APPENDIX 6
GEOTECHNICAL INVESTIGATION
GEOTECHNICAL INVESTIGATION

for

SPANISH CASTLE ESTATES

Near Quincy, in Douglas County, Washington

Prepared by:

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WPE Project No. 07611
May 2007
May 8, 2007

Entezar Development Group Inc.
ATTN: Mr. Wade Entezar
14120 N.E. 21st Street
Bellevue, WA 98007

SUBJECT: Geotechnical Investigation, Spanish Castle Estates Project, Douglas County, Washington
WPE&S Project No. 07611

Dear Mr. Entezar:

Western Pacific Engineering and Survey, Inc. (WPE&S) is pleased to provide you with this summary of our field investigations, findings, conclusions, and recommendations for the Spanish Castle Resort Project near Rock Island, Washington (See Plate 1).

Our soils investigation services were supplied in accordance with your request of January 2007. The scope of work was limited to excavation and logging of ten to fifteen (10-15) test pits, providing soils classifications for the various soil horizons, and providing our conclusions and recommendations regarding specific soils engineering considerations for the site development.

Our primary goal was to provide soil classifications. In addition, ancillary suggestions to extend the longevity and improve the appearance of the project site will be made. Several assumptions were made by WPE&S for the purposes of arriving at our recommendations. It was assumed that the structures will be facilities with normal loadings, and that the footings and column pads will bear directly on the in-situ soil or on a prepared gravel base, as discussed herein.
EXISTING SITE CONDITIONS

The site is located in Township 20 North, Range 22 East, W.M., Douglas County, Washington. The Spanish Castle Estates Project is a planned community development located south of Wenatchee and west of Quincy, in Douglas County, Washington, in Sections 04, 09 and 10 of Township 20 North, Range 22 East, W.M. The land for the proposed project is adjacent to the west boundary of State Route 28 and extends west toward the Columbia River and the BNSF railroad.

The site has had some development activity. There is an existing concrete foundation, a couple of irrigation pumping stations, and a few underground irrigation pipes that feed an adjoining orchard. Most of the site has probably been used as grazing land. There are two unimproved roads that traverse the property; the first one is mainly for access to the pumping stations, and the other runs adjacent to the railroad and telephone line that bisect the property. There is some evidence of dumping near these roads. However, no evidence of substantial development was encountered. The site vegetation is a mix of native grasses, small plants, and sagebrush. The site has a prominent ridgeline running parallel to the river with a couple of good-sized ravines. Also, there are a fairly large number of significant basalt rock outcroppings. These outcroppings vary in size from about the size of a riding lawn mower to the size of a single-family house.

EQUIPMENT

The excavated pits were dug with a Caterpillar 320C 45,000 lb. track hoe that has the ability to excavate to a depth of about eighteen feet. The excavation of the test pits took two days. Because of the presence of large cobbles and boulders, it is recommended that further excavation be done with similar equipment. The location of the test pits is shown on the attached Plate 2.

SITE INVESTIGATION

WPE&S investigated the subsurface conditions on January 24 and 25, 2007. The weather was partly cloudy with a temperature of about 25°F.

The test pits were dug in a grid pattern along existing ridgelines in the western portion of the site. The areas excavated were deemed most likely to be developed and have potential problems. Most of the test pits were dug to determine the likely bearing capacities of the soils, the depth of the water table near the river, and to determine if there would be any problems with construction. Additionally, test pits were dug in an attempt to determine if any areas of the site had once been filled.
This site has a layer of very thin topsoil, which in some places is non-existent. There is a substantial amount of rock outcroppings throughout the site.

There are some consistencies between test pits and their soils when the test pits are located at similar elevations. Top layers range from an almost pure sand at lower elevations, close to the river, to a more silty sand material with few rocks then to a soil with predominately large boulders.

The next layers encountered were usually poorly graded gravels with some or few fines. As would be expected, the water table was encountered close to the river at approximately eighteen feet deep. It should be noted that for the most part, excavation was difficult due to the number of large rocks.

In several test pits, compaction tests were taken. The relative compactions of the native soils were generally close to an assumed optimum density. However, some areas were found to be far below an assumed optimum density. This may be due to the nature of the excavation. In general, no loose soil layers were found in any of the excavations.

The soils on the site were sporadic in moisture content due to the varied soil types. In-place moisture percentages ranged from about two percent (2%) to eight percent (8%). Additional moisture will be needed for proper compaction of some of these soils.

