

Geotechnical Engineering Report

**Tomah VAMC Warehouse
Oshkosh, Wisconsin**

January 7, 2017

Terracon Project No. MR165406

Prepared for:

Nagel Architects + Engineers
Elm Grove, Wisconsin

Prepared by:

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January 7, 2017



Nagel Architects + Engineers
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Attn: Mr. Rich Luce
Email: rich.luce@nagel.us

Re: Geotechnical Engineering Report
Tomah VAMC Warehouse
Tomah, Wisconsin
Terracon Project No. MR165406

Dear Mr. Luce:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with our proposal signed November 23, 2016. This geotechnical engineering report presents the results of the subsurface exploration and provides recommendations regarding earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service to you, please contact us.

Sincerely,

TERRACON CONSULTANTS, INC.

A handwritten signature in black ink, reading "Nick Stefani". The signature is fluid and cursive, with the first and last names clearly legible.

Nick P. Stefani, E.I.
Staff Engineer

A handwritten signature in black ink, reading "Paul A. Tarvin". The signature is fluid and cursive, with the first and last names clearly legible.

Paul A. Tarvin, P.E., FAEC
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Geotechnical



Environmental



Construction Materials



Facilities

EXECUTIVE SUMMARY

Terracon Consultants, Inc. (Terracon) has completed the subsurface exploration for the proposed Tomah VAMC Warehouse to be constructed within the Tomah VA facility at 500 E. Veterans Street in Tomah, Wisconsin. Seven borings extending to depths of 15 feet were performed for the project site. This report describes the subsurface conditions encountered at the boring locations, presents the test data, and provides recommendations regarding the design and construction of foundations, floor slabs and pavements for the proposed project.

Based on the information obtained from our subsurface exploration, it is our opinion that the site can be developed for the proposed project. The following geotechnical considerations were identified:

- The soil borings generally encountered 4 to 6 inches of topsoil at the surface underlain by fill to a depth of 3 to 5.5 feet. The fill consisted of clayey sand, sand with clay and lean clay. The fill was underlain by medium dense poorly graded sand to the boring termination depths of 15 feet. Water was observed between 4 feet and 10 feet below grade, roughly corresponding to elevation 943 to 947 feet. Some excavation dewatering may be required due to the shallow groundwater conditions, depending on the final finish floor elevation.
- The proposed building can be supported on shallow spread footings bearing on the native medium dense sands below the fill, or on newly placed engineered fill or lean concrete extending to suitable native soils at minimum footing frost depths. A maximum net allowable soil bearing pressure of 3,000 pounds per square foot (psf) can be used for footings supported directly on the medium dense sand, or on lean concrete extending to the native sand. Average total settlements of about 1 inch or less are expected.
- The floor slab for the new building can be supported at grade on the existing fill soils or on newly placed engineered soil fill used to raise site grades, provided the floor slab subgrade is observed, tested and approved as recommended in this report. We recommend that a minimum 6-inch thick granular leveling course be placed directly below the slab to provide uniform support.
- Pavements for parking or drive areas can be supported at grade on the existing fill soils or on newly placed engineered soil fill used to raise site grades. The existing fill soils should be prepared, observed and tested as recommended in this report to confirm that they are suitable for support of new pavements.
- The on-site cohesive fill and granular fill soils typically appear suitable for use as engineered soil fill, provided they are placed with controlled density and moisture content as recommended in this report and do not contain appreciable amounts of organic material.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to provide observation/testing during this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
TOMAH VAMC WAREHOUSE
OSHKOSH, WISCONSIN
Terracon Project No. MR165406
January 7, 2017

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) has completed the subsurface exploration for the proposed Tomah VAMC Warehouse to be constructed within the Tomah VA facility at 500 E. Veterans Street in Tomah, Wisconsin. Seven borings extending to depths of 15 feet below existing grades were performed for the project site. Boring logs and a Boring Location Diagram are included in Appendix A. This report describes the subsurface conditions encountered at the boring locations, presents the test data, and provides geotechnical engineering recommendations regarding the following items:

- site preparation and earthwork
- foundation design and construction
- construction dewatering
- estimated infiltration rates
- floor slab design and construction
- seismic considerations
- preliminary pavement recommendations

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-2 Exploration Plan.
Proposed Structures	The proposed site contains an existing building that will be demolished to facilitate construction of the proposed warehouse. The 16,000 square foot building, single story, slab-on-grade will be metal framed.
Finished floor elevation	The building finished floor elevation is anticipated to be 948 feet.
Maximum loads	The following structural loads were provided in the RFP. Maximum column loads: 100 kips Maximum wall loads: 2 kips per lineal foot Floor slab loads (provided by Client): The floor slab will support storage racks with a maximum average soil pressure of 1,000 psf under the racks.
Below-grade walls	None are anticipated.

Item	Description
Grading	Based on our understanding site, proposed building and current site grades, cuts and fills on the order 2 to 7 feet will be required to establish the finished floor elevation for the new warehouse.
Pavements	A new truck area is planned to the south of the new VAMC warehouse.

2.2 Site Location and Description

Item	Description
Location	Within the Tomah VA facility at 500 E. Veterans Street, Tomah, Wisconsin
Existing improvements	The site is currently occupied by an existing building that will be demolished. There is a fenced area in the north part of the site that is functioning as a materials stockyard. The rest of the site is covered with grass or asphalt. A large pond exists on the western edge of the project footprint.
Existing topography	There is approximately 4 to 5 feet of topographic relief across the site, with the site grades declining slightly from east to west.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Subsurface conditions at each boring location are described on the individual boring logs in Appendix A. The stratification boundaries shown on the boring logs represent the approximate depths where changes in material types occur. In-situ, transitions between material types can be more gradual in both the vertical and horizontal directions. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum	Material Encountered	Consistency/Density ¹
Surface	4 to 6 inches	Topsoil	Not applicable
Stratum 1	3 to 5.5 feet	Fill: Lean clay, sand with clay and clayey sand ¹	Cohesive: very stiff Granular: loose to medium dense
Stratum 2	Termination depth of 15 feet	Poorly graded sand with trace silt and clay	Medium dense to dense

1. Fill was not encountered in boring B-1
2. Sand with silt and traces of clay was encountered beneath the fill to a depth of 5½ feet in boring B-7

3.2 Water Level Observations

The borings were observed during and after completion of drilling for the presence and level of water. Due to the relatively moderate to high permeability of the native granular soils, we expect these observations to provide a relatively good indicator of the long term position of the groundwater table. The water levels observed during drilling are presented on the boring logs and are summarized in the following table.

