Appendix I-4: Penstemon Solar Project Geotechnical Engineering Study

June 9, 2017

Tuusso Energy, LLC
500 Yale Avenue North
Seattle, WA 98109

Attention: Ms. Joy Potter

Subject: Geotechnical Engineering Study – Phase I
Penstemon – Proposed Solar Array Installation
1585 Tjossem Road
Ellensburg, Washington

Dear Ms. Potter,

In accordance with our proposal dated April 11, 2017, we have completed our field work at the subject site and have prepared this report with detailed descriptions of the site soils and geotechnical recommendations for the proposed project. The approximate site location is shown on the attached Site Vicinity Map (Figure 1). On April 26, 2017, we observed installation of two test borings using a GeoProbe 8140-LC track-mounted drill rig, provided by Holocene Drilling, Inc. of Puyallup, Washington. Based on our observation of soil conditions at the site, it is our opinion that the site is satisfactory for installation of the proposed solar panel array supported on driven H-beams.

The following is a summary of our observations of soils conditions at the subject site. We encountered one (1.0) to two (2.0) feet of dark brown, moist, loose to medium dense silty fine sand to sandy silt with varying amounts of gravel. This unit comprises a topsoil-like horizon. Underlying this unit, we observed a dense to very dense lightly to moderately cemented sandy gravel with varying amounts of silt and clay minerals. N-Values in the upper, loose, topsoil-like material ranged from 3 to 4. N-Values in the underlying gravel unit were observed to be up to 50 which indicates very high density. Soil profiles observed in the borings appeared quite uniform across the site from northwest to southeast and we expect that soils across the site will be uniform for the purpose of installation of the H-beams. We expect there will be some variation in the soil profile, however, given the apparent depositional environment and the existing site topography, we expect that the soil profile variation will be minimal. As noted above, given appropriate pile embedment, the site soils will be capable of supporting our estimated loads for the solar panels and ancillary equipment. Once we have been provided with live and dead loads for the H-beams, we will be able to compute pile bearing capacities and pile embedment lengths.

Based on the results of our study, and on our understanding of the proposed project, we believe that the site can be developed with the solar panel array, as planned. Swiftwater Environmental and Geotechnical (SEG) should be retained to observe installation of one or more test piles. Further, it might be prudent to perform pile load testing. SEG should also be retained to provide construction monitoring services during

Swiftwater Environmental & Geotechnical
165 NE Juniper St., Ste 201A, Issaquah, WA 98027
407 Swiftwater Blvd., Ste A, Cle Elum, WA 98922
425.321.0787
www.SwiftwaterEG.com

construction to ensure that the recommendations for pile embedment are adhered to during installation. SEG should be provided with a set of the final plans and specifications for review to ensure that the recommendations contained in this and in subsequent reports have been incorporated into the plans and specifications.

Please let me know if you have any questions or need additional information regarding this phase of the project. Thank your allowing SEG to assist you with this first phase and we look forward to assisting you with subsequent phases as the project comes to fruition. I look forward to hearing from you.

Sincerely,

James Hatch, P.G., L.E.G.
Principal

State of Washington
Engineering Geologist
228
Licensed Geologist
James L. Hatch

Geotechnical Engineering Study, Phase 1
Penstemon Solar Array Site
1585 Tjossem Road
Ellensburg, Washington
Project No. 170016:GES

Site Description

The subject site is a single tax lot, Kittitas County Tax Parcel No. 840233, and is located at 1585 Tjossem Road in Ellensburg, Washington. The site is nearly square and comprises 39.2 acres that is currently being used to grow hay. The site is currently undeveloped. There are no structures on or immediately adjacent to the property. The site is flat with a very slight inclination from north to south. Access to the lot is via a driveway that is located along Tjossem Road.

Proposed Site Development

It is our understanding that a series of linear solar panel racks will be constructed on the property along with access/maintenance roads and power infrastructure for distribution to the power grid. We have not been provided with detailed plans and specifications for installation of the solar panels nor have we been provided with a grading plan. However, based on review of similar projects, we believe that very little grading will be required to construct the solar panel racks. We understand that the solar panels are then attached to horizontal steel rods that are supported on driven H-beams. The solar panels are attached to the horizontal supports which are oriented north-south. The panels rotate so that they are always exposed to the sun as it moves from east to west. We assume that the maintenance roads will run between the racks, provide access to the electrical infrastructure elements, and will probably run around the perimeter of the array.

