab-on-grade following subgrade improvements and construction review as discussed further herein. The fill observed is of limited thickness and amounts of organic material and does not appear to contain debris. As an alternative to completely removing and replacing the fill material with compacted structural fill, proposed pavilion and bathroom floor slabs could be constructed over the fill materials if the Owner can tolerate some differential settlement. If this option is chosen, the fill subgrade should be proofrolled as recommended in this report. Localized undercut areas of loose fill, as identified by proofrolling of the pad, is recommended.

The selection of whether to construct the slab above the fill should be made based on the type of fill encountered, the risk tolerance of the Owner, and the intended use of the slab (i.e., anticipated floor coverings, importance of a flat floor to the intended use of the space, aesthetic concerns, etc.). Regardless of the chosen option, field review is recommended during construction to identify the extent of fill material and potential localized "soft" areas. It is noted that while a pile supported structure may be resistant to "uplift" during flooding events, a slab-on-grade is at greater risk of damage due to those uplift forces. If these risks are not considered tolerable, the structure slab could be designed to be supported by a deep (helical anchor) foundation system, as discussed herein.

CONCLUSIONS AND RECOMMENDATIONS

Based on the subsurface conditions encountered, the following conclusions and recommendations are provided.

DESIGN

1. **Foundation System Alternatives.** Based on the subsurface conditions encountered and subsequent analyses, it is Duffield Associates' opinion that either of the proposed foundation alternatives, including a shallow foundation or a helical anchor foundation system (e.g., Chance Anchors, RamJack, etc.) are suitable for support of the proposed construction. However, several conditions exist which favor the utilization of a helical anchor foundation system. Utilizing a helical anchor

foundation system for the proposed vestibule addition would reduce the risk of differential settlement across the footprint of the structure between new column supported by new footings and existing pile caps. Further, helical anchor foundation systems can provide greater "uplift" resistance than a shallow foundation system in the design for flood events, and structures supported on deep foundation systems are less susceptible to displacement and possible damage resulting from cyclical flooding events.

2. **Shallow Foundations.** It is Duffield Associates' opinion that the "natural" site clay soil of Stratum C, encountered beneath the existing pavement section, topsoil, and fill (i.e., Strata A and B) is generally suitable for supporting the proposed structure on a shallow foundation system. Structural fill, placed and compacted as recommended in this report, is also considered suitable for supporting a shallow foundation system. Analysis indicates that the foundations bearing on the natural soils or on compacted structural fill could be sized for a maximum allowable bearing pressure of 2,000 pounds per square foot (psf). This analysis has assumed a shallow foundation system with a minimum width of 3 feet for isolated footings, 2 feet for continuous footings, and a minimum burial depth of 32 inches. It is estimated that maximum total foundation settlement for the proposed structures should be on the order of 1½ inches or less, with differential settlement estimated to be 1 inch or less between an approximately 20-foot spacing.

3. **Slab-on-Grade.** Due to its variability, construction of a slab-on-grade over previously, placed "apparent" fill soils (Stratum B) with no subgrade preparation is <u>not</u> recommended. Several options should be considered related to apparent fill in the proposed structure slab areas as follows:

   - <u>Option 1 - Complete Removal of Previously Placed Fill</u>. A "least-risk" alternative would be to remove the fill in its entirety. The previously placed fill was observed to depths approximately 3 feet below the existing ground surface within the pavilion and bathroom structure footprints. Undercut areas should be backfilled with structural fill, placed, compacted, and reviewed in accordance with the recommendations of this report.

   - <u>Option 2 - Subgrade Review and Construction Over Previously Placed Fill</u>. As an alternative to complete removal of previously placed material (Stratum B), it may be feasible to allow the previously placed fill to remain in place underneath the slab-on-grade following subgrade improvements and construction review as discussed further herein. The fill observed is of limited thickness and amounts of organic material, and does not appear to contain debris. As an alternative to completely removing and replacing the fill material with compacted structural fill, proposed floor slabs could be constructed over the fill materials if the Owner can tolerate some differential settlement. If this option is chosen, the fill subgrade should be proofrolled as recommended in this report. Localized undercut areas of loose fill, as identified by proofrolling of the pad, is recommended.

   The selection of whether to construct the slab above the fill should be made based on the type of fill encountered, the risk tolerance of the Owner, and the intended use of the slab (i.e., anticipated floor coverings, importance of a flat floor to the intended use of the space, aesthetic concerns, etc.). Regardless of the chosen option, field review is recommended during construction to identify the extent of fill material and potential localized "soft" areas. It is noted that while a pile supported

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structure may be resistant to "uplift" during flooding events, a slab-on-grade is at greater risk of damage due to those uplift forces. If these risks are not considered tolerable, the structure slab could be designed to be supported by a deep (helical anchor) foundation system, as discussed herein.

Ground-supported floor slabs should be designed as free floating and should not be connected to the structural elements (e.g., walls, framing, etc.) of the building. Isolation joints should be utilized at the interface of proposed ground-supported floor slab and pile supported structural elements to accommodate potential differential settlement. A minimum 10 mil polyethylene vapor barrier and free draining subbase, consisting of at least 4 inches of poorly graded crushed stone aggregate, such as AASHTO SP-57 stone, should be provided beneath all floor slabs and above the stabilization layer. Subgrade conditions should be modeled for design utilizing a subgrade modulus, K_S, of 100 pci.

4. **Helical or "Screw" Anchor Foundations.** Based on the subsurface data obtained during this evaluation, it is Duffield Associates' opinion that the "natural" site soils of Strata C, D, and E could provide suitable bearing and uplift resistant with the use of helical anchors with three (3) helix per shaft of 10-inch, 12-inch, and 14-inch diameters. Based on the subsurface data obtained during this evaluation and static analysis, it is Duffield Associates' opinion that a typical three (3) helix per shaft system consisting of 10-inch, 12-inch, and 14-inch-diameter helixes should be capable of developing the following allowable capacities with the embedment depths indicated in the following table:

Table 2: Summary of Helical Anchor Analysis

Location	Depth of Bottom Helix	Allowable Compression Capacity	Allowable Tension Capacity
Vestibule Addition	15 feet	10 kips	7 kips
	20 feet	20 kips	14 kips
Pavilion and Bathroom Structure	10 feet	7 kips	5 kips
	15 to 20 feet	12 kips	8 kips

NOTE: Estimated allowable capacities are based on static analysis and a factor of safety of 2.0 for compression and 3.0 for tension.

