FROEHLING & ROBERTSON, INC.

Report of Subsurface Exploration
and Geotechnical Engineering Evaluation
VAMC Salem 4kV Replacement
Salem, Virginia
F&R Project No. 62P0257

Prepared For:
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September 2012

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F&R Project No.: 62P0257 14 September 2012

Wiley Wilson
127 Nationwide Drive
Lynchburg, Virginia 24502-4272

Attention: Mr. Stephen A. Bowman, P.E.

Subject: VAMC Salem 4kV Replacement
Salem, Virginia

Mr. Bowman:

The purpose of this report is to present the results of the subsurface exploration program and geotechnical engineering analyses undertaken by Froehling & Robertson, Inc. (F&R) in connection with the above referenced project in Salem, Virginia. Our services were performed in general accordance with our Proposal No. 1362-210G as authorized by Wiley Wilson. The attached report presents our understanding of the project, reviews our exploration procedures, describes existing site and general subsurface conditions, and presents our evaluations, conclusions, and recommendations.

We have enjoyed working with you on this project, and we are prepared to assist you with the recommended quality assurance monitoring and testing services during construction. Please contact us if you have any questions regarding this report or if we may be of further service.

Sincerely,
FROEHLING & ROBERTSON, INC.

COMMONWEALTH OF VIRGINIA
ANDREW R. FRANK
Lic. No. 33731
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PROFESSIONAL ENGINEER

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1.0 INTRODUCTION

1.1 Project Information

Our understanding of the project is based on information provided by Mr. Stephen Bowman and Mr. Jay Lewis of Wiley Wilson and our previous experience with similar projects. We understand that the Veterans Affairs Medical Center (VAMC) is planning for a 4kV high voltage distribution system replacement project at the VAMC facility in Salem, Virginia (see Site Vicinity Map, Drawing No. 1). Based on discussions with Mr. Bowman, we understand that the proposed project will include underground duct banks as well as some manholes.

Included in the provided information was a drawing entitled *Civil Key Plan Soil Boring Location Map,* Drawing No. C-000, dated 7-25-12, prepared and provided by Wiley Wilson. This drawing shows nine (9) requested boring locations across the VAMC Salem facility. Subsequent to our exploration, we were provided with existing ground surface and proposed bottom of structure elevations at each of the boring locations. The provided elevations (summarized below) indicate that required excavations will range between 10 and 12 feet at the explored locations.

Existing Ground Surface & Proposed Bottom of Structure Elevations

Boring Location	Existing Surface Elevation (ft)	Proposed Bottom of Structure Elevation (ft)
B-1	1076	1066
B-2	1084	1073
B-3	1093	1083
B-4	1089	1079
B-5	1092	1082
B-6	1092	1082
B-7	1096	1084
B-8	1095	1085
B-9	1101	1091

1.2 Scope of Services

The purposes of our involvement on the project were to 1) provide general descriptions of the subsurface soil conditions at the locations explored, 2) provide lateral earth pressure design recommendations and 3) comment on geotechnical aspects of the proposed development. In order to accomplish the above objectives, we undertook the following scope of services:

1) Visited the site to observe existing surface conditions and features as well as boring locations pre-staked by others.
2) Coordinated utility clearance with Miss Utility as well as a subcontracted private utility locator.
3) Reviewed and summarized readily available geologic information relative to the project site.
4) Executed the requested subsurface exploration consisting of nine standard penetration test borings drilled to planned depths of 15 feet, except for boring B-9 (and its offset boring B-9A) which was terminated at 5 feet due to an unknown (possible concrete) obstruction.
5) Performed a laboratory testing program consisting of one standard Proctor and two soil classification (Atterberg limits and wash #200) tests, as well as ten natural moisture content tests.
6) Evaluated the findings of the test borings and laboratory test results relative to lateral earth pressure design parameters and anticipated subgrade conditions for the proposed structures.
7) Prepared this written report summarizing our geotechnical engineering work on the project, providing descriptions of the subsurface conditions encountered, providing lateral earth pressure design parameters, and discussing geotechnical related aspects of the proposed construction. Copies of the test boring logs are included.

Our scope of services did not include rock coring, survey services, quantity estimates, pavement design, preparation of plans or specifications, formal slope stability analysis, detention pond considerations, evaluations of earthquake motions, or the identification and evaluation of wetland or other environmental aspects of the project site.

2.0 SUBSURFACE EXPLORATION PROCEDURES

The subsurface exploration program consisted of nine (9) test borings (designated as B-1 through B-9) and one offset boring (B-9A) performed on 16 August 2012. The locations for borings B-1 through B-9 were originally staked by others prior to our mobilization to the site. Subsequent to the utility clearance efforts, some of the boring locations were shifted from the staked locations at the discretion of an F&R staff professional due to existing surface, overhead, or underground conflicts. Every effort was made to keep the boring locations as close as possible to the originally staked locations while maintaining the safety of our drilling staff. The approximate pre-marked locations are shown on the attached Boring Location Plan (Drawing No. 2, Appendix B). The offset distance and direction from the original stakes are noted on the attached boring logs. Given the requirement for some field alterations, we recommend that the test boring locations and elevations shown on the attached Boring Location Plan, Composite Subsurface Profile (Drawing No. 3), and boring logs be considered approximate.

The test borings were performed in accordance with generally accepted practice using a truck-mounted CME-55 rotary drill rig. Hollow-stem augers were advanced to pre-selected depths, the center plug was removed, and representative soil samples were recovered with a standard split-spoon sampler (1 3/8 in. ID, 2 in. OD) in general accordance with ASTM D 1586, the Standard Penetration Test. Utilizing an automatic hammer, a weight of 140 pounds is freely dropped from a height of 30 inches to drive the split-spoon sampler into the soil. The number of blows required to drive the split-spoon sampler three consecutive 6-inch increments is recorded, and the blows of the last two increments are summed to obtain the Standard Penetration Resistance (N-value). In some of the Standard Penetration Tests, the blow count is recorded as "0", or weight of hammer (WOH). In these cases, the static weight of the hammer, rods, and sampler penetrated into the soft subsurface soil with no hammer blows. The N-value provides a general indication of in-situ soil conditions and has been correlated with certain engineering properties of soils.

Subsurface water level readings were taken in each the borings immediately upon completion of the soil drilling process. Upon completion of drilling, the boreholes were backfilled with auger cuttings (soil). Periodic observation and maintenance of the boreholes should be performed due to potential subsidence at the ground surface, as the borehole backfill could settle over time.

Representative portions of the split-spoon soil samples obtained throughout the exploration program were placed in glass jars and transported to our laboratory. In the laboratory, the soil samples were classified by a member of our professional staff in general accordance with techniques outlined in the visual-manual identification procedure (ASTM D 2488) and the Unified Soil Classification System. The soil descriptions and classifications discussed in this report and shown on the attached boring logs are generally based on visual observation and should be considered approximate. Copies of the boring logs are provided and classification procedures are further explained in the attached Appendix B.