If development plans should change or if our assumptions regarding development are incorrect, Swiftwater Environmental and Geotechnical (SEG) should be contacted as soon as possible to review and/or revise the recommendations contained herein. SEG should be provided an opportunity to review final plans and specifications to confirm that these recommendations have been incorporated into the plans.

Subsurface Conditions

On April 24, 2017, SEG personnel observed the installation of two test borings using a track-mounted vibratory drilling rig known as a "sonic" rig. A 4" steel hollow-stem drill string is driven into the soil under high-frequency vibratory loading. Standard Penetration Testing (SPT) is then carried out at standard depths for this type of report. For this project, we directed the drillers to complete at least one SPT at the surface before drilling commenced to collect N-values for the surficial soils. SPTs were then variously carried out at standard depths of 2.5', 5.0', 7.5', 10.0', 12.5' and 15.0'. Samples were collected from the SPT split-spoons. One of the advantages of using the sonic drill rig is that a continuous 4-inch diameter sample is collected in the hollow stem drill string as it is advanced. The continuous soil sample is then extruded into polyethylene bags and removed from the immediate area of the drill rig. The continuous sample can then be examined by cutting the bag open to expose the sample. We were thus able to closely examine the site soil profile and to identify bearing soils with unusual precision. The borings were advanced to a maximum depth of 16.5 feet below existing grade. We understand that standard H-beam penetration for this type of installation is 6 to 8 feet below grade. Boring locations are shown on the attached Boring Location Plan (Figure 2) along with the Boring Logs on subsequent pages. Please refer to the Boring Logs for detailed descriptions of the site soils. A general description of soils and groundwater conditions is provided below.

The boring locations were selected to attempt to be representative of the entire site. Boring P-1 was completed in the northwestern quadrant of the site and Boring P-2 was located in the southeastern quadrant of the site. The soil profiles in both borings were very consistent and we believe that based on the likely depositional environment and also on the locally flat topography that the soil profile across the site will be similar to the profiles found in the borings.

In Boring P-1, we observed about one and one-half feet of dark brown topsoil-like material comprising a moist, very loose to loose silty SAND to sandy SILT with varying amounts of gravel. Immediately underlying the topsoil unit we observed a dark gray to light gray, slightly moist to moist, very dense and partially cemented sandy GRAVEL with varying amounts of silt. Below about 10 feet, we observed thin (<6 inches) reddish-brown fine sand seams with minor amounts of perched groundwater. This boring was terminated in the sandy gravel unit.

In Boring P-2, we observed a soil profile that was nearly identical to that found in P-1. The only difference is that in P-2, we observed a reddish-brown, stiff to very stiff silty CLAY to clayey SILT unit below about 12.5 feet. Boring P-2 was terminated in this unit.

In both borings, we observed that drilling became more difficult with depth indicating increasing density, increasing cementation, or both. It should be noted that the upper topsoil unit is probably quite moisture-sensitive and will be difficult or impossible to drive on or compact should the moisture content exceed optimum. If these soils are to be used as fill anywhere on the site, they should be stockpiled and protected from rainfall. We recommend that these soils be removed from the areas that are intended to be maintenance roads and replaced with either crushed rock or suitable structural fill.

Groundwater

As noted above, we observed minor groundwater seepage from the thin, fine sand seams found in boring P-2 below about 10 feet. We believe that this water was probably "perched" groundwater from within the reddish-brown sand seams. Otherwise, we did not observe any groundwater seepage in the borings. It is possible, though not likely, that groundwater seepage might be encountered elsewhere on the site.

If grading and/or construction is carried out during the winter or spring months, the contractor should anticipate that more significant groundwater seepage might be present and should plan accordingly. The upper unit of the site soil profile is moisture sensitive and those soils will be difficult to use as structural fill during the rainy winter and spring months. The underlying partially cemented sandy gravel soils will be less moisture-sensitive, but natural variability of the fine-grained fraction (e.g. silts and clay minerals) might cause these soils to be moisture-sensitive as well. In any case, if excavated site soils are to be used as structural fill, they should be protected from moisture while stock-piled.