The soils logs were tabulated (Plates 3 through 12) and logged in accordance with the Unified Soils Classification method (USC). An explanation of the USC method is illustrated on Plates 14 and 15.

The laboratory test results are indicated on the subsurface logs (Plates 3 through 12), as are the visual reports and the in-situ field reports.

SUBSURFACE CONDITIONS

The soil conditions found in most of the test pits were essentially the same with some variations in layer depth and thickness, with a couple of exceptions.

Test Pit One

The area around the test pit was essentially native ground that has most likely not been disturbed. A very thin layer of topsoil and weeds was found at the surface of excavation. The next layer encountered was a layer of poorly graded gravel (GP) composed of some silt and large cobbles. This layer was not sampled due to the limited amount of soil and the large amount of large aggregate. The material was reddish brown in appearance. The layer was encountered from a depth of three inches to twelve feet.
The next layer encountered, at twelve feet, was a layer of well-graded gravel with sand (GW). The material was comprised of 79% gravel, 19% sand, and 2% silty fines. The material was gray in appearance. Excavation was halted at a depth of eighteen feet, the limit of the excavator.

Test Pit Two

Test pit two had the same thin topsoil layer as test pit one. Then, like test pit one, a second layer of poorly graded gravel (GP) composed of mostly large cobbles, up to approximately ten inches in diameter, and some silt was found. This time, however, the material was brown in appearance. This layer was not sampled due to the limited amount of soil and the large amount of large aggregate. This layer was encountered at approximately three inches to eighteen inches deep. At eighteen inches in depth, a layer with similar texture was found, however this layer was red in appearance and had much larger aggregate which measured up to two feet in diameter. Again, this layer was not sampled due to the limited amount of soil and the large amount of large aggregate. The layer was encountered to a depth of five feet.

The final layer observed also contained a number of large boulders, however this time more sands and slits were found. The sample of this material was comprised of approximately 88% gravel, 11% sand, and 1% silty fines. The material was gray in appearance. This layer was encountered from a depth of five feet to a depth of fifteen feet.

Test Pit Three

Test pit three had the same thin layer of topsoil as the previous two test pits and then two distinct layers. The first distinct layer encountered was composed of silty sand (SM). The sample of this material was comprised of approximately 4% gravel, 83% sand, and 13% silty fines. The material was dark brown in appearance. The layer was encountered from three inches below the surface to a depth of seven and a half feet.

The next distinct layer encountered was a layer of grey colored, well-graded gravel with sand (GW) similar to test pits one and two. The material was not sampled due to its similar nature. This layer was encountered at seven and a half feet to where we stopped excavation at thirteen feet.

Test Pit Four

Test pit four was fairly close to the river, which made it very different from the previous, three test pits. The first layer of the test pit was Poorly-Graded Sand (SP) with organic material for about the first six inches. The poorly graded sand continued to a depth of ten feet. The material was comprised of 1% gravel, 95% sand, and 4% silty fines. A penetrometer test was done on this layer with a reading of 0.75 Tons/sq. ft.
first, however the new layer contained a few large boulders. This layer was encountered from a depth of ten feet to thirteen feet.

The final layer encountered was a layer of Well-Graded Gravel (GW). The material was comprised of 84% gravel, 14% sand, and 2% silty fines. This layer was encountered from a depth of thirteen feet to eighteen feet. At a depth of eighteen feet ground water was encountered.

Test Pit Five

Test pit five was very similar to test pit four, except that the soil layer thicknesses varied. No samples were taken due to the visual similarity with the previous test pit. The first layer encountered was poorly graded sand, with no sizable aggregate. This layer extended to a depth of six feet. The second layer encountered was a layer of poorly graded sand, with a few large cobbles greater than 12” in diameter. This layer was found to a depth of ten feet. At ten feet, a layer of well-graded gravel was encountered. The excavation was halted at a depth of seventeen feet due to the similarity of the soils and pit wall sluffing.

Test Pit Six

Test pit six was different than the rest of the test pits. The first layer encountered was comprised of a silty sand (SM) material, with some large cobbles. This layer contained 3% gravel, 77% sand, and 20% silty fines. The layer ended at a depth of four and half feet. The next layer was comprised of a well-graded gravel (GW). This layer, extended from four and half feet to fourteen feet, was comprised of 88% gravel, 11% sand, and 1% silty fines. The material within this layer contained a few pieces of green clay like substance that was encountered at fourteen feet. The material was gray in appearance with an angular shape.

