



GEOTECHNICAL EXPLORATION AND ENGINEERING REVIEW

VA Medical Center Parking Ramp

1 Veterans Drive
Minneapolis, Minnesota

NTI Project No. 11.50534.100



NORTHERN TECHNOLOGIES, INC.

6588 141st Avenue NW, Ramsey, MN 55303 763-433-9175 763-323-4739 Fax

March 28, 2011

Leo A. Daly
730 Second Avenue South
Suite, 1100
Minneapolis, Minnesota 55402-2454

Attn: Mr. John D. Albers

Subject: Geotechnical Exploration and Engineering Review
VA Medical Center Parking Ramp
1 Veterans Drive
Minneapolis, Minnesota
NTI Project No. 11.50534.100

Dear Mr. Albers:

In accordance to your request and subsequent February 1, 2011 authorization, Northern Technologies, Inc. (NTI) conducted a Geotechnical Exploration for the above referenced project. Our services included drilling ten exploratory borings and preparation of an engineering report with recommendations developed from our geotechnical services. Our work was performed in general accordance with our proposal of January 21, 2011.

Soil samples obtained at the site will be held for 6 months at which time they will be discarded. Please advise us in writing if you wish to have us retain them for a longer period.

We appreciate the opportunity to have been of service on this project. If there are any questions regarding our review and recommendations, please contact us at (763) 433-9175.

Northern Technologies, Inc.

Anthony Francis, P.E.
Project Engineer

Mervyn Mindess, P.E.
Senior Project Engineer



TABLE OF CONTENTS
GEOTECHNICAL EXPLORATION AND ENGINEERING REVIEW

VA Medical Center Parking Ramp
Minneapolis, Minnesota

NTI Project No. 11.50534.100

	<u>Page</u>
1.0 EXECUTIVE SUMMARY	1
2.0 INTRODUCTION	2
2.1 Site / Project Description	2
2.2 Scope of Services	2
3.0 EXPLORATION PROGRAM RESULTS	3
3.1 Exploration Scope	3
3.2 Surface Conditions	3
3.3 Subsurface Conditions	4
3.4 Ground Water Conditions	5
3.5 Laboratory Test Program	5
4.0 ENGINEERING REVIEW AND RECOMMENDATIONS	5
4.1 Project Scope	5
4.2 Site Preparation/Foundation Support	5
4.3 Shallow Foundations	6
4.4 Deep Foundations	7
4.5 Bearing Factor of Safety and Estimate of Footing Settlement	9
4.6 Exterior Backfill & Subsurface Drainage	10
4.7 Surface Drainage	11
4.8 Utilities	11
4.9 Pavement Construction	12
5.0 CONSTRUCTION CONSIDERATIONS	15
5.1 Excavation Stability	15
5.2 Engineered Fill and Winter Construction	15
6.0 CLOSURE	15
APPENDICES	
Appendix A - Geotechnical Evaluation of Recovered Soil Samples, Field Exploration Procedures, General Notes, Classification of Soils for Engineering Purposes, Excavation Oversize Diagram	
Appendix B - Ground Water Issues, Placement and Compaction of Engineered Fill	
Appendix C - Site Diagram, Boring Logs	



GEOTECHNICAL EXPLORATION AND ENGINEERING REVIEW

VA Medical Center Parking Ramp
Minneapolis, Minnesota

NTI Project No. 11.50534.100

1.0. EXECUTIVE SUMMARY

We briefly summarize below our geotechnical recommendations for the proposed project. The summary must be read in complete context with our report.

- The uppermost sand soils at this site are loose and are not suitable for the use of standard shallow foundations without improvements. Our report presents three options for founding the Parking Ramp:
 1. Improving the existing soils by excavating the upper loose sand and replacing it and compacting it in layers as engineered fill
 2. Deep foundation consisting of drilled shaft concrete piers.
 3. Compacted stone piers (the Impact® System by Ground Improvement Engineering) to improve the existing soils.
- Our exploration indicates the existing bituminous pavement and aggregate base course in the area of the proposed ramp extends to approximately 0.6 to 0.7 feet below existing grade. Fill occurs at Borings 1, 3, 4, 7, 8, 9, and 10 to depths of 4.5 to 11.5 feet below existing grade.
- Measurable groundwater was encountered at approximately 39.5 feet below grade in Boring 6, corresponding to elevation 802.9 feet. A lens of perched groundwater occurs at 19.5 foot depth in Boring 7, corresponding to elevation 822.7 feet. Free groundwater was not observed in the other borings.



2.0. INTRODUCTION

2.1. Site / Project Description

The area of the proposed Parking Ramp is currently a bituminous paved parking lot northeast of the Hospital at the VA Medical Center Campus at 1 Veterans Drive in Minneapolis, Minnesota.

The Parking Ramp will be a four story structure with a height of approximately 50 feet. The ramp will be constructed utilizing braced steel framing and precast concrete double-tee planks for the elevated floors. We assume that the ground floor level will be close to present grade. We were informed by Leo A Daly that the column loads will be up to 1100 kips, and the wall loads will be 1.5 kips per lineal foot.

The parking ramp structure will be approximately 200 feet from the existing hospital, and about 130 feet from an adjacent building northeast of the hospital.

2.2. Scope of Services

The purpose of this report is to present a summary of our geotechnical exploration and provide generalized opinions and recommendations regarding the soil conditions and design parameters for founding of the project. Our scope of services was limited to the following:

1. Explore the project subsurface by means of ten (10) standard penetration borings extending to nominal depths of 20 to 50 feet
2. Submit a geotechnical engineering report presenting the findings from our field exploration and provide engineering recommendations for foundation types, footing depths, allowable soil bearing capacity, estimated settlements, excavation, engineered fill, backfill, compaction and potential construction difficulties related to excavation, backfilling and drainage.



3.0 EXPLORATION PROGRAM RESULTS

3.1 Exploration Scope

NTI performed the subsurface exploration on March 1 through 3 and 14, 2011 with individual borings advanced at the approximate locations shown on the site plan in Appendix C. NTI located the borings relative to existing site features, and determined the approximate elevation of the borings using the catch basin in the parking lot northeast of Boring 3 as a benchmark. The elevation of the benchmark as listed on the survey provided to us is 840.8 feet, National Geodetic Vertical Datum.

We drilled the borings with a truck-mounted CME-55 drill rig operated by a two person crew, following standard and locally accepted drilling and sampling procedures. NTI's drill crew backfilled the boreholes with auger cuttings or high solids bentonite grout per Minnesota Department of Health regulations. Minor settlement of the boreholes will occur. Owner is responsible for final closure of the boreholes.

3.2 Surface Conditions

The property for the proposed Parking Ramp is currently a bituminous paved parking lot. We assume this lot does not include demolition material from prior occupancy or from other off site locations. However portions of this area were filled during previous construction at the VA site. Surface drainage appears to flow towards the existing municipal storm water system. The maximum elevation change among our borings is 2.8 feet.

3.3 Subsurface Conditions

Please refer to the boring logs in Appendix C for detailed descriptions and depths of stratum at each boring. The general geologic origin of retained soil samples is listed on the boring logs. The upper portion of each boring was sampled using auger flights and is approximate.

Our borings penetrated approximately 3 to 4 inches of bituminous pavement and 4 to 6 inches of aggregate base. Fill occurs at Borings 1, 3, 4, 7, 8, 9, and 10 to depths of approximately 4.5 to 11.5 feet below existing grade. The majority of the fill consists of non-organic silty sand, although the uppermost 1 foot of fill in Boring 1 consists of silty sand topsoil. Traces of organics were found within the fill at Borings 4, 7, and 8.



Below the fill, our borings encountered Coarse Alluvium (CA) sand soils with random seams of Fine Alluvium (FA) sandy silt overlying Platteville limestone bedrock. The CA soils consist of sand, sand with silt, silty sand, and clayey sand with varying amounts of gravel and tend to get coarser with depth. These are valley train deposits in the glacial Mississippi river valley. Standard Penetration N-Values in the sand ranged from 4 to over 50 blows per foot, indicating it is very loose to dense in relative density. In general, the uppermost 16 to 22 feet of sand at this site is loose.

A thin layer of sandy clay GT occurs directly above the bedrock in Boring 6 at approximately 44.5 feet below existing grade. The clay is very stiff with a Standard Penetration N-Value of over 50 blows per foot.

Auger refusal was encountered at Boring 10 at a depth of 30 feet below grade, probably on a boulder, and at Boring 6 at a depth of 45.5 feet below grade. A rock core sample was obtained at Boring 6 to determine the type of bedrock in this area. The rock core indicated the bedrock in this area consists of limestone. According to the Minnesota Geological Survey, the bedrock in this area is limestone of the Platteville Formation.

Additional comment on the evaluation of recovered soil samples is presented Appendix A.

The Minnesota Building Code has adopted the IBC 2007 Standards. Based on the soils, this site would be classified as Site Class D for Seismic Design in accordance with IBC Standards. However, the Minnesota Building Code has deleted the Seismic.

3.4 Ground Water Conditions

The drill crew observed the borings for ground water and noted cave-in depth of the borings, during and at the completion of drilling activities. These observations and measurements are noted on the boring logs.