Boring Number	Groundwater Depth After Drilling ^{1,2} (ft)	Groundwater Elevation After Drilling ² (ft)
B-1	4	946.5
B-2	5	947
B-3	3.5	947.5
B-4	13	943
B-5	6.5	944.5
B-6	8	944
B-7	8.5	942.5

1. Below grade
2. Measurements have been rounded down to the nearest 0.5 foot

However, water levels may fluctuate due to seasonal variations in the amount of rainfall, runoff, the level of the adjacent pond to the west, and other factors not evident at the time the borings were performed. Trapped or “perched” water can occur above lower permeability soil layers. The possibility of water level fluctuations should be considered when developing design and construction plans for the project. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels at sites with predominantly cohesive soils.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The borings encountered approximately 4 to 6 inches of topsoil at the surface. Fill was encountered at depths of 3 to 5.5 feet. The fill consisted of lean clay, sand with clay and sandy clay. The undocumented fill was generally underlain by native medium dense sand to the boring

termination depths. Based on the conditions encountered at the boring locations, it is our opinion that the new building can be supported on shallow spread foundations bearing on the medium dense native sand or on lean concrete or engineered soil fill extending to suitable native soils at minimum frost footing depths. Foundations should not be supported on or above the existing undocumented fill materials.

We anticipate that the building floor slab and new pavements can be supported on stable portions of the existing undocumented fill soils provided the owner accepts the risks associated with support of building floor slabs and pavements over undocumented fill in exchange for reduced construction costs. The risk can be reduced through thorough observation and testing of the subgrade during construction as recommended in this report. Where unsuitable conditions are observed, corrective procedures should be implemented (e.g., improvement by scarification/compaction, or removal of unsuitable materials and replacement with engineered fill).

Because of the shallow groundwater conditions, some excavation dewatering may likely be required to construct the building foundations, the extent of which will be dependent on the final finish floor elevation. At present, we understand that the finish floor slab elevation has been established at elevation 948 feet, which is within 2 to 5 feet of the elevation of the water table. We strongly recommend that consideration be given to raising the site grades several feet to provide greater separation between the structure and the water table, thereby reducing the temporary construction dewatering requirements.

The on-site cohesive and granular fill soils and the native inorganic soils typically appear suitable for use as engineered soil fill, provided they are placed with controlled density and moisture content as recommended in this report. Cohesive soils with a high moisture content may require some moisture conditioning (e.g., disking and drying) in order to reduce the in-situ moisture content to a workable level. Fill material containing organic material may be present in the area around boring B-7.

Our recommendations for earthwork, fill placement and compaction, design and construction of shallow spread footings, floor slabs and pavements, seismic site classification and other geotechnical design and construction considerations for the proposed structure are presented in the following sections.

4.2 Earthwork

Recommendations for site preparation, excavation, subgrade preparation and placement of engineered soil fill for the project are provided in the following subsections.

4.2.1 Site Preparation

The areas of any proposed new construction should be cleared of topsoil, debris, and other unsuitable material for an area extending at least five feet beyond the edges of the proposed

building footprint. The existing structures should be removed from within the proposed building footprint. The existing foundation elements could remain in place provided they do not interfere with new construction, and there is at least 2 feet of separation between the existing foundation and any new structural element. Stripped topsoil could be stockpiled for later reuse in green areas. Any existing underground utilities that will be impacted by the construction of the new building should be relocated. The exposed subgrade should then be proofrolled to delineate any remaining soft areas. Proofrolling can be accomplished using a loaded tandem-axle dump truck with a gross weight of at least 25 tons, or similarly loaded equipment. Areas that display deflections greater than 1 inch pumping or rutting should be improved by scarification and compaction or by removal and replacement with engineered soil fill as described below.

4.2.2 Engineered Soil Fill Material Requirements

Engineered soil fill should meet the following material property requirements:

Fill Type ^{1,2}	USCS Classification	Acceptable Location for Placement
Granular	GW, GP, GM, GC SW, SP, SM, SC	Below/adjacent to foundations, slabs and pavements
Cohesive	CL, CL-ML	Adjacent to foundations, below/adjacent to slabs and pavements
Unsuitable	CH, MH, ML, OL, OH, PT	Non-structural locations

1. Engineered soil fill should consist of approved materials that are free of organic matter and debris. Granular fill soils should have between 5 and 15% passing the No. 200 sieve. Cohesive (clay) soils used as fill for this project should have liquid limit less than 45 and a plasticity index less than 20; cohesive soils that do not meet these criteria should be considered "unsuitable." Frozen material should not be used, and fill should not be placed on a frozen subgrade.
2. Based on visual and tactile examination of recovered soil samples, the fill and native inorganic soils encountered in the borings would likely meet the criteria for engineered soil fill. Any organic materials, rock fragments larger than 3 inches, and other unsuitable materials should be removed prior to use of the existing fill materials in new fill sections.

4.2.3 Structural Fill Placement and Compaction Requirements

Item	Description
Fill Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used. 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used.

Item	Description
Compaction of Granular Material and Cohesive Soil ^{1, 2}	<p>Fill placed below footing bearing level and in the upper 12 inches below slabs and pavements should be compacted to at least 95% of the material's modified Proctor maximum dry density (ASTM D1557). This level of compaction should extend beyond the edges of the footings at least 8 inches for every foot of fill placed below the foundation base elevation.</p> <p>Fill placed more than 12 inches below final grade for support of floor slabs and pavements should be compacted to at least 92% of the material's modified Proctor maximum dry density.</p>
Moisture Content of Cohesive Soil	Within 2% below to 4% above the modified Proctor optimum moisture content at the time of placement and compaction.
Moisture Content of Granular Material ³	Workable moisture levels.
<ol style="list-style-type: none"> 1. We recommend that engineered soil fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved. 2. If the granular material is a coarse sand or gravel, is of a uniform size, or has a low fines content, compaction comparison to relative density (ASTM D4253 and D4254) may be more appropriate. In this case, granular materials should be compacted to at least 60% of the material's maximum relative density. 3. The gradation of a granular material affects its stability and the moisture content required for proper compaction. Moisture levels should be maintained to achieve compaction without bulking or pumping during placement or when proofrolled. 	

4.2.4 Earthwork Construction Considerations

We recommend that a Terracon geotechnical engineer or his qualified representative be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during stripping of topsoil, subgrade preparation, placement and compaction of controlled compacted fills, backfilling of excavations, and just prior to construction of the building foundations and floor slab.

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. New fill compacted above optimum moisture content or that accumulates water during construction can also become disturbed under construction equipment. Construction traffic over the exposed subgrade should be avoided to the extent practical. If the subgrade becomes saturated, desiccated, or disturbed, the affected materials should either be scarified and compacted or be removed and replaced.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Based on the soil boring results, we anticipate that the majority of shallow excavations will encounter granular fill and native granular soils in the upper soil profile. These materials are classified as Type "C" soils in accordance with OSHA regulations. Therefore, we recommend that shallow excavations be planned at a preliminary 1.5 horizontal to 1.0 vertical (1.5H:1.0V) inclination for Type "C" soils. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

4.2.5 Grading and Drainage

During construction, grades should be developed to direct surface water flow away from or around the site. Exposed subgrades should be sloped to provide positive drainage so that saturation of subgrades is avoided. Surface water should not be permitted to accumulate on the site.

Final grades should slope away from the structures to promote rapid surface drainage. Accumulation of water adjacent to the structures could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement.