Split-spoon soil samples recovered on this project will be stored at F&R's office for a period of sixty days. After sixty days, the samples will be discarded unless prior notification is provided to us in writing.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Description

The subsurface exploration program included nine sites in and around the existing VAMC facility in Salem, Virginia. In general, the VAMC facility is situated on a topographically raised area adjacent the northern bank of the Roanoke River (see Site Vicinity Map, Drawing No. 1). Ground cover at the various exploration locations generally consisted of short maintained grass. Other site features included existing buildings, concrete sidewalks, parking lots, access drives, light poles, and trees. In addition, we note that boring B-8 was performed in the vicinity of the existing project research gardens ("PRRC Gardens").

Other than ground surface elevations at the pre-staked boring locations, no definitive topographic information for the project areas has been provided at this time; however, site grades appear to generally vary from flat to moderately sloping. Based on observations of utility clearance efforts, underground utilities are present in the vicinity of each of the boring locations.

3.2 Regional Geology

The proposed project lies within the Valley and Ridge Physiographic province of Virginia. Available geologic references (Geologic Map of the Salem Quadrangle Virginia, 1974) indicate that the site is underlain by Cambrian-aged rocks of the Rome Formation. The Rome Formation is composed of maroon, green, and gray mudstone interbedded with fine-grained sandstone and siltstone. The Rome can also contain numerous carbonate intervals of gray dolomite.

The mineral residues remaining after the parent mudstone, sandstone, siltstone, and/or dolomite have weathered are known as residual soils and typically consist of medium to highly plastic silts and clays. Where the residual soils result from minerals that had been widely dispersed throughout the parent rock, the residual soils are likely to have a very low in-situ density and low shear strength, and are also likely to be highly compressible. Transitional zones of partially weathered rock of varying thickness may occur between the residual soils and the underlying bedrock. Partially weathered rock is defined, for engineering purposes, as residual material with standard penetration resistances in excess of 100 blows per foot.

Our experience with the underlying Rome Formation indicates that the medium-bedded, alternating rock layers are oriented nearly vertical. The varying susceptibility to weathering creates seams of soil-like material sandwiched between weather resistant rock pinnacles. From an excavation and support point of view, this geology contains, very hard, layers that may require blasting to excavate, interbedded with soft clay seams that may require undercutting to some depth to provide adequate structural support. Where soil test borings encounter a vertical bed of auger refusal material, direct interpretation of the field data might lead one to envision a rock surface between the auger refusal points. Likewise, where vertical soil seams are encountered, a deep soft soil profile might be anticipated. However, in the Rome Formation our experience is that a combination of both conditions exists. Therefore, the boring data should be viewed as a specific example of the subsurface condition at each explored location rather than a broad interpretation of conditions across the site area.

Carbonate rocks (dolomite and limestone) may decompose in the presence of subsurface water that is slightly acidic. This decomposition may leave subsurface voids that may ravel up to the ground surface and form sinkholes. There are numerous other variations on sinkhole development. Regardless of the mode of development, it is important to note that changes in soil stress and water regime can greatly accelerate sinkhole development. Natural geologic processes that might otherwise occur over thousands of years can occur within several years or even months. Construction activities such as site grading, building construction, and water impoundment have reportedly caused sinkholes to develop rapidly or to collapse suddenly. This site lies within a geologic formation known to contain solutional features; however, the potential for development of sinkholes, along with the rate at which a sinkhole will develop, are not easily determined or accurately predicted.

3.3 Subsurface Conditions

3.3.1 General

The subsurface conditions discussed in the following paragraphs and those shown on the boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. The transitions between different soil strata are usually less distinct than those shown on the boring logs. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times. Data from the specific test borings are shown on the attached boring logs in Appendix B.

Below the existing ground surface, the borings generally encountered surficial soils underlain by existing fill materials and/or residual soils. These materials are generally discussed in the following paragraphs.

3.3.2 Surficial Soils

Surficial soils were encountered in each boring to depths ranging from approximately 1 to 2 inches. Surficial soils are typically a dark-colored soil material containing roots, fibrous matter, and/or other organic components, and are generally unsuitable for engineering purposes. We note that no laboratory testing has been performed to determine the organic content or horticultural properties of the observed surficial soil materials. Therefore, the term "surficial soils" is not intended to indicate suitability for landscaping and/or other purposes. The surficial soil depths provided in this report are based on driller observations and should be considered approximate. Actual surficial soil depths should be expected to vary across the site.

3.3.3 Existing Fill Materials

Existing fill materials include those materials deposited by man. Materials identified as existing fill were encountered in borings B-1, B-2, B-3, B-7, B-9, and B-9A to depths ranging from approximately 3 to 6 feet below the existing ground surface. The encountered fill soils were generally described as clays (CL and CH) and clayey sand (SC) with standard penetration resistances (N-values) ranging from 1 to 20 blows per foot (bpf). We note that borings B-9 and B-9A were terminated prior to penetrating the existing fill materials due to an obstruction that the drillers presumed to have been some type of relatively level concrete surface.

3.3.4 Residual Soils

Residual soils, formed by the in-place weathering of the parent rock, were encountered in each of the borings below the surficial soils and/or fill materials. Sampled residual soils were generally described as clays (CL and CH), silts (ML), and silty and clayey sands (SM and SC). Standard penetration resistances within the sampled residuum ranged from 4 to 65 bpf with a typical range of 7 to 27 bpf.

3.3.5 Subsurface Water

Subsurface water for the purposes of this report is defined as water encountered below the existing ground surface. Measurable subsurface water was not encountered in any of the test borings immediately upon completion of the soil drilling process. Fluctuations in subsurface water levels and soil moisture can be anticipated with changes in precipitation, run-off, and season.

3.4 Laboratory Testing Program

A bulk sample from boring B-3 as well as selected split-spoon samples were tested in general accordance with applicable ASTM International (ASTM) standards for moisture content (ASTM D2216), Atterberg limits (ASTM D4318), percent passing #200 sieve (ASTM D1140). In addition, standard Proctor moisture-density relationship testing (ASTM D698) was performed on the bulk sample. The results of the laboratory tests are summarized in the following tables, and specific results of the standard Proctor test are provided in Appendix C.

Soil Classification Test Summary

Location	Sample Depth (feet)	Sample Type	Moisture Content (%)	% Finer than No. 200	Atterberg Limits			USCS Classification
					L.L.	P.L.	P.I.	
B-3	0 - 5	Bulk	34.7	92.8	48	31	17	silty CLAY (CL)
B-7	6 - 7.5	SS	19.9	81.5	44	22	22	silty CLAY (CL) with sand

Standard Proctor Test Summary

Boring No.	Sample Depth (ft)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)
B-3	0 – 5	34.7	26.0	94.6

Natural Moisture Content Summary

Boring No.	Sample Depth (ft)	Natural Moisture Content (%)	Boring No.	Sample Depth (ft)	Natural Moisture Content (%)
B-3	1 – 2.5	26.3	B-7	1 – 2.5	20.5
B-3	3.5 – 5	33.5	B-7	3.5 – 5	20.7
B-3	6 – 7.5	48.2	B-7	6 – 7.5	19.9
B-3	8.5 – 10	43.5	B-7	8.5 – 10	22.7
B-3	13.5 – 15	21.3	B-7	13.5 – 15	18.0

4.0 DESIGN AND CONSTRUCTION RECOMMENDATIONS

4.1 General

The following evaluations and recommendations are based on our observations at the site, interpretation of the field and laboratory data obtained during this exploration, and our experience with similar subsurface conditions and projects. Using established correlations, the soil penetration and laboratory test data have been used to develop appropriate lateral earth pressure design parameters. Subsurface conditions in unexplored locations may vary from those encountered.