Measurable groundwater was encountered at approximately 39.5 feet below grade during advancement of Boring 6, corresponding to elevation 802.9 feet. Free groundwater was not observed in the remainder of the soil borings. The groundwater level at this site is closely related to the prevailing water level in the adjacent Mississippi River, and will fluctuate as the river level varies; the long term average water elevation in the river near this site is less than 800 feet.

We direct your attention to other report sections and Appendix B concerning ground water issues and subsurface drainage. The cave-in depths of the borings were recorded as varying from approximately 13.5 to 23 feet below existing grade.



3.5 Laboratory Test Program

The analysis and recommendations of this report are based upon our interpretation of the standard penetration resistance determined while sampling soils, classification of the soils, and experience with similar soil. We performed moisture content, gradation, resistivity and pH tests on select samples. The results of the tests are summarized on the boring logs in Appendix C.

4.0 ENGINEERING REVIEW AND RECOMMENDATIONS

The following recommendations are based on our present knowledge of the project. We ask that you or your design team notify us immediately if significant changes are made to project size, location or design as we would need to review our current recommendations and provide modified or different recommendations with respect to such change(s).

4.1 Project Scope

The Parking ramp will be a four-story steel and precast concrete structure. Leo A. Daly provided us the anticipated structural loads for the project. The maximum column load will be 1100 kips and wall loads will be approximately 1.5 kips per lineal foot (klf).

Our assessment of the project soils, and opinions and recommendations presented within this report are based directly on these estimated structural loads being applied to the existing site soils.

4.2 Site Preparation/Foundation Support

The uppermost sand soils at this site are loose in relative density, and are not suitable to support the proposed parking ramp in their present condition.

The existing bituminous pavement section and any organic soils occurring within 3 feet of the pavement subbase elevation, such as those in Boring 1, should be stripped from the Parking Ramp site.

If standard shallow foundations are to be used, the loose sand soils should be densified prior to construction of the Parking Ramp. We recommend that the soils below the proposed Ramp be subcut to a depth of 14 feet below the proposed lower floor elevation. This excavation should be oversized a minimum of 1 foot horizontally for every 1 foot of vertical cut outside the project foundations.



The sand soils at the base of excavation should be surface compacted with a smooth drum vibratory roller with a drum diameter of at least 5 feet and a static weight of at least 10,000 pounds to a minimum of 100 percent of the Standard Proctor maximum dry density (ASTM: D 698-96). The excavated non-organic sand soils can then be replaced as engineered fill. The engineered fill should be placed in 8 to 10 inch loose lifts, moisture conditioned to within plus or minus 3 percent of the optimum moisture content, and compacted to a minimum of 100 percent of the Standard Proctor dry density back to the proposed floor subgrade elevation. Silt or clay soils from the excavation should not be used as engineered fill.

The Geotechnical Engineer of Record or their designated representative should review project excavations to determine removal of unsuitable material(s) and adequate bearing support of exposed soils. Such observations should occur prior to the placement of engineering fill, or construction of footings and floor slabs.

In our opinion, the non-organic sand soils on-site may be used as engineered fill for preparation of the parking ramp pad and pavement subgrade when such soils are moisture conditioned and placed as presented within this report. If import fill is required, it should consist of “pit run” sand or “sand & gravel” with 100 percent material passing the 1 ½ inch sieve and no more than 10 percent material passing the No. 200 U.S. Sieve. Engineered fill for site corrective earthwork and for support of project footings should be tempered to within plus or minus 3 percent of the optimum moisture content and placed to the criteria presented within Appendix B herein amended such that the fill is compacted to no less than 100 percent of the Standard Proctor maximum dry density.

Due to site constraints and the existing structures, it may not be feasible to excavate to this depth and provide the necessary oversize. Section 4.4 outlines two alternatives to soil corrections for founding the Parking Ramp.

4.3 Shallow Foundations

The following bearing recommendations are based on our understanding of the project. We should be notified of any changes made to the project size, location, design, or site grades so we can assess how such changes impact our recommendations. We assume foundation elements will impose maximum vertical loads as previously noted within this report.

Strip and column footings for the Parking Ramp supported on compacted sand fill can be designed for a maximum net allowable soil bearing capacity of 6000 pounds per square foot at indicated in Table 1, provided the soil corrections are performed as outlined in Section 4.2 of this report.



Table 1: Recommended Maximum Net Allowable Soil Bearing Pressure ¹

<i>Location</i>	<i>Criteria</i>
Perimeter Strip Footings, Perimeter Columns: Perimeter strip footings and perimeter column footing supported on natural soils or engineered fill below depth of frost penetration, and at an elevation as referenced within this report.	Maximum of 6000 psf
Interior Strip Footings: Interior strip footings supported on natural, competent soils and/or engineered fill at a depth which provides no less than 6 inches of clearance between the top of footing and underside of floor slab (for sand cushion).	Maximum of 6000 psf
Interior Column Footings: Supported on natural, competent soils and/or engineered fill at a depth which provides no less than 6 inches of clearance between the top of footing and underside of floor slab (for sand cushion).	Maximum of 6000 psf
1. Maximum net allowable soil bearing pressure recommendations predicated on footing design and construction complying with recommendations presented within this report. To minimize local failure of supporting soils, it is our opinion footing construction should comply with the International Building Code (IBC) requirements.	

Construction should extend footings to sufficient depth below ground (exposed slab) surface as protection against frost action. For this project, we recommend extending the footings for at-grade footing construction to no less 4 feet below outside grade.

If the ground floor is to consist of a concrete slab, it may be designed for a modulus of subgrade reaction of 300 pounds per square inch (pci).

Foundation walls and retaining walls will experience lateral loading from retained soils. This lateral loading may be modeled as an equivalent earth pressure applied to the foundation wall providing such complies with geometric conditions which support such modeling. We recommend using the Table 2 “at-rest” equivalent fluid pressure for design of below grade foundation walls.

Table 2: Estimate of Equivalent Fluid Weight of Retained Soils

Type of Retained Soil		“At Rest” Condition (pcf)	“Active” Condition (pcf)
Unit Weight of Equivalent Fluid *	Sand (SP, SP-SM, SM)	66	40
	Sandy Silt	50	45
	Sandy Clay	85	71
* The recommendations for equivalent fluid weight are based solely on assumed conditions with respect to sloping ground and/or surcharge loads. Design professional is cautioned that actual loads imparted to the structure will be dependent on soil conditions, site geometric considerations and surcharge loads imparted to the structure.			

The coefficient of friction to resist lateral sliding may be taken to be 0.38.



4.4 **Deep Foundations**

In lieu of soil excavation and replacement, deep foundations can be used to support the proposed Parking Ramp. We understand that there are vibration constraints at this site due to the existing hospital, which has a below grade imaging near the proposed Parking Ramp location. For this reason, it is our opinion that the heavy columns for the Parking Ramp should be supported by concrete filled and reinforced drilled piers extending to a minimum of 5 feet into competent bedrock. We estimate the depths to range from 45 to 50 feet; however, total depths of the drilled piers may vary across the site. Drilled Pier construction should be protected by casing the entire length of the drilled shaft within the overlying sand soils.

We recommend using Table 1B design parameters for sizing of Drilled Pier construction.

**Table 1B: Recommended Design Parameters to Determine
Ultimate Resisting Soil Strength of Drilled Pier Construction**

<i>Condition</i>	<i>Design Criteria</i>
Skin Friction - Bedrock	2.75 tons / square foot surface area (5.5 ksf surface area)
End Bearing - Bedrock	18 tons / square foot (36 ksf)
1. For caissons drilled a minimum of 5 feet into bedrock. Refer to other report comments and recommendations concerning sizing and positioning of caissons.	

The Table 1B design parameters are based on the following factors of safety with respect to ultimate soil capacity; skin friction – 1.5, end bearing – 2.0. Note that we have ignored skin friction provided by the overlying sands. It is our opinion significant movement of the drilled piers would be necessary to mobilize skin friction within the sands, with such movement unlikely to occur. Furthermore, the above design recommendations are predicated on the drilled piers bearing a minimum of 5 feet into sound bedrock.

Using the Table 1B design parameters, we estimate a nominal 5 foot diameter caisson shaft formed a minimum of 5 feet into the bedrock should provide an ultimate capacity on the order of 1,136 kips with a design capacity of 568 kips. You may achieve increased capacity by installation of a shaft with increased diameter or extending the diameter shaft further into the sound bedrock.

If drilled piers are used for support of the columns, the lightly loaded walls can be supported on strip footings designed for a maximum net allowable soil bearing capacity of 3000 psf, providing that organic soils and fill are subcut and replaced with non-organic sand engineered fill. The fill should be placed and compacted as outlined in Section 4.2 of this report.



Impact® System – Compacted Stone Columns

As an alternative to subcutting the soft sand soils from below the parking ramp pad and replacing them as engineered fill, a compacted stone column **Impact® System** can be used.

The *Impact* system is an intermediate design-build soil reinforcement system that is commonly used to improve the soil's ability to support structures. It consists of a series of Rammed Aggregate Piers®, and is an alternative to over-excavation of poor soils or deep foundations (piles and caissons). The system allows the use of conventional spread footings and floor slabs cast on-grade, and typically provides settlement control to within 1-inch or less.