Test Pit Seven

Test pit seven was composed of three layers. The first layer of the test pit was a silty sand material similar to previous test pits therefore no sample was taken. The second layer was found at a depth of six feet to nine and half feet and was light gray in appearance. This layer of poorly graded gravel with sand (GP) was comprised of 73% gravel, 25% sand, and 2% silty fines with cobbles sizing up to two feet in diameter. The third, and final, layer was very similar to the previous layer with the exception of substantially smaller cobbles with slightly darker color. This layer was found at a depth of nine and half feet to sixteen feet.
Test Pit Eight

The material in this test pit was similar to various other layers throughout the project therefore no samples were taken. The first layer was three and a half feet deep with a penetrometer reading of 0.75 Ton/sq. ft. This layer was silty sand with a few large cobbles, which was then followed by a layer of silty sand with a substantial amount of cobble. This layer also had a few boulders approximately four and a half feet in diameter. The final layer was poorly graded gravel with a dark gray appearance. This layer was encountered at six and a half to thirteen feet where excavation stopped due to the pit sides collapsing repeatedly.

Test Pit Nine

The ninth test pit was comprised of three layers. The first layer had an appearance of red soil with a vast amount of aggregate ending at a depth of three and a half feet. None of the three layers were sampled due to the similarities of previous test pits. The second layer was predominately gravel with sizable aggregate. The material had a dark gray appearance and was encountered at three and a half feet to four and a half feet. The final layer was comprised of silty sand with sizable aggregate. This material was gray in appearance but not as dark as the previous layer. This layer extended to a depth of thirteen and a half feet where excavation was terminated due to the pit sides collapsing repeatedly.

Test Pit Ten

Test pit ten was in an area of rock outcropping which proved to be a more challenging test pit due to the nature of the material at lower levels. The first layer was poorly graded sand with silt and clay (SP-SM). This layer was comprised of 25% gravel, 65% sand, and 10% silty fines. This layer had large aggregate in segregated areas. The layer continued to a depth of three feet. The second layer was identified as poorly graded gravel with sand (GP). This layer was comprised of 71% gravel, 26% sand, and 3% silty fines. The appearance of this layer was dark gray. The layer's depth ranged from three feet to six feet deep. The third layer consisted of large boulders up to five feet in diameter. Then at a depth of thirteen feet an extremely large boulder or rock shelf was encountered to cause the halt of excavation.

Test Pit Eleven

The eleventh test pit had some similarities to test pit ten, such as it was also located in an area of rock outcropping and the first layer was comprised of similar material. This first layer extended to a depth of two feet. The second layer was also seen in previous test pits and consisted of silty sand with a
substantial amount of cobble. This layer had a red/brown appearance and extended to a depth of six and a half feet. The second and third layer contained rocks of five feet (plus) in diameter. The third and final layer contained angular pieces of basalt with a classification of well-graded gravel (GW). This layer was comprised of 92% gravel, 7% sand, and 1% silty fines. The material had a gray appearance. The layer started at six and a half feet deep and reached past a depth of eleven and a half feet where excavation ceased.

Test Pit Twelve

This test pit was located east of the railroad tracks in an area of very few to no rock outcropping. The first layer consisted of poorly graded sand with gravel (SP) and was red/brown in appearance. This layer was comprised of 19% gravel, 77% sand, and 4% silty fines. It extended to a depth of one and a half feet from the surface. The second layer was classified as well-graded gravel (GW) and was brown in appearance. This layer consisted of 92% gravel, 7% sand, and 1% silty fines. There was aggregate one and a half feet in diameter. This thick layer of material started at one and a half feet deep and continued to a depth of ten feet. The final layer contained poorly graded gravel with sand (GP) with a gray appearance. No sample was taken due to the similarity of soils found in other test pits. This layer continued past the depth of excavation, which ended at fourteen feet.

Test Pit Thirteen

This test pit was also located east of the railroad tracks in an area of very few to no rock outcropping. Digging was pretty much effortless in this area after penetrating the frost line. There were only two layers found in this test pit and they were similar in composition. The first layer was defined as well-graded gravel (GW) and had a red/brown appearance. It consisted of 89% gravel, 10% sand, and 1% silty fines. This layer ended at three and a half feet deep. The second layer was also considered well-graded gravel (GW) but had a gray appearance. It consisted of 93% gravel, 6% sand, and 1% silty fines. This layer continued past the depth of excavation, which ended at thirteen feet.