4.2 Lateral Earth Pressures

The following information is provided to aid in analysis of soil loads on below grade structures. Earth pressures on structures below-grade are influenced by structural design, conditions of structure restraint, methods of construction and/or compaction, and the strength of the materials being restrained. The most common conditions assumed for below grade structure design are the active and at-rest conditions. Active conditions apply to relatively flexible earth retention structures, such as freestanding walls, where some movement and rotation may occur to mobilize soil shear strength. Structures that are rigidly restrained, such as basement, pit, and tunnel walls, require design using at-rest earth pressures.

A third condition, the passive state, represents the maximum possible pressure when a structure is pushed against the soil, and is used in design to help resist active or at-rest pressures. Because significant structure movements are required to develop the passive pressure, the total calculated passive pressure should be reduced by one-half to two-thirds for design purposes.

Based on the subsurface exploration, the upper 15 feet of the site's subsurface profile generally consists of fill materials and residual soils described as a mixture of clays (CL and CH), silts (ML), as well as clayey and silty sands (SC and SM). We do not typically recommend the use of CH clays as backfill for retaining/below grade walls. However, we envision that a soil mixture including CH clay material could be utilized for below grade structures subjected to equal soil pressures on all sides (i.e. manholes, duct banks, etc.); although with a less favorable assigned lateral earth pressure than parameters assigned to less cohesive or select cohesionless backfill.

The following tables provide lateral earth pressure parameters for the anticipated on-site soils mixture.

ON-SITE SOILS MIXTURE (CL/CH/ML/SC/SM)

Earth Pressure Conditions	Coefficient	Recommended Equivalent Fluid Pressure (pcf)
Active (K_a)	0.44	53
At-Rest (K_o)	0.61	73
Passive (K_p)	2.28	---

* A moist soil unit weight of 120 pounds per cubic foot should be used for design calculations.

For design calculations of resistance to sliding, a value of 0.27 should be used as the coefficient of friction between concrete surfaces and the underlying on-site soils.

Our recommendations assume that the ground surface above the below grade structure is level. The recommended equivalent fluid pressures assume that constantly functioning drainage systems are installed between structures and soil backfill to prevent the accidental buildup of hydrostatic pressures and lateral stresses in excess of those stated. In the event that a functioning drainage system is not installed, the lateral earth pressures should be determined using the buoyant weight of the soil and the appropriate above provided coefficient of earth pressure. Hydrostatic pressures calculated with the unit weight of water (62.4 pcf) should then be added to these earth pressures to obtain the total stresses for design.

Heavy equipment should not operate within 5 feet of below-grade walls to prevent lateral pressures in excess of those cited. If footings or other surcharge loads are located a short distance outside below grade structures, they may also exert appreciable additional lateral pressures. Surcharge loads should be evaluated using the appropriate active or at-rest pressure coefficients provided above. The effect of surcharge loads should be added to the recommended earth pressures to determine total lateral stresses.

These retaining/below grade structure recommendations should not be correlated for use in the design of mechanically stabilized earth (MSE) walls. We recommend that soil parameters for any MSE wall design be established through appropriate laboratory testing directed by the wall designer.

4.3 Subgrade Preparation

Excavations for new structures should be made in such a way as to provide subgrade surfaces that are firm and free of loose, soft, wet, or otherwise disturbed soils. Below grade structures should not be placed on frozen or saturated subgrades. If such materials are allowed to remain below structures, settlements will increase. Water should not be allowed to pond in any excavation.

Based on provided structure bottom elevations as well as the subsurface exploration data, anticipated subgrade conditions appear favorable for support of the intended structures at the locations explored. However, it is possible that soft soil conditions could be encountered at locations intermediate of our boring locations. If or where soft subgrade conditions are encountered, additional evaluation should be requested at the time of construction.

4.4 Controlled Structural Fill

Based on the boring data, controlled structural fill may be constructed using the non-organic on-site soils. If needed, off-site borrow materials should generally have a classification of CL, ML, SM, SC, GM, or GC as defined by the Unified Soil Classification System (USCS). Other materials may be suitable for use as controlled structural fill material and should be individually evaluated by the geotechnical engineer. Controlled structural fill should be free of boulders, organic matter, debris, or other deleterious materials and should have a maximum particle size no greater than 3 inches. In addition, we recommend a minimum standard Proctor (ASTM D 698) maximum dry density of 90 pounds per cubic feet for fill materials.

Fill materials should be placed in horizontal lifts with maximum height of 8 inches loose measure. New fill should be adequately keyed into stripped and scarified subgrade soils and should, where applicable, be benched into existing slopes. During fill operations, positive surface drainage should be maintained to prevent the accumulation of water. We recommend that structural fill be compacted to at least 95 percent of the standard Proctor maximum dry density. In confined areas such as utility trenches, portable compaction equipment and thin lifts of 3 to 4 inches may be required to achieve specified degrees of compaction. Each lift of fill should be tested in order to confirm that the recommended degree of compaction is attained.

In general, we recommend that the moisture content of fill soils be maintained within three percentage points of the optimum moisture content as determined from the standard Proctor density test. We recommend that the contractor have equipment on site during earthwork for both drying and wetting of fill soils. Moisture control may be especially difficult during winter months or extended periods of rain. Attempts to work the soils when wet can be expected to result in deterioration of otherwise suitable soil conditions or of previously placed and properly compacted fill. Where construction traffic or weather has disturbed the subgrade, the upper 8 inches of soils (or more if warranted) intended for structural support should be scarified and re-compacted.

4.5 Excavation Conditions

With the exception of borings B-9 and B-9A, the test borings did not encounter partially weathered rock or auger refusal materials. Therefore, based on the boring data and planned excavation depths, we do not generally envision that difficult excavation conditions will be encountered during planned excavations for the project except for the obstruction at borings B-9/B-9A.

However, as explained in Regional Geology, the Rome formation consists of a highly variable bedrock surface consisting of troughs and pinnacles which may greatly fluctuate in elevation within short lateral distances. Although generally unanticipated, if difficult excavation materials are encountered, the definition of rock can be a source of conflict during construction. The following terms have been used on other projects for defining purposes:

GENERAL EXCAVATION:

Rip Rock - Any material that cannot be removed by scrapers, loaders, pans, dozers, or graders; and requires the use of a single-tooth ripper mounted on a crawler tractor having a minimum draw bar pull rated at not less than 56,000 pounds.

Blast Rock - Any material which cannot be excavated with a single-tooth ripper mounted on a crawler tractor having a minimum draw bar pull rated at not less than 56,000 pounds (Caterpillar D-8K or equivalent) or by a Caterpillar 977 front-end loader or equivalent; and occupying an original volume of at least one (1) cubic yard.