The *Impact* system involves driving a specially designed mandrel and tamper foot into the ground using a static force and dynamic vertical impact energy. Depths on this project are estimated to be approximately 16 to 20 feet. After driving to the specified depth, aggregate is placed inside the mandrel and compacted in lifts.

Ramming takes place with a high-energy beveled tamper that both densifies the aggregate and forces the aggregate laterally into the sidewalls of the hole. This action increases the lateral stress in the surrounding soil, thereby further stiffening the stabilized composite soil mass. The result of *Impact* installation is a significant strengthening and stiffening of subsurface soils that then support floor slabs and high-capacity footings.

After reinforcement with the *Impact* system, the foundations may be designed as conventional spread footings, sized for an allowable soil bearing pressure of approximately 6,000 to 7,000 pounds per square foot.

Please contact Mr. Charles M. Allgood, P.E. of *Ground Improvement Engineering – Midwest* at (763) 416-2136 regarding the final system design, including the allowable foundation bearing pressure, *Impact* shaft lengths and spacing, anticipated floor slab thickness, and a cost to support the building.

If the *Impact* system is selected, it is recommended that Borings 2, 3, and 4 be extended to approximately 30 foot depths to aid in settlement calculations. Quality Assurance Testing should be performed during installation, including documentation of the soil conditions encountered, the shaft lengths, amount of aggregate used, and tests on the compacted aggregate lifts. We should be contacted to provide this service.

4.5 Bearing Factor of Safety and Estimate of Footing Settlement

The recommended soil bearing pressure for the standard footings or the Rammed Aggregate Pier System provides a factor of safety greater than 3 against localized bearing failure when construction complies with report criteria and recommendations.



We estimate that footings for these two systems loaded per report assumptions may experience long term, total settlement of approximately 1/2 to 1 inch. Differential settlement will be on the order of 50 to 75 percent of total settlement. Much of the settlement will occur on first loading as the structure is erected. Generally, the greatest differential settlement occurs between lightly loaded and heavily loaded footings, particularly if heavily loaded column footings are located adjacent to lightly loaded strip footings. Settlement of drilled piers extending to the limestone bedrock would be negligible.

Total and differential movement of footings and floor slabs could be greater than the above estimates if construction is supported on frozen soils, the moisture content of the bearing soils significantly changes from insitu conditions, or snow or ice lenses are allowed to develop in the foundation subsoils.

4.6 Exterior Backfill & Subsurface Drainage

Exterior fill placement around the foundation and associated final grading adjacent to the building can significantly impact the performance of a structure. ***We understand the project will include foundation walls which retain soils, such as an elevator pit.***

A subsurface drainage system should be installed at or below the perimeter footings at the below grade walls to limit moisture accumulation within granular soils below floor slabs.

As a general guideline, such drainage should consist of a slotted or perforated pipe factory wrapped in a geofabric sleeve, and surrounded with 1 ½ crushed rock, draining to a sump pit. We recommend that exterior drainage be separated from interior drainage to reduce risk of cross flow and moisture infiltration below the structure interior.

Exterior backfill for foundation walls which retain soils should consist of the on-site sand or “pit run” sand with less than 12 percent passing the No. 200 US Sieve opening (i.e. fill extending to within 2 feet of final grade). Much of the on-site sand will be suitable for use as the exterior backfill. The final 1.5 to 2 feet of exterior backfill within landscaped areas may consist of silty sand and topsoil. Exterior backfill within 2 feet of final grade and below sidewalks and pavements should consist of a free draining aggregate base as recommended for the respective construction. Backfill should be tempered for appropriate moisture content and then placed and compact in individual lifts per criteria presented within Appendix B.

Placement of exterior backfill against the at-grade foundation walls should be performed concurrent with interior backfill to minimize differential loading, rotation and/or movement of the wall system. The backfill should be compacted to at least 100 percent of the maximum Standard Proctor dry density.



4.7 Surface Drainage

Positive site drainage should be maintained during and after construction. Water should not be allowed to pond on the site soils during construction. Exterior grades in unpaved areas should slope away from the Ramp on at least a 6% grade within 10 feet of the Ramp.

Roof runoff should be diverted away from the Ramp by a system of interior roof and scupper drains, or rain gutters, down spouts and splash pads.

4.8 Utilities

We anticipate underground utilities will be located below project pavements. Excavations and backfill of utility trenches should follow the general recommendations presented elsewhere in this report.

Utility trenches should be backfilled with native sand soils placed in 6-inch maximum depth loose lifts. The utility trench backfill should be compacted sufficiently to minimize future settlement of lawn and pavement areas. We recommend that such soils be compacted to no less than 90 percent of the Standard Proctor maximum dry density for non-paved locations, and to the criteria outlined in Section 4.8 for areas which receive pavement (i.e. sidewalks, driveways, parking areas).

The stability of the utility trench sideslopes is dependent on soil strength, site geometry, moisture content, and surcharge load from excavated soils and equipment.

The Contractor is solely responsible for assessing the stability of and executing underground utility and project excavations using safe methods. Contractor is also responsible for naming the “competent individual” as per Subpart P of 29 CFR 1926.6 (Federal Register - OSHA).

Soil Resistivity tests were performed on two (2) soil samples by Prime Testing Inc., one each from Boring 5 and 10. The individual soil resistivity test results can be found in Appendix C. These tests were performed to determine the soil corrosion susceptibility for the installation of ductile iron watermain.



Resistivity Test Results

Sample Identification	Saturated Resistivity (ohm-cm)	Corrosivity Rating	pH
Boring No. 5	970	Extremely Corrosive	6.5
Boring No. 10	810	Extremely Corrosive	6.4

The test indicated resistivities of 970 to 810 ohm-cms, indicating of soils which are extremely corrosive. Thus new watermain piping should preferably consist of AWWA PVC pipe.

4.9 Pavement Construction

The existing bituminous pavement section and other unsuitable soils should be stripped from the parking and drive lanes l as outlined in Section 4.2. ***We anticipate some variation in depth of excavation and subgrade correction. Additional removal in excess of the depths encountered at our boring locations may be necessary at select locations within the pavement area.***

The exposed sand soils at the base of excavation should be surfaced compacted to a minimum of 100% of the Standard Proctor maximum dry density. If fill is placed below the pavement the improvement/fill placement should allow for a 2 foot oversize beyond the edges of the pavement.

The project geotechnical engineer or their designated representative **should observe and test** the pavement subgrade excavation to determine that unsuitable materials have been properly removed and adequate bearing support is provided by the exposed soils. Such observations should be performed prior to the placement of engineered fill.

The on-site non organic sandy soils can be used as engineered fill below the pavement. Additional import fill, if required, should consist of “pit run” sand or sand and gravel having 100 percent passing the 1 ½ inch Sieve and no more than 10 percent passing the No. 200 Sieve. Individual lifts of engineered fill should be tempered for moisture content, placed and compacted as follows:

- Engineered fill placed to within 3 feet of the aggregate base layer should be compacted to no less than 95 percent of the Standard Proctor maximum dry density.
- Engineered fill placed within three feet (3 ft) of the aggregate base layer should be compacted to no less than 100 percent of the Standard Proctor maximum dry density.



Density tests should be taken during the engineered fill placement to determine that adequate compaction is achieved per project specifications. We also recommend performance of a “proof roll” of the completed subgrade section to define areas of underperforming soil and allow subsequent correction.

We recommend performing such proof roll using a tandem axle dump truck loaded to gross capacity. Acceptance criteria of the proof roll shall be limited to rut formation no more than one inch (1”) depth (front or rear axles).

Pavements should provide positive drainage to ditching, the local storm water collection system or natural drainage systems. The actual profile and grade of the pavement with respect to cross-direction and longitudinal gradient should be determined by the project Civil Engineer of Record.

Underground utility crossing of the pavement should be performed concurrent with correction of the subgrade profile. We present cautionary remarks concerning stability of excavation sideslopes in Section 5.1 Excavation Stability. The Contractor is solely responsible for the evaluation, execution and safety of such excavations.

For this project we estimate a stabilometer R-value of 45 for a sand subgrade which has been properly compacted.

For a 25-year design pavement life, and heavy traffic volumes, Table 2 presents our thickness recommendations.



Table 2: Recommended Pavement Thickness Design*

Parameter	Light Duty Pavement^{Note A}	Heavy Duty Pavement^{Note B}	Concrete Pavement^{Note C}
Untreated Aggregate Base ^{Note 1}	8	10	8
Asphalt Concrete Base ^{Note 2}	One - 2 inch lift	One - 2 inch lift	NA
Asphalt Concrete Wear ^{Note 3}	One – 1 1/2 inch lift	One - 2 inch lift	NA
Estimated Subgrade Support <i>k</i>	NA	NA	275 psi
Estimated Maximum Stress from Refuse Truck Rear Tandem Axle	NA	NA	280 psi
Stress Ratio (based on 600 psi flexural)	NA	NA	0.47
Concrete Pavement (in) ^{Note 4}	NA	NA	Minimum 8
Note A	Pavement construction for light duty vehicles.		
Note B	Pavement construction for heavy duty vehicles. No distinction between drive lanes and parking areas.		
Note C	Concrete pavement construction for refuse truck turn around, and truck load/unload areas.		
Note 1	Aggregate base shall conform to Minnesota Department of Transportation (MnDOT) Specification Section 3138, Class 5 materials herein amended such that the percent crushed material within the aggregate is no less than 20 percent.		
Note 2	Asphalt Concrete Base shall conform to MnDOT Specification Section 2360.		
Note 3	Asphalt Concrete Wear shall conform to MnDOT Specification Section 2360.		
Note 4	Portland cement concrete pavement proportioned such that the 28 day flexural strength is equal to or greater than 600 pounds per square inch (psi). We recommend such pavement conform to MnDOT concrete mix designations.		
*	All pavement construction shall be completed using NAPA or ACI approved methods to optimize the performance of in-place construction. We recommend that the construction specifications include necessary controls to eliminate practices which lead to poorly performing pavements.		