4.2.6 Dewatering and Excavation Construction Considerations

Groundwater was encountered as shallow as 3.5 feet below grade after drilling. The anticipated bottom of foundation is expected to be at least 4 feet below the surface to reach minimum frost depths, and up to 5 feet for unheated structures. Thus, shallow excavations to construct the buildings foundations could intercept the local groundwater table and the Contractor should be prepared to dewater the excavations as necessary. We anticipate that excavations extending one to two feet below the level of the water table could be dewatered using conventional sump pit and pump techniques, though multiple sumps and pumps may be required. Excavations extending to greater depths below the water table may require more extensive dewatering measures, such as large diameter pumping wells or vacuum well points. For this reason, we strongly recommend that consideration be given to raising the site grades as much as possible to maintain separation between the new building foundations and floor slabs and the local water table. It is critical for successful performance of the foundations that excavations be adequately dewatered; otherwise, a quick condition may develop at the base of the excavations below the water table wherein the bearing soils will be excessively disturbed and lose strength. The groundwater level should be

lowered to a depth of at least 2 feet below the maximum depth of excavation at the time of construction.

4.3 Foundations

In our opinion, the proposed building can be supported on shallow spread footing foundations bearing on the native medium dense sands below the near surface fill, or on engineered soil fill or lean concrete extending to suitable native soils. Foundations should not bear on or above the existing fill materials. Design recommendations for footing foundations to support the proposed structures are presented below

4.3.1 Shallow Spread Foundation Design Recommendations

Description	Value
Maximum net allowable soil bearing pressure ¹	3,000 psf
Minimum embedment below finished grade for frost protection	4 feet for heated structures ² 5 feet for unheated structures
Approximate total settlement ³	Average of 1 inch or less
Approximate differential settlement ³	1/2 to 2/3 of the total settlement

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. This pressure assumes that any existing fill soils, lower strength soils or otherwise unsuitable materials, if encountered, will be undercut and supported at that lower elevation, or replaced with properly placed and compacted engineered soil fill or lean concrete.
2. Interior footings for heated structures can be supported above the minimum frost depth.
3. The foundation settlement will depend upon variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footing, and if applicable, the thickness of engineered soil fill, and the quality of earthwork operations.

The minimum width of rectangular footings should be 30 inches and the minimum width of continuous footings should be 18 inches to avoid disproportionately small footings sizes.

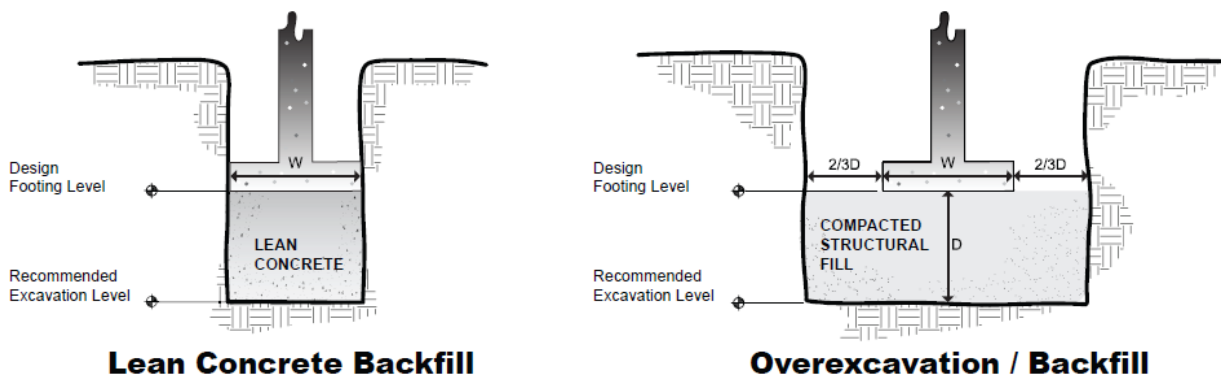
Results of soluble sulfate testing conducted as part of this study indicate less than 100 parts per million (ppm) sulfate content in the soil. The Portland Cement Association suggests that the sulfate attack from soils containing less than 1,000 ppm water soluble sulfate is “negligible”. Therefore ASTM Type I Portland cement should be appropriate for project concrete on or below grade. Foundation concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

4.3.2 Foundation Construction Considerations

The soils at the base of the foundation excavation should be observed and tested to evaluate whether they meet the requirements for suitable bearing soils as defined in this report. The excavation should be probed or otherwise sampled at regular intervals.

The base of the foundation excavation should be free of water and loose sands prior to placing concrete. As previously discussed, groundwater may be encountered during foundation excavations. Concrete should still be placed as soon after excavating as possible to reduce bearing soil disturbance. If the soils at bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. Placement of a lean concrete mud-mat over the bearing soils should be considered if the excavations must remain open overnight or for an extended period of time.

Footings should bear directly on tested and approved native sandy soils or on new engineered soil fill or lean concrete that extends to approved native soils. If unsuitable bearing materials are encountered at the base of a footing excavation, the excavation should be extended deeper to suitable bearing soils. The footing could then bear at this lower elevation or the excavation could be backfilled to the original design footing elevation with engineered soil fill or lean concrete backfill. If engineered soil fill is used as backfill, the base of the excavation should be 8 inches wider on each edge than the footing for each vertical foot of over-excavation, not accounting for sloping or benching. It may be preferable, however, to use lean concrete to backfill any overexcavation to avoid the potential for a loss of strength of the granular bearing soils due to the shallow groundwater conditions. If lean concrete backfill (minimum 28-day compressive strength of 1,500 psi) is used, the excavation should be widened at least 6 inches on all sides of the footing. The recommended extents of the over excavation and backfill procedure are illustrated in the following figure. Note that the sidewalls in this figure are shown vertical for ease of dimensioning. The excavation sidewalls will need to be properly sloped or shored (i.e., with trench boxes, etc.) to prevent caving.



Note: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

4.4 Floor Slab

4.4.1 Floor Slab Design Recommendations

The floor slab for the new building can be supported at grade on the fill or on newly placed engineered soil fill used to raise site grades. We recommend that a minimum 6-inch thick granular leveling course be placed directly below the slab to provide uniform support. Additional floor slab recommendations are provided below.

Item	Description
Floor slab support	Approved in-place granular fill or new engineered soil fill that have been prepared and tested in accordance with section 4.2.
Granular leveling course ¹	Minimum 6 inches of well-graded granular material with less than 5% passing the No. 200 sieve placed directly below the floor slab.
Modulus of subgrade reaction ²	125 pounds per cubic inch (pci) for a subgrade prepared as recommended in this report

1. The floor slab should be placed on a leveling course comprised of well-graded granular material (e.g., WisDOT Open Graded Base) compacted to at least 95% of the material's modified Proctor maximum dry density (ASTM D1557).
2. The recommended modulus value is based on a 12-inch square plate. The modulus value used in design should be adjusted based on the actual size of the floor slab.

Joints should be constructed at regular intervals as recommended by the American Concrete Institute (ACI) to help control the location of cracking. It should be understood that differential settlement between the floor slabs and foundations could occur. Thus, floor slabs should be structurally independent of building footings and walls supported on the footings to reduce the potential for floor slab cracking caused by differential movements between the slab and foundation.

That portion of the floor slab below the storage rack legs could be designed as thickened edges to accommodate the increased loading from the racks. In this case, the thickened edge slab could be designed as a shallow spread foundation or grade beam using the parameters provided in Section 4.3.