TRENCH EXCAVATION:

Blast Rock - Any material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 25,700 pounds (Caterpillar Model 225 or equivalent), and occupying an original volume of at least one-half (1/2) cubic yard

4.6 Temporary Slopes

Our exploration did not include a detailed analysis of slope stability for temporary excavation slopes. However, we generally recommend temporary slopes no steeper than 1(H):1(V) up to a maximum height of 20 feet, for construction in undisturbed residual soils or compacted soil fill placed in accordance with our recommendations. For temporary slopes in uncontrolled fill materials, we recommend utilizing a maximum slope configuration of 1.5(H):1(V); however, due to the variability of soil conditions inherent to fill materials, temporary slopes in fill materials should be regularly observed for signs of instability during construction. For excavated slopes constructed in competent rock, we generally recommend temporary slopes no steeper than 0.5(H):1(V). Steeper rock cut slopes may be possible; however, extensive geologic mapping and rock slope stability analyses would be required to consider more aggressive recommendations.

These general excavation slope recommendations are appropriate for slopes underlain by competent materials. However, the provided recommendations should not be used to deviate from OSHA regulations. Construction should be performed in accordance with applicable OSHA regulations. During construction, temporary slopes should be regularly evaluated for signs of movement or unsafe conditions. Soil slopes should be covered for protection from rain, and surface runoff should be diverted away from the slopes.

4.7 Temporary Bracing

Where site or other constraints preclude the use of sloped excavations, some form of temporary bracing will be required. For larger excavations, the temporary bracing system might consist of soldier piles and timber lagging with rows of tie-back tendons, soldier piles with shotcrete lagging, or a soil nail shoring system. For trench excavations, trench box systems might be utilized. The boring data indicates existing fill materials, which should be considered in selection of an appropriate bracing system. Selection of an appropriate bracing system as well as the system's actual design and installation should be performed by a specialty contractor experienced in excavation bracing.

4.8 Subsurface Water Conditions

Subsurface water for the purposes of this report is defined as water encountered below the existing ground surface. Based on the subsurface water data obtained during our exploration program, we generally anticipate that subsurface water will not be encountered during anticipated earthwork or excavations. However, given the site's setting adjacent the Roanoke River, as well as the potential for variable subsurface water conditions intermediate of the boring locations, the contractor should be prepared to dewater during construction. Fluctuations in subsurface water levels and soil moisture can be anticipated with changes in precipitation, runoff, the surface water levels of the Roanoke River, as well as season.

5.0 CONTINUATION OF SERVICES

We recommend that Froehling & Robertson, Inc. be retained for professional and construction materials testing services during construction of the project. Our continued involvement on the project helps provide continuity for proper implementation of the recommendations discussed herein.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of Wiley Wilson or their agent, for specific application to the VAMC Salem 4kV Replacement Project in Salem, Virginia, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. Our conclusions and recommendations are based on design information furnished to us, the data obtained from the previously described subsurface exploration program, and generally accepted geotechnical engineering practice. The conclusions and recommendations do not reflect variations in subsurface conditions which could exist in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to re-evaluate our conclusions and recommendations based upon on-site observations of the conditions.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions at the boring location will differ from those at the structure location, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should evaluate earthwork, pavement, and foundation construction to verify that the conditions anticipated in design actually exist. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or recommendations.

In the event that changes are made in the design or location of the proposed structure, the recommendations presented in the report shall not be considered valid unless the changes are reviewed by our firm and conclusions of this report modified and/or verified in writing. If this report is copied or transmitted to a third party, it must be copied or transmitted in its entirety, including text, attachments, and enclosures. Interpretations based on only a part of this report may not be valid. This report contains 12 pages of text and the attached appendices.

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APPENDIX A

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
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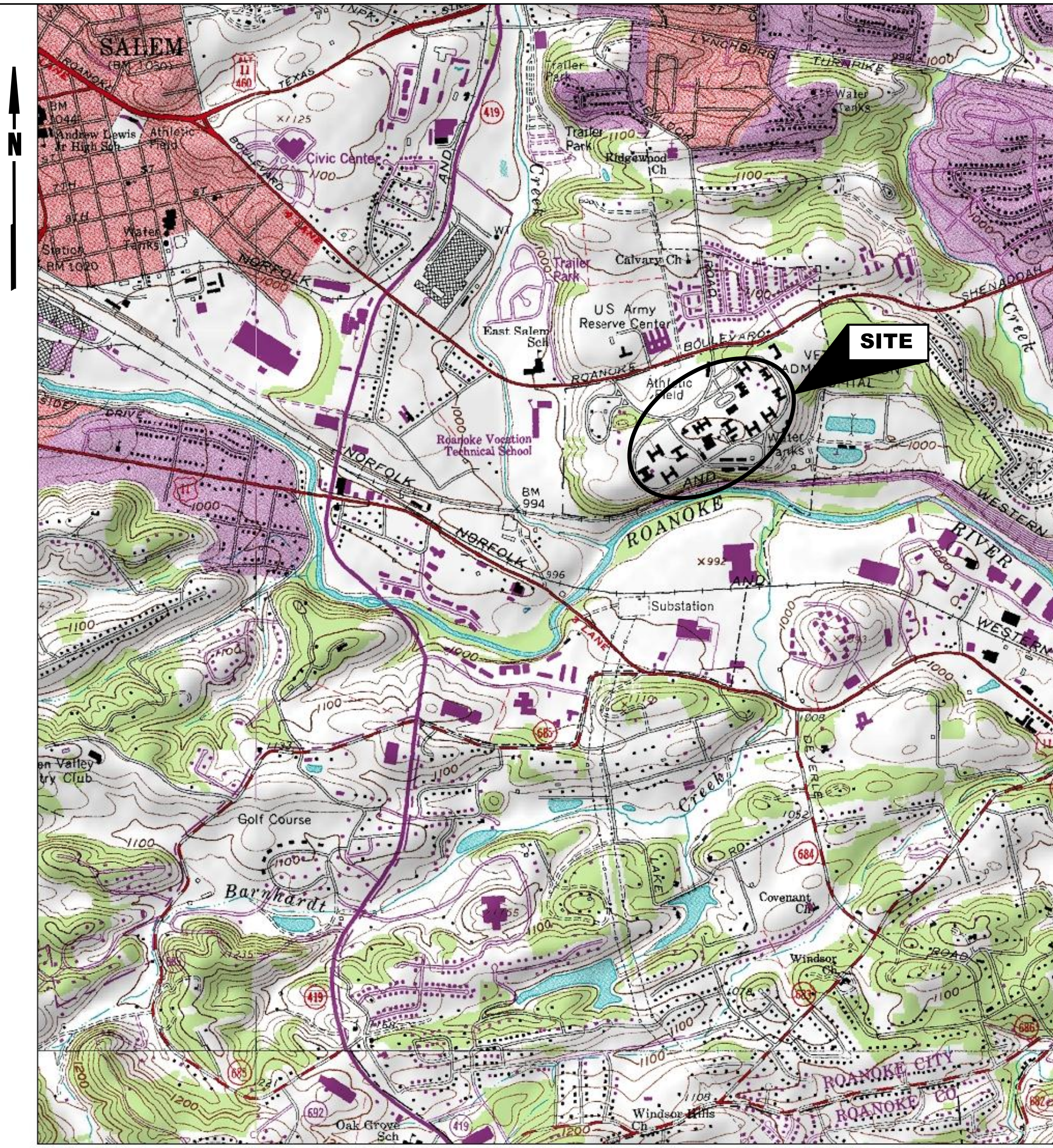
e-mail: info@asfe.org www.asfe.org