Pavement recommendations assume the subgrade soils and aggregate section below paved surfaces will drain to subsurface piping for eventual discharge into storm sewer, or above grade to ditching, or similar acceptable systems. Lack of surface and subsurface drainage will significantly reduce the capacity and longevity of the pavement systems indicated above.

We recommend pavements receive annual maintenance, as a minimum, to correct damages to the pavement structure, clean and infill cracks which develop, and repair or resurface areas which exhibit reduced subgrade performance. The lack of maintenance can lead to moisture infiltration of the pavement structure and softening of the subgrade soils. This, in turn, can degrade the performance of the pavement system and result in poorly performing pavements with shortened life expectancy.



5.0. CONSTRUCTION CONSIDERATIONS

5.1. Excavation Stability

Excavation depth and sidewall inclination should not exceed those specified in local, state or federal regulations. Excavations may need to be widened and sloped, or temporarily braced, to maintain or develop a safe work environment. Contractors must comply with local, state, and federal safety regulations including current OSHA excavation and trench safety standards. Temporary shoring must be designed in accordance with applicable regulatory requirements.

5.2. Engineered Fill & Winter Construction

The subsoil should be tested for moisture content and density prior to placement of new fill. The backfill around the perimeter foundation walls of the structure should be tested in 1-foot vertical increments.

Frozen soil should not be used as backfill and foundations should not be placed on frozen soils. When the ambient air temperature falls below freezing for an extended period of time, frost forms, and soil near the surface grade experiences a moisture-volume expansion. Settlement of the fill may occur as the frozen soils thaw.

During construction, footing and column pad excavations should be protected from freezing. If frost penetrates the soil prior to the placement of the footings, column pads or floor slabs, soils must be thawed, scarified, and re-compacted to the required percentage of compaction recommended in this report prior to concrete placement. Footing, column pad excavations, and floor slab areas should be inspected prior to the placement of concrete to determine that the frozen soils have been eliminated.

6.0 CLOSURE

The conclusions and recommendations in this report are predicated on observation and testing of the earthwork directed by Geotechnical Engineer of Record. Our opinions are based on data assumed representative of the site. However, the area coverage of borings in relation to the entire project is very small. For this and other reasons, we do not warrant conditions below the depth of our borings, or that the strata logged from our borings are necessarily typical of the site. Deviations from our recommendations by plans, written specifications, or field applications shall relieve us of responsibility unless our written concurrence with such deviations has been established.



This report has been prepared for the exclusive use of Leo A. Daly and its agents for specific application to the proposed VA Medical Center Parking Ramp in Minneapolis, Minnesota. Northern Technologies, Inc. has endeavored to comply with generally accepted geotechnical engineering practice common to the local area. Northern Technologies, Inc. makes no other warranty, expressed or implied.

Northern Technologies, Inc.

Anthony Francis, P.E.
Project Engineer

Mervyn Mindess, P.E.
Senior Project Engineer

AF:mm

Attachments

\\H:\1-Projects\2011 Projects\VA Medical Center Parking Ramp (11.50534.100)\Geotechnical\Reports-Logs\VA Medical Center Parking Ramp.doc

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a Duly Licensed Professional Engineer under the Laws of the State of Minnesota.

Mervyn Mindess

Date: 3-28-2011 Reg. No. 8435



APPENDIX A



GEOTECHNICAL EVALUATION OF RECOVERED SOIL SAMPLES

We visually examined recovered soil samples to estimate distribution of grain sizes, plasticity, consistency, moisture condition, color, presence of lenses and seams, and apparent geologic origin. We then classified the soils according using the Unified Soil Classification System (ASTM D2488). A chart describing this classification system and general notes explaining soil sampling procedures are presented within appendices attachments.

The stratification depth lines between soil types on the logs are estimated based on the available data. Insitu, the transition between type(s) may be distinct or gradual in either the horizontal or vertical directions. The soil conditions have been established at our specific boring locations only. Variations in the soil stratigraphy may occur between and around the borings, with the nature and extent of such change not readily evident until exposed by excavation. These variations must be properly assessed when utilizing information presented on the boring logs.

We request that you, your design team or contractors contact NTI immediately if local conditions differ from those assumed by this report, as we would need to review how such changes impact our recommendations. Such contact would also allow us to revise our recommendations as necessary to account for the changed site conditions.



FIELD EXPLORATION PROCEDURES

Soil Sampling – Standard Penetration Boring:

Soil sampling was performed according to the procedures described by ASTM D-1586. Using this procedure, a 2 inch O.D. split barrel sampler is driven into the soil by a 140 pound weight falling 30 inches. After an initial set of six inches, the number of blows required to drive the sampler an additional 12 inches is recorded (known as the penetration resistance (i.e. “N-value”) of the soil at the point of sampling. The N-value is an index of the relative density of cohesionless soils and an approximation of the consistency of cohesive soils.

Soil Sampling – Power Auger Boring:

The boring(s) was/were advanced with a 6 inch nominal diameter continuous flight auger. As a result, samples recovered from the boring are disturbed, and our determination of the depth, extend of various stratum and layers, and relative density or consistency of the soils is approximate.

Soil Classification:

Soil samples were visually and manually classified in general conformance with ASTM D-2488 as they were removed from the sampler(s). Representative fractions of soil samples were then sealed within respective containers and returned to the laboratory for further examination and verification of the field classification. In addition, select samples were submitted for laboratory tests. Individual sample information, identification of sampling methods, method of advancement of the samples and other pertinent information concerning the soil samples are presented on boring logs and related report attachments.



General Notes

DRILLING & SAMPLING SYMBOLS		LABORATORY TEST SYMBOLS	
SYMBOL	DEFINITION	SYMBOL	DEFINITION
C.S.	Continuous Sampling	W	Moisture content-percent of dry weight
P.D.	2-3/8" Pipe Drill	D	Dry Density-pounds per cubic foot
C.O.	Cleanout Tube	LL, PL	Liquid and plastic limits determined in accordance with ASTM D 423 and D 424
3 HSA	3 1/4" I.D. Hollow Stem Auger	Q _u	Unconfined compressive strength-pounds per square foot in accordance with ASTM D 2166-66
4 FA	4" Diameter Flight Auger	Additional insertions in Qu Column Pq Penetrometer reading-tons/square foot S Torvane reading-tons/square foot G Specific Gravity – ASTM D 854-58 SL Shrinkage limit – ASTM 427-61 pH Hydrogen ion content-meter method O Organic content-combustion method M.A.* Grain size analysis C* One dimensional consolidation Q _c Triaxial Compression * See attached data Sheet and/or graph	
6 FA	6" Diameter Flight Auger		
2 1/2 C	2 1/2" Casing		
4 C	4" Casing		
D.M.	Drilling Mud		
J.W.	Jet Water		
H.A.	Hand Auger		
NXC	Size NX Casing		
BXC	Size BX Casing		
AXC	Size AX casing		
SS	2" O.D. Split Spoon Sample		
2T	2" Thin Wall Tube Sample		
3T	3" Thin Wall Tube Sample		

Water Level Symbol

Water levels shown on the boring logs are the levels measured in the borings at the time and under the conditions indicated. In sand, the indicated levels can be considered reliable ground water levels. In clay soils, it is not possible to determine the ground water level within the normal scope of a test boring investigation, except where lenses or layers of more pervious water bearing soil is present and then a long period of time may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed soils may not indicate the true level of the ground water table. The available water level information is given at the bottom of the log sheet.

Descriptive Terminology

DENSITY		CONSISTENCY	
TERM	"N" VALUE	TERM	"N" VALUE
Very Loose	0-4	Soft	0-4
Loose	5-8	Medium	5-8
Medium Dense	9 – 15	Rather Stiff	9 – 15
Dense	16 – 30	Stiff	16 – 30
Very Dense	Over 30	Very Stiff	Over 30

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon.

Relative Proportions

TERMS	RANGE
Trace	0-5%
A little	5-15%
Some	15-30%
With	30-50%

Particle Sizes

Boulders	Over 3"
Gravel - Coarse	3/4" – 3"
Medium	#4 – 3/4"
Sand - Coarse	#4 - #10
Medium	#10 - #40
Fine	#40 - #200
Silt and Clay	Determined by plasticity characteristics.
Note: Sieve sizes are U.S. Standard.	