The capacity of the helical or "screw" anchor foundations generally increases with the embedment depth into competent bearing materials as the resistance to vertical compression or uplift loads is based on soil bearing against the helical plates. The capacity of the anchors can be empirically evaluated based on the torque required for installation, or can be determined by "pullout" testing following installation. Due to the anticipation of encountering predominately fine-grained clay and silt soils, Duffield Associates recommends the performance of a helical anchor testing program, particularly for "pullout" or uplift resistance to confirm the anticipated helical anchor capacities. A minimum of two (2) "pullout" tests, one (1) within the location of the vestibule addition and one (1) within the location of the proposed bathroom and pavilion structures are recommended. These foundation support systems (e.g., Chance Anchors, RamJack, etc.) are typically installed by experienced specialty foundation system contractors, who can be contacted directly for final design and cost-estimating assistance. It is noted that many helix options can be evaluated for different loading conditions; however, for the purposes of this evaluation, one option was evaluated.

5. **Influence of New Buildings on the Existing Structures.** Construction of the new vestibule could result in some degree of additional loading to the existing foundations if a shallow foundation system is utilized. For the deep foundation pile supported hospital, the additional loading due to the vestibule construction is anticipated to be relatively light. The vertical and lateral load tolerance on the existing hospital foundation system should be confirmed by the project design team.

   If a shallow foundation system is selected for the vestibule, the connection between the proposed and the existing structures should be designed to tolerate up to 1½ inches of differential settlement, as the existing structures have likely already experienced their full load-induced settlement.

6. **Groundwater.** Groundwater was encountered in all three (3) of the test borings performed and was observed to range between 6.2 to 13.5 feet below the existing ground surface. It is noted that seasonal and annual variations in precipitation could influence groundwater elevations on the order of several feet above or below those observed during the performance of our field program.

7. **Flood Consideration.** Based on the information contained on FIRM No. 10003C0151J prepared by FEMA, the project site is located in a Special Flood Hazard Area characterized as Zone "AE." These maps indicate that this flood hazard area is not subjected to high velocity wave action and is considered a "General Floodplain Area." Foundations for new construction or site improvements should be designed and adequately anchored to prevent floatation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy. No assumptions regarding erosion or scour were made during the analysis for building foundations summarized in this report.

8. **Seismic Design Parameters.** Based on subsurface conditions encountered during the field exploration at the site, a Site Class "D," as defined by Table 1613.5.2 of the 2009 International Building Code, is recommended.

9. **Analysis Assumptions.** This evaluation has been based on the information provided regarding design loads and foundation elevation for the proposed structure. These assumptions should be verified by the project team prior to the completion of their design. If the proposed loading conditions vary from those assumed herein, Duffield Associates should be notified to possibly modify the recommendations provided herein as required.

CONSTRUCTION

1. **Proofroll and Subgrade Preparation.** At the start of construction, the proposed construction areas should be stripped of all topsoil and the existing pavement section removed. Following rough grading and prior to footing excavation, placement of fill, or construction of the floor slab, it is recommended that the exposed subgrade be proofrolled. The proofroll should be performed using a minimum 10-ton static roller in the presence of a qualified soils technician working under the supervision of a geotechnical engineer. The purpose of the proofrolling is to identify yielding subgrade conditions. Yielding or otherwise unsuitable subgrade conditions encountered within the proposed building areas should be undercut to firm subgrade conditions and backfilled with compacted structural fill in accordance with the recommendations of this report. A qualified soils technician working under the supervision of a geotechnical engineer should also confirm the consistency and texture of the exposed soils with the conditions encountered by this evaluation, as described herein, since localized loose and yielding subgrade conditions may be encountered.

2. **Foundation Subgrade Review.** All shallow foundations should be placed on firm, dry, non-frozen subgrade consisting of the clay of Stratum C. Foundation excavations should be reviewed by a qualified technician working under the supervision of a geotechnical engineer who is familiar with the recommendations of this report. Subgrade review should be performed prior to the placement of reinforcing steel or concrete and should verify the presence of these strata. If these conditions are not encountered at the proposed foundation depth, additional excavation should be performed until they are uniformly encountered across the base of the foundation's excavation. Foundation undercut areas should be backfilled with structural fill, as recommended herein.

3. **Re-use of On-Site Soils as Structural Fill.** On-site soils free of organic material, topsoil, miscellaneous fill, debris and rock fragments in excess of 3 inches in their largest dimension may be suitable as structural fill. While it is possible to utilize the fine-grained soils encountered as structural fill or foundation backfill, these soils were encountered with an in-situ moisture content above that which would allow the recommended compaction to be achieved. As a result, drying of these soils may be required to achieve the recommended compaction. Drying fine-grained soils requires an area in which to spread them out, extended periods of warm, dry weather, and time. Therefore, Duffield Associates recommends the utilization of imported borrow consisting of predominately granular soils conforming to the requirements of the Delaware Department of Transportation Standard Specifications Select Borrow, Type G should be utilized. AASHTO SP-57 stone could also be utilized as structural fill and should be considered for localized, relatively deep fills such as foundation undercuts.

4. **Compaction Requirements.** Structural fill utilized within the proposed building areas should be placed in loose lifts with a maximum thickness of 12 inches. Each lift of fill placed within the proposed building areas should be compacted to at least 95% of the maximum dry density, as determined by the Modified Proctor test (ASTM D 1557). For areas of undercut and backfill, it is recommended that a non-woven geotextile separator fabric (Propex 601 or equivalent) be placed between the fine-grained (silt or clay) soils and structural fill. The placement and compaction of structural fill should be monitored on a full-time basis by a qualified technician under the supervision of a geotechnical engineer.

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5. **Groundwater Control.** Based on the conditions observed during this evaluation, groundwater is not anticipated to be encountered if a shallow foundation support systems are selected. However, due to the observed near surface fine-grained soils, it is considered possible that localized perched groundwater may be encountered at relatively shallow depths within the footing or utility excavations. If groundwater is encountered, localized sumping may be required. Wherever significant quantities of groundwater are encountered during foundation and utility trench excavations, it may become necessary for the resulting excavation to be over excavated by several inches and backfilled with AASHTO SP-57 stone to facilitate sumping and to protect the exposed subgrade during construction.