Geologic Setting

According to the USGS Open File Report 1127, *Late Cenozoic Deposits, Landforms, Stratigraphy, and Tectonism in Kittitas Valley, Washington*, Richard B. Waitt, Jr., 1979, the subject site and surrounding area are underlain by Qs (Quaternary Alluvium, Sidestream Facies) which is characterized as downstream aggradation deposits with their source being upstream glacial moraines located to the west and northwest areas of the Kittitas Valley. These deposits consist primarily of basaltic gravels and sands with varying amounts of silt and clay minerals. The gravels vary from fine to coarse with occasional specimens in excess of 1.5 meters. These undifferentiated sandy GRAVEL deposits are overlain by varying thicknesses of topsoil, weathered sandy gravel horizons, and loessal (wind) deposits that comprise the silty SAND and sandy SILT units that we observed from the surface down to the relatively un-weathered partially cemented gravels. The gravel deposits consistently displayed some level of cementation that is most likely caused by breakdown of the basaltic rock to silt and clay minerals and then subsequent re-lithification under normal loading. The soils we observed in our borings at the subject site are consistent with this mapping.

In Boring P-2, we encountered a fine-grained, reddish brown to tan silty clay to clayey silt unit underlying the sandy gravel deposits. We contacted Dr. Nick Zentner, Professor of Geological Sciences at Central Washington University about this unit. Dr. Zentner indicated that it is probably an alluvial deposit that develops in slow-water areas and ox-bows proximate to streams and to the Yakima River. Dr. Zentner stated that these deposits are horizontally discontinuous and are found throughout the valley. The deposit on the subject site is thus likely limited in lateral extent, especially given that we did not encounter it in Boring P-1.

General Discussion and Recommendations

Based on the results of our site investigation, construction of the proposed solar panel array is feasible from a geotechnical standpoint. We understand that the site will be developed by constructing linear racks, oriented north to south, which support the solar panels on oscillating horizontal members. Those horizontal members are in turn supported on a series of driven steel H-beams. We have reviewed plans for similar installations and it appears that there is variation in the length of the horizontal supports meaning there will be variation on the total loading for each individual H-beam. For example, some H-beams will support 8 solar panels along with their mounting and support equipment while others will support 6 panels, etc. This means that for a design bearing capacity, pile embedment will vary or possibly, H-beam sizing will vary. In either case, it is critical that final plans be reviewed by SEG to ensure that appropriate bearing capacities and embedment lengths have been incorporated into the plans and specifications. Further, SEG should be retained to provide construction monitoring to ensure that the H-beams are installed in accordance with the plans and specifications and to document that adequate bearing capacity is developed.

Final bearing capacities and embedment lengths can be computed once the loading for the piles has been provided to us. Alternatively, we can estimate the loading for each pile if we are provided with information about the weight of the panels, supporting members and ancillary equipment. In either case, we have been informed that this information will be forthcoming and we can then complete the pile designs. We have attached a figure that shows the appropriate embedment zone for the H-beams.

We strongly recommend that once the bearing capacities and embedment lengths have been determined, a series of test piles should be driven using the same equipment that will be used during construction. The purpose of this testing is two-fold: 1) it is necessary to determine that the piles can be driven into the bearing soils to the required embedment depth without damaging the pile and, 2) it is required in order to load test the resulting piles to determine that adequate bearing capacity is being developed.

Wind Loading

The Kittitas Valley, particularly the Ellensburg area, is known for year-around windy conditions. We understand that the solar panels that will be used for this project are 32-square-foot panels mounted immediately adjacent to one another in linear "bays" of 7 or 8 panels. Therefore, for purposes of computing wind-loading, each "bay" will effectively be a single panel of 224 or 256 square feet.

We computed the maximum wind load for a 32-square-foot panel using the Uniform Building Code (UBC, 1997) formula with the preferred alternate methodology for computing wind pressure. The following are wind loads for a 4-foot by 8-foot panel erected vertically that is exposed to wind that is moving over a flat surface with few obstructions. Wind speeds were obtained from the Applied Technology Council (ATC) website wherein maximum wind speeds are obtained by location. The ASCE site-specific wind speed values are obtained from the ASCE manuals noted, but were retrieved from the ATC Windspeed by Location website. The wind speed values were then used in the UBC formula to calculate the following values for wind pressure in pounds for a single 4-foot by 8-foot solar panel.