Adapted from the USGS 7.5 minute series topographic quadrangle:
Salem, VA (1984)

0 600 1200 1800 2400 3000 3600 ft

FROEHLING & ROBERTSON, INC.
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DATE:	September 2012	
SCALE:	As Shown	
DRAWN:	BWS	62P0257

Wiley Wilson VAMC Salem 4kV Replacement Salem, Virginia	SITE VICINITY MAP	**DRAWING NO.** 1

APPENDIX B

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487
(Based on Unified Soil Classification System)

SOIL ENGINEERING

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retaining on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well graded gravel[F]
			Cu<4 and/or 1>Cc>3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu≥6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand[I]
			Cu<6 and/or 1>Cc>3[E]	SP	Poorly graded sand[I]
		Sands with Fines, More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	Silts and Clays Liquid Limit less than 50	Inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

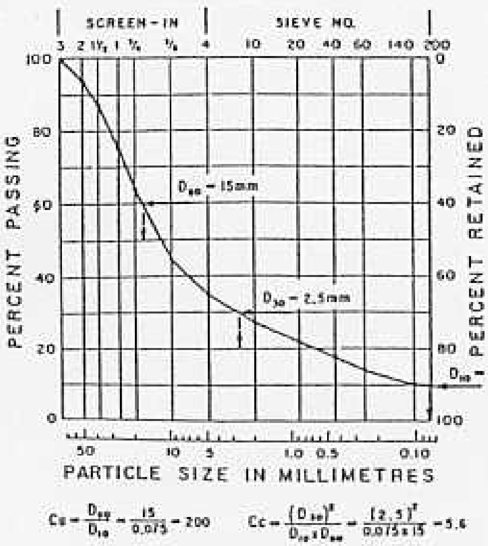
[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

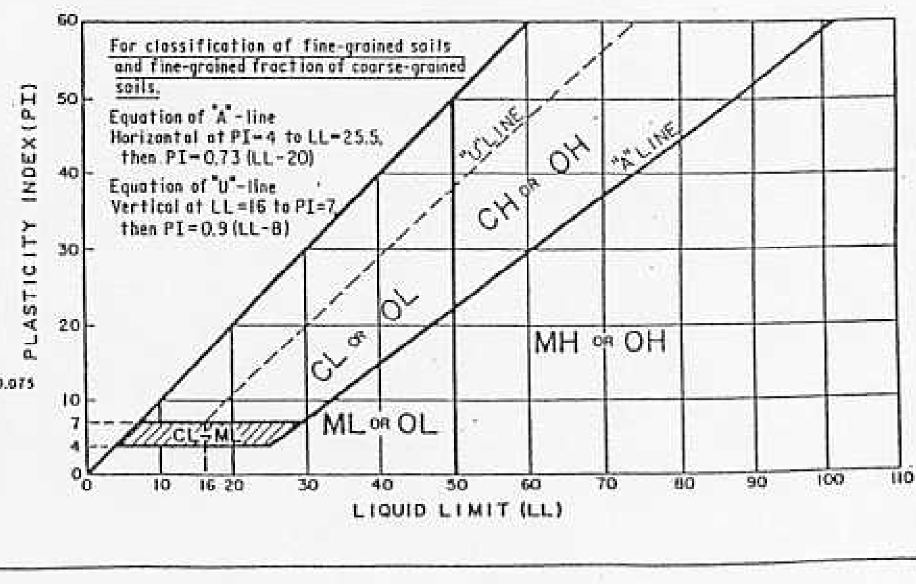
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line
[Q] PI plots below "A" line.

SIEVE ANALYSIS



$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$



KEY TO BORING LOG SOIL CLASSIFICATION

Particle Size and Proportion

Visual descriptions are assigned to each soil sample or stratum based on estimates of the particle size of each component of the soil and the percentage of each component of the soil.

Particle Size Descriptive Terms		Proportion Descriptive Terms		
Soil Component	Particle Size	Component	Term	Percentage
Boulder	> 12 inch	Major	Uppercase Letters	> 50%
Cobble	3 - 12 inch		(e.g., SAND, CLAY)	
Gravel-Coarse	3/4 - 3 inch			
-Fine	#4 - 3/4 inch	Secondary	Adjective	25% - 50%
Sand-Coarse	#10 - #4		(e.g., sandy, clayey)	
-Medium	#40 - #10			
-Fine	#200 - #40	Minor	Some	15% - 25%
Silt (non-cohesive)	< #200		Little	5% - 15%
Clay (cohesive)	< #200		Trace	0% - 5%

Notes:
1. Particle size is designated by U.S. Standard Sieve Sizes
2. Because of the small size of the split-spoon sampler relative to the size of gravel, the true percentage of gravel may not be accurately estimated.

Density or Consistency

The standard penetration resistance values (N-values) are used to describe the density of coarse-grained soils (GRAVEL, SAND) or the consistency of fine-grained soils (SILT, CLAY). Sandy silts of very low plasticity may be assigned a density instead of a consistency.

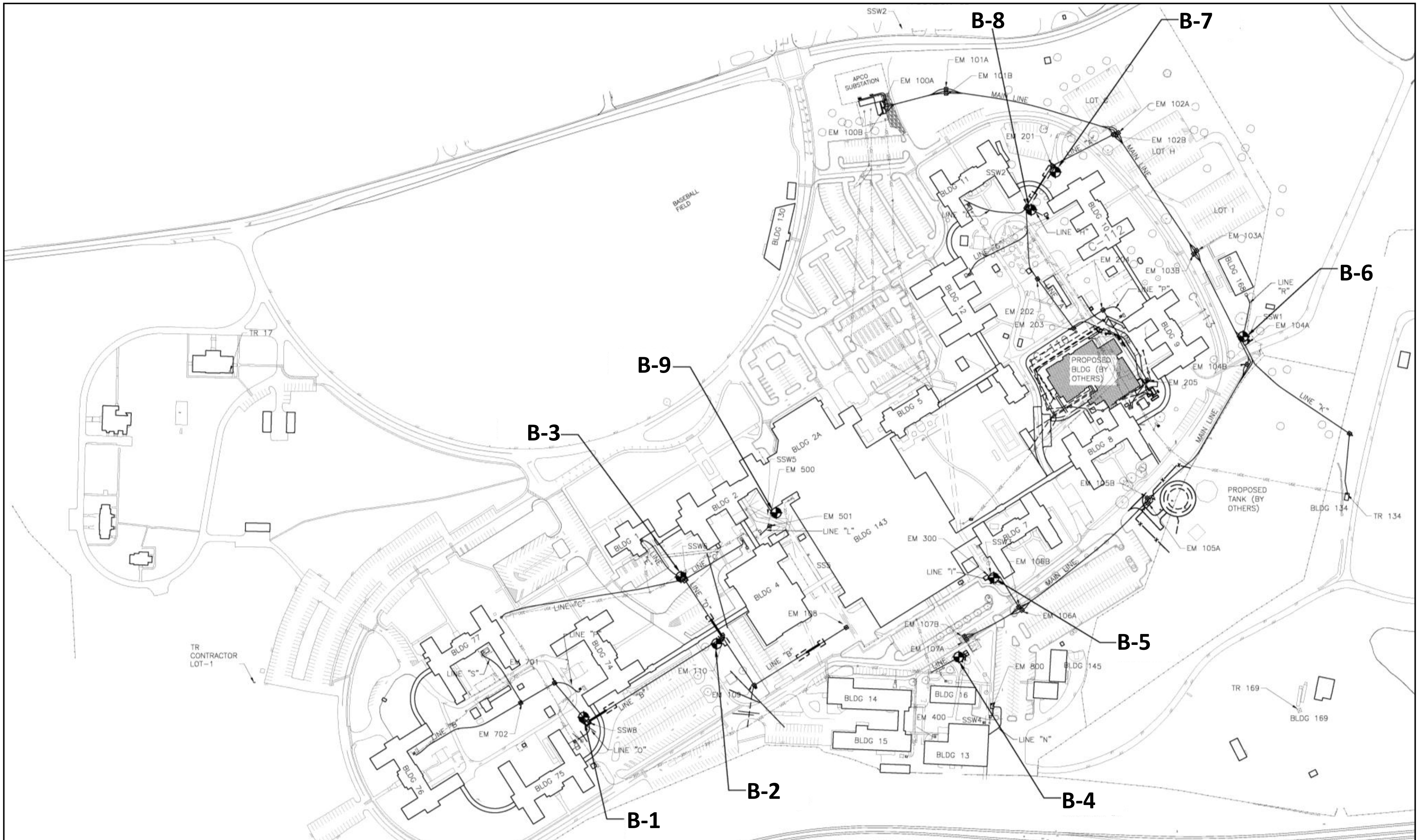
DENSITY		CONSISTENCY	
Term	N-Value	Term	N-Value
Very Loose	0 - 4	Very Soft	0 - 1
Loose	5 - 10	Soft	2 - 4
Medium Dense	11 - 30	Medium Stiff	5 - 8
Dense	31 - 50	Stiff	9 - 15
Very Dense	> 50	Very Stiff	16 - 30
		Hard	> 30