6. **Protection of Subgrade Soils.** The fine-grained (silt and clay) subgrade soils are easily disturbed by precipitation and construction traffic and should be undercut and replaced with structural fill as previously discussed. Subgrade disturbance could be reduced by maintaining positive surface drainage, by establishing and maintaining a sump throughout the construction period, and by limiting construction traffic on the exposed subgrade soils.

7. **Obstructions to Helical Anchor Installation (if selected).** The contract documents should include provisions for pre-excavation or pre-augering if debris and/or obstructions are encountered. While debris and/or obstructions were not encountered during the drilling program, if obstructions are encountered during helical anchor installation, these actions may be necessary. The presence of obstructions may also require "offsetting" of anchor locations during installation. Therefore, the project's structural engineer should be contacted to determine allowable tolerances for horizontal location.

8. **Helical Anchor Installation (if selected).** Helical anchors should be designed with the assistance of a qualified geotechnical engineer and installed by a certified specialty contractor with experience in the installation of the specified anchors. A written installation record should be maintained for each anchor installed. The record for each anchor should include the following, at a minimum: location of anchor; description of the lead section and extensions installed; depth of installation as referenced from the existing ground surface; torque reading for the last 5 feet of installation; and termination torque. In addition, the installation of the anchors should be reviewed by a geotechnical engineer familiar with this report to observe that the penetration depth is consistent with the subsurface data from the test borings.

9. **Excavation Safety.** All utility and foundation excavation should be performed in accordance with OSHA guidelines. Typically, the fine-grained clay and silt soils can be characterized by OSHA CFR Part 1926 Excavation Standards as Type B soils. Should it be required, all temporary sheeting and shoring should be designed by a qualified engineer registered in the State of Delaware.

10. **Available Data.** All contractors interested in bidding on phases of this work which involve subsurface conditions should be given full access to this report so that they can develop their own interpretations of the available data.

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These recommendations have been prepared according to generally accepted soil and foundation engineering standards and are based on the conditions encountered by the sampling performed at the site. It is noted that, although soil quality has been inferred from the interpolation of the sampling data, subsurface conditions beyond the sampling points are, in fact, unknown. As a result, these recommendations may require modifications based on the conditions encountered and exposed during construction excavation. Should any conditions encountered during construction differ from those described in this report, this office should be notified immediately in order to review and possibly modify these recommendations. The cost for construction review is not part of the existing agreement. This report applies solely to the size, type, and location of the structure described herein. In the event that changes are proposed, this report will not be considered valid unless the changes have been reviewed and the recommendations of this report modified and reapproved in writing by Duffield Associates, Inc.

We appreciate this opportunity to be of service to you. Should you have any questions concerning this evaluation, please do not hesitate to contact us.

Very truly yours,

DUFFIELD ASSOCIATES, INC.

Joseph Jakubowski, P.E., LEED AP
Project Manager

James F. Cloonan, P.E., ~~LEED AP~~
Geotechnical & Foundations Division Director

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Enclosures: Site Location Sketch
Test Boring Location Sketch
Test Boring Logs (3)
General Notes

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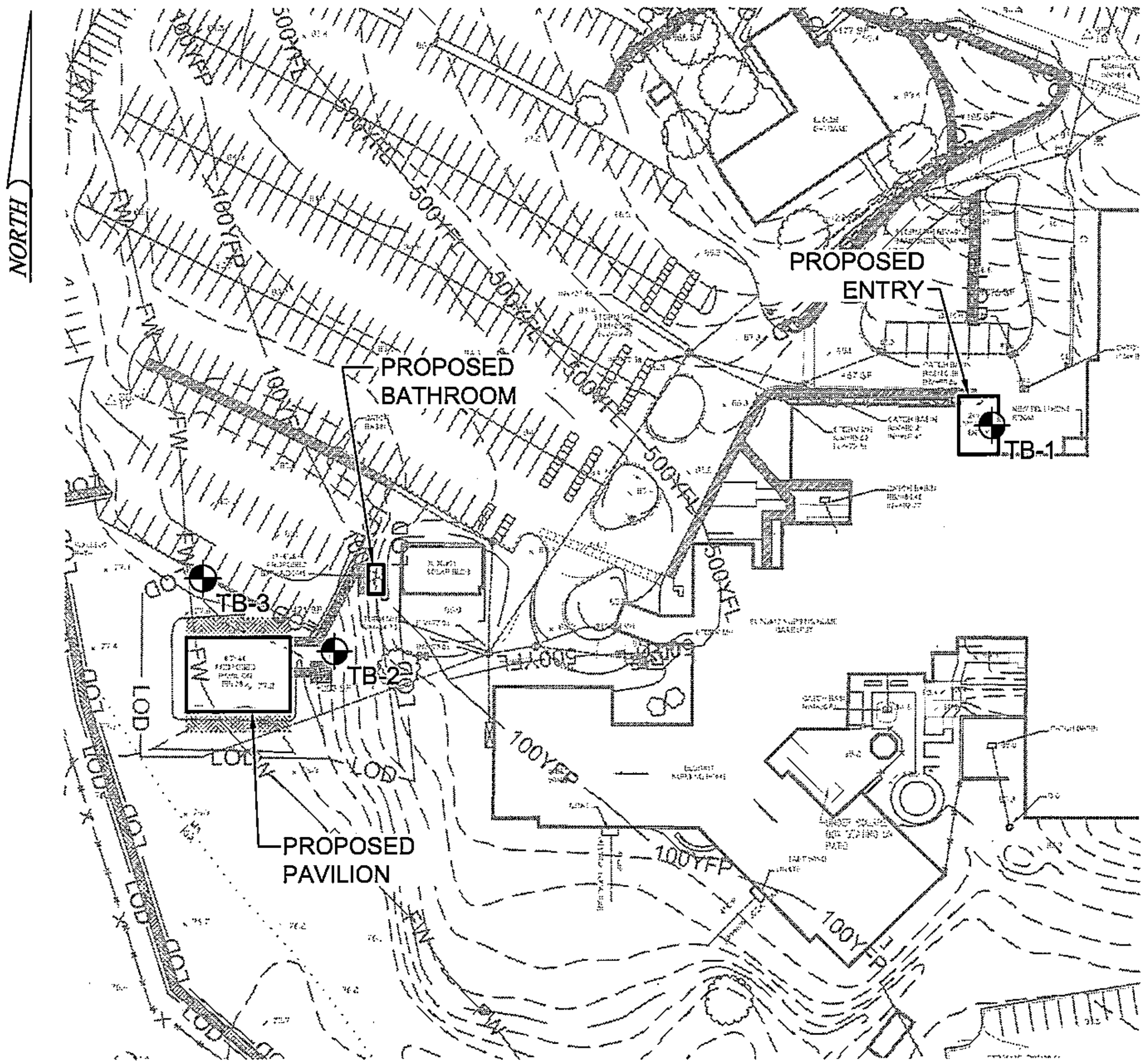
SITE LOCATION SKETCH

NOTE:
THIS LOCATION SKETCH IS ADAPTED FROM THE U.S.G.S. TOPOGRAPHIC MAP, 7.5 MINUTE SERIES, FOR WILMINGTON SOUTH, DELAWARE DATED 1993.