The use of a vapor retarder or barrier should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder/barrier, the slab designer and slab contractor should refer to ACI 302 and ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder/barrier.

We anticipate that the total settlement of the floor slab, designed in accordance with this report, will be on the order of ½ inch beneath the storage racks (base pressure of 1,000 psf). Settlement beneath more lightly loaded areas (e.g., 500 psf or less) should be equal to or less than about ½ inch. The floor slab subgrade is anticipated to be capable of supporting the live loads from the forklift, provided the subgrade is prepared, observed and tested as recommended in this report and the slab is underlain by the 6-inch thick compacted granular leveling course as described above.

4.4.2 Floor Slab Construction Considerations

On most project sites, the site grading is generally accomplished early in the construction phase. However as construction proceeds, the subgrade may be disturbed by utility excavations, construction traffic, desiccation, rainfall, etc. As a result, corrective action may be required prior to placement of the granular leveling course and concrete.

The condition of the floor slab subgrades should be reviewed and tested immediately prior to placement of the granular leveling course and construction of the slabs. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing the affected material and replacing it with engineered soil fill.

4.6 Storm Water Design Considerations

We understand that storm water management areas are being considered for development of the site. Though specifics on the location and designs of the pond were not provided, it will likely be constructed within and at depth in the native soils. The native soils encountered in our borings consisted predominantly of sand (s) with occasional loamy sand (ls) and sandy loam (sl) as defined by the USDA Textural Classification System. Per the Wisconsin Department of Natural Resources (WDNR) Technical Standard 1001, the least permeable soil layer within 5 feet of the filter bottom or depth to limiting layer defines the infiltration rate. For this site, the infiltration rate is anticipated to be on the order of 3.6 to 1.63 in/hr. These infiltration rates are derived from standard default rates provided in WDNR Technical Standard 1001, see below.

Soil Texture (USDA abbreviation)	Design Infiltration Rate Without Measurement (inches/hour)
Coarse sand or coarser (cos)	3.60
Loamy coarse sand (lcos)	3.60
Sand (s)	3.60
Loamy sand (ls)	1.63
Sandy loam (sl)	0.50

Soil Texture (USDA abbreviation)	Design Infiltration Rate Without Measurement (inches/hour)
Loam (l)	0.24
Silt loam (sil)	0.13
Sandy clay loam (scl)	0.11
Sandy clay (sc)	0.04
Silty clay (sic)	0.07
Clay (c)	0.07

4.7 Pavements

4.7.1 Subgrade Preparation

Pavement subgrades, likely prepared during the initial phases of construction, should be carefully evaluated prior to paving to delineate any areas that have been softened by rainfall and surface water and/or disturbed by construction. We recommend the moisture content and density of the top 9 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and re-compacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

After proofrolling and repairing deep subgrade deficiencies, the pavement subgrade should be scarified and developed as recommended in Section 4.2 of this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.7.2 Design Considerations

We anticipate that the subgrade in pavement areas will likely consist of existing fill, the native granular soils or new engineered soil fill placed over the existing fill as a means to raise site grades. The native granular soils generally classified as SP per the Unified Soil Classification System. Based on a review of the Natural Resource Conservation Service Web Soil Survey, the primary pedological units in this area of Tomah are generally expected to include the Bilmod sandy loam (466A). The native sandy soils encountered in the soil borings compare favorably with the primary pedological units mapped in the project area and are considered suitable for support of pavements, provided they do not contain appreciable amounts of organic matter and

are prepared as recommended in this report. The following table provides design parameters for use in the design of both bituminous and Portland cement concrete pavements supported on the native lean clay, existing cohesive fill or on engineered soil fill used to raise site grades.

Design Parameter ¹	Value
California Bearing Ratio (CBR)	5
AASHTO Classification (typical)	A-3
Design Group Index (typical)	0
Soil Support Value	5.5
Frost Group Index	F-2
Modulus of Subgrade Reaction	125 pci

1. The design parameters can be used if the following criteria are met during pavement construction:

- Subgrade is inspected properly.
- Subgrade has uniform and adequate compaction.
- Wet or soft soil zones are treated or removed.
- Subgrade soil is a homogeneous mixture.
- Adequate drainage is provided.

4.7.3 Estimates of Minimum Pavement Thickness

All pavements should be designed for the types and volumes of traffic, subgrade and drainage conditions that are anticipated. Traffic patterns and anticipated loading conditions were not available at the time that this report was prepared. However, we anticipate from the preliminary design drawings that traffic loads will be produced by heavy trucks. Based upon the design parameters provided above, we have developed recommended minimum pavement sections for both bituminous and Portland cement concrete, where the subgrade appears firm under proofrolling at the time of construction.

The recommended minimum pavement sections are provided in the following table. The minimum thicknesses provided are based on the assumption of 25,000 total 18-kip Equivalent Single Axle Load Applications (W_{18}) for parking areas and 100,000 W_{18} for truck and drive areas over a 20 year design life. Greater pavement and/or base course thicknesses may be required for greater expected traffic loads and volumes, or if poorer subgrade conditions are encountered. The actual design thickness of pavements should be evaluated using expected traffic volumes, vehicle types, and vehicle loads and should be in accordance with local, city or county ordinances.

Pavement Area	Type	Pavement Thickness (in)	Base Course Thickness ¹ (in)
Standard Duty	Rigid (Concrete) Pavement	5	4
	Flexible (Bituminous) Pavement	3 ²	6

Pavement Area	Type	Pavement Thickness (in)	Base Course Thickness ¹ (in)
Heavy Duty	Rigid (Concrete) Pavement	6	4
	Flexible (Bituminous) Pavement	4 ³	8

1. The base course aggregate beneath the new pavement should conform to the ¾-inch or 1-1/4-inch Dense Graded Base listed in Section 305 of the WisDOT Standard Specifications (current edition). The base course material should be compacted to a minimum of 95% of the modified Proctor density (ASTM D1557) within -2 to +4% of the optimum moisture content.
2. Minimum 1¼ inch asphalt concrete (AC) surface course and 1¾ inch AC binder course.
3. Minimum 1½ inch AC surface course and 2½ AC binder course.

The American Association of State and Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures 1993 procedure, along with engineering judgement, was used to calculate the recommended minimum bituminous and Portland cement concrete thicknesses, and adjusted based on local experience. Asphalt, concrete and aggregate base course materials for pavements should conform to the applicable Wisconsin Department of Transportation Standard Specifications. Concrete pavement should be air-entrained and have a minimum compressive strength of 4,000 psi after 28 days of laboratory curing (ASTM C 31).

4.7.4 Pavement Drainage, Performance and Maintenance

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a pavement maintenance program. Additional engineering observation is recommended to evaluate the type and extent of a cost effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance as described above, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to parking lots and drives should slope down from pavement edges at a minimum 2% ;
- The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote proper surface drainage;
- Install pavement drainage surrounding areas anticipated for frequent wetting;
- Install joint sealant and seal cracks immediately;
- Seal all landscaped areas in, or adjacent to, pavements to reduce moisture migration to subgrade soils;
- Place compacted, low permeability backfill against the exterior side of curb and gutter.

