Independent Testing Technologies, Inc.

JULY 23, 2018

PROJECT 18-211
REPORT OF GEOTECHNICAL EXPLORATIONS

For

CASS GILBERT MEMORIAL PARK SOLAR GARDEN
CAPITOL COMPLEX
ST. PAUL, MINNESOTA

Prepared For:

STATE OF MINNESOTA
DEPARTMENT OF ADMINISTATION

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Independent Testing Technologies, Inc.

July 23, 2018

Mr. Bee Yang
State of Minnesota- Department of Administration
309 9Administration Building
50 Sherburne Avenue
St. Paul, MN 55155

RE: 18-211 Report of Geotechnical Exploration
Cass Gilbert Memorial Park Solar Garden
Capitol Complex
St. Paul, Minnesota

Dear Mr. Yang:

Independent Testing Technologies, Inc. is pleased to submit the results of our subsurface investigation program for this project in St. Paul, Minnesota. This report represents our work for this project as authorized by you. An electronic copy is submitted herewith. An electronic copy and two (2) hard copies have also been submitted to the Legislative Reference Library.

The soils on this site are predominantly medium grained sands and gravels (SP, SP-SM). Groundwater was not observed to the depths explored in any of the borings during drilling. Soil samples obtained during our investigation will be stored at our office for thirty days after the date of this report. After that time, they will be disposed of unless you advise otherwise.

Mr. Yang, please contact Patrick Johnson if you have any questions regarding this report. Please contact Daryl Dhein if you would like a proposal for the materials testing services that will be needed during the construction phase.

Sincerely,

Patrick A. Johnson, P.E.
MN License #22037

Kevin T Reller
Vice President

Cc: Legislative Reference Library

337 31st Avenue South. Waite Park, MN 56387
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CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Minnesota.

Patrick A. Johnson

Date: July 23, 2018 **License No.:** 22037

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GEOTECHNICAL EXPLORATIONS
CASS GILBERT MEMORIAL PARK SOLAR GARDEN
CAPITOL COMPLEX
ST. PAUL, MINNESOTA
PROJECT 18-211

A. Introduction

This report is being prepared for use by our client on this specific project. We intend to present this report and our findings in the same logical manner that led us to arrive at our recommendations. This report is based on some general assumptions regarding the anticipated construction based on experience with similar projects. These assumptions and the entire report should be reviewed immediately upon receipt.

Purpose:

The purpose of our investigation was to evaluate the existing soil and water conditions on this site and provide a report of our findings and recommendations regarding design and construction of the proposed improvements. The project will consist of construction of a new solar garden on the south side of the Cass Gilbert Memorial Park at the Capitol Complex in St. Paul, Minnesota. In accordance with your written authorization, we have conducted a subsurface exploration program for the proposed project.

Scope of Services:

Our authorized scope of services included the following:

1. To investigate the subsurface soil and water conditions encountered at six (6) split-spoon soil boring locations. The borings were planned to be ten (10) feet deep.
2. To provide a report of our findings including the results of our subsurface investigation and recommendations regarding construction, earthwork, fill and compaction, foundation design, allowable soil bearing pressures, slab support and deep foundation or pile design.

General Site Conditions:

The proposed solar garden site is located on the south side of the Cass Gilbert Memorial Park at 30 Sherburne Avenue in St. Paul, Minnesota. The site is on the south side of the park on a slope west of the observation deck. The slope is very steep and extends to the top of a retaining wall along University Avenue. The area is an open, grassy area that is not mowed.

Available Subsurface Information:

According to the Geologic Map of Minnesota, Quaternary Geology, prepared by Howard C. Hobbs and Joseph E. Goebel (1982, Minnesota Geological Survey), this site lies within an outwash unit not associated with a particular moraine. It is associated with the Des Moines glaciation of Pleistocene, Late Wisconsinan age. The drift is derived from parent material in North Dakota and Manitoba.

According to the Soil Survey of Ramsey County prepared by the Soil Conservation Service, the site lies within Chetek Sandy Loam soil unit. These consist of very steep, well drained, coarse textured soils formed in sandy outwash. Most of the individual soils mapped on this site are sandy and have slight limitations for development of commercial building sites. The only limitation is the steep slope.