DATE: 2 AUGUST 2010	SITE LOCATION SKETCH **WILMINGTON VAMC**	DESIGNED BY: TRA	DUFFIELD ASSOCIATES *Consultants in the Geosciences*
SCALE: 1"=2000'	**ARCHITECTURAL BARRIERS**	DRAWN BY: TRA	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL: (302)239-6634 FAX (302)239-8485
PROJECT NO. 6772.GC	**PHASE II**	CHECKED BY: [signature]	OFFICES IN DELAWARE, MARYLAND PENNSYLVANIA AND NEW JERSEY
SHEET: FIGURE 1	WILMINGTON~NEW CASTLE COUNTY~DELAWARE	FILE: A-6772GC-01	E-MAIL: DUFFIELD@DUFFNET.COM

DUFFIELD ASSOCIATES

TEST BORING LOCATION SKETCH



KEY:

TB-1 APPROXIMATE LOCATION OF TEST BORING

NOTE:
THIS SKETCH IS ADAPTED FROM A DRAWING TITLED "SEDIMENT & STORMWATER PLANS, INDEX SHEET, WILMINGTON VAMC, 460-09-109 REPAIR AND REPLACEMENT OF ARCHITECTURAL BARRIERS - PHASE II," PREPARED BY DUFFIELD ASSOCIATES, INC. DATED JUNE 25, 2010.

DATE: 2 AUGUST 2010	TEST BORING LOCATION SKETCH	DESIGNED BY: TRA	DUFFIELD ASSOCIATES, Consultants in the Geosciences
SCALE: 1"=100'	WILMINGTON VAMC	DRAWN BY: TRA	5400 LIMESTONE ROAD, WILMINGTON, DE 19808-1232, TEL. (302)239-6634, FAX (302)239-8485
PROJECT NO. 6772.GC	ARCHITECTURAL BARRIERS	CHECKED BY: JJ	OFFICES IN DELAWARE, MARYLAND, PENNSYLVANIA AND NEW JERSEY
SHEET: FIGURE 2	PHASE II / WILMINGTON~NEW CASTLE COUNTY~DELAWARE	FILE: A-6772GC-01	E-MAIL: DUFFIELD@DUFFNET.COM

TEST BORING LOGS (3)

DUFFIELD ASSOCIATES

Consultants in the Geosciences

TEST BORING TB-1

Geotechnical Evaluation
Wilmington VAMC
Repair and Replacement of
Architectural Barriers - Phase II
Wilmington, Delaware
Project No. 6772.GC

Date Started	: July 14, 2010	Drilling Equipment	Truck Mtd Diedrich D-50
Date Completed	: July 14, 2010	Drilling Methods	: 3.75" HSA
Logged by	: TRA	Surface Elevation	: 86 feet ± Project Datum
Weather	: Cloudy, 70's		
Driller/Agency	: W. Proud/Feldmann Brothers		

Sample Condition: ☒ Remolded

Water Levels: ▼ During Drilling; ▽ At completion

Depth in feet	Surf. Elev. 86 ft	GRAPHIC	USCS	DESCRIPTION	SAMPLES	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL
0				BITUMINOUS CONCRETE pavement (±7 inches) and millings (±4 inches)							
	85		CH	Orange-brown, green-brown, gray, slightly mottled silty CLAY, trace to little fine sand (moist)	☒	S-1	2-3-3	2.0			
5			ML	Varicolored: (Gray, light blue, orange-brown, green-brown) clayey SILT, some fine sand (moist, micaceous)	☒	S-2	2-3-5	1.4	46.4	67.4	
	80			Varicolored: (Green, orange-brown, black, white-pink) SILT, some fine sand, trace clay, trace medium sand (moist, micaceous)	☒	S-3	5-7-7	1.4			
10				Varicolored: (Green, pink-brown, yellow-brown, blue-gray) SILT, some fine sand, trace to little clay, trace medium sand (moist, micaceous)	☒	S-4	4-5-7	1.4			
	75										▼ ▽
15				Varicolored: (White, light gray, yellow-green-brown, orange-brown, pink) SILT, some to and fine sand, trace medium sand, trace clay (moist, micaceous)	☒	S-5	8-7-8	1.3			
	70										
20				Varicolored: (Dark green-gray, yellow-brown, white) clayey SILT, little to some fine sand (moist, micaceous)	☒	S-6	6-10-11	1.4			
	65										
25											

NOTES:

1. Test boring terminated at ± 20 feet b.e.g.s. (below existing ground surface).
2. Ground surface elevations estimated based on a drawing titled "Sediment & Stormwater Plans, Index Sheet, Wilmington VAMC, 460-09-109 Repair and Replacement of Architectural Barriers - Phase II," prepared by Duffield Associates, Inc., dated June 25, 2010.
3. Wet on spoon conditions (WOS) at 8.5 feet b.e.g.s. with augers at 8.5 feet b.e.g.s., water level (WL) at 9.9 feet b.e.g.s..
4. WOS at 13 feet b.e.g.s. with augers at 13.5 feet b.e.g.s., WL at 13.5 feet b.e.g.s..
5. Borehole caved at 14.5 feet b.e.g.s., WL at 14.3 feet b.e.g.s. upon completion.
6. Borehole backfilled with auger cuttings and topped with bituminous concrete cold patch upon completion.