• ASCE 7-93 Wind speed (fastest mile in mph	70 mph	593 lbs
• ASCE 7-05 Wind speed (3 second peak gust)	85 mph	878 lbs
• ASCE 7-10 100-year Mean Recurrence Interval	91 mph	1006 lbs
• ASCE 7-10 Risk Category II	110 mph	1470 lbs

The wind pressure values are the functional equivalent of lateral pressure on the H-beams. These values are maximum values. Wind pressure and equivalent lateral pressure will be less than the values shown because the solar panels are rarely, or never, in a vertical position and presumably can be rotated to a horizontal position before or during high-wind events. Once we have received the H-beam size information, we can compute actual lateral loads based on the wind pressure values above.

Site Preparation and Earthwork

We anticipate that site preparation for the subject site will consist of installation of Temporary Erosion and Sedimentation Control (TESC) measures, installation of grade staking, establishing clearing and grading limits, site clearing and stripping, and possible stockpiling of strippings and organic material in non-structural areas. Once these activities have been completed, installation of underground utilities and final grading can occur and construction of the solar panel array can commence.

Infiltration and Temporary Erosion and Sedimentation Control (TESC)

It is important to understand and utilize Low Impact Development (LID) practices and LID Best Management Practices (BMP) in Eastern Washington to reduce or eliminate concentrated storm water runoff and erosion. BMPs also help limit the introduction of pollutants/contamination into Eastern Washington's arid land soils and rangeland soils. BMPs that address these issues can be found in the Washington State Department of Ecology (DOE) publication 13-10-036, *Eastern Washington Low Impact Development Guidance Manual*, June 13, 2013.

Construction of the solar array will tend to create a *variable* increase in the total *and effective* impervious area of the site that is equivalent to the area of the solar panels and associated infrastructure. The increase is variable because the panels move in accordance with the position of the sun and are tilted most of the time. There will also be an increase in less pervious area because of the proposed gravel access roads.

Based on the results of our subsurface investigation, we believe that infiltration into the upper, topsoil-like silty sand/sandy silt soils is not only feasible, but is ongoing. This site, like many others in the vicinity of Ellensburg, have been cultivated using flood irrigation methods. This consists of running a perforated PVC pipe along the upslope side of a site and simply flooding the entire area. Irrigation water percolates into the soil and is stored above the underlying relatively impervious layer found throughout the area. Based on our observations at several of these sites and on publications and anecdotal testimonies, it is clear that these soils are quite capable of infiltrating storm water during an average year. According to the referenced DOE publication, Ellensburg is located in Climate Region 2 – Central Basin – and receives an average of about 8 inches of precipitation per year, some of it in the form of snow. Given the variable nature of the solar panel position, and relatively low precipitation in the area, combined with the natural permeability of the upper soil horizon, it is our opinion that infiltration of normal storm water amounts will occur and that normal levels of storm water will not be concentrated to a significant extent.

Based on the texture and class of the soil types that we encountered, and on a review of various documents related to storm water control in Eastern Washington, it is our opinion that it is reasonable to assume an infiltration rate of 1.02 inches/hour for the upper, silty sand unit and 0.27 inches/hour for the underlying sandy gravel. The rate for the sandy gravel unit is assumed to be low because of the presence of fine-grained silt and clay minerals in the interstitial spaces and fractures of this partially cemented unit.

Temporary construction ingress and egress should be completed prior to the start of on-going construction traffic. A temporary construction entrance should be constructed of 8-12 inches of quarry spalls. If the soils in the entrance location are soft, a layer of geotextile fabric can be laid down as a barrier prior to placement of quarry spalls. The quarry spalls will provide a stable entrance/exit to the site and will limit tracking of mud onto Tjossem Road during and after wet weather. TESC measures consist of installation of silt fencing *as needed* around the site entrance, around the perimeter of the low side of the site, and at discharge points where sediment-laden surface water may enter off-site drainage features. Because the subject site is flat and slopes very gently to the south, silt fencing will probably not be required at the south perimeter unless desired by Kittitas County.

Stripping

No well-developed sod or heavily organic topsoil layer was observed at this site because of ongoing cultivation, thus stripping should not be required. If a topsoil horizon is observed in areas where maintenance roads are proposed, the topsoil should be removed down to mineral soil and replaced with crushed rock or structural fill. It is important that all deleterious material is removed prior to placement of structural fill. Topsoil strippings can be stockpiled for use in non-structural areas, as desired, but should not be allowed to mix with soils that will be used for structural fill.