4.8 Seismic Site Class

Code	Site Class
2012 International Building Code (IBC) ¹	D ²
<ol style="list-style-type: none"> 1. In general accordance with Table 20.3-1 of the of ASCE 7-10 Standard (as referenced in the 2012 International Building Code). 2. The 2012 IBC requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The maximum depth explored during our subsurface exploration was about 15 feet. We have assumed that the soil conditions beyond the depths explored are similar to or better than the soil conditions in the upper 15 feet. Thus, based on this section of the IBC and the conditions encountered at the boring locations, Site Class C can be used for design of the proposed project. Additional deeper borings and/or a site-specific seismic evaluation using geophysical methods would be required to further define the seismic site class. 	

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. A qualified geotechnical engineering firm should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

Support of floor slabs and pavements on/above existing fill is discussed in this report. Even with the construction observation/testing recommended in this report, a risk remains for the owner that unsuitable materials within or buried by the fill will not be discovered. This may result in larger than normal settlement and damage to the slab, requiring additional maintenance. This risk cannot be eliminated without removing the existing fill from below the building floor slab and pavements or the use of a structural slab, but can be reduced by quality earthwork operations and thorough observation and testing as discussed herein.

Geotechnical Engineering Report

Tomah VAMC Warehouse ■ Tomah, Wisconsin

January 7, 2017 ■ Terracon Project No. MR165406

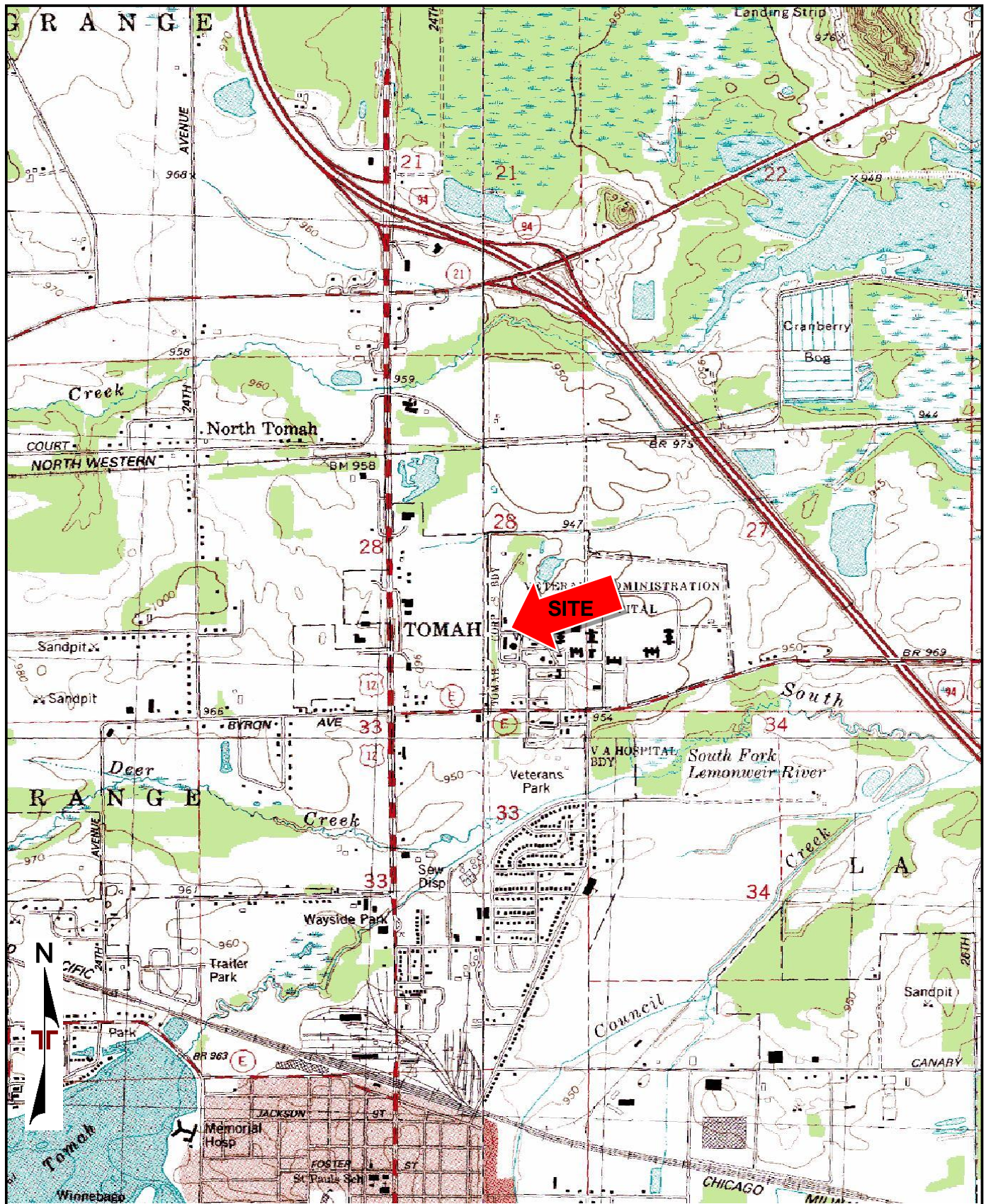


The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
 QUADRANGLES INCLUDE: TUNNEL CITY, WI (1/1/1983), WYEVILLE, WI (1/1/1981), TOMAH, WI (1/1/1983) and OAKDALE, WI (1/1/1983).

Project Manager: JDW	Project No. MR165406	 204 Moravian Valley Rd Ste G Waunakee, WI 53597-2514	SITE LOCATION Tomah VAMC Warehouse 500 East Veteran Street Tomah, WI	Exhibit A-1
Drawn by: PAT	Scale: 1"=2,000'			
Checked by: JDW	File Name:			
Approved by: PAT	Date: Dec 2016			