Rock Outcropping

A test pit was dug under a randomly selected large rock outcropping. The purpose of the test pit was to determine if the rock outcroppings were part of the bedrock or irregular large boulders. The test pit revealed that the rock outcropping was resting on soil and not part of the bedrock.

CONCLUSIONS AND GENERAL RECOMMENDATIONS

The subsurface conditions are geotechnically suitable for construction as long as some design considerations are taken into account. The following Geotechnical recommendations will help assure a lasting site development.
Bearing Capacity

Normal spread footings can be supported on compact native soils or engineered compacted fill. It is strongly recommended that all exterior footings be placed at least twenty-four inches (24") below grade for proper frost protection. All footings and concrete slabs shall be placed on compacted native material or on compacted fill.

The bearing capacity of the soils found on site is fairly uniform over the entire site, mostly because the soil types and consistencies did not change. According to Table 1804.2 of the 2003 International Building Code, an allowable foundation pressure for the gravelly soils (the GP and GW material) is 3000 psf while an allowable foundation pressure of 2000 psf is allowed for the sandy soils (SP and SM). While there are some problems with using a number this high, there are also some advantages to using this value.

This soil has a lot of rock, most of which is of significant size. This is good for bearing because the large boulders can act as additional footing width, much as in the conditions of a spread footing. The problem is that the excavation of this type of soil is difficult, and it disturbs the soil structure. When these large boulders are moved, air voids are created under them. Additionally, because of their size, compaction with this material can be difficult. The excavation of footings in the cobble type of soil will be very difficult with small-scale equipment, and a flat working surface will be hard to obtain. The designer may want to consider alternative foundation types and possibly some imported material to provide uniform surfaces upon which to build.

Lateral bearing pressure for the gravelly soils found on-site is 200 psf/foot of depth and 150 psf/foot of depth is allowed for the sandy soils. Lateral sliding coefficients of 0.35 and 0.25, respectively, can also be used for these materials.

Construction on Slopes

A large portion of the site is fairly steep. Based on some of the site drawings provided to this office it appears that many of the buildings will be constructed on the sides of slopes. Structures can be supported on compacted fill material, however the finished slope of any fill area should be no steeper than 2:1. Structural footings should be placed a minimum of ten feet from the edge of any fill. In no cases should any structural foundation be located less than ten feet from the edge of any existing native or fill slope.

Extensive use of terracing might be necessary to cut building pads large enough for some of the proposed structures. Due to the possibility of encountering large rocks and or bedrock, the use of stepped foundations and multilevel buildings will most likely be needed.
Typical Soil Properties

Typically, silty sands have the following approximate physical properties:

(GP)
- Optimum Moisture: 8% +/-
- Native Moisture Content: 5%
- Angle of Repose: $\phi \cong 37^\circ$
- California Bearing Ratio: 30 – 60
- Sub-grade Modulus (k): 300 – 500

(GW)
- Optimum Moisture: 8% +/-
- Native Moisture Content: 5%
- Angle of Repose: $\phi \cong 37^\circ$
- California Bearing Ratio: 40 – 80
- Sub-grade Modulus (k): 300 – 500

(SP)
- Maximum Density (ASTM 1557): 110-130 lb/ft$^3$
- Optimum Moisture: 17% +/-
- Native Moisture Content: 5%
- Angle of Repose: $\phi \cong 36^\circ$
- California Bearing Ratio: 10 – 40
- Sub-grade Modulus (k): 150 – 400

(SM)
- Maximum Density (ASTM 1557): 105-117 lb/ft$^3$
- Optimum Moisture: 19% +/-
- Native Moisture Content: 5%
- Angle of Repose: $\phi \cong 34^\circ$
- California Bearing Ratio: 10 – 40
- Sub-grade Modulus (k): 100 – 400
Sub-grade Preparation

This will not be an easy site to work in because of the presence of the larger rocks. Proper construction on this site must take into consideration what can be done with the available soils.

The large rocks on the site will pose a disposal problem due to their size. When trenches for utilities are dug, the large boulders will not be allowed back in the trenches due to their size and issues with compatibility. You will not necessarily be able to use soil with large boulder as fill material because of the size of the rock and the ability to get good compaction with the large rock. It is my recommendation that you limit the total amount of excavation in the areas with the large rock.

All sub-grade materials below asphalt or concrete should be brought to optimum moisture and compacted to 95% of ASTM D-1557. The sub-grade should also be sterilized using a sterilizing agent that contains lime, which will also provide added stabilization to the topsoil material. It is recommended that the top eight inches (8") of material be removed from any areas that will have asphalt or concrete placed over them to prevent settling as the organic material decays.