DUFFIELD ASSOCIATES
Consultants in the Geosciences

TEST BORING TB-2

Geotechnical Evaluation
Wilmington VAMC
Repair and Replacement of
Architectural Barriers - Phase II
Wilmington, Delaware
Project No. 6772.GC

Date Started : July 14, 2010
Date Completed : July 14, 2010
Logged by : TRA
Weather : Cloudy, 80's
Driller/Agency : W. Proud/Feldmann Brothers

Drilling Equipment: Truck Mtd Diedrich D-50
Drilling Methods : 3.75" HSA
Surface Elevation : 79.5 feet ± Project Datum

Sample Condition: Remolded

Water Levels: ▼ During Drilling; ▽ At completion

Depth in feet	Surf. Elev. 79.5 ft	USCS	DESCRIPTION	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL
0			TOPSOIL (± 5 inches)						
			FILL: Gray, dark-brown clayey silt, little fine sand, trace roots, trace gravel (moist)	S-1A	5-3-4	1.2			
		CL	Blue-gray, light brown, gray silty CLAY, trace fine sand, trace roots (moist)	S-1B					
	75	CH	Light blue-gray, orange-brown, green-brown, mottled CLAY, trace fine sand (moist)	S-2	2-3-6	1.7			
5									▽
			Blue-gray, light brown, slightly mottled CLAY, trace fine sand (moist)	S-3	3-4-4	1.5			▼
	70	SM	Brown, orange-brown, green-brown fine SAND, trace to little silt, trace medium to coarse sand, trace fine gravel (wet)	S-4	6-10-15	0.7			
10									
	65	ML	Varicolored: (Bright orange-brown, green-gray, green-brown) clayey-SILT, trace to little fine sand (moist, micaceous)	S-5	3-5-4	1.2			
15									
	60		Varicolored: (Dark green-gray, dark orange-brown, dark gray) SILT, trace to little fine sand (moist, micaceous)	S-6	7-16-21	1.4			
20									
	55								
25									

NOTES:
1. Test boring terminated at ± 20 feet b.e.g.s. (below existing ground surface).
2. Ground surface elevations estimated based on a drawing titled "Sediment & Stormwater Plans, Index Sheet, Wilmington VAMC, 460-09-109 Repair and Replacement of Architectural Barriers - Phase II," prepared by Duffield Associates, Inc., dated June 25, 2010.
3. Wet on spoon conditions at 8.5 feet b.e.g.s. with augers at 8.5 feet b.e.g.s., water level at 6.5 feet b.e.g.s..
4. Borehole caved at 9.7 feet b.e.g.s., water level at 5.2 feet b.e.g.s. upon completion.
5. Borehole backfilled with auger cuttings upon completion.

DUFFIELD ASSOCIATES
Consultants in the Geosciences

TEST BORING TB-3

Geotechnical Evaluation
Wilmington VAMC
Repair and Replacement of
Architectural Barriers - Phase II
Wilmington, Delaware
Project No. 6772.GC

Date Started : July 14, 2010
Date Completed : July 14, 2010
Logged by : TRA
Weather : Cloudy, 80's
Driller/Agency : W. Proud/Feldmann Brothers

Drilling Equipment: Truck Mtd Diedrich D-50
Drilling Methods : 3.75" HSA
Surface Elevation: 79 feet ± Project Datum

Sample Condition: ⊠ Remolded

Water Levels: ▼ During Drilling; ▽ At completion

Depth in feet	Surf. Elev. 79 ft	GRAPHIC	USCS	DESCRIPTION	SAMPLES	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL
0				TOPSOIL (± 5 inches)							
				FILL: Gray clayey silt, trace fine sand, trace roots) (wet)	⊠	S-1	WH/0.5'-2-2	1.0			
	75		CH	Blue-gray, orange-brown, mottled CLAY, trace silt (moist); Atterberg Limits: Liquid Limit = 54, Plasticity Index = 31	⊠	S-2	1-2-4	1.8	30.3	90.0	
5											▽ ▼
			SM	Brown, dark brown fine to coarse SAND, little gravel, little silt (wet)	⊠	S-3A	5-3-2	0.8			
			ML	Light gray, orange-brown SILT, some to and fine sand (moist to wet, micaceous)		S-3B					
	70		SM	Dark yellow-green, orange-brown, brown fine SAND, little silt, trace medium to coarse sand, trace fine gravel (wet, micaceous, 0.4' heave)	⊠	S-4	6-11-16	0.9			
10											
	65		ML	Varicolored: (Orange-brown, yellow-white, green) clayey SILT, some fine sand (moist, micaceous)	⊠	S-5	8-7-7	1.1			
15											
	60			Varicolored: (Dark gray, yellow-green-brown, orange-brown, yellow-brown) clayey SILT, some to and fine sand (moist, micaceous)	⊠	S-6	7-9-9	1.4			
20											
	55										
25											

NOTES:
1. Test boring terminated at ± 20 feet b.e.g.s. (below existing ground surface).
2. Ground surface elevations estimated based on a drawing titled "Sediment & Stormwater Plans, Index Sheet, Wilmington VAMC, 460-09-109 Repair and Replacement of Architectural Barriers - Phase II," prepared by Duffield Associates, Inc., dated June 25, 2010.
3. Wet on spoon conditions at every sample, water running into boring from adjacent graded aggregate under bituminous concrete.
4. Wet on rods conditions at 9.0 feet b.e.g.s. with augers at 13.5 feet b.e.g.s., water level at 6.2 feet b.e.g.s..
5. Borehole caved at 8.0 feet b.e.g.s., water level at 5.5 feet b.e.g.s. upon completion.

DUFFIELD ASSOCIATES

GENERAL NOTES

GENERAL NOTES

DUFFIELD ASSOCIATES uses the following definitions and terminology to classify and correlate the field and laboratory samples.

VISUAL UNIFIED CLASSIFICATIONS: The soil samples are described by color, major constituent, modifiers (by percentage), and density (or consistency). Coarse Grained or Granular Soils have more than 50% of their dry weight retained on a No. 200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a No. 200 sieve; they are described as: clays or clayey silts if they are cohesive and silts if they are noncohesive. In addition to gradation, granular soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their strength or consistency and their plasticity.