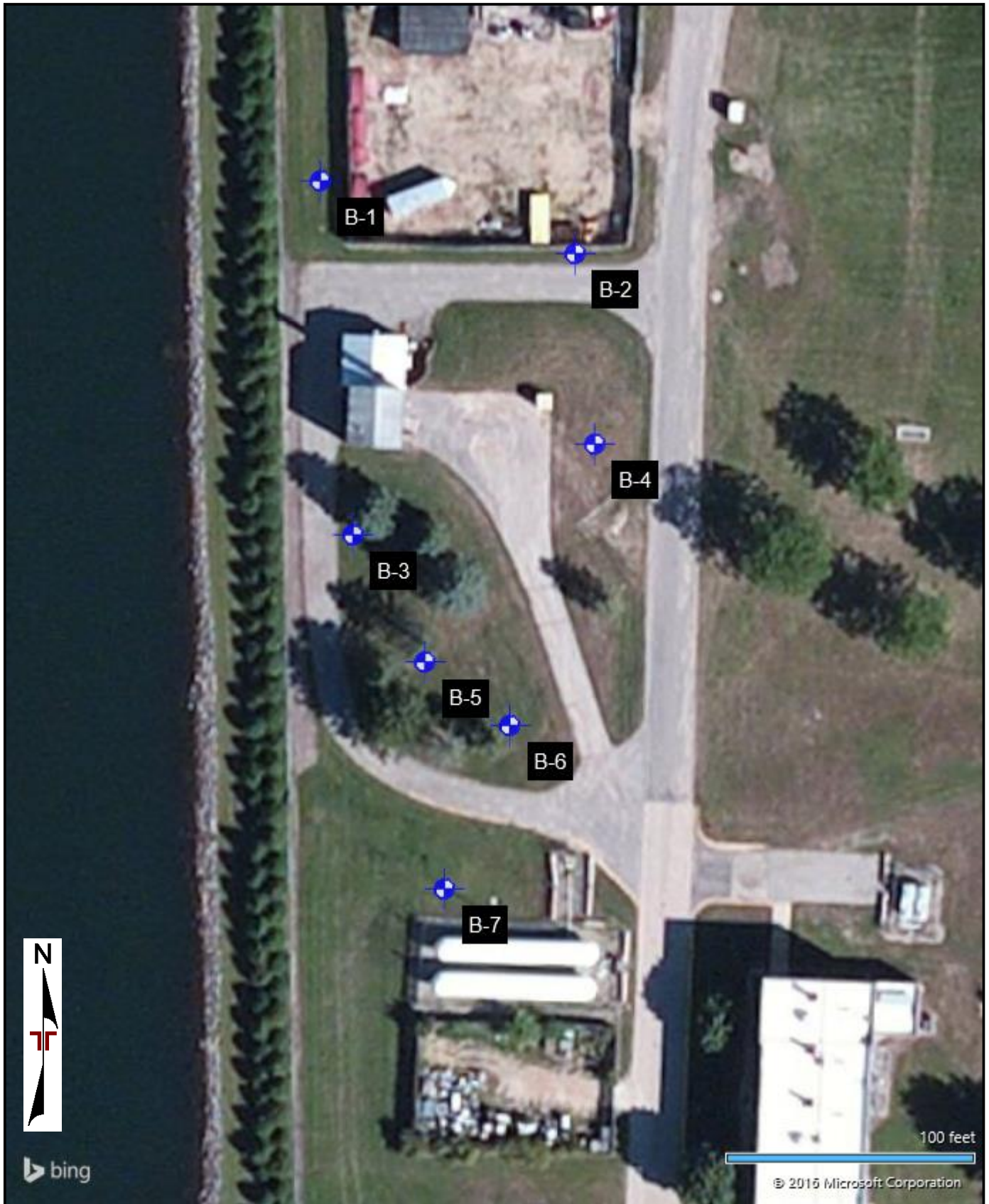


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: JDW	Project No. MR165406	 204 Moravian Valley Rd Ste G Waunakee, WI 53597-2514	<div>EXPLORATION PLAN</div> <div>Tomah VAMC Warehouse 500 East Veteran Street Tomah, WI</div>	Exhibit
Drawn by: PAT	Scale: AS SHOWN			A-2
Checked by: JDW	File Name:			
Approved by: PAT	Date: Dec 2016			

Field Exploration Description

The borings were drilled at the approximate locations indicated on the attached Boring Exploration Plan (Exhibit A-2). Boring locations were provided by the client and located in the field by the drill crew using a measuring tape referencing distances from known features. The ground surface elevations at the individual boring locations were estimated the schematic floor plan with existing ground surface elevations provided by the client. The locations of the borings and ground surface elevations should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a truck-mounted, rotary drill rig using continuous flight, hollow-stemmed augers to advance the boreholes. Soil samples were generally obtained using split-barrel sampling procedures, in which a standard 2-inch (outside diameter) split-barrel sampling spoon is driven into the ground with a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. These values, also referred to as SPT N-values, are an indication of soil strength/relative density and are provided on the boring logs at the depths of occurrence. The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification.

The drill crew prepared a field log of each boring. These logs included visual classifications of the materials encountered during drilling and the driller's interpretation of the subsurface conditions between samples. The boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings and bentonite chips prior to the drill crew leaving the site.

Page 1 of 1

**CLIENT: Nagel Architects + Engineers
Elm Grove, WI**

[illegible]

Hammer Type: Automatic SPT Hammer

Notes:

Exhibit: A-4

BORING LOG NO. B-2

Page 1 of 1

PROJECT: Tomah VAMC Warehouse

CLIENT: Nagel Architects + Engineers
Elm Grove, WI

SITE: 500 East Veterans Street
Tomah, Wisconsin

GRAPHIC LOG	LOCATION See Exhibit A-2	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	HAND PENETROMETER (1st)	WATER CONTENT (%)
	Latitude: 44.00573° Longitude: -90.4994° Surface Elev.: 952 (Ft.) ELEVATION (Ft.)								
	DEPTH								
	0.3 TOPSOIL , Approximately 4" of topsoil 951.5								
	FILL - CLAYEY SAND (SC) , fine grained, brown, loose, moist								
	3.0 949								
	POORLY GRADED SAND (SP) , trace clay, fine grained, tan, medium dense, moist								
	8.0 944								
	POORLY GRADED SAND (SP) , trace silt, fine grained, gray, loose to medium dense, wet								
	15.0 937								
	Boring Terminated at 15 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with bentonite chips.

WATER LEVEL OBSERVATIONS

6 feet while sampling
5 feet after completion

Terracon
204 Moravian Valley Rd Ste G
Waunakee, WI

Boring Started: 12/1/2016

Boring Completed: 12/1/2016

Drill Rig: CME-55

Driller: PTS

Project No.: MR165406

Exhibit: A-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. 15135108 LOG MR165406.GPJ TERRACON2015.GDT 12/13/16

Page 1 of 1

CLIENT: Nagel Architects + Engineers
Elm Grove, WI

LOCATION See Exhibit A-2		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	HAND PENETROMETER (1st)	WATER CONTENT (%)
Latitude: 44.00552° Longitude: -90.49937°	Surface Elev.: 956 (Ft.)								
DEPTH	ELEVATION (Ft.)								
0.3	955.5	5							
TOPSOIL , Approximately 4" of topsoil									
FILL - POORLY GRADED SAND WITH CLAY (SP-SC) , fine grained, brown, medium dense, moist			X	14	4-8-8 N=16	1			
			X	16	6-5-7 N=12	2			
5.5	950.5								
POORLY GRADED SAND (SP) , trace clay, fine grained, gray brown, medium dense, moist									
13.5	942.5								
POORLY GRADED SAND (SP) , trace clay, fine grained, gray brown, medium dense, wet		X	8	3-5-12 N=17	5				
15.0	941								
Boring Terminated at 15 Feet		15							

Hammer Type: Automatic SPT Hammer

Notes:

Exhibit: A-7

BORING LOG NO. B-5

Page 1 of 1

PROJECT: Tomah VAMC Warehouse

CLIENT: Nagel Architects + Engineers
Elm Grove, WI

SITE: 500 East Veterans Street
Tomah, Wisconsin

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 44.00528° Longitude: -90.49963° Surface Elev.: 951.5 (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	HAND PENETROMETER (1st)	WATER CONTENT (%)
	DEPTH ELEVATION (Ft.)								
0.3	TOPSOIL , Approximately 4" of topsoil FILL - POORLY GRADED SAND WITH CLAY (SP-SC) , with organics, fine grained, blackish gray, medium dense, moist	951							
3.0	POORLY GRADED SAND (SP) , trace clay and organics, fine grained, blackish gray, medium dense, moist	948.5							
5.5	POORLY GRADED SAND (SP) , trace clay, fine grained, gray, medium dense, moist	946							
8.0	POORLY GRADED SAND (SP) , trace clay, fine grained, gray, medium dense, wet	943.5							
15.0	Boring Terminated at 15 Feet	936.5							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with bentonite chips.