Engineered Fill

Fill used to support slabs or footings should be well-graded gravel placed in eight inch (8") loose lifts maximum and compacted to at least 95% of maximum dry density as determined by ASTM D-1557 Modified Proctor Compaction. Some of the existing material may be used for engineered fill, however, due to the coarse nature of the material, the material should be screened to eliminate any cobbles over twelve inches in diameter.

We recommend that the sub-grade for both footings and slabs be thoroughly compacted by a heavy vibrating drum roller to achieve 95% of maximum dry density as determined by ASTM D-1557, then proof-rolled using a heavily loaded vehicle on rubber tires. Any soft or otherwise unsuitable soils should be excavated and replaced with engineered fill. The intent of this recommendation is to provide a uniform, firm, unyielding, base for the foundations and slabs.

Pavements and Concrete

Asphalt pavements should be on a two percent (2%) or steeper slope in all locations to prevent ponding on the asphalt and its subsequent degradation.

In areas where roads and parking lots are to be constructed on gravely soils, it is recommended that asphalt pavements be supported by six inches (6") of crushed rock. Typically, this consists of four inches (4") of crushed surfacing base course and two inches (2") of five-eighths inch (5/8") minus crushed surfacing top course rock compacted to 95% of maximum dry density as determined by
ASTM D-1557. Four inches (4") of crushed surfacing top course rock may be substituted for the four inches (4") of crushed surfacing base course rock.

In areas where roads and parking lots are to be constructed on sandy soils, it is recommended that asphalt pavements be supported by nine inches (9") of crushed rock. Typically, this consists of six inches (6") of crushed surfacing base course and three inches (3") of five-eighths inch (5/8") minus crushed surfacing top course rock compacted to 95% of maximum dry density as determined by ASTM D-1557.

Any sidewalks should also be built on at least two inches (2") of top course material. All materials under pavement or concrete should be compacted to at least 95% of ASTM D-1557 densities.

**Concrete Slab on Grade**

Concrete slabs can be supported on either undisturbed, compact native soils or engineered compacted fill. However, it is recommended that the floor be placed on a minimum of two inches (2") of 5/8-inch minus crushed surfacing top course or four inches (4") of crushed surfacing ballast.

All building slabs should be on four inches (4") of clean, well-graded sand, or more preferably, six inches (6") of crushed surfacing top course or six inches (6") of crushed surfacing ballast. The rock under layer will provide additional bearing capacity above what is found with sand. For this project, I would recommend the use of at least six inches (6") of crushed rock for slab support. A six (6) mil visquene vapor barrier should be used. This will prevent moisture passage (as well as any gas passage) into the building from below the sub-grade. (This is not to indicate that we have any reason to think that gases do exist at this site.) All materials shall be wetted to optimum moisture, and then compacted to 95% of ASTM D-1557.

Others will design the concrete slab according to the loads to be imposed on the slab. According to ACI 330R-92 Section 2.6, slab thickness for gravely material should be at least five inches (5’’), if not more. Also according to ACI 330R-92 Section 2.6, slab thickness for sandy material should be at least six and a half inches (6.5’’), if not more. All roadway slabs should be supported on at least nine inches of crushed rock.

**Stripping**

All vegetation and loose or organic soils should be excavated from below the building area. In areas of fill, the excavation should extend laterally beyond the building a distance equal to the fill thickness.
Corrosion Potential

This material is generally non-corrosive for concrete. However for steel, the silts are generally moderately corrosive.

Drainage

The native soils found on the site have very good drainage properties. The silty sands will take water. Infiltration rates will be greater than 0.6 to 2 inches per hour, given good conditions.

Drywells can be used to dispose of storm water in this type of soil. However, the use of drywells should be limited to only those necessary because of increasing resistance to their use by different state agencies, especially when located near the river.

According to the Washington State Department of Ecology “Storm Water Manual for Eastern Washington,” this site is in Region 2. The area receives approximately ten to fourteen inches of rain per year on average, with a two-year design, twenty-four hour storm average precipitation of less than 0.45”.

Footings

Others, based upon the loadings imposed by the structures, will design the stem wall and footing widths. Currently, the Douglas County Building Department recognizes the 2003 International Building Code, with the following minimum design loads:

Minimum snow, roof live load: 35 psf
Basic Wind Speed: 85 mph

Seismic Site Classification

Based on the information from the test pits and information from well logs in the area, the gravels and sands typically extend to various moderate depths then are followed by layers of basalt. Based on the information gathered, and based on the requirements of the 2003 International Building Code, a soil site classification of ‘C’ could be used for design.