Native Soils and Imported Soils

Native site soils encountered below the surface contain significant fines and are very moisture sensitive. However, if moisture content is near optimum, the soil can be used as compacted structural fill. Excavated site soils should be stockpiled and covered immediately if they are to be saved and used as structural fill. If the soils are above optimum moisture content, it may be possible to aerate them to reduce moisture content. This is possible during the warmer summer months, but it is difficult to achieve uniform moisture content. It may also be possible to use Portland cement as an admixture to reduce moisture content. If the site soils cannot be adequately compacted, it may be necessary to use imported soil for structural fill. Imported soil should be a well-graded granular mineral soil with fines content below 5 percent (i.e. less than 5 percent passing the No. 200 sieve) and should be at or slightly above the optimum moisture content. If construction is scheduled to occur during periods where precipitation is expected, a contingency should be built into the project budget for imported soil/crushed rock base (CRB) and other costs associated with placement of imported structural fill.

Subgrade Preparation

Once the site has been prepared for construction of the maintenance roads and placement of the H-beams, a SEG representative should observe subgrade conditions to confirm that they are as expected and to provide additional recommendations, if necessary. If disturbed native soil is encountered in structural areas (e.g. maintenance road prism or foundations for solar panel infrastructure) the fill should re-compacted in accordance with the specifications for structural fill or should be removed and replaced with structural fill as required to reach design grade. As an alternative, CRB can be placed and compacted. SEG should observe and confirm subgrade conditions as construction progresses. The contractor should be prepared to retain a local materials testing firm to sample soils to be used as structural fill, collect samples for Proctor testing, and to provide compaction testing as structural fill is placed, as needed.

Structural Fill

Structural fill is fill that is deliberately placed in thin lifts and compacted to a design specification. Structural fill is intended to support overlying structures in a manner that produces little or no post-construction movement. It is typically used under foundations, slabs, in utility trenches, roads, behind retaining walls, and in constructed slopes. Structural fill should be placed in loose lifts that do not exceed 12 inches and compacted to a relative compaction of 95 percent of maximum dry density as determined by Modified Proctor (ASTM D1557). Compaction specifications may vary, especially in utility trenches in public or private roads as specified by the local jurisdiction. Moisture content is critical to achieving adequate densification (compaction) and the upper unit of the site soils is very moisture sensitive, e.g. a small change in moisture content can make them unusable as structural fill. *If the soils are stockpiled and not covered, precipitation will make them difficult or impossible to use as structural fill.*

Foundations

We believe that foundations for the electrical infrastructure elements of the project can be supported on undisturbed, competent, native sandy gravel soils found below the upper topsoil-like horizon, on re-compacted native soils, on structural fill, or on CRB. Where loose or unsuitable soils are encountered at design subgrade, it will be necessary to re-compact the native soils to structural fill specifications or to over-excavate down to competent native soils then place structural fill or CRB up to design subgrade.

If the subgrade is prepared as described above, the following parameters may be used for design:

- Allowable soil bearing capacity — 1,500 psf
- Passive earth pressure — 300 pcf (equivalent fluid)
- Coefficient of friction — 0.35

A one-third increase in the allowable soil bearing capacity may be assumed for short-term wind and seismic loading conditions. The passive pressure and friction values above include a factor-of-safety of at least 1.5. With anticipated structural loads, total settlement of one inch and differential settlement of one-half inch is anticipated. Most settlement should occur during construction, as dead loads are applied.

Seismic Design

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. In accordance with Table 20.3-1 of the ASCE Minimum Design Loads for Buildings and Other Structures manual, Site Class D should be used for design.

Based on our observations of the upper native silty sand soils and the underlying partially cemented sandy gravels, it is our opinion that the subject site has very low susceptibility to liquefaction. Liquefaction is a phenomenon wherein loose, saturated soils suddenly lose shear strength and begin to behave as a fluid. Liquefaction typically occurs under seismic loading conditions and if structures are supported on soils that liquefy, structural damage can occur. The site groundwater and native soil conditions we observed in the test borings have allowed us to reach this conclusion.

Drainage

We observed light to moderate seepage in TP-2, but not in any other of the test pits. We did observe occasional mottling/rust-staining in the weathered till units indicating presence of water at some time in the past. During the rainy winter months, it is prudent to anticipate seepage in excavations and groundwater control measures should be on-site or readily available, including trash pumps, sumps and discharge ditches. Seepage may create instability in the walls of excavations – SEG should be notified if seepage is observed in excavations so that control measures may be discussed with the contractor and properly implemented. The site should be graded such that surface water is directed away from structures and slopes. Surface water must never be allowed to pond near the tops or toes of slopes.