The Unified Soil Classification symbols are:

COARSE GRAINED SOILS

GW -	Well graded gravels
GP -	Poorly graded gravels
GM -	Silty gravels
GC -	Clayey gravels
SW -	Well graded sands
SP -	Poorly graded sands
SM -	Silty sands
SC -	Clayey sands

FINE GRAINED SOILS

ML -	Silts of low plasticity
CL -	Clays of low to medium plasticity
OL -	Organic silt clays of low plasticity
MH -	Silts of high plasticity
CH -	Clays of high plasticity
OH -	Organic silt clays of high plasticity
PT -	Peat and highly organic soils

SIZE DESCRIPTION

F -	Fine
M -	Medium
C -	Coarse
G -	Gravel

MODIFIERS (PERCENTAGE)

Tr -	Trace	1 - 10%
Ltl -	Little	11 - 20%
Some		21 - 35%
& -	And	36 - 50%

COLOR

Or - Orange	Blk - Black	Vc - Varicolored
Yel - Yellow	Gr - Gray	Dk - Dark
Br - Brown	R - Red	Lt - Light

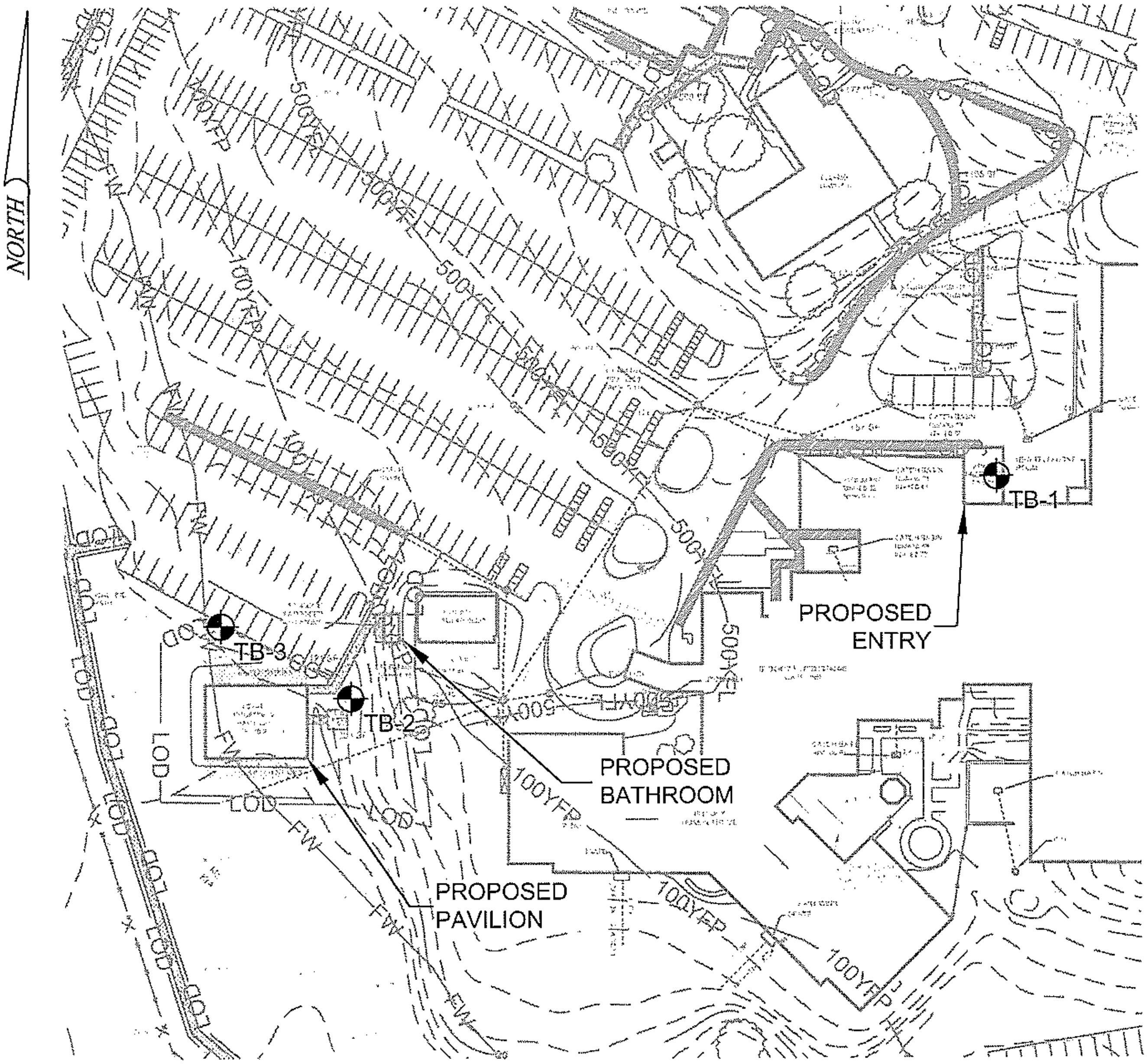
DENSITY: COARSE GRAINED SOILS

Very loose	4 blows/ft or less
Loose	5 to 10 blows/ft
Medium	11 to 30 blows/ft
Dense	31 to 50 blows/ft
Very Dense	51 blows/ft or more

CONSISTENCY: FINE GRAINED SOILS

Very soft	2 blows/ft or less
Soft	3 to 4 blows/ft
Medium	5 to 8 blows/ft
Stiff	9 to 15 blows/ft
Very stiff	16 to 30 blows/ft
Hard	31 blows/ft or more

NOTE: The Standard Penetration Test "N" value is the number of blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split spoon sampler, except where otherwise noted.



KEY:

⊕ TB-1 APPROXIMATE TEST BORING SKETCH

NOTE:
THIS TEST BORING LOCATION SKETCH IS ADAPTED FROM A DRAWING TITLED "SEDIMENT & STORMWATER PLANS, INDEX SHEET, WILMINGTON VAMC, 460-09-109 REPAIR AND REPLACEMENT OF ARCHITECTURAL BARRIERS - PHASE II," PREPARED BY DUFFIELD ASSOCIATES, INC. DATED JUNE 25, 2010.