Appendices and Attachments

Vicinity Maps: Plates 1, 2 and 3 show the location of the proposed site and the locations of the test pits within the proposed site.
Test Pit Logs: Plates 4 through 16 show the test pit logs and the layers of soil encountered. Plates 17 through 20 show additional soils information.

Sieve Reports: Included are the mechanical analyses of the soils found in the excavation.

Photographs: There are nine included photos, which show the excavation of the test pits. On the first sheet, upper left, you can see the distinct layering of the soil found in the test pit number 1. This layering of soil was encountered in many of the test pits. Notice the reddish soil layer near the surface, followed by a layer of grayish material with considerably larger cobbles. At the bottom of the test pit you can see the well-graded sand, which looks cleaner that the overlying layers. The upper left photograph is of test pit number 3. Again notice the segregated layers of the poorly graded gravel layers. The bottom photograph is a picture of test pit number 4. The picture clearly shows the sand layer over the top of the gravel layer. Note the water in the bottom of the test pit.

On the second sheet, the upper left photograph shows the excavated well-graded gravel from test pit six. If you look closely you can see some of the cohesion in the smaller partials due to a small amount of clay in the sample. The upper right photograph is from test pit 10. You will see that the soil layers are similar to some of the other photos, however, you will also see a very large rock in the upper left of the test pit. The lower photograph is from test pit 13. Notice the severe undercutting close to the excavator.

On the final sheet of photographs, the upper right picture is of a large rock excavated from test pit number eight. The rock measured about four and a half feet in diameter. While not common, many of these types of rocks were found in the test pits or on the surface. These rocks may not be used for any structural fill or trench backfill. Also, sizeable equipment will be needed to move rocks like these. The lower picture shows the general terrain of the project site. Note the large boulders resting on the hillside. The picture in the upper left corner is from the test area where we tried to determine if the basalt rocks were floating on the soil or were attached to the bedrock. The excavation showed that in general, most of the large basalt chunks are floating on the surface and can easily be excavated if their size were not an issue.

USDA Information: Also included is information concerning the storm water runoff qualities of the site. This includes hydrologic soils information along with storm water volumes for the year and for design storms.

Limitations

These subsurface investigations were conducted in a manner consistent with the level of care and skill ordinarily exercised by a member of the profession currently practicing under similar conditions. No warranty, either expressed or implied, is made. WPE&S's discoveries, assumptions,
recommendations, interpretations, and suggestions are solely for the use of Entezar Development and their design team for the Spanish Castle Resort Project near Rock Island, Washington, and are based upon the results obtained in our research and subsurface investigations. Conditions described are for the test pits only; should different conditions be encountered at any time, WPE&S should be contacted to insure that the integrity of the project is maintained. WPE&S is not responsible for the interpretation by others of the data, information, suggestions, or recommendations made herein.

ADDITIONAL SERVICES

During the design and construction of the project, WPE&S would be available to provide the following services:

- Hydrology and Drainage Report
- Biofiltration and/or Drywell Design
- Civil Engineering Design
- Construction Staking
- Construction Inspection for the Project
- Field Densities to Check Sub-grade and Base Compaction
- Compression Testing of Concrete
- Slump and Air Entrainment Testing of Concrete

These services will allow us to observe the site conditions during construction and to verify that the requisite high quality of workmanship is being performed by the contractor. It will also allow the staff of WPE&S to verify that the intent of the recommendations in this report is being abided by during construction.

In conclusion, we appreciate having the opportunity to provide you with this report. If you have any questions or require further information, please contact us at our Moses Lake office.

Sincerely,

Nathaniel D. Nofziger, P.E.
WESTERN PACIFIC ENGINEERING, INC.