Based on the soil types observed in our test pits, it is our opinion that infiltration is not feasible at this site. Storm water discharge BMPs should be implemented to control runoff from the site. Sediment-laden surface water must be treated such that water discharged from the site meet all water quality requirements. Storm water should not be discharged over the slope to the north of the site.

Excavations/Slopes

Soils observed in the upper 1.5 to 2.0 feet of the test borings would be classified as OSHA/WISHA Type C. Temporary excavations like utility excavations and foundation excavations with heights in excess of 4 feet must be sloped no steeper than 1.5H:1V. If seepage is observed in these excavations, they may need to sloped at 2H:1V to prevent sloughing due to seepage pressure. The dense native sandy gravel soil observed below about 2.0 feet would be considered OSHA/WISHA Type B soils and can be laid back at 1H:1V.

SEG should be contacted to observe temporary slopes and utility excavations as they are constructed or excavated to assess slope stability and recommend additional measures, if necessary.

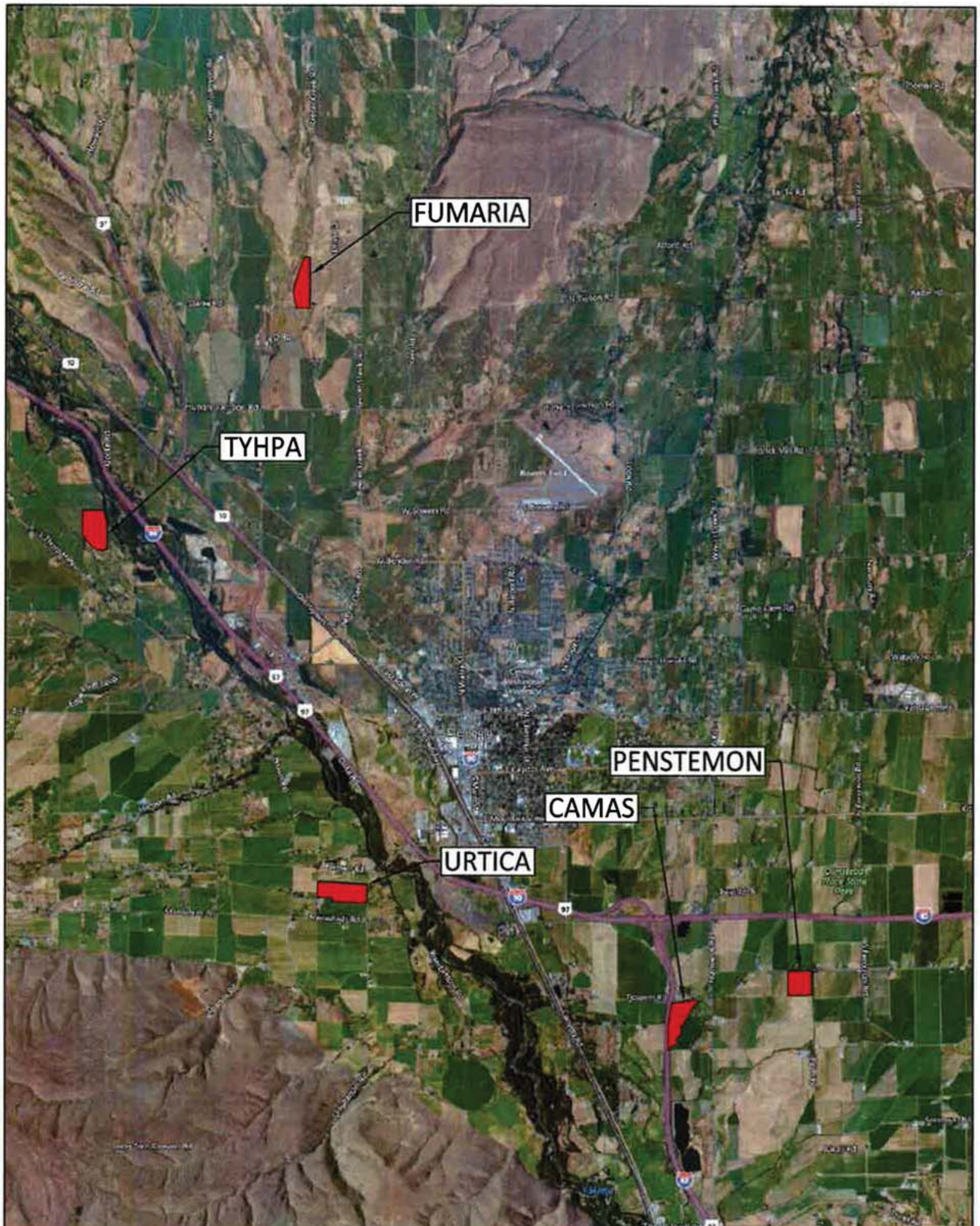
Utility Support, Trenches, and Trench Backfill