Classification of Soils for Engineering Purposes

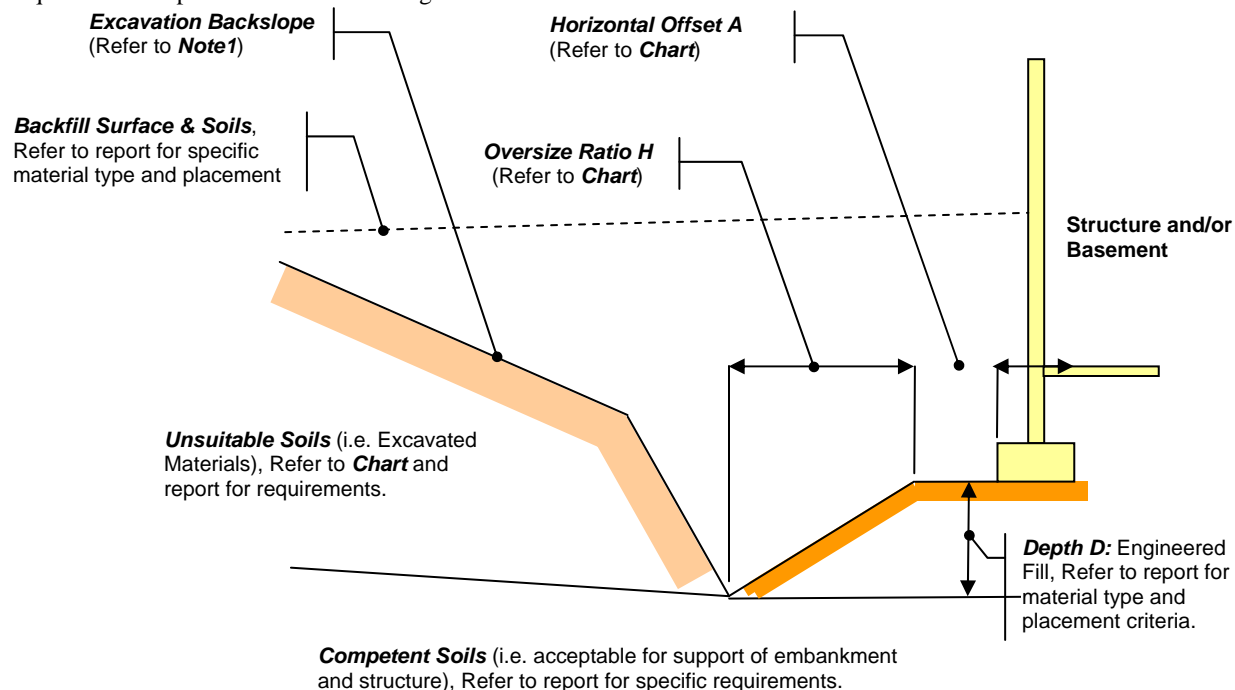
ASTM Designation D-2487 and D 2488 (Unified Soil Classification System)

Major Divisions	Group Symbols	Typical Names	Classification Criteria
Course Grained Soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve.	Clean Gravels	GW Well-graded gravels and gravel-sand mixtures, little or no fines. GP Poorly graded gravels and gravel-sand mixtures, little or no fines.
		Gravels with Fines	GM Silty gravels, gravel-sand-silt mixtures. GC Clayey gravels, gravel-sand-clay mixtures.
		Clean Sands	SW Well-graded sands and gravelly sands, little or no fines. SP Poorly-graded sands and gravelly sands, little or no fines.
		Sands with Fines	SM Silty sands, sand-silt mixtures. SC Clayey sands, sand-clay mixtures.
	Classification on basis of percentage of fines. GW, GP, SW, SP GM, GC, SM, SC Borderline Classification requiring use of dual symbols.		$C_u = D_{60} / D_{10}$ greater than 4. $C_z = (D_{30})^2 / (D_{10} \times D_{60})$ between 1 & 3. Not meeting both criteria for GW materials.
			Atterberg limits below "A" line, or P.I. less than 4. Atterberg limits plotting in hatched area are <i>borderline</i> classifications requiring use of dual symbols. Atterberg limits above "A" line with P.I. greater than 7.
			$C_u = D_{60} / D_{10}$ greater than 6. $C_z = (D_{30})^2 / (D_{10} \times D_{60})$ between 1 & 3. Not meeting both criteria for SW materials.
			Atterberg limits below "A" line, or P.I. less than 4. Atterberg limits plotting in hatched area are <i>borderline</i> classifications requiring use of dual symbols. Atterberg limits above "A" line with P.I. greater than 7.
Fine Grained Soils More than 50% passes No. 200 sieve *	Silts and Clays Liquid Limit of 50% or less	ML Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	
		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.	
	Silts and Clays Liquid Limit greater than 50%.	MH Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.	
		CH Inorganic clays of high plasticity, fat clays.	
		OH Organic clays of medium to high plasticity.	
	Highly Organic Soils	Pt Peat, muck and other highly organic soils.	



Excavation Oversize

Excavation oversize facilitates distribution of load induced stress within supporting soils. Unless otherwise superseded by report specific requirements, all construction should conform to the minimum oversize and horizontal offset requirements as presented within the diagram and associated chart.



Definitions

Oversize Ratio H: The ratio of the horizontal distance divided by the engineered fill depth (i.e. # Horizontal / Depth D). Refer to Chart for specific requirements.

Horizontal Offset A: The horizontal distance between the outside edge of footing or critical position and the crest of the engineered fill section. Refer to Chart for specific requirements.

Note 1: Excavation depth and sidewall inclination should not exceed those specified in local, state or federal regulations including those defined by Subpart P of Chapter 27, 29 CFR Part 1926 (of Federal Register). Excavations may need to be widened and sloped, or temporarily braced, to maintain or develop a safe work environment.

Condition	Unsuitable Soil Type	Horizontal Offset A	Oversize Ratio H
Foundation Unit Load equal to or less than 3,000 psf.	SP, SM soils, CL & CH soils with cohesion greater than 1,000 psf	2 feet or width of footing, whichever is greater	Equal to or greater than Depth D
Foundation Unit Load greater than 3,000 psf	SP, SM soils, CL & CH soils with cohesion less than 1,000 psf	5 feet or width of footing, whichever is greater	Equal to or greater than Depth D
Foundation Unit Load equal to or less than 3,000 psf.	Topsoil or Peat	2 feet or width of footing, whichever is greater	Equal to or greater than two (2) time Depth D
Foundation Unit Load greater than 3,000 psf	Topsoil or Peat	5 feet or width of footing, whichever is greater	Equal to or greater than two (2) time Depth D



APPENDIX B



GROUND WATER ISSUES

The following presents additional comment and soil specific issues related to measurement of ground water conditions at your project site.

Note that our ground water measurements, or lack thereof, will vary depending on the time allowed for equilibrium to occur in the borings. Extended observation time was not available during the scope of the field exploration program and, therefore, ground water measurements as noted on the borings logs may or may not accurately reflect actual conditions at your site.

Seasonal and yearly fluctuations of the ground water level, if any, occur. Perched ground water may be present within sand and silt lenses bedded within cohesive soil formations. Groundwater typically exists at depth within cohesive and cohesionless soils.

Documentation of the local ground water surface and any perched ground water conditions at the project site would require installation of temporary piezometers and extended monitoring due to the relatively low permeability exhibited by the site soils. We have not performed such ground water evaluation due to the scope of services authorized for this project.

We anticipate pumps installed within temporary sumps should control subsurface seepage from perched conditions. However, we caution such seepage from such formations and any water entry from excavations below the ground water table may be heavy and will vary based on seasonal and annual precipitation, and ground related impacts in the vicinity of the project.



PLACEMENT and COMPACTION OF ENGINEERED FILL

Unless otherwise superseded within the body of the Geotechnical Exploration Report, the following criteria shall be utilized for placement of engineered fill on project. This includes, but is not limited to earthen fill placement to improve site grades, fill placed below structural footings, fill placed interior of structure, and fill placed as backfill of foundations.

Engineered fill placed for construction, if necessary should consist of natural, non-organic, competent soils native to the project area. Such soils may include, but are not limited to gravel, sand, or clays with Unified Soil Classification System (ASTM D2488) classifications of GW, SP, SM, CL or CH. Use of silt or clayey silt as project fill will require additional review and approval of project Geotechnical Engineer of Record. Such soils have USCS classifications of ML, MH, ML-CL, MH-CH. Use of topsoil, marl, peat, other organic soils construction debris and/or other unsuitable materials as fill is not allowed. Such soils have USCS classifications of OL, OH, Pt.

Engineered fill, classified as clay, should be tempered such that the moisture content at the time of placement is equal to and no more than 3 percent above the optimum content for as defined by the appropriate proctor test. Likewise, engineered fill classified as gravel or sand should be tempered such that the moisture content at the time of placement is within 3 percent of the optimum content.

All engineered fill for construction should be placed in individual 8 inch maximum depth lifts. Each lift of fill should be compacted by large vibratory equipment until the in-place soil density is equal to or greater than the criteria established within the following tabulation.

Type of Construction	Compaction Criteria (% respective Proctor) ¹
	Sand or Gravel
General Embankment Fill	Min. 95
Engineered Fill below Foundations	Min. 100
Engineered Fill below Floor Slabs	Min. 100
Engineered Fill placed against Foundation Walls	95 to 100
Engineered Fill placed as Pavement Subgrade	Min. 100
Engineered Fill placed as Pavement Aggregate Base	Min. 100
Engineered Fill placed within Utility Trench (to within 3 feet of pavement aggregate base or final grade	Min. 95
Engineered Fill placed as Utility Trench Fill (within 3 feet of pavement aggregate base or final grade	Min. 100

Note 1 Unless otherwise required, compaction criteria shall be based on the Standard Proctor Compaction Test (ASTM D698).