Notes:
1. The N-value is the number of blows of a 140 lb. Hammer freely falling 30 inches required to drive a standard split-spoon sampler (2.0 in. O.D., 1-3/8 in. I.D.) 12 inches into the soil after properly seating the sampler 6 inches.
2. When encountered, gravel may increase the N-value of the standard penetration test and may not accurately represent the in-situ density or consistency of the soil sampled.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
EXISTING FILL				FILL	EXISTING FILL MATERIALS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS



Note: Adapted from provided drawing, *Civil Key Plan Soil Boring Location Map,* Drawing No. C-000 (filename: *SOILBOREMAP.pdf*)

SINCE 1881

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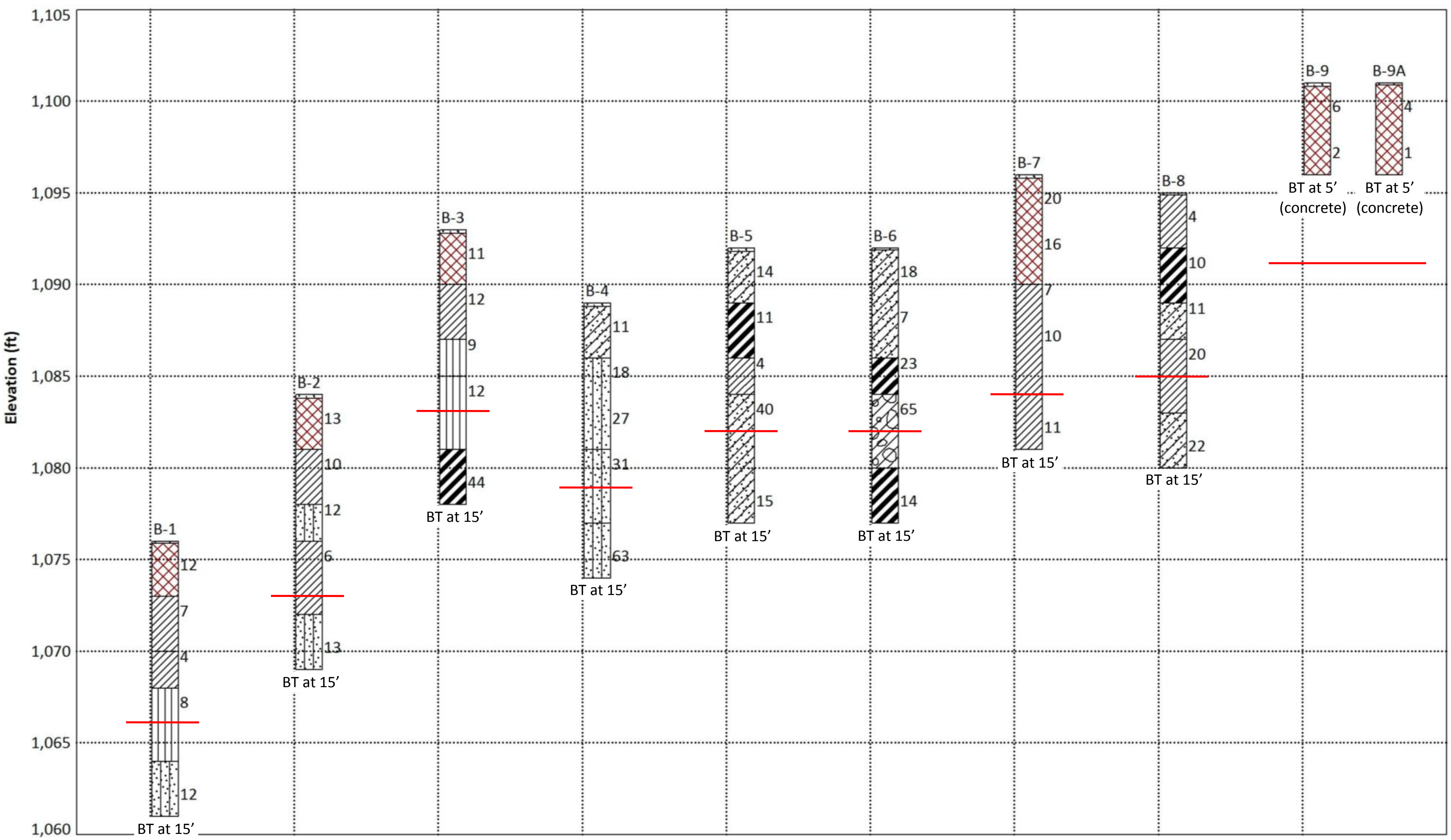
DATE:	September 2012	
SCALE:	Not to Scale	
DRAWN:	BWS	62P0257

Wiley Wilson VAMC Salem 4kV Replacement Salem, Virginia	BORING LOCATION PLAN	**DRAWING NO.** 2



Legend

BT = Boring Terminated
AR = Auger Refusal
—— = Proposed Bottom of Structure at Boring Location

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DATE:	September 2012	
SCALE:	Not to Scale	
DRAWN:	BWS	62P0257

Wiley Wilson
VAMC Salem 4kV Replacement
Salem, Virginia

COMPOSITE SUBSURFACE PROFILE

DRAWING NO. 3

FROEHLING & ROBERTSON, INC.