B. Exploration Program

Five (5) split-spoon soil borings were conducted on this project. The borings were advanced to 10 feet deep using a 3¼ inch I.D. hollow stem auger. Samples were obtained every 2 ½ feet using a 2-inch O.D. split spoon sampler in accordance with the American Society for Testing and Materials (ASTM D1586). Standard penetration values (N-values) were obtained at each sample interval by driving the sampler into the soil using a 140-pound hammer falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler 12 inches is known as the standard penetration resistance or N-value. Where the sampler can not be driven at least 6 inches by 50 blows of the hammer, the total number of blows as well as the distance driven is reported on the boring logs.

One (1) hand auger boring was conducted on a portion of the slope that was too steep to access with the rig. Dynamic Cone Penetrometer (DCP) tests were conducted within the borehole at intervals to assist in determining the shear strength of the soil. The DCP values were obtained by driving a 1.66-inch, 45 degree cone into the soil using a 15 pound weight. The number of blows required to drive the sampler a set distance is correlated to the standard penetration value in accordance with ASTM Special Technical Publication #399 "*Dynamic Cone for Shallow Penetration Testing.*" The blow counts determined by the DCP roughly correlate at 1.5:1 with standard penetration blow counts or N-values.

Groundwater levels were noted during drilling and immediately after completion. The holes were backfilled with the auger cuttings. Some settlement of the bore holes may be expected. The borings were conducted with a track mounted rig. The boring locations were staked by us.

Exploration Results:

The borings were conducted in existing open grassy slope. All of the borings encountered topsoil material consisting of black silty sand (SM) to depths of 24 to 32 inches.

Below the topsoil, all of the borings encountered native fine to medium grained poorly graded sand with silt (SP-SM) and poorly graded sand (SP) with varying amounts of gravel.

Penetration Test Results:

The standard penetration blow counts in the native sand (SP, SP-SM) soils ranged from 3 to 16, which are low to moderate, indicating that they are in a very loose to medium dense condition. Refusal of the spoon or auger did not occur in the split spoon borings and drilling was relatively easy in all of the borings. Refusal of the hand auger occurred at a depth of 5.0 feet due to collapsing sands.

Water Level Observations:

Observations of the subsurface water conditions were made during drilling operations. Groundwater was not encountered in any of the borings during drilling. It should be noted that the water levels were observed over a very short period of time. However, we feel the water levels observed are a true representation of the water levels on this site at the time due to high permeability of the native sandy soils.

It should be noted that fluctuations in the level of the groundwater can occur due to variations in rainfall, temperature, spring thaw and other factors not evident at the time of our investigation. Mottled soils were not observed. Mottled soils are a historical indication of a temporarily or seasonally saturated soil condition. Grey soils were not observed. Grey soils are an indication of a permanently saturated soil condition.

Laboratory Test Results:

Moisture Content Tests- Moisture content tests were performed on every split spoon sample in accordance with ASTM method D2216; *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*. Individual test results are shown on the boring logs adjacent to the sample that was tested.

C. Engineering Review

Discussion:

Based on our findings, the site appears to be well suited for the proposed improvements. The granular soils at this site are well suited for support of slabs and foundations. The sand soils are also excellent for use as structural fill and are excellent for pavement support. They are not frost susceptible and are also excellent for infiltration for storm water treatment. Groundwater will not have an impact on design or construction.

D. Recommendations

The following recommendations are based on our understanding of the proposed project. If our understanding of the project is not accurate, or if changes are made to the project scope, please inform us so that our recommendations can be amended, if necessary. We have included recommendations regarding earthwork and construction that may help in cost estimates and aid in design. We should be allowed to review the proposed construction plans to provide further detailed recommendations, if necessary. Without the opportunity to review the final construction plans, the recommendations made in this report may no longer be valid.

Site Grading:

We recommend that the existing topsoil be removed from the construction areas prior to placing any fill or beginning construction. The topsoil should be removed from the site or stockpiled and re-used for landscaping. We estimate this may require 24 to 32 inches of excavation over the site.

We recommend the bottom of the excavation be observed by a soils engineer or a qualified technician to verify that native, competent material has been reached prior to placing fill or foundations. We recommend any excavation to remove unsuitable material from beneath any structures be oversized one foot for every foot of fill required to reach planned grade (1:1 oversizing). After removal of topsoil and any unsuitable soils, we recommend clean, mineral fill,

meeting the requirements of structural fill, be placed and compacted to bring the building and pavement areas to grade.

Structural Fill:

The native, on-site soils consisting of poorly graded sands (SP) and poorly graded sands with silt (SP-SM) are considered excellent material for use as structural fill. These soils are not susceptible to moisture variations and are easy to work with, even if they become wet. These soils are fairly easy to compact using vibratory compaction equipment, especially when at or near optimum moisture content for compaction.