Site soils should be suitable for support of solar panel infrastructure and utilities. In shallower trenches, particularly shallower than about 2 feet, it may be necessary to over-excavate loose or wet soil down to suitable, stable soils, and then replace them with compacted structural fill or CRB. Groundwater seepage may be encountered in trench walls, particularly if deeper than 2 to 3 feet. Seepage may cause caving of the trench walls and temporary shoring may be required. Dewatering measures may also be needed to control seepage and SEG should be contacted to assess the need for such measures.

Site soils may be suitable for use as backfill provided the moisture content is optimal as determined in the laboratory. Trench backfill should be placed and compacted in accordance with the specifications for structural fill as described above or in accordance with specifications provided by the local jurisdiction. CRB should be placed in 6-8 inch lifts and compacted with a plate compactor or other compaction device.

Limitations

This report is an instrument of service and has been prepared for the exclusive use of Tuusso Energy, LLC and their representatives and agents. The recommendations and conclusions provided in this study are professional opinions consistent with the level of care and skill that is typical of other members of the profession currently practicing in this area. A warranty is neither expressed nor implied. Variations in the soil and groundwater conditions observed in the test boring locations may exist and may not become apparent until construction commences. SEG should reevaluate the conclusions contained in this study if such variations are encountered.



TUUSO ENERGY, LLC
ELLENSBURG SOLAR PROJECTS
LOCATION MAP

Swiftwater
Environmental & Geotechnical
Western Washington Division
165 NE Juniper Street, Suite 201A • Issaquah, WA 98027 • Phone: (425) 321-0787
Eastern Washington Division
407 Swiftwater Blvd., Suite A • Cle Elum, WA 98922 • Phone: (425) 321-0787

FIG. 2
PENSTEMON SITE
TEST BORING LOCATIONS

Swiftwater
Environmental & Geotechnical
Western Washington Division
165 NE Juniper Street, Suite 201A • Issaquah, WA 98027 • Phone: (425) 321-0787
Eastern Washington Division
407 Swiftwater Blvd., Suite A • Cle Elum, WA 98922 • Phone: (425) 321-0787

Swiftwater
Environmental & Geotechnical

Project: Tuusso - Penstemon Site			Project No. 170016		Date: 4/26/2017
Location 1585 Tjossem Road			Surface Elevation 1511		Groundwater N/A
Earthwork Contractor Holocene Drilling		Excavation Equip. Geoprobe 8104	Logged By JH		Test Boring No. P - 1

Depth (feet) From	To	Tests	USCS Soil Class.	Generalized Soil Description
0.0	**-1.5**	**N = 3**	**SM**	Brown silty fine **SAND**, trace gravel and cobble,
				moist, very loose (recently tilled) scattered organics.
-1.5	**-6.5**	**N = 38**	**SM - SP**	Brown to gray gravelly **SAND** to sandy **GRAVEL**, trace to some
				silt, moist, dense. Difficult drilling from -3.0 to -5.5
				Same - slightly easier drilling from -5.0 to -8.0, denser below -8.0
-10.0	**-11.5**	**N = 50/4"**	**SM - SP**	Same, very dense
				6" red **SAND** lense at -14.0, slightly less dense, wet
-15.0	**16.5**	**N = 50/5"**	**SM - SP**	Same, Boring P - 1 terminated at 16.5

Notes:	**BORING NO.**	**P-1**
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Swiftwater
Environmental & Geotechnical

Project: Tuusso - Penstemon Site			Project No. 170016		Date: 4/26/2017
Location 1585 Tjossem Road			Surface Elevation 1504		Groundwater N/A
Earthwork Contractor Holocene Drilling		Excavation Equip. Geoprobe 8104	Logged By JH		Test Boring P - 2