BORING LOG

Boring: B-1 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1076
Total Depth: 15.0'
Boring Location: No Offset Required

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1075.9	0.1	Surficial Soils	45-8-4	1.0 2.5	12	Subsurface water was not encountered immediately upon completion of drilling.
1073.0	3.0	**FILL:** Sampled as stiff, orange brown, moist, CLAY (CH) with little fine to medium sand				
		RESIDUUM: Medium stiff, orange brown, moist, silty CLAY (CL)	3-4-3	3.5 5.0	7	
1070.0	6.0	Soft, orange brown and light brown, moist, fine to coarse sandy CLAY (CL)	3-2-2	6.0 7.5	4	
1068.0	8.0	Medium stiff, light brown and red brown, moist, fine to medium sandy SILT (ML)	3-3-5	8.5 10.0	8	
1064.0	12.0	Medium dense, light brown, moist, silty fine to coarse SAND (SM)	9-6-6	13.5 15.0	12	
1061.0	15.0	Boring terminated at 15 feet				

*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-Value.

FROEHLING & ROBERTSON, INC.

BORING LOG

Boring: B-2 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1084
Total Depth: 15.0'
Boring Location: Offset ~5' NE of stake

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1083.8	0.2	Surficial Soils		1.0		Subsurface water was not encountered immediately upon completion of drilling.
		FILL: Sampled as stiff, red brown and light brown, moist, fine to coarse, sandy CLAY (CH)	18-7-6	2.5	13	
1081.0	3.0	**RESIDUUM:** Stiff, light brown, moist, fine to coarse sandy CLAY (CL)	3-5-5	3.5 5.0	10	
1078.0	6.0	Medium dense, light brown and red brown, moist, silty fine to coarse SAND (SM)	3-5-7	6.0 7.5	12	
1076.0	8.0	Medium stiff, brown and orange brown, moist, silty CLAY (CL) with little fine to medium sand	2-3-3	8.5 10.0	6	
1072.0	12.0	Medium dense, light brown and orange brown, moist, silty fine to coarse SAND (SM)	4-7-6	13.5 15.0	13	
1069.0	15.0	Boring terminated at 15 feet				

*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-Value.

FROEHLING & ROBERTSON, INC.

BORING LOG

Boring: B-3 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1093
Total Depth: 15.0'
Boring Location: Offset ~5' S of stake

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1092.8	0.2	Surficial Soils				Subsurface water was not encountered immediately upon completion of drilling.
		FILL: Sampled as stiff, brown, moist, silty CLAY (CL) with little fine sand	5-5-6	1.0 2.5	11	
1090.0	3.0	**RESIDUUM:** Stiff, brown and light brown, moist, silty CLAY (CL) with little fine sand	7-6-6	3.5 5.0	12	
1087.0	6.0	Stiff, orange brown, moist, clayey SILT (ML) with some fine to medium sand	3-5-4	6.0 7.5	9	
1085.0	8.0	Stiff, light brown and red brown, moist, clayey SILT (ML) with trace fine sand	3-5-7	8.5 10.0	12	
1081.0	12.0	Hard, tan, moist, CLAY (CH)	11-22-22	13.5 15.0	44	
1078.0	15.0	Boring terminated at 15 feet				

*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-Value.

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BORING LOG

Boring: B-4 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1089
Total Depth: 15.0'
Boring Location: Offset ~4' E of stake

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1088.8	0.2	Surficial Soils				Subsurface water was not encountered immediately upon completion of drilling.
		RESIDUUM: Medium dense, light brown and orange brown, moist, clayey fine to coarse SAND (SC) with little fine gravel	21-5-6	1.0 / 2.5	11	
1086.0	3.0	Medium dense, light brown and gray, moist, silty fine to coarse SAND (SM)	6-8-10	3.5 / 5.0	18	
			13-13-14	6.0 / 7.5	27	
1081.0	8.0	Dense, gray, moist, silty fine to coarse SAND (SM)	18-15-16	8.5 / 10.0	31	
1077.0	12.0	Very dense, gray and brown, moist, silty fine to coarse SAND (SM) with some fine gravel	31-38-25	13.5 / 15.0	63	
1074.0	15.0	Boring terminated at 15 feet				

BORING LOG 62P-0257.GPJ F&R.GDT 9/14/12

*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-Value.

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BORING LOG

Boring: B-5 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1092
Total Depth: 15.0'
Boring Location: Offset ~5' W of stake

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1091.8	0.2	Surficial Soils		1.0		Subsurface water was not encountered immediately upon completion of drilling.
		RESIDUUM: Medium dense, red brown and brown, moist, clayey fine to coarse SAND (SC)	20-7-7	2.5	14	
1089.0	3.0	Stiff, red brown, moist, fine to coarse sandy CLAY (CH) with little fine gravel		3.5		
			5-6-5	5.0	11	
1086.0	6.0	Stiff, red brown, mosit, fine to coarse sandy CLAY (CL)		6.0		
			4-2-2	7.5	4	
1084.0	8.0	Dense to medium dense, orange brown and red brown, moist, clayey fine to coarse SAND (SC) with little fine gravel		8.5		
			4-27-13	10.0	40	
				13.5		
			5-7-8	15.0	15	
1077.0	15.0	Boring terminated at 15 feet				

*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-Value.

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BORING LOG

Boring: B-6 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1092
Total Depth: 15.0'
Boring Location: No Offset Required

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1091.9	0.1	Surficial Soils				Subsurface water was not encountered immediately upon completion of drilling.
		RESIDUUM: Medium dense to loose, brown and orange brown, moist, clayey fine to coarse SAND (SC)	17-8-10	1.0 - 2.5	18	
			4-4-3	3.5 - 5.0	7	
1086.0	6.0	Very stiff, red brown, moist, CLAY (CH) with little fine sand	8-11-12	6.0 - 7.5	23	
1084.0	8.0	Very dense, light brown and red brown, moist, fine to coarse GRAVEL (GC) with some fine to coarse sand and little clay	39-37-28	8.5 - 10.0	65	Drillers note rocky drilling from approximately 8.5 to 10.5 feet
1080.0	12.0	Stiff, light brown and red brown, moist, CLAY (CH)	10-6-8	13.5 - 15.0	14	
1077.0	15.0	Boring terminated at 15 feet				

*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-Value.

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BORING LOG

Boring: B-7 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1096
Total Depth: 15.0'
Boring Location: Offset ~5' E of stake

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1095.8	0.2	Surficial Soils				Subsurface water was not encountered immediately upon completion of drilling.
		FILL: Sampled as medium dense, red brown, moist, clayey SAND (SC) -with little fine gravel from 3 to 6 feet	9-9-11	1.0 - 2.5	20	
			6-8-8	3.5 - 5.0	16	
1090.0	6.0	**RESIDUUM:** Medium stiff to stiff, red brown, moist, silty CLAY (CL) with some fine to coarse sand	4-4-3	6.0 - 7.5	7	
			6-5-5	8.5 - 10.0	10	
1084.0	12.0	Stiff, red brown, moist, fine to coarse sandy CLAY (CL)	4-5-6	13.5 - 15.0	11	
1081.0	15.0	Boring terminated at 15 feet				

*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-Value.