<table>
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<th>Name</th>
<th>GW Well-Graded Gravels</th>
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<tr>
<td>Value as Sub-grade When Not Subject to Frost Action</td>
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<tr>
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</tr>
<tr>
<td>Action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressibility and</td>
<td>None</td>
<td>Slight</td>
</tr>
<tr>
<td>Expansion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage Characteristics</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Compaction Equipment</td>
<td>Rubber Tired Roller</td>
<td>Rubber Tired Roller</td>
</tr>
<tr>
<td>Unit Dry Weight</td>
<td>1.70-2.15 (105-135)</td>
<td>1.60-2.10 (100-135)</td>
</tr>
<tr>
<td>g/cm³ (lb/ft³)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**FIELD TESTS AND PROCEDURES**

<table>
<thead>
<tr>
<th>TURVANE (psf)</th>
<th>PENETROMETER (tsf)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/ cu. ft)</th>
<th>% COMPACPTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>126.4</td>
<td></td>
</tr>
</tbody>
</table>

**NARRATIVE AND DESCRIPTION**

- Dirt with large aggregate (1" & smaller)
  - Red in color
  (No Sample Taken)

- Well graded gravel with sand (GW)
  - 79% gravel, 19% sand, 2% silt & clay
  - Small aggregate with sandy material

**EXPLORATION METHOD:** 320C Trackhoe

**SURFACE ELEVATION:** N/A

**SUBSURFACE LOG:** Test Pit No. 1

**DATE PERFORMED:** January 24, 2007

**WESTERN PACIFIC ENGINEERING, INC.**
Pioneer Professional Center
1328 Hunter Place
Moses Lake, WA 98837
(509) 765-1023

**ENTEZAR DEVELOPMENT**
Spanish Castle Project
Test Pit Log

**DRAWN BY:** CAB
**CHECKED BY:** NDN
**DATE:** April 06, 2007
**WPE PROJECT #:** 07611
**Scale:** 1" = N/A
**PLATE NO.:** 4
### Field Tests and Procedures

<table>
<thead>
<tr>
<th>TORVANE (psf)</th>
<th>PENETROMETER (tsf)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/cu.ft)</th>
<th>% COMPACTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td>136.3</td>
<td></td>
</tr>
</tbody>
</table>

**NSSURFACE LOG:** Test Pit No. 2  
**DATE PERFORMED:** January 24, 2007  
**EXPLORATION METHOD:** 320C Trackhoe  
**SURFACE ELEVATION:** N/A

### Narrative and Description

- **Dirt with some aggregate -10” minus**  
  - Brown in color  
  - (No Sample Taken)

- **Dirt / Sand with aggregate - 2” minus**  
  - Red in color  
  - (No Sample Taken)

- **Well graded Gravel, (GW) 88% gravel, 11% sand, 1% silt & clay. Dirt & sand with aggregate - 2” minus - Grey in color**

---

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Pioneer Professional Center  
1326 Hunter Place  
Moses Lake, WA 98837  
(509) 765-1023

**Entezar Development**  
Spanish Castle Project  
Test Pit Log

**Drawn by:** CAB  
**Date:** April 06, 2007  
**WPE Project #:** 07611  
**Scale:** 1” = N/A  
**Plate No.:** 5
**FIELD TESTS AND PROCEDURES**

<table>
<thead>
<tr>
<th>TORVANE (psf)</th>
<th>PENETROMETER (ft/s)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/cu.ft)</th>
<th>% COMPACTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUBSURFACE LOG:** Test Pit No. 3

**DATE PERFORMED:** January 24, 2007

**EXPLORATION METHOD:** 320C Trackhoe

**SURFACE ELEVATION:** N/A

**NARRATIVE AND DESCRIPTION**

Silty sand (SM) Dirt with aggregate. 4% gravel, 83% sand, 13% silt & clay. Very large few large rocks 1' & mostly 10" minus.

Sand & gravel with aggregate (No Sample Taken)

Excavation Limit

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1328 Hunter Place
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(509) 765-1023

**ENTEZAR DEVELOPMENT**
Spanish Castle Project
Test Pit Log

**DRAWN BY:** CAB
**DATE:** April 06, 2007
**WPE PROJECT #** 07611
**CHECKED BY:** NDN
**PLATE NO.:** 6

Scale: 1" = N/A
**FIELD TESTS AND PROCEDURES**

<table>
<thead>
<tr>
<th>TOPVANE (psf)</th>
<th>PENETROMETER (tsf)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/cu.ft)</th>
<th>% COMPACTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUBSURFACE LOG:** Test Pit No. 4  
**DATE PERFORMED:** January 24, 2007  
**EXPLORATION METHOD:** 320C Trackhoe  
**SURFACE ELEVATION:** N/A

**NARRATIVE AND DESCRIPTION**

- Poorly graded sand (SP)  
  1% gravel, 95% sand, 4% silt & clay

- Sandy & large aggregate.  
  No small aggregate  
  (No Sample Taken)