Density tests should be taken during engineered fill placement to document earthwork has achieved necessary compaction of the material(s). Recommendations for interior fill placement and backfill of foundation walls are presented within other sections of this report.



PROJECT SUMPS

The collection, control and removal of seepage and runoff from within project excavations is critical in maintaining the bearing capacity of native soils, in-place density of engineered fill and stability of the sidewalls at project excavations.

If necessary, we recommend that the sumps should consist of a 2 foot by 2 foot or larger plan dimension excavation(s) located adjacent to and directly exterior to the excavation oversize limit for structural engineered fill. Sump excavations should extend a minimum of 2 feet below the base of the excavation for collection of seepage and runoff.

Sumps should be lined with a non-woven, needle-punched, geotextile having a grab tensile strength equal to or greater than 70 pounds per square inch (psi). A standpipe of 12 inches in diameter or larger should be centered within the sump excavation. This pipe should include sufficient openings for entry of seepage. We recommend that the standpipe extend to the ground surface to facilitate pumping during project construction. Infill within the sump area should consist of a 1½ to ¾ inch clear rock placed between the standpipe and walls of the sump excavation.

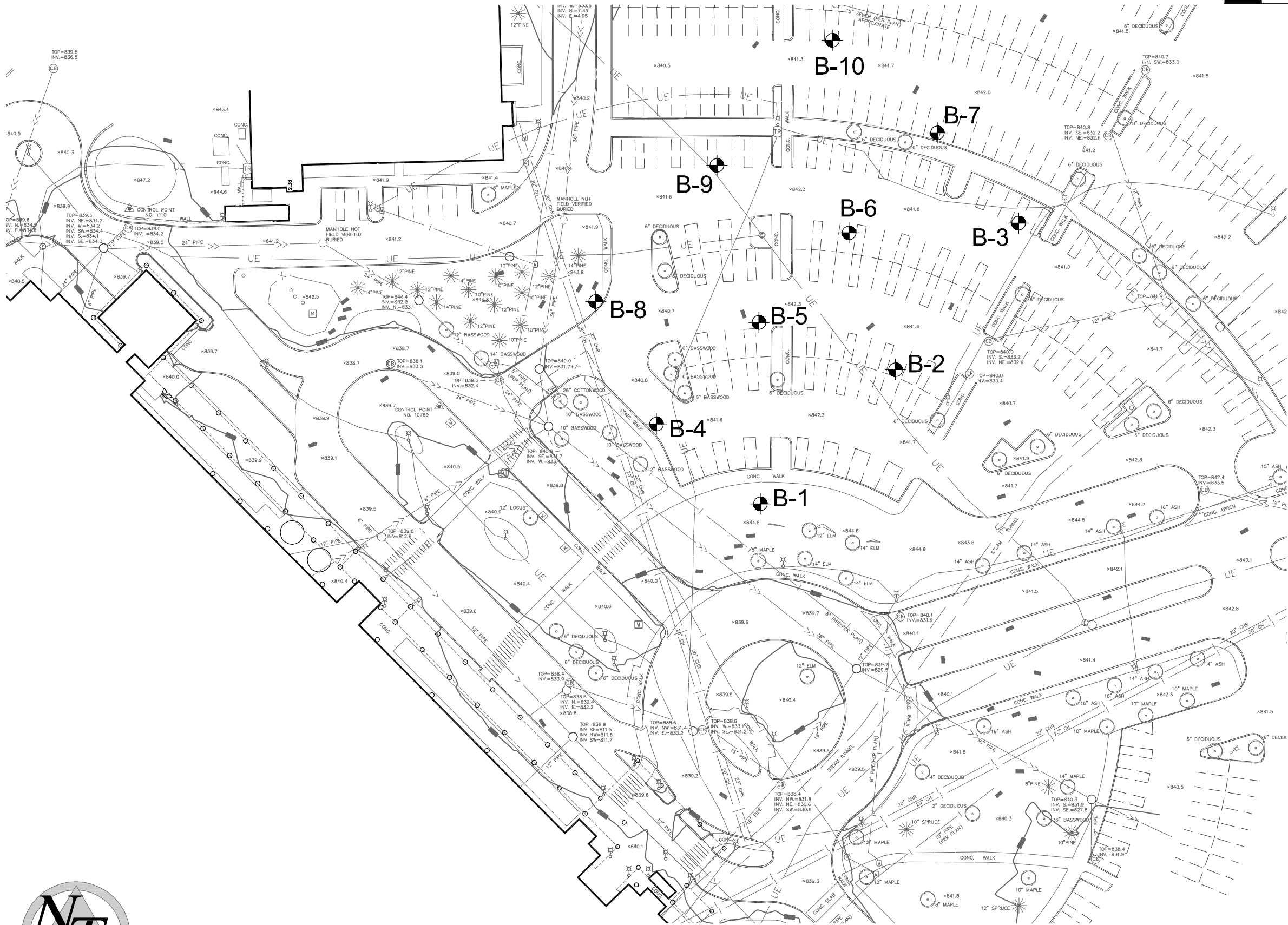
Pumping of sump(s) should continue until completion of the construction or until the Geotechnical Engineer of Record indicates such pumping is no longer necessary for stability of the project footings and related construction. Sumps should be abandoned per methods required by the Geotechnical Engineer of Record and per Federal, State and local governmental statutes.

Discharge from sumps should be directed away from site and be disposed within storm water systems or other systems which comply with Federal, State and local governmental statute. As constructed and operated, the General Contractor should be responsible for all permits, operation and abandonment of sumps or other temporary dewatering systems.




APPENDIX C

SOIL BORING
LOCATION MAP



LEGEND

 **B-1** SOIL BORING





Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 1

PAGE 1 OF 1

CLIENT <u>Leo A. Daly</u>	PROJECT NAME <u>VA Parking Ramp</u>
PROJECT NUMBER <u>11.50534.100</u>	PROJECT LOCATION <u>Minneapolis, MN</u>
DATE STARTED <u>3/3/11</u> COMPLETED <u>3/3/11</u>	GROUND ELEVATION <u>843.7 ft</u> HOLE SIZE <u>8" O.D.</u>
DRILLING CONTRACTOR <u>NTI</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>3 1/4 Hollow Stem Auger</u>	AT TIME OF DRILLING <u>---</u>
LOGGED BY <u>BC</u> CHECKED BY <u>AF</u>	AT END OF DRILLING <u>---</u>
NOTES <u>Cave in depth = 21'. Frost depth = 4'.</u>	AFTER DRILLING <u>---</u>

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								☐ FINES CONTENT (%) ☐			
								20	40	60	80
0		FILL: Silty Sand - SM-OL, fine grained, trace organics, dark brown.	AU 1								
		FILL: Silty Sand - SM, fine to medium grained, trace gravel, dark brown.	AU 2								
5		FILL: Silty Sand - SM, fine to medium grained, brown to dark brown.	SS 3	89	5-4-4 (8)						
			SS 4	56	3-2-2 (4)						
10			SS 5	100	1-1-2 (3)						
		SAND - SP, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 6	100	3-3-3 (6)						
15		SILTY SAND - SM, fine grained, brown, moist, very loose. (Coarse Alluvium)	SS 7	100	3-2-2 (4)						
20		SAND - SP, fine to coarse grained, with gravel, brown, moist, dense to very dense. (Coarse Alluvium)	SS 8	67	19-14-13 (27)						
25			SS 9	11	26-24-26 (50)						
30		SAND - SP, fine to medium grained, brown, moist, very dense. (Coarse Alluvium)	SS 10	56	7-14-20 (34)						
		Bottom of hole at 31.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 2

PAGE 1 OF 1

CLIENT	Leo A. Daly	PROJECT NAME	VA Parking Ramp
PROJECT NUMBER	11.50534.100	PROJECT LOCATION	Minneapolis, MN
DATE STARTED	3/3/11	COMPLETED	3/3/11
DRILLING CONTRACTOR	NTI	GROUND ELEVATION	841.4 ft
DRILLING METHOD	3 1/4 Hollow Stem Auger	HOLE SIZE	8" O.D.
LOGGED BY	BC	CHECKED BY	AF
NOTES	Cave in depth = 15'. Frost depth = 4.5'.		
		GROUND WATER LEVELS:	
		AT TIME OF DRILLING	---
		AT END OF DRILLING	---
		AFTER DRILLING	---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
0								20	40	60	80
		3" Asphalt, 5-6" Aggregate Base.	AU 1								
		SAND with SILT - SP-SM, fine to medium grained, trace gravel, brown, frozen. (Coarse Alluvium)	AU 2								
5		SAND - SP, fine to medium grained, brown, moist, very loose to dense. (Coarse Alluvium)	SS 3	100	15-15-10 (25)						
		Blow counts influenced by frost at sample 3.	SS 4	100	1-2-2 (4)						
10			SS 5	100	1-2-2 (4)						
		Lens of Silty Sand - SM at 12'	SS 6	100	3-3-3 (6)						
15			SS 7	100	4-4-4 (8)						
20		SILTY SAND - SM, with lens of gray silt, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 8	100	2-3-5 (8)						
		Bottom of hole at 21.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 3