WATER LEVEL OBSERVATIONS

8.5 feet while drilling
6.5 feet after completion

Terracon
204 Moravian Valley Rd Ste G
Waunakee, WI

Boring Started: 12/1/2016

Boring Completed: 12/1/2016

Drill Rig: CME-55

Driller: PTS

Project No.: MR165406

Exhibit: A-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. 15135108 LOG MR165406.GPJ TERRACON2015.GDT 12/13/16

Page 1 of 1



CLIENT: Nagel Architects + Engineers
Elm Grove, WI

SITE: 500 East Veterans Street
Tomah, Wisconsin

<div style="writing-mode: vertical-rl; transform: rotate(180deg);">GRAPHIC LOG</div>	LOCATION See Exhibit A-2 Latitude: 44.00521° Longitude: -90.4995° <div style="text-align: right;">Surface Elev.: 952 (Ft.)</div>	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	HAND PENETROMETER (lbf)	WATER CONTENT (%)
	DEPTH ELEVATION (Ft.)								
	0.5 TOPSOIL, Approximately 6" of topsoil 951.5								
	FILL - POORLY GRADED SAND WITH CLAY (SP-SC), fine grained, brownish gray, loose, moist		X		12	1-1-2 N=3	1		
	3.0 POORLY GRADED SAND (SP), trace clay, fine grained, gray, medium dense, moist 949		X		18	8-8-12 N=20	2		
		5	X		10	8-12-15 N=27	3		
			V						
			X		7	8-8-7 N=15	4		
		10	V						
	12.0 POORLY GRADED SAND (SP), fine grained, gray, loose, wet 940								
			X		16	1-1-5 N=6	5		
	15.0 Boring Terminated at 15 Feet 937	15							

Hammer Type: Automatic SPT Hammer

Notes:

	8 feet while drilling
	10 feet after completion

Terracon
204 Moravian Valley Rd Ste G
Waukegan, WI

Exhibit: A-9

BORING LOG NO. B-7

Page 1 of 1

PROJECT: Tomah VAMC Warehouse

CLIENT: Nagel Architects + Engineers
Elm Grove, WI

SITE: 500 East Veterans Street
Tomah, Wisconsin

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 44.00503° Longitude: -90.4996° Surface Elev.: 951 (Ft.) DEPTH ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	HAND PENETROMETER (sf)	WATER CONTENT (%)
	0.5 TOPSOIL , Approximately 6" of topsoil 950.5								
	FILL - LEAN CLAY (CL) , black, medium stiff, USDA CLAY								
	3.0 948								
	POORLY GRADED SAND WITH SILT (SP-SM) , trace clay, fine grained, blackish gray, medium dense, moist, USDA LOAMY SAND Sample 2: % Gravel = 0.0, % Sand = 88.4, % Silt = 8.6, % Clay = 3.0								
	5.5 945.5	5							
	POORLY GRADED SAND (SP) , trace clay, fine grained, blackish gray, medium dense, moist, USDA SAND								
	8.0 943								
	POORLY GRADED SAND (SP) , trace clay, fine grained, blackish gray, medium dense, wet, USDA SAND								
	15.0 936	15							
	Boring Terminated at 15 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with bentonite chips.

WATER LEVEL OBSERVATIONS

8 feet while drilling
8.5 feet after completion

Terracon
204 Moravian Valley Rd Ste G
Waukegan, WI

Boring Started: 12/1/2016

Boring Completed: 12/1/2016

Drill Rig: CME-55

Driller: PTS

Project No.: MR165406

Exhibit: A-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL MR165406_REV1.GPJ TERRACON2015.GDT 1/7/17

APPENDIX B
LABORATORY TESTING

Laboratory Testing

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the laboratory testing described above. The soil descriptions presented on the boring logs for native soils are in accordance with the enclosed General Notes and Unified Soil Classification System (USCS). The estimated USCS group symbols for native soils are shown on the boring logs, and a brief description of the USCS is included in this report in Appendix C. The soil samples from boring B-7 were also classified according to the USDA textural system for aid in stormwater design, to be completed by others.

Hand penetrometer tests were performed on cohesive samples to estimate the unconfined compressive strength. Moisture content tests were performed on select cohesive samples recovered using the spilt-barrel sampling procedure. A grain size analysis test was performed on a sample of granular soil from boring B-7 to aid in the USDA classification. The results of all tests performed are shown on the boring logs included in Appendix A and the individual test results are included in Exhibit B-2.

A composite sample obtained from a depth of approximately 1 to 2½ feet in borings B-1 to B-6 was also submitted for laboratory electrical resistivity, pH, soluble sulfates, sulfide and soluble chloride tests to provide information to help evaluate the corrosion potential for underground pipes. The test results are summarized below and the individual test results are included in Exhibit B-2.

Boring No.	Sample depth (feet)	Resistivity ¹ (ohm-cm)	SOIL pH ²	Water Soluble Sulfate ³ (mg/kg)	Sulfides Reaction ⁴	Chlorides ⁵ (mg/kg)	Red-Ox ⁴ (mV)
B-1 to B-6	1 – 2½	10,800 field ⁶ 10,600 sat. ⁷	7.27	25	Negative	55	+215