We recommend that any imported fill consist of mineral soils meeting the following requirements. No organic soils, roots, stumps, logs, brush, etc. should be used as structural fill below any foundation, slab or pavement section. We recommend that all fill material be free of soft, wet or frozen soils, highly expansive soils, rubble, debris and rocks in excess of 6 inches in diameter. The fill should be as uniform as possible both in composition and moisture content. We recommend all fill be compacted to the minimum relative density levels shown in the table below:

Location	Recommended Compaction (% Std. Proctor)
Below Foundations	100 %
Below Slabs on Grade	98%
Below Pavements, deeper than 3 feet from finished subgrade	95%
Below Pavements within 3 feet of finished subgrade	100%
Landscape Areas	90%
Wall Backfill	95%

All fill should be compacted at a moisture content within plus or minus 3% of the optimum moisture as determined by a standard proctor. We recommend compaction tests be taken on any fill below the foundations in the building area at a rate of one test per 50 linear feet of strip footings and one per column pad. We recommend compaction tests be taken on any fill area at a rate of one test per vertical foot per 2500 square feet.

Foundations:

The N-values recorded in the penetration borings indicate that the existing native soils at anticipated foundation depth on this site are in a medium dense condition capable of supporting the proposed structures. All exterior footings can be placed at a nominal depth, as long as they are on non-frost susceptible soil. Non-frost susceptible material is defined as sands with less than 5% passing a number 200 sieve and less than 50% passing a number 40 sieve.

Any footings placed on native soils or on properly compacted fill should be proportioned for a maximum net allowable soil bearing pressure of 3000 psf. We recommend compaction tests be taken on any fill immediately prior to pouring the footings. We recommend the native sands be watered and surface compacted prior to placing the foundations.

The recommended bearing pressure is a net value and represents the actual loads that may be transmitted to the soil independent of overburden pressures. We estimate total settlement to be less than 1 inch with differential settlement about half of this if the recommendations in this report are followed.

We recommend a minimum of 6 inches of clean, free draining washed sand with less than 5% passing a No. 200 sieve be placed beneath slabs-on-grade. The native, poorly graded sands (SP) should meet this requirement. This will provide a capillary break and a uniform level subgrade for the floor slabs. We recommend slabs-on-grade be designed using a modulus of subgrade reaction of 300 pounds per cubic inch.

Drilled Pier Foundations

We understand a drilled concrete pier or a combination pier and pad mat foundation will be used for support of the proposed structure. The sandy soils on this site have limited ability to remain open for long periods to allow installation of rebar cages in drilled caissons without support such as temporary casings or forms.

For drilled concrete piers, we recommend the following design parameters be used for the soil

type encountered:

Soil Type- USCS	Dry Unit Weight- pcf	Internal Friction Angle	Coefficient of Passive Resistance K_p	Passive Resistance- per foot of shaft	End Bearing Capacity Factor N_q	Side Friction Factor, compression K_{HC}	Side Friction Factor, tension K_{HT}
Poorly Graded Sand	115	32	3.25	370 pf/ft	14	0.7	0.4

For end bearing capacity calculations, we recommend that the overburden effective stress be limited to that value corresponding to a depth of 20 times the shaft diameter. For drilled shafts in excess of 24 inches in diameter, we recommend the shaft design be checked for settlement by calculating settlement for end bearing of an equivalent size spread footing.

For a combination pier and pad, we recommend the pad be designed using a modulus of subgrade reaction of 300 pounds per cubic inch. We recommend the exposed soils beneath the pad be compacted to a minimum of 98% of standard proctor maximum density prior to placing the concrete or any re-bar.

Wall Backfill:

The on-site soils consisting of poorly graded sands (SP) and poorly graded sands with silt (SP-SM) are considered excellent material for wall backfill. Cobbles exceeding 3 inches in diameter should not be used as backfill against below grade walls or retaining wall within two feet of the wall. All wall backfill should be compacted to at least 95% of standard proctor. We recommend below grade walls be designed using a coefficient of active pressure (K_a) of 0.3, an at-rest coefficient (K_o) of 0.55, a passive coefficient (K_p) of 3.5, and an equivalent fluid pressure of 60 psf for the at-rest condition.

E. Pavement Recommendations

We recommend all topsoil be removed from roadway and drive areas prior to placing any fill needed to reach planned subgrade. The subgrade sand (SP, SP-SM) soils encountered below the topsoil are classified as A-1-b soils in accordance with the American Association of State Highway Transportation Officials (AASHTO) classification system. A-1-b soils are rated excellent material for use as roadway subgrade material. In no instance should organic soils be used as parking lot subgrade material. Without benefit of a laboratory R-value determination and based on Mn/DOT guidelines, an R-value of 70 can be assumed for these materials.