DRAFT

DATE: 28 JULY 2010	TEST BORING LOCATION SKETCH	DESIGNED BY: TRA	DUFFIELD ASSOCIATES *Consultants in the Geosciences*
SCALE: 1"=100'	**WILMINGTON VAMC**	DRAWN BY: TRA	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT. NO. 6772.GC	**ARCHITECTURAL BARRIERS** **PHASE II**	CHECKED BY:	OFFICES IN DELAWARE, MARYLAND PENNSYLVANIA AND NEW JERSEY
SHEET: FIGURE 2	WILMINGTON~NEW CASTLE COUNTY~DELAWARE	FILE: A-6772GC-01	E-MAIL: DUFFIELD@DUFFNET.COM

DUFFIELD ASSOCIATES
Consultants in the Geosciences

TEST BORING TB-1

(Page 1 of 1)

Geotechnical Evaluation
Wilmington VAMC
Repair and Replacement of
Architectural Barriers - Phase II
Wilmington, Delaware
Project No. 6772.GC

Date Started : June 24, 2010
Date Completed : July 14, 2010
Logged by : TRA
Weather : Cloudy, 70's
Driller/Agency : W. Proud/Feldmann Brothers

Drilling Equipment: Truck Mtd Diedrich D-50
Drilling Methods : 3.75" HSA
Surface Elevation : 86 feet ± Project Datum

DRAFT

Sample Condition: Remolded

Water Levels: ▼ During Drilling; ▽ At completion

Depth in feet	Surf. Elev. 86 ft	GRAPHIC	USCS	DESCRIPTION	SAMPLES	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL
0	85			Bituminous concrete (±7 inches), bituminous concrete millings (±4 inches)							
			CH	Orange-brown, green-brown, gray, slightly mottled silty CLAY, trace to little fine sand (moist)	X	S-1	2-3-3	2.0			
5	80		ML	Varicolored: (Gray, light blue, orange-brown, green-brown) clayey SILT, trace to little fine sand (moist, micaceous)	X	S-2	2-3-5	1.4			
				Varicolored: (Green, orange-brown, black, white-pink) SILT, some fine sand, trace clay, trace medium sand (moist, micaceous)	X	S-3	5-7-7	1.4			
10	75			Varicolored: (Green, pink-brown, yellow-brown, blue-gray) SILT, some fine sand, trace to little clay, trace medium sand (moist, micaceous)	X	S-4	4-5-7	1.4			
15	70			Varicolored: (White, light gray, yellow-green-brown, orange-brown, pink) SILT, some to and fine sand, trace medium sand, trace clay (moist, micaceous)	X	S-5	8-7-8	1.3			▼ ▽
20	65			Varicolored: (Dark green-gray, yellow-brown, white) clayey SILT, little to some fine sand (moist, micaceous)	X	S-6	6-10-11	1.4			
25											

NOTES:
1. Test boring terminated at ± 20 feet b.e.g.s. (below existing ground surface).
2. Ground surface elevations estimated based on a drawing titled "Sediment & Stormwater Plans, Index Sheet, Wilmington VAMC, 460-09-109 Repair and Replacement of Architectural Barriers - Phase II," prepared by Duffield Associates, Inc., dated June 25, 2010.
3. Wet on spoon conditions (WOS) at 8.5 feet b.e.g.s. with augers at 8.5 feet b.e.g.s., water level (WL) at 9.9 feet b.e.g.s..
4. WOS at 13 feet b.e.g.s. with augers at 13.5 feet b.e.g.s., WL at 13.5 feet b.e.g.s..
5. Borehole caved at 14.5 feet b.e.g.s., WL at 14.3 feet b.e.g.s. upon completion.
6. Borehole backfilled with auger cuttings and topped with bituminous concrete cold patch upon completion.

DUFFIELD ASSOCIATES
Consultants in the Geosciences

TEST BORING TB-2

Geotechnical Evaluation
Wilmington VAMC
Repair and Replacement of
Architectural Barriers - Phase II
Wilmington, Delaware
Project No. 6772.GC

Date Started : June 24, 2010
Date Completed : July 14, 2010
Logged by : TRA
Weather : Cloudy, 80's
Driller/Agency : W. Proud/Feldmann Brothers

Drilling Equipment: Truck Mtd Diedrich D-50
Drilling Methods : 3.75" HSA
Surface Elevation : 79.5 feet ± Project Datum

DRAFT

Sample Condition: ⊠ Remolded
Water Levels: ▼ During Drilling; ▽ At completion

Depth in feet	Surf. Elev. 79.5 ft	USCS	DESCRIPTION	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL
0			TOPSOIL (± 5 inches)						
			FILL: Gray, dark-brown topsoil: (clayey silt, little fine sand, trace roots, trace gravel), (moist)	S-1A	5-3-4	1.2			
		CL	Blue-gray, light brown, gray silty CLAY, trace fine sand, trace roots (moist)	S-1B					
	75	CH	Light blue-gray, orange-brown, green-brown, mottled CLAY, trace fine sand (moist)	S-2	2-3-6	1.7			
5									▽
			Blue-gray, light brown, slightly mottled CLAY, trace fine sand (moist)	S-3	3-4-4	1.5			▼
	70	SM	Brown, orange-brown, green-brown fine SAND, trace to little silt, trace medium to coarse sand, trace fine gravel (wet)	S-4	6-10-15	0.7			
10									
	65	CL	Varicolored: (Bright orange-brown, green-gray, green-brown) silty CLAY, trace to little fine sand (moist, micaceous, Apparent Vincentown Fm?)	S-5	3-5-4	1.2			
15									
	60	ML	Varicolored: (Dark green-gray, dark orange-brown, dark gray) SILT, trace to little fine sand (moist, micaceous, Apparent Vincentown Fm?)	S-6	7-16-21	1.4			
20									
	55								
25									

NOTES:
1. Test boring terminated at ± 20 feet b.e.g.s. (below existing ground surface).
2. Ground surface elevations estimated based on a drawing titled "Sediment & Stormwater Plans, Index Sheet, Wilmington VAMC, 460-09-109 Repair and Replacement of Architectural Barriers - Phase II," prepared by Duffield Associates, Inc., dated June 25, 2010.
3. Wet on spoon conditions at 8.5 feet b.e.g.s. with augers at 8.5 feet b.e.g.s., water level at 6.5 feet b.e.g.s..
4. Borehole caved at 9.7 feet b.e.g.s., water level at 5.2 feet b.e.g.s. upon completion.
5. Borehole backfilled with auger cuttings upon completion.

