DRAFT

March 2, 2014

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SUBJECT: **Geotechnical Investigation**
VA White City Solar Power System
Jackson County, Oregon

At your request, Applied Geotechnical Engineering and Geologic Consulting LLC (AGEGC) has completed a geotechnical investigation for the proposed solar power system to be located at the VA White City Facility in Jackson County, Oregon. The investigation consisted of subsurface explorations, and engineering studies and analyses. This report describes the work accomplished and provides our conclusions and recommendations for support of the solar panels for this project.

PROJECT DESCRIPTION

We understand the solar panels racking system will be supported on concrete ballast foundations that may be either cast-in-place or precast. Foundations loads have not been provided.

SITE DESCRIPTION

The site is located on the northeastern side of the VA White City property. The area is currently used primarily for storage of landscaping materials but includes portion of a golf driving range, small garden plots and undeveloped land. A small irrigation ditch crosses the central portion of the site from southeast to northwest. The site is relatively flat.

SUBSURFACE CONDITIONS

General. Subsurface materials and conditions at the site were investigated by AGEGC on December 2, 2013, with seven test pits, designated TP-1 through TP-7. The test pits were completed using a mini-excavator provided and operated by Frank Norris Excavation. The locations of the test pits were mapped in the field by Adkins Engineering. A senior geotechnical engineer from our firm maintained a detailed log of the conditions and materials encountered in the test pits. Logs of the test pits are provided in Appendix A. The terms used to describe the materials encountered in the explorations are defined in Table 1A.

Soil Descriptions. All seven test pits encountered a surficial layer of brown silt soil. The brown silt soil ranges from 0.5 to 1.5 ft thick. The silt contains scattered rounded to subrounded gravel and cobbles. The silt is typically soft to stiff.

Test pits TP-3, TP-4, and TP-7 encountered a 6- to 12-in.-thick layer of fill mantling the surficial brown silt. The fill consists of organic silt (topsoil) with scattered rounded to subrounded gravel and cobbles. The fill is typically soft.

The brown silt is underlain by gravel/cobble soils. The soils typically have a silt matrix and are poorly to well cemented. The upper 6 in. of the gravel/cobble matrix in test pits TP-1 and TP-7 consists of a moderately expansive clay. All seven test pits were terminated in the gravel/cobble soils at depths of 30 to 50 in.

Groundwater. Groundwater seepage was not observed in any of the five test pits at the time of our fieldwork; however, perched groundwater can approach the ground surface during periods of heavy and/or extended rainfall. The site is underlain by relatively poorly draining cemented gravel/cobble soils at shallow depths resulting in seasonal shallow (perched) groundwater conditions.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this investigation and our understanding of the proposed solar project, it is our opinion that, from a geotechnical standpoint, the site is suitable for the proposed new solar panel ballast foundations. In our opinion, the most important geotechnical considerations associated with the new solar foundations are the presence of a surficial layer of compressible silt soils and fill, gravel/cobble soils with local zones of moderately expansive clay soil matrix, locally hard/well cemented gravel/cobble spoils, and seasonally shallow (perched) groundwater.

The following sections provide our conclusions and recommendations for development of the site with the solar array.

Site Preparation. The existing fill soils and silt soils are not suitable for support of solar ballast concrete foundations. The fill and silt soils should be removed within a horizontal distance of 12 in. of any foundation and replaced with structural fill. In addition, the pockets of gravel/cobble soils with a clay matrix should be overexcavated and replaced with structural fill. We estimate that overexcavation to depths of 1 to 2 ft below original grade will be required to remove most of the unsuitable soils. The excavated spoils and strippings are not suitable for use as structural fill and should be removed from the site.

Structural Fill. All fill placed within the 12 in. of any foundation should consist of imported granular fill compacted to at least 95% of the maximum dry density as determined by ASTM D 698. The compaction should be accomplished using a large, smooth-drum vibratory roller. In our opinion, ¾-in.-minus crushed rock would be appropriate for use as structural fill for foundation and slab-on-grade support. Mass grading may be completed using crushed rock with a maximum size of up to about 3 in. and contain less than about 5% passing the No. 200 sieve (washed analysis).

Foundation Support Recommendations. Based on the results of our investigation and our understanding of the proposed solar panel supports, it is our opinion that foundation support for the solar structures can be provided by ballast spread footing foundations established on structural fill (imported crushed rock) over undisturbed, non-expansive gravel/cobble soils.

Excavations for foundations should be completed using a backhoe or trackhoe equipped with a smooth-lip bucket. Subgrade soils disturbed during excavation for the foundations should be removed prior to placement of the crushed rock foundation support.