Based on an assumed R-value of 70, we recommend gravel drives and roads consist of 6 inches of Class 1 Aggregate surfacing on properly prepared sand subgrade. In using the assumed R-value for pavement design, it is essential that the subgrade be constructed of uniform soils at a moisture content and density in accordance with Mn/DOT specification 2105 and capable of passing a test roll in accordance with Mn/DOT specification 2111. The native, undisturbed soils may need preparation (drying and compacting) to pass a proof roll.

If the subgrade is not compacted, uniform and capable of passing a test roll, then we recommend the subgrade be scarified and recompacted or subcut and replaced with geotextile fabric and select granular material meeting Mn/DOT specification 3149. The top of the subgrade should be compacted to a minimum of 100% of standard proctor maximum density. The subgrade should be sloped towards the edges to provide drainage.

E. Closing

Our work was performed for geotechnical purposes only and not to document the presence or extent of any contamination on the site. We can note that our crew did not detect any obvious contamination by sight or smell during drilling operations. However, human senses are limited in terms of contamination detection and, therefore, the lack of detection through human sensing does not preclude the possibility of the presence of contamination of the site.

This report represents the result of our subsurface investigation and is based on information

gathered at specific locations. Subsurface conditions can change a great deal over short horizontal distances. Also, the actual interface between strata will likely be a gradual transition rather than an abrupt change as represented on the boring logs.

Geotechnical engineering is based extensively on opinion. Therefore, the data contained in this report should be used as a guide, and we recommend that construction monitoring be performed by a qualified geotechnical engineer or technician. Any changes in the subsurface conditions from those found during this geotechnical investigation should be brought to the attention of a soils engineer.

C:211-rpt

APPENDIX 1

BORING LOCATION PLAN

SB-1
SB-2
SB-3
SB-4
SB-5
SB-6

APPENDIX 2

SOIL BORING LOGS

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **18-211** **STATE OF MN DEPT OF ADMIN. CASS GILBERT MEMORIAL PARK SOLAR GARDEN - CAPITOL COMPLEX ST. PAUL, MINNESOTA**

DATE: **7/5/18** *BORING #:* **SB-1**

START TIME: **11:45** *END TIME:* **1:10**

METHOD: **3 ¼" I.D. Hollow Stem Auger**

CREW: **BH/ CD**

LOCATION: **Moved 25.5' South** N44° 57.376' E93° 06.037'

ELEVATION: **NA**

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
	SM	**SILTY SAND, fine grained, black, TOPSOIL.**				
24"						
	SP	**POORLY GRADED SAND, fine to medium grained, brown.**				
			1	**10**	3.7	
5.0						
			2	**10**	2.8	
			3	**9**	1.7	
10.0						
			4	**11**	1.6	
11.5						
		Boring complete to 11.5 feet. **No water encountered during drilling.** **No water measured to cave-in at 4' 5".**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **18-211** **STATE OF MN DEPT OF ADMIN. CASS GILBERT MEMORIAL PARK SOLAR GARDEN - CAPITOL COMPLEX ST. PAUL, MINNESOTA**

DATE: **7/5/18** *BORING #:* **SB-2**

START TIME: **8:15** *END TIME:* **8:45**

METHOD: **3 ¼" I.D. Hollow Stem Auger**

CREW: **BH/ CD**

LOCATION: **See Boring Location Plan** N44° 57.369' E93° 06.033'

ELEVATION: **NA**

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
	SM	**SILTY SAND, fine grained, dark brown, TOPSOIL.**	**1**	**3**	14.5	
24"						
	SP	**POORLY GRADED SAND, medium to coarse grained, brown.**	**2**	**7**	1.6	
5.0			**3**	**6**	1.6	
		fine to medium grained.	**4**	**6**	2.2	
10.0			**5**	**12**	2.1	
11.5		**Boring complete to 11.5 feet.** **No water encountered during drilling.** **No water measured to cave-in at 5' 4".**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **18-211** **STATE OF MN DEPT OF ADMIN. CASS GILBERT MEMORIAL PARK SOLAR GARDEN - CAPITOL COMPLEX ST. PAUL, MINNESOTA**