Depth (feet) From	To	Tests	USCS Soil Class.	Generalized Soil Description
0.0	-1.5	N = 4	SM	Brown silty fine **SAND (topsoil-like)**, trace to some gravel and cobble,
				moist, loose, scattered organics.
-1.5	-6.5	N = 64	SM - SP	Brown gravelly **SAND** to sandy **GRAVEL**, trace to some
				silt, moist to -2.0 then wet, very dense.
				Same - color change to gray below -6.0,
				some partial cementation observed -6.0 to -10.0
-10.0	-11.5	N = 28	SM	Brown silty **SAND** to sandy **SILT**, trace to some gravel, wet, medium dense.
-12.0	-16.5	N = 27	SM	Same, reddish brown, no gravel, some clay mineral,
				moist, medium dense.
				Same, Boring P - 2 terminated at 16.5

Notes:	BORING NO.	P - 2
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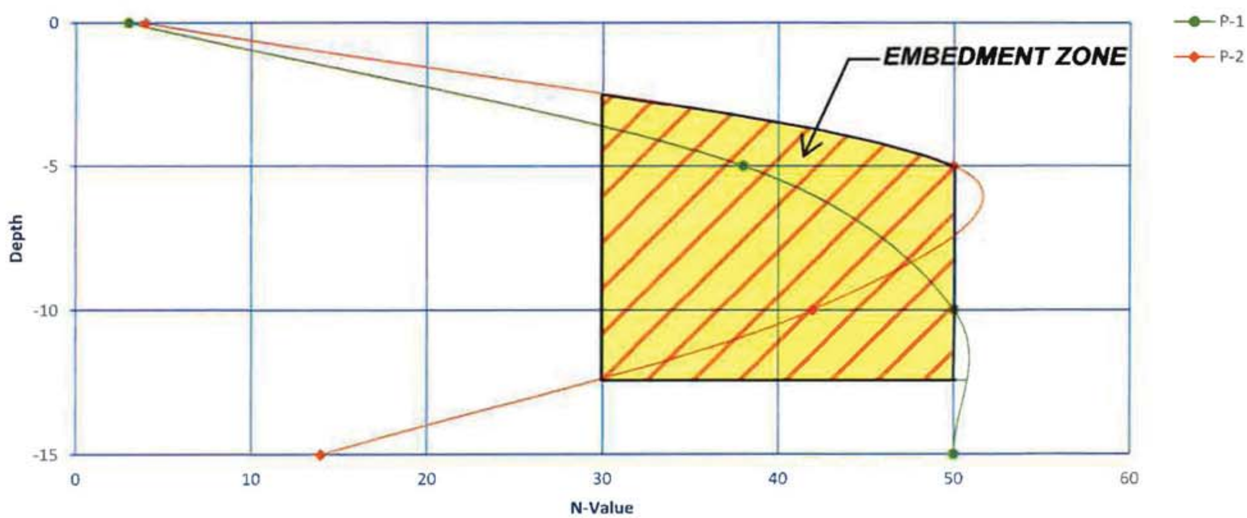
Swiftwater Environmental & Geotechnical

Project: Tuusso - Penstemon Site		Project No. 170016	Date: 6/6/2017
Location 1585 Tjossem Road		Surface Elevation	Groundwater N/A
Earthwork Contractor	Excavation Equip.	Logged By	
Holocene Driling	Geoprobe 8104	JH	

		P-1				P-2			
		Depth (ft)	N			Depth (ft)	N		
		0.0	3.0			0.0	4.0		
		-5.0	38.0			-5.0	50.0		
		-10.0	50.0			-10.0	42.0		
		-15.0	50.0			-15.0	14.0		

Approximate Embedment Depth



Note: Tests conducted per ASTM D1586-11 (Standard test method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils)

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SWIFTWATER ENVIRONMENTAL & GEOTECHNICAL
SOIL CLASSIFICATION CHART

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

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

Swiftwater
Environmental & Geotechnical

Important Information about Your
Geotechnical Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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

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

Read the Full Report

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

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

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are *Not* Final

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

A Geotechnical Engineering Report Is Subject to Misinterpretation

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

Do Not Redraw the Engineer's Logs

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

Give Contractors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

Geoenvironmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

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

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

ASFE
THE BEST PEOPLE ON EARTH

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

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