Footings should be established at a minimum depth of 18 in. below the lowest adjacent finished grade. The width of footings should not be less than 18 in. All footing excavations should be observed by the geotechnical engineer of record prior to placement of rebar and concrete.

For foundations founded on structural fill as discussed above, we estimate that the total, long-term settlement of spread footings designed in accordance with the above recommendations and imposing a real bearing pressure of 3,000 psf will be less than ½ in.

For design purposes, the real bearing value refers to the total of dead load plus frequently and/or permanently applied live loads, and can be increased by one-third for the total of all loads; dead, live, and wind or seismic.

Lateral Load Resistance. Horizontal shear forces can be resisted by frictional forces developed between the base of spread footings and the underlying soil. The total frictional resistance between the footing and the soil is the normal force times the coefficient of friction between the soil and the base of the footing. We recommend an ultimate value of 0.4 for the coefficient of friction; the normal force is the sum of the vertical forces (dead load plus real live load).

Seismic Considerations. The seismic design recommendations in this section are based on the current International Building Code (IBC) and the State of Oregon's Structural Specialty Code Amendments. The site is underlain by gravel/cobble over sandstone and siltstone. Based on our review of the IBC and the results of our subsurface explorations, we recommend a Site Class C for the site.

LIMITATIONS

This report has been prepared to aid in the design team in the design and construction of the solar system for this site. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the geotechnical aspects of the project.

The conclusions and recommendations submitted in this report are based on the data obtained from the test pits made at the locations discussed in this report and from other sources of information discussed in this report. In the performance of subsurface investigations, specific information is obtained at specific locations at specific times. However, it is acknowledged that variations in soil and groundwater conditions may exist between exploration locations. This report does not reflect any variations which may occur between these explorations.

Submitted for Applied Geotechnical Engineering and Geologic Consulting LLC.

Robin L. Warren, P.E., R.G.
Principal Engineer

Renewal: June 2014

APPENDIX A

TEST PIT LOGS

Test Pit TP-1

00 to 18 in. Medium stiff, brown SILT; trace clay, scattered rounded to subrounded gravel and cobbles.
18 to 50 in. Dense, light brown GRAVEL and COBBLES in a clay matrix grading to a silt matrix below a depth of 24 in.
Test pit terminated at a depth of 50 in.
Groundwater seepage not observed.
Completed December 2, 2013.

Test Pit TP-2

00 to 12 in. Medium stiff, brown SILT; scattered rounded to subrounded gravel and cobbles.
12 to 30 in. Dense, light brown GRAVEL and COBBLES in a silt matrix, poorly to moderately cemented.
Test pit terminated at a depth of 30 in.
Groundwater seepage not observed.
Completed December 2, 2013.

Test Pit TP-3

00 to 06 in. FILL: soft, brown and black SILT; fine organics, scattered gravels.
06 to 18 in. Medium stiff, brown SILT; scattered rounded to subrounded gravel and cobbles.
18 to 36 in. Dense, light brown GRAVEL and COBBLES in a silt matrix, poorly to well cemented.
Test pit terminated at a depth of 36 in.
Groundwater seepage not observed.
Completed December 2, 2013.

Test Pit TP-4

00 to 12 in. FILL: soft, brown and black SILT; fine organics, scattered gravels.
12 to 24 in. Medium stiff, brown SILT; scattered rounded to subrounded gravel and cobbles.
24 to 36 in. Dense, light brown GRAVEL and COBBLES in a silt matrix, poorly cemented.
Test pit terminated at a depth of 36 in.
Groundwater seepage not observed.
Completed December 2, 2013.

Test Pit TP-5

00 to 12 in. Medium stiff, brown SILT; scattered rounded to subrounded gravel and cobbles.
12 to 24 in. Dense, light brown GRAVEL and COBBLES in a silt and sand matrix, poorly cemented.
Test pit terminated at a depth of 24 in.
Groundwater seepage not observed.
Completed December 2, 2013.

Test Pit TP-6

00 to 12 in. Medium stiff, brown SILT; scattered rounded to subrounded gravel and cobbles.
12 to 24 in. Dense, light brown GRAVEL and COBBLES in a silt matrix, poorly to moderately cemented.
Test pit terminated at a depth of 24 in.
Groundwater seepage not observed.
Completed December 2, 2013.

Test Pit TP-7

00 to 06 in. FILL: soft, brown and black SILT; fine organics, scattered gravels.
06 to 12 in. Medium stiff, brown SILT; scattered rounded to subrounded gravel and cobbles.
12 to 18 in. Dense, light brown GRAVEL and COBBLES in a clay matrix.
18 to 30 in. Dense, light brown GRAVEL and COBBLES in a silt matrix, poorly cemented.
Test pit terminated at a depth of 30 in.
Groundwater seepage not observed.
Completed December 2, 2013.