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SINCE 1881

BORING LOG

Boring: B-8 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1095
Total Depth: 15.0'
Boring Location: Offset ~15' SW of stake

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1094.9	0.1	Surficial Soils		1.0		Subsurface water was not encountered immediately upon completion of drilling.
		RESIDUUM: Soft, red brown, moist, CLAY (CL) with some fine to coarse sand	12-2-2	2.5	4	
1092.0	3.0	Stiff, red brown, moist, CLAY (CH) with some fine to coarse sand		3.5		
			3-4-6	5.0	10	
1089.0	6.0	Medium dense, red brown, moist, clayey fine to coarse SAND (SC)		6.0		
			3-5-6	7.5	11	
1087.0	8.0	Very stiff, red brown, moist, fine to coarse sandy CLAY (CL)		8.5		
			3-10-10	10.0	20	
1083.0	12.0	Medium dense, red brown and brown, moist, clayey fine to coarse SAND (SC) with little fine gravel		13.5		Drillers note rocky drilling from approximately 12 to 13.5 feet
			8-14-8	15.0	22	
1080.0	15.0	Boring terminated at 15 feet				

*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-Value.

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BORING LOG

Boring: B-9 (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1101
Total Depth: 5.0'
Boring Location: No Offset Required

Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1100.8	0.2	Surficial Soils				Subsurface water was not encountered immediately upon completion of drilling.
		FILL: Sampled as medium stiff to soft, brown and light brown, moist, CLAY (CL) with some fine to coarse sand	10-3-3	1.0 2.5	6	
			1-2	3.5 5.0	2	
1096.0	5.0	Boring terminated at 5 feet on presumed concrete obstruction				Final split-spoon sampling interval truncated due to obstruction

*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-Value.

FROEHLING & ROBERTSON, INC.

BORING LOG

Boring: B-9A (1 of 1)

Project No: 62P0257
Client: Wiley Wilson
Project: VAMC Salem 4kV Replacement
City/State: Salem, VA

Elevation: 1101
Total Depth: 5.0'
Boring Location: Offset ~5' SW of B-9

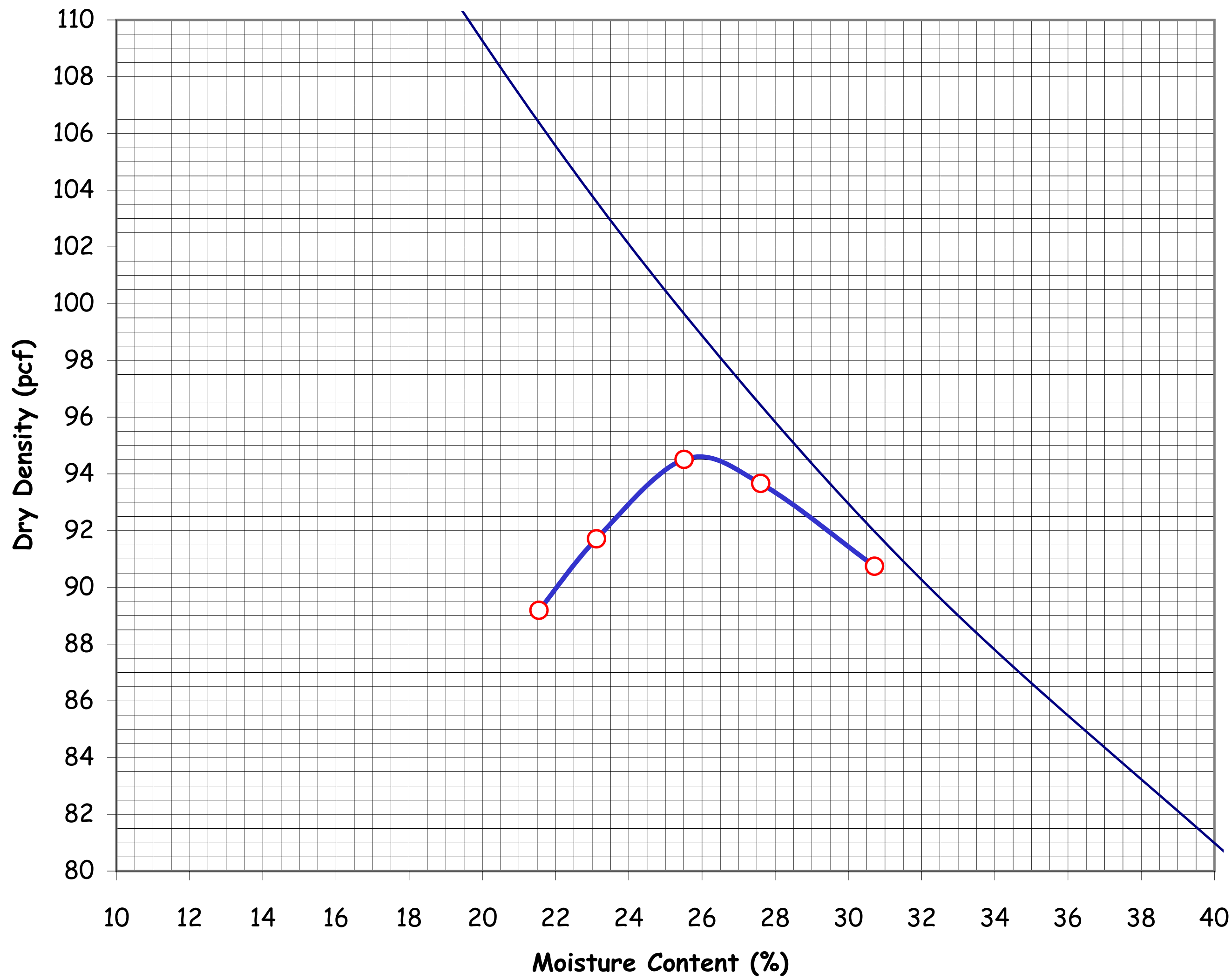
Drilling Method: 2.25" ID HSA
Hammer Type: Automatic
Date Drilled: 8/16/12
Driller: W. Wilson

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1100.9	0.1	Surficial Soils		1.0		Subsurface water was not encountered immediately upon completion of drilling. 0 = WOH = Weight of Hammer
		FILL: Sampled as soft to very soft, brown and light brown, moist, CLAY (CL) with some fine to coarse sand	13-2-2	2.5	4	
			1-1-0	3.5		
1096.0	5.0	Boring terminated at 5 feet on presumed concrete obstruction		5.0	1	

*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-Value.

APPENDIX C

Moisture-Density Relationship



MOISTURE-DENSITY RELATIONSHIP TEST			
ASTM D-698, Method A	Rammer Type: Manual	Preparation Method: Dry	
Boring No.:	B-3	Depth (ft):	0'-5'
Soil Description:	Orangish Brown		
USCS Classification:			

Liquid Limit (LL):		**Max. Dry Density, $\gamma_{d\ max}$ (pcf):**	**94.6**
Plastic Limit (PL):		**Optimum Moisture Content, $m_{c\ opt}$ (%):**	**26.0**
Plastic Index (PI):		Assumed Specific Gravity, G_s:	2.70
% Passing No. 200 Sieve:	92.8	Test Fraction. P_F (%)	100.0
Received Moisture Content (%)	34.7	Oversize Fraction, P_c (%)	0.0

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VAMC Salem 4kV Replacement
F&R Project No. 62P-0257

Project No.:	**G-694**
Date:	**9/7/2012**
Sheet:	

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