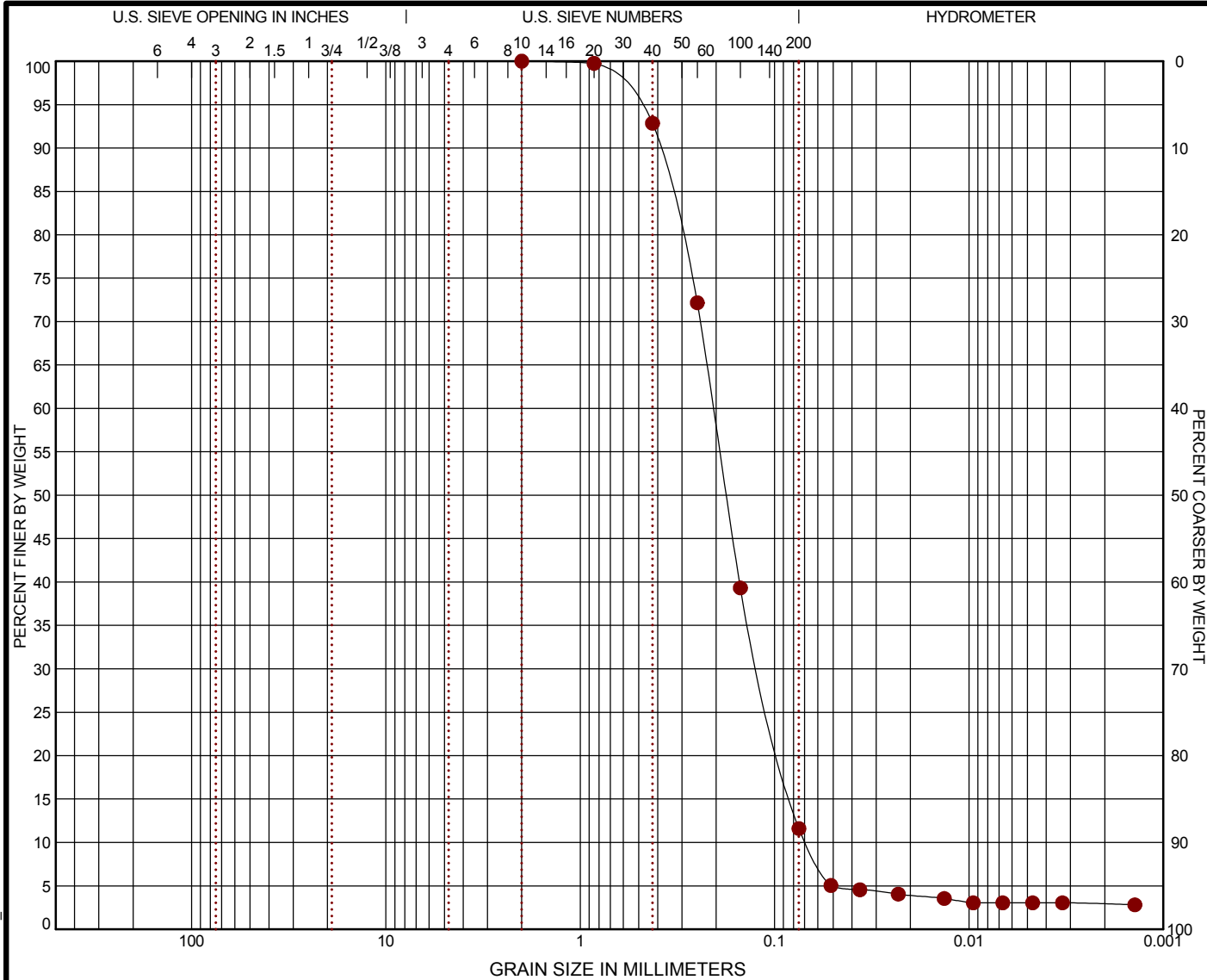
1. AASHTO T280 / ASTM G57
2. AASHTO T289 / ASTM G51
3. AASHTO T290-94
4. DIPRA Method
5. AASHTO T291-94
6. Resistivity of unaltered field sample.
7. Resistivity of field sample after being saturated in the lab.

Procedural standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 MR165406 LAB-COPY.GPJ TERRACON2015.GDT 1/4/17



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
B-7	3.5 - 5	0.0	0.0	88.4	8.6		3.0	SP

GRAIN SIZE			
D_{60}	0.207		
D_{30}	0.119		
D_{10}	0.068		
COEFFICIENTS			
C_c	1.00		
C_u	3.03		

SIEVE (size)	PERCENT FINER		
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#10	100.0		
#20	99.75		
#40	92.85		
#60	72.17		
#100	39.32		
#200	11.6		

SOIL DESCRIPTION
POORLY GRADED SAND WITH SILT (SP-SM), trace clay, brown SP-SM
REMARKS

PROJECT: Tomah VAMC Warehouse	<p>204 Moravian Valley Rd Ste G Waunakee, WI</p>	PROJECT NUMBER: MR165406
SITE: 500 East Veterans Street Tomah, Wisconsin		CLIENT: Nagel Architects + Engineers Elm Grove, WI
		EXHIBIT: B-2

Soil Corrosivity Indication Series

Project No.: MR165406
Project Name: Tomah VAMC Warehouse
Client Name: Nagel Architects
Test Date: 12/22/2016

Summary of Test Results

Boring / Sample No.	Resistivity Natural Miller Soil Box(ohms)	Resistivity Saturated Miller Soil Box(ohms)	pH Soil Water Slurry	REDOX (mV)Soil Water Slurry	Sulfides Reaction	As Received WC%	Saturated WC%	Total Points
B1-B5 1.0'-2.5'	10800	10600	7.27	215	Negative	14.1	16.1	
Points		0	0	0	0			0
Description:	Brown silty sand							

Resistivity:	Points:	pH:	Points:	Redox:	Points:	Sulfides:	Points:
<1500 ohms	10	0.0-2.0	5	Negative	5	Positive	3.5
1500-1800	8	2.0-4.0	3	0 - 50mV	4	Trace	2
1800-2100	5	4.0-6.5	0	50 - 100mV	3.5	Negative	0
2100-2500	2	6.5-7.5	0*	100mV+	0		
2500-3000	1	7.5-8.5	0				
3000+	0	8.5 +	3				

*- If Sulfides are present and a low or neg. ReDox, add 3 points

Tested by: SJH

Checked By: WPQ

CHEMICAL LABORATORY TEST REPORT

Project Number: MR165406
Service Date: 01/04/17
Report Date: 01/04/17
Task: 112

Terracon

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Client

Project

Tomah VAMC Warehouse Project

Sample Submitted By: Terracon (MR)

Date Received: 12/30/2016

Lab No: 16-1099

Results of Soluble Salt Analysis

<i>Sample Number</i>	
<i>Sample Location</i>	B-1 - B-6
<i>Sample Depth (ft.)</i>	1.0-2.5
Water Soluble Sulfate (SO ₄), AASHTO T290 (mg/kg)	25
Chlorides, AASHTO T291, (mg/kg)	55

Analyzed By:














Kurt D. Ergun
Chemist

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING			WATER LEVEL		Water Initially Encountered	FIELD TESTS	(HP) Hand Penetrometer
					Water Level After a Specified Period of Time		(T) Torvane
					Water Level After a Specified Period of Time		(b/f) Standard Penetration Test (blows per foot)
							(PID) Photo-Ionization Detector
	Auger	Split Spoon					(OVA) Organic Vapor Analyzer

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS	RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			BEDROCK		
	Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency)
	Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3	< 30	Weathered
	Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4	30 - 49	Firm
	Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9	50 - 89	Medium Hard
	Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18	90 - 119	Hard
	Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42	> 119	Very Hard
				Hard	> 8,000	> 30	> 42		

RELATIVE PROPORTIONS OF SAND AND GRAVEL

<u>Descriptive Term(s) of other constituents</u>	<u>Percent of Dry Weight</u>
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

<u>Major Component of Sample</u>	<u>Particle Size</u>
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

<u>Descriptive Term(s) of other constituents</u>	<u>Percent of Dry Weight</u>
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

<u>Term</u>	<u>Plasticity Index</u>
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A					Soil Classification	
					Group Symbol	Group Name ^B
Coarse Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained 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:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K,L,M,N}
			Liquid limit - not dried			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:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K,L,M,P}
			Liquid limit - not dried			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-inch (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

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

^F If soil contains $\geq 15\%$ 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 $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded 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 $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

^M If soil contains $\geq 30\%$ 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.