PAGE 1 OF 1

CLIENT <u>Leo A. Daly</u>	PROJECT NAME <u>VA Parking Ramp</u>
PROJECT NUMBER <u>11.50534.100</u>	PROJECT LOCATION <u>Minneapolis, MN</u>
DATE STARTED <u>3/1/11</u> COMPLETED <u>3/1/11</u>	GROUND ELEVATION <u>841.5 ft</u> HOLE SIZE <u>8" O.D.</u>
DRILLING CONTRACTOR <u>NTI</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>3 1/4 Hollow Stem Auger</u>	AT TIME OF DRILLING <u>---</u>
LOGGED BY <u>BC</u> CHECKED BY <u>AF</u>	AT END OF DRILLING <u>---</u>
NOTES <u>Cave in depth = 13.5'. Frost depth = 4'.</u>	AFTER DRILLING <u>---</u>

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								☐ FINES CONTENT (%) ☐			
								20	40	60	80
0		3" Asphalt, 5-6" Aggregate Base.	AU 1								
		FILL: Silty Sand - SM, fine to medium grained, trace gravel, dark brown.	AU 2								
5		SAND with SILT - SP-SM, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 3	67	2-2-3 (5)						
		SAND - SP, fine to medium grained, brown, moist, loose to medium dense. (Coarse Alluvium)	SS 4	83	5-4-6 (10)						
10			SS 5	83	4-3-4 (7)						
			SS 6	106	5-5-6 (11)						
15		SAND with SILT - SP-SM, fine to medium grained, brown, moist, loose to medium dense. (Coarse Alluvium)	SS 7	100	5-4-5 (9)						
20		4-6" Lens of Sandy Silt - ML at 20'.	SS 8	72	1-2-4 (6)						
		Bottom of hole at 21.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 4

PAGE 1 OF 1

CLIENT <u>Leo A. Daly</u>	PROJECT NAME <u>VA Parking Ramp</u>
PROJECT NUMBER <u>11.50534.100</u>	PROJECT LOCATION <u>Minneapolis, MN</u>
DATE STARTED <u>3/1/11</u> COMPLETED <u>3/1/11</u>	GROUND ELEVATION <u>841.5 ft</u> HOLE SIZE <u>8" O.D.</u>
DRILLING CONTRACTOR <u>NTI</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>3 1/4 Hollow Stem Auger</u>	AT TIME OF DRILLING <u>---</u>
LOGGED BY <u>BC</u> CHECKED BY <u>AF</u>	AT END OF DRILLING <u>---</u>
NOTES <u>Cave in depth = 14'. Frost depth = 4'.</u>	AFTER DRILLING <u>---</u>

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								☐ FINES CONTENT (%) ☐			
								20	40	60	80
0		3" Asphalt, 4-5" Aggregate Base.	AU 1								
		FILL: Silt Sand - SM, fine to medium grained, a little gravel, brown.	AU 2								
5		FILL/BURIED TOPSOIL: Silty Sand - SM-OL, fine grained, trace organics, black.	SS 3	67	3-3-4 (7)						
		SAND with SILT - SP-SM, fine to medium grained, brown, moist, loose. (Coarse Alluvium)									
		SILTY SAND - SM, fine to medium grained, brown, moist, medium dense. (Coarse Alluvium)	SS 4	111	5-5-6 (11)						
10		SAND - SP, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 5	78	3-4-3 (7)						
		SILTY SAND - SM, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 6	89	4-4-4 (8)						
15		SANDY SILT - ML, brown, medium. (Fine Alluvium)	SS 7	94	1-2-4 (6)						
		SILTY SAND - SM, fine to medium grained, brown, moist, dense. (Coarse Alluvium)									
20			SS 8	89	6-13-15 (28)						
		Bottom of hole at 21.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 5

PAGE 1 OF 1

CLIENT	Leo A. Daly	PROJECT NAME	VA Parking Ramp
PROJECT NUMBER	11.50534.100	PROJECT LOCATION	Minneapolis, MN
DATE STARTED	3/3/11	COMPLETED	3/3/11
DRILLING CONTRACTOR	NTI	GROUND ELEVATION	842.1 ft
DRILLING METHOD	3 1/4 Hollow Stem Auger	HOLE SIZE	8" O.D.
LOGGED BY	BC	CHECKED BY	AF
NOTES	Cave in depth = 14'. Frost depth = 4'.		
GROUND WATER LEVELS:		AT TIME OF DRILLING ---	
		AT END OF DRILLING ---	
		AFTER DRILLING ---	

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								☐ FINES CONTENT (%) ☐			
								20	40	60	80
0		3" Asphalt, 5" Aggregate Base.	AU 1								
		SILTY SAND - SM, fine to medium grained, trace gravel, dark brown, frozen. (Coarse Alluvium)	AU 2								
5		SILTY SAND - SM, fine to medium grained, brown, moist, medium dense. (Coarse Alluvium)	SS 3	78	4-5-4 (9)						
			SS 4	100	3-5-5 (10)						
10		SAND - SP, fine to medium grained, brown, moist, very loose to loose. (Coarse Alluvium)	SS 5	100	4-3-4 (7)						
			SS 6	100	4-2-3 (5)						
15			SS 7	100	2-2-2 (4)						
20		SAND - SP, fine to medium grained, with lens of silty sand, with gravel, brown, moist very dense. (Coarse Alluvium) Blow counts influenced by large rocks	SS 8	56	7-50						
		Bottom of hole at 21.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 6

PAGE 1 OF 2

CLIENT <u>Leo A. Daly</u>	PROJECT NAME <u>VA Parking Ramp</u>
PROJECT NUMBER <u>11.50534.100</u>	PROJECT LOCATION <u>Minneapolis, MN</u>
DATE STARTED <u>3/2/11</u> COMPLETED <u>3/2/11</u>	GROUND ELEVATION <u>842.4 ft</u> HOLE SIZE <u>8" O.D.</u>
DRILLING CONTRACTOR <u>NTI</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>3 1/4 Hollow Stem Auger</u>	<u>▽ AT TIME OF DRILLING</u> <u>39.5 ft / Elev 802.9 ft</u>
LOGGED BY <u>BC</u> CHECKED BY <u>AF</u>	AT END OF DRILLING <u>---</u>
NOTES <u>Frost depth = 4'.</u>	AFTER DRILLING <u>---</u>

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								□ FINES CONTENT (%) □			
								20	40	60	80
0		3" Asphalt, 5" Aggregate Base.	AU 1								
		FILL: Sand with Silt - SP-SM, fine to medium grained, trace gravel, brown to dark brown.	AU 2								
5		SAND - SP, fine to medium grained, trace gravel, brown, moist, very loose to medium dense. (Coarse Alluvium)	SS 3	67	7-6-4 (10)						
			SS 4	67	2-2-2 (4)						
10			SS 5	67	1-2-2 (4)						
			SS 6	100	5-4-4 (8)						
15		SAND with SILT - SP-SM, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 7	100	5-4-3 (7)						
20		SILTY SAND - SM, with lenses of sandy silt, gray, wet, loose. (Coarse Alluvium)	SS 8	100	3-2-3 (5)						
25		SAND - SP, fine to medium grained, with gravel, brown, moist, very dense. (Coarse Alluvium)	SS 9	78	7-15-36 (51)						
30		SAND - SP, fine to coarse grained, a little gravel, brown, moist, very dense. (Coarse Alluvium)	SS 10	78	17-19-26 (45)						
35											

(Continued Next Page)



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 6

PAGE 2 OF 2

CLIENT Leo A. Daly

PROJECT NAME VA Parking Ramp

PROJECT NUMBER 11.50534.100

PROJECT LOCATION Minneapolis, MN

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								□ FINES CONTENT (%) □			
								20	40	60	80
35		SILTY SAND - SM, fine grained, trace gravel, and cobbles, dark gray, very dense. (Coarse Alluvium) <i>(continued)</i>	SS 11	67	18-41-50 (91)						
40		SAND - SP, fine to coarse grained, with gravel and cobbles, brown, wet to waterbearing, very dense. (Coarse Alluvium)	SS 12	89	36-34-35 (69)						
45		SANDY CLAY - CL, with gravel and cobbles, brown to gray, very stiff. (Glacial Till)	SS 13	67	9-50						
		Limestone Bedrock.									
		Bottom of hole at 45.5 feet.									