DUFFIELD ASSOCIATES
Consultants in the Geosciences

TEST BORING TB-3

Geotechnical Evaluation
Wilmington VAMC
Repair and Replacement of
Architectural Barriers - Phase II
Wilmington, Delaware
Project No. 6772.GC

Date Started : June 24, 2010
Date Completed : July 14, 2010
Logged by : TRA
Weather : Cloudy, 80's
Driller/Agency : W. Proud/Feldmann Brothers

Drilling Equipment Truck Mtd Diedrich D-50
Drilling Methods : 3.75" HSA
Surface Elevation: 79 feet ± Project Datum

DRAFT

Sample Condition: ⊠ Remolded

Water Levels: ▼ During Drilling; ▽ At completion

Depth in feet	Surf. Elev. 79 ft	GRAPHIC	USCS	DESCRIPTION	SAMPLES	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL
0				TOPSOIL (± 5 inches)							
				FILL: Gray, topsoil: (clayey silt, trace fine sand, trace roots), (wet)	⊠	S-1	WH/0.5'-2-2	1.0			
	75		CH	Blue-gray, orange-brown, mottled CLAY, trace silt (moist)	⊠	S-2	1-2-4	1.8			
5											▽ ▼
			SM	Brown, dark brown fine to coarse SAND, little gravel, little silt (wet)	⊠	S-3A	5-3-2	0.8			
			ML	Light gray, orange-brown SILT, some to and fine sand (moist to wet, micaceous)	⊠	S-3B					
	70		SM	Dark yellow-green, orange-brown, brown fine SAND, little silt, trace medium to coarse sand, trace fine gravel (wet, micaceous, 0.4' heave)	⊠	S-4	6-11-16	0.9			
10											
	65		ML	Varicolored: (Orange-brown, yellow-white, green) clayey SILT, some fine sand (moist, micaceous)	⊠	S-5	8-7-7	1.1			
15											
	60			Varicolored: (Dark gray, yellow-green-brown, orange-brown, yellow-brown) clayey SILT, some to and fine sand (moist, micaceous)	⊠	S-6	7-9-9	1.4			
20											
	55										
25											

NOTES:
1. Test boring terminated at ± 20 feet b.e.g.s. (below existing ground surface).
2. Ground surface elevations estimated based on a drawing titled "Sediment & Stormwater Plans, Index Sheet, Wilmington VAMC, 460-09-109 Repair and Replacement of Architectural Barriers - Phase II," prepared by Duffield Associates, Inc., dated June 25, 2010.
3. Wet on spoon conditions at every sample, water running into boring from adjacent graded aggregate under bituminous concrete.
4. Wet on rods conditions at 9.0 feet b.e.g.s. with augers at 13.5 feet b.e.g.s., water level at 6.2 feet b.e.g.s..
5. Borehole caved at 8.0 feet b.e.g.s., water level at 5.5 feet b.e.g.s. upon completion.

BORING LOG

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"
SINCE 1881

Report No.: 72L-0017 Date: May 2009

Client: Alpha Coporation

Project: Veterans Association Building Addition, 1601 Kirkwood Hwy, Wilmington, Delaware

Boring No.: SB-1 (1 of 1) Total Depth 30.0' Elev: 94.0 ± ** Location: See Boring Location Plan

Type of Boring: 3.25" HSA Started: 5/5/09 Completed: 5/5/09 Driller: S. Foster

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
93.5	0.5	6 Inches asphalt				Corrected N60 Value
92.8	1.2	8 Inches subbase	2-4-5	1.0	9	N60 = 11
		FILL: Olive-brown, moist, stiff, LEAN CLAY with sand and trace root fragments		2.5		
90.0	4.0	COASTAL PLAIN: Brown, moist, medium-stiff, LEAN CLAY (CL) with sand	3-3-4	3.5	7	N60 = 9
				5.0		
88.5	5.5	Brown, moist, loose, clayey SAND (SC)	5-3-5	6.0	8	N60 = 10
				7.5		
86.0	8.0	Yellow-brown, moist, stiff to medium-stiff, sandy LEAN CLAY (CL)	3-3-6	8.5	9	N60 = 11
				10.0		
			3-3-4	13.5	7	N60 = 9
				15.0		
77.0	17.0	RESIDUUM: Yellow-brown to gray, moist, medium-dense, silty SAND (SM)	4-9-18	18.5	27	N60 = 35
				20.0		
72.0	22.0	Olive and brown mottled, moist, loose to medium-dense, fine sandy ELASTIC SILT (MH) with mica	3-4-5	23.5	9	N60 = 11
				25.0		
			4-5-9	28.5	14	N60 = 18
64.0	30.0	Boring terminated at 30.0 feet		30.0		Boring dry upon completion
		**Ground surface elevataion data estimated to the nearest 1.0 foot from information contained on the untitled topographic plan provided by Alpha Corporation				Boring caved at 27.5 feet upon completion
		Note: Standard Penetration Tests (SPT) conducted utilizing an automatic hammer				

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG BORING LOGS.GPJ F&R.GDT 5/26/09

BORING LOG

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"
SINCE 1881

Report No.: 72L-0017 Date: May 2009

Client: Alpha Coporation

Project: Veterans Association Building Addition, 1601 Kirkwood Hwy, Wilmington, Delaware

Boring No.: SB-2 (1 of 1) Total Depth 30.0' Elev: 96.0 ± ** Location: See Boring Location Plan

Type of Boring: 3.25" HSA Started: 5/5/09 Completed: 5/5/09 Driller: S. Foster

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
95.8	0.2	2 Inches asphalt				Corrected N60 Value
95.0	1.0	10 Inches subbase	3-4-5	1.0	9	N60 = 11
		FILL: Brown, moist, stiff to medium-stiff, sandy LEAN CLAY with coal fragments and gravel		2.5		
			2-3-4	3.5	7	N60 = 9
				5.0		
			1-2-4	6.0	6	N60 = 8
89.5	6.5	COASTAL PLAIN: Brown, moist, medium-stiff to stiff, sandy LEAN CLAY (CL)		7.5		
			3-5-5	8.5	10	N60 = 13
				10.0		
84.0	12.0	Yellow-brown, moist, medium-stiff, sandy ELASTIC SILT (MH) with mica				
			2-2-3	13.5	5	N60 = 6
				15.0		
79.0	17.0	RESIDUUM: Pink and olive mottled, moist, medium-dense, fine sandy SILT (ML) with mica				
			4-7-10	18.5	17	N60 = 22
				20.0		
			5-7-9	23.5	16	N60 = 21
				25.0		
			5-6-12	28.5	18	N60 = 23
66.0	30.0	Boring terminated at 30.0 feet		30.0		Boring dry upon completion
		**Ground surface elevataion data estimated to the nearest 1.0 foot from information contained on the untitled topographic plan provided by Alpha Corporation				Boring caved at 27.0 feet upon completion
		Note: Standard Penetration Tests (SPT) conducted utilizing an automatic hammer				

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG BORING LOGS.GPJ F&R.GDT 5/26/09