DATE: **7/5/18** *BORING #:* **SB-3**

START TIME: **9:40** *END TIME:* **10:10**

METHOD: **3 ¼" I.D. Hollow Stem Auger**

CREW: **BH/ CD**

LOCATION: **Moved 25.5' South** N44° 57.370' E93° 06.009'

ELEVATION: **NA**

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
	SM	**SILTY SAND, fine grained, black, TOPSOIL.**				
24"						
	SP	**POORLY GRADED SAND, fine to medium grained, brown.**				
			1	**3**	1.6	
5.0						
			2	**5**	2.7	
			3	**16**	2.2	
10.0						
			4	**12**	2.1	
11.5		**Boring complete to 11.5 feet.** **No water encountered during drilling.** **No water measured to cave-in at 3' 5".**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **18-211** **STATE OF MN DEPT OF ADMIN. CASS GILBERT MEMORIAL PARK SOLAR GARDEN - CAPITOL COMPLEX ST. PAUL, MINNESOTA**

DATE: **7/5/18** *BORING #:* **SB-4**

START TIME: **1:25** *END TIME:* **2:00**

METHOD: **3 ¼" I.D. Hollow Stem Auger**

CREW: **BH/ CD**

LOCATION: **Moved 24.5' South** N44° 57.372' E93° 05.999'

ELEVATION: **NA**

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
32"	SM	**SILTY SAND, fine grained, black, TOPSOIL.**				
5.0	SP-SM	**POORLY GRADED SAND w/ SILT, fine to medium grained, brown.**	1	4	6.0	
7.0			2	4	4.5	
10.0	SP	**POORLY GRADED SAND, fine to medium grained, brown.**	3	5	4.4	
11.5			4	6	4.6	
		Boring complete to 11.5 feet. **No water encountered during drilling.** **No water measured to cave-in at 6' 5".**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **18-211** **STATE OF MN DEPT OF ADMIN. CASS GILBERT MEMORIAL PARK SOLAR GARDEN - CAPITOL COMPLEX ST. PAUL, MINNESOTA**

DATE: **7/5/18** *BORING #:* **SB-5**

START TIME: **2:30** *END TIME:* **3:10**

METHOD: **3 ¼" I.D. Hollow Stem Auger**

CREW: **BH/ CD**

LOCATION: **Moved 100' East** N44° 57.369' E93° 05.991'

ELEVATION: **NA**

Depth (Feet)	ASTM Symbol	Soil Description	Sample #	N Value	W_n	Notes
	SM	**SILTY SAND, fine grained, black, TOPSOIL.**	**1**	**4**	12.1	
28"						
	SP-SM	**POORLY GRADED SAND w/ SILT, fine to medium grained, brown.**	**2**	**7**	7.3	
5.0						
			3	**8**	3.5	
7.0						
	SP	**POORLY GRADED SAND, medium grained, brown.**				
			4	**6**	2.9	
10.0						
			5	**3**	3.1	
11.5						
		Boring complete to 11.5 feet. **No water encountered during drilling.** **No water measured to cave-in at 6' 8".**				

INDEPENDENT TESTING TECHNOLOGIES, INC. LOG OF SOIL BORING

PROJECT: **18-211** **STATE OF MN DEPT OF ADMIN. CASS GILBERT MEMORIAL PARK SOLAR GARDEN - CAPITOL COMPLEX ST. PAUL, MINNESOTA**

DATE: **7/5/18** *BORING #:* **SB-6**

START TIME: **3:15** *END TIME:* **3:30**

METHOD: **3" I.D. Bucket Auger**

CREW: **BH/ CD**

LOCATION: N44° 57.364' E93° 06.030' *ELEVATION:* **NA**

Depth (Feet)	*ASTM Symbol*	*Soil Description*	*Sample #*	*N Value*	W_n	*Notes*
24"	SM	**SILTY SAND, fine grained, black, TOPSOIL.**	1	2	21.5	
5.0	SP-SM	**POORLY GRADED SAND w/ SILT, fine to medium grained, brown.**	2	3	3.8	
		Boring complete to 5.0 feet. **No water encountered during drilling.**				

Unified Soil Classification (USC) System (from ASTM D 2487)

Major Divisions			Group Symbol	Typical Names
Course-Grained Soils More than 50% retained on the 0.075 mm (No. 200) sieve	**Gravels** 50% or more of course fraction retained on the 4.75 mm (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
	Sands 50% or more of course fraction passes the 4.75 (No. 4) sieve	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
Fine-Grained Soils More than 50% passes the 0.075 mm (No. 200) sieve	**Silts and Clays** Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/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 or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic
Suffix: W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%