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 8

PAGE 1 OF 1

CLIENT <u>Leo A. Daly</u>	PROJECT NAME <u>VA Parking Ramp</u>
PROJECT NUMBER <u>11.50534.100</u>	PROJECT LOCATION <u>Minneapolis, MN</u>
DATE STARTED <u>3/1/11</u> COMPLETED <u>3/1/11</u>	GROUND ELEVATION <u>840.9 ft</u> HOLE SIZE <u>8" O.D.</u>
DRILLING CONTRACTOR <u>NTI</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>3 1/4 Hollow Stem Auger</u>	AT TIME OF DRILLING <u>---</u>
LOGGED BY <u>BC</u> CHECKED BY <u>AF</u>	AT END OF DRILLING <u>---</u>
NOTES <u>Cave in depth = 23'. Frost depth = 4'.</u>	AFTER DRILLING <u>---</u>

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								☐ FINES CONTENT (%) ☐			
								20	40	60	80
0		3" Asphalt, 5" Aggregate Base.	AU 1								
		FILL/BURIED TOPSOIL: Silty Sand - SM, trace organics, fine grained, black.	AU 2								
		POSSIBLE FILL: Silty Sand - SM, fine to medium grained, trace gravel, dark brown.									
5		SILTY SAND - SM, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 3	83	4-3-4 (7)						
		SILTY SAND - SM, fine grained, brown, moist, medium dense. (Coarse Alluvium)	SS 4	106	4-4-5 (9)						
10		SAND - SP, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 5	106	4-3-3 (6)						
		SANDY SILT - ML, brown, soft. (Fine Alluvium)	SS 6	94	2-2-2 (4)						
15			SS 7	72	2-1-2 (3)						
20		CLAYEY SAND - SC, fine to medium grained, trace gravel, brown, moist, medium dense. (Coarse Alluvium)	SS 8	100	5-5-7 (12)						
25		SAND - SP, fine to medium grained, brown, moist, very dense. (Coarse Alluvium)	SS 9	78	13-20-22 (42)						
30		SAND - SP, fine to medium grained, a little gravel, brown, moist, very dense. (Coarse Alluvium)	SS 10	72	10-17-18 (35)						
		Bottom of hole at 31.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 9

PAGE 1 OF 1

CLIENT	Leo A. Daly	PROJECT NAME	VA Parking Ramp
PROJECT NUMBER	11.50534.100	PROJECT LOCATION	Minneapolis, MN
DATE STARTED	3/2/11	COMPLETED	3/2/11
DRILLING CONTRACTOR	NTI	GROUND ELEVATION	841.7 ft
DRILLING METHOD	3 1/4 Hollow Stem Auger	HOLE SIZE	8" O.D.
LOGGED BY	BC	CHECKED BY	AF
NOTES	Frost depth = 4'.		
		GROUND WATER LEVELS:	
		AT TIME OF DRILLING	---
		AT END OF DRILLING	---
		AFTER DRILLING	---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								☐ FINES CONTENT (%) ☐			
								20	40	60	80
0		3" Asphalt, 5" Aggregate Base.	AU 1								
		FILL/BURIED TOPSOIL: Sandy Silt - ML-OL, trace organics, dark brown to black.	AU 2								
		POSSIBLE FILL: Clayey Sand - SC, fine to medium grained, dark brown.									
5		SILTY SAND - SM, fine grained, brown, moist, loose to medium dense. (Coarse Alluvium)	SS 3	56	5-5-4 (9)						
			SS 4	78	9-3-4 (7)						
10		SAND - SP, fine to medium grained, brown, moist, loose. (Coarse Alluvium)	SS 5	100	3-3-3 (6)						
			SS 6	89	6-4-5 (9)						
15		SAND with SILT - SP-SM, fine to medium grained, brown, moist, medium dense. (Coarse Alluvium)	SS 7	100	7-5-5 (10)						
20		CLAY - CL, brown. (Fine Alluvium)	SS 8	100	4-6-20 (26)						
		SAND - SP, fine to coarse grained, with gravel, brown, moist, dense. (Coarse Alluvium)									
		Bottom of hole at 21.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



Northern Technologies, Inc
6588 141st Ave NW
Ramsey, MN 55393
Telephone: 763-433-9175
Fax: 763-323-4739

BORING NUMBER 10

PAGE 1 OF 1

CLIENT <u>Leo A. Daly</u>	PROJECT NAME <u>VA Parking Ramp</u>
PROJECT NUMBER <u>11.50534.100</u>	PROJECT LOCATION <u>Minneapolis, MN</u>
DATE STARTED <u>3/1/11</u> COMPLETED <u>3/1/11</u>	GROUND ELEVATION <u>841.6 ft</u> HOLE SIZE <u>8" O.D.</u>
DRILLING CONTRACTOR <u>NTI</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>3 1/4 Hollow Stem Auger</u>	AT TIME OF DRILLING <u>---</u>
LOGGED BY <u>BC</u> CHECKED BY <u>AF</u>	AT END OF DRILLING <u>---</u>
NOTES <u>Cave in depth = 19'. Frost depth = 4'.</u>	AFTER DRILLING <u>---</u>

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								☐ FINES CONTENT (%) ☐			
								20	40	60	80
0		3" Asphalt, 5" Aggregate Base.	AU 1								
		FILL: Silty Sand - SM, fine to medium grained, trace gravel, dark brown.	AU 2								
		POSSIBLE FILL: SILTY SAND - SM, fine to medium grained, brown to dark brown.									
5		SILTY SAND - SM, fine to medium grained, brown, moist, very loose. (Coarse Alluvium)	SS 3	56	2-2-2 (4)						
		SAND - SP, fine to medium grained, brown, moist, loose to medium dense. (Coarse Alluvium)	SS 4	100	2-2-3 (5)						
10			SS 5	100	3-4-5 (9)						
			SS 6	100	4-5-6 (11)						
15			SS 7	94	3-4-5 (9)						
20		SILTY SAND - SM, fine grained, with lens of silt, gray, moist, medium dense. (Mixed Alluvium)	SS 8	83	2-4-6 (10)						
			ST 9								
25		SAND - SP, fine to medium grained, trace gravel, brown, moist, very dense. (Coarse Alluvium)	SS 10	67	13-16-17 (33)						
30		SAND with SILT - SP-SM, fine to medium grained, with pieces of weathered limestone, brown, moist, very dense. (Weathered Bedrock)	SS 11	11	50						
		Bottom of hole at 30.0 feet.									

GEOTECH BH PLOTS VA PARKING RAMP.GPJ GINT US.GDT 3/29/11



NORTHERN TECHNOLOGIES, INC.

6588 141st Avenue NW, Ramsey, MN 55303 763-433-9175 763-323-4739 Fax

REPORT OF: MECHANICAL ANALYSIS TEST

PROJECT: VA Medical Center Parking Ramp Design
Minneapolis, Minnesota

DATE: 3/28/2011

REPORT TO: Leo A Daly
John D. Albers
730 Second Ave. South, Suite 1100
Minneapolis, MN 55402-2454

COPIES TO:

PROJECT #: 11-50534.100

AGGREGATE TYPE: Silty sand, fine to medium grained, brown, (SM)
LOCATION SAMPLED: Boring 5, Sample 3 (5 foot depth)
MECHANICAL ANALYSIS:

SAMPLE TAKEN: 3/22/2011
SAMPLE SIZE:
PASSING:

#8	100
#10	100
#16	100
#30	99
#40	97
#50	83
#100	51
#200	15.9



NORTHERN TECHNOLOGIES, INC.

6588 141st Avenue NW, Ramsey, MN 55303 763-433-9175 763-323-4739 Fax

REPORT OF: MECHANICAL ANALYSIS TEST

PROJECT: VA Medical Center Parking Ramp Design
Minneapolis, Minnesota

DATE: 3/28/2011

REPORT TO: Leo A Daly
John D. Albers
730 Second Ave. South, Suite 1100
Minneapolis, MN 55402-2454

COPIES TO:

PROJECT #: 11-50534.100

AGGREGATE TYPE: Silty sand, fine to medium grained, brown (SM)
LOCATION SAMPLED: Boring 10, Sample 3 (5 foot depth)
MECHANICAL ANALYSIS:

SAMPLE TAKEN: 3/22/2011
SAMPLE SIZE:
PASSING:

#8	100
#10	100
#16	100
#30	100
#40	99
#50	96
#100	74
#200	29.5



NORTHERN TECHNOLOGIES, INC.

6588 141st Avenue NW, Ramsey, MN 55303 763-433-9175 763-323-4739 Fax

REPORT OF: MECHANICAL ANALYSIS TEST

PROJECT: VA Medical Center Parking Ramp Design
Minneapolis, Minnesota

DATE: 3/28/2011

REPORT TO: Leo A Daly
John D. Albers
730 Second Ave. South, Suite 1100
Minneapolis, MN 55402-2454

COPIES TO:

PROJECT #: 11-50534.100

AGGREGATE TYPE: Sand, fine to medium grained, brown (SP)
LOCATION SAMPLED: Boring 3, Sample 4 (5 foot depth)
MECHANICAL ANALYSIS:

SAMPLE TAKEN: 3/22/2011
SAMPLE SIZE:
PASSING:

#8	100
#10	100
#16	100
#30	98
#40	94
#50	72
#100	13
#200	6



Prime Testing, Inc.

41658 Ivy Street Ste 114 Murrieta, CA 92562
ph (951) 894-2682 • fx (951) 894-2683

Work Order No.: 11C2187

Client: Northern Technologies, Inc.

Project No.: 11.50534.100

Project Name: VA Parking Ramp

Report Date: March 25, 2011

Laboratory Test(s) Results Summary

The subject soil samples were processed with the U.S. Standard No. 10 Sieve and tested for Soil Resistivity per ASTM International Standard G 57-06. The test results follow:

Sample Identification	As Rec'd Resistivity (ohm-cm)	Saturated Resistivity (ohm-cm)
B-5 @ 7-10'	2,400	970
B-10 @ 7-10'	4,800	840

We appreciate the opportunity to serve you. Please do not hesitate to contact us with any questions or clarifications regarding these results or procedures.

Ahmet K. Kaya, Laboratory Manager