- Well graded gravel (GW), sand & gravel  
  84% gravel, 14% sand, 2% silt & clay  
  Aggregate – few 8” minus with most 2” minus  
  Water table at 18’  
  Excavation Limit
**FIELD TESTS AND PROCEDURES**

<table>
<thead>
<tr>
<th>TORVANE (psf)</th>
<th>PENETROMETER (tsf)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lb/ft³)</th>
<th>% COMPACTATION</th>
<th>DEPTH (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRAPHIC LOG**

- Sand (No Sample Taken)
- Sand & large cobbles greater than 12" in dia. (No small aggregate, 1+) (No Sample Taken)
- Sand & gravel. Aggregate – few 8” – 10” with most 2” minus. (No Sample Taken)

**SUBSURFACE LOG:** Test Pit No. 5
**DATE PERFORMED:** January 24, 2007
**EXPLORATION METHOD:** 320C Trackhoe
**SURFACE ELEVATION:** N/A

**NARRATIVE AND DESCRIPTION**

- Excavation Limit

---

**WESTERN PACIFIC ENGINEERING, INC.**
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1328 Hunter Place
Moses Lake, WA 98837
(509) 765-1023

**ENTEZAR DEVELOPMENT**
Spanish Castle Project
Test Pit Log

**DRAWN BY:** CAB
**CHECKED BY:** NDN
**DATE**
April 06, 2007

**WPE PROJECT #**
07611

**Scale:** 1" = N/A

**PLATE NO.:** 8
FIELD TESTS AND PROCEEDURES

<table>
<thead>
<tr>
<th>TORVANE (psf)</th>
<th>PENETROMETER (ips)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/cu.ft)</th>
<th>% COMPACTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SUBSURFACE LOG: Test Pit No. 6
DATE PERFORMED: January 24, 2007
EXPLORATION METHOD: 320C Trackhoe
SURFACE ELEVATION: N/A

NARRATIVE AND DESCRIPTION

Silty Sand (SM)
2% gravel, 77% sand, 20% silt & clay
Dirt with large rocks.

Gravel, Small chunks of Basalt
86% gravel, 11% sand, 1% silt & clay
(At 14' also a few chunks of green clay)

Excavation Limit

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1328 Hunter Place
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ENTEZAR DEVELOPMENT
Spanish Castle Project
Test Pit Log

DRAWN BY: CAB  DATE: April 06, 2007
CHECKED BY: NDN  WPE PROJECT #: 07611
Scale: 1" = N/A
PLATE NO.: 9
FIELD TESTS AND PROCEDURES

SUBSURFACE LOG: Test Pit No. 7
DATE PERFORMED: January 24, 2007
EXPLORATION METHOD: 320C Trackhoe
SURFACE ELEVATION: N/A

NARRATIVE AND DESCRIPTION

Dirt with few aggregate (8" minus)
- Red in color
(No Sample Taken)

Poorly graded gravel with sand (GP)
73% gravel, 25% sand, 2% silt & clay
Sand with gravel. – Light grey in color

Sand with gravel
Aggregate 8" - 10" minus
- Dark grey in color.
(No Sample Taken)

Excavation Limit
FIELD TESTS AND PROCEDURES

<table>
<thead>
<tr>
<th>TORVANE (psf)</th>
<th>PENETROMETER (tsf)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/cu.ft)</th>
<th>% COMPACTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.75</td>
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</tr>
</tbody>
</table>

SUBSURFACE LOG: Test Pit No. 8

DATE PERFORMED: January 24, 2007

EXPLORATION METHOD: 320C Trackhoe

SURFACE ELEVATION: N/A

NARRATIVE AND DESCRIPTION

Dirt with very few aggregate.
(Per reading 0.75)
(No Sample Taken)

Dirt with lots of aggregate
8" - 10" minus. A few 4 1/2' dia. rocks
- Red / Brown in color,
(No Sample Taken)

Sand with aggregate - 8" minus
- Dark grey in color
(No Sample Taken)

Excavation Limit

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ENTEZAR DEVELOPMENT
Spanish Castle Project
Test Pit Log

DRAWN BY: CAB
CHECKED BY: NDN
DATE April 06, 2007
WPE PROJECT # 07611
Scale: 1" = N/A
PLATE NO.: 11
# Field Tests and Procedures

<table>
<thead>
<tr>
<th>Torvane (psf)</th>
<th>Penetrometer (1ft)</th>
<th>Dry Density (pcf)</th>
<th>Moisture Content (%)</th>
<th>Maximum Dry Density (lbs/cu.ft)</th>
<th>% Compaction</th>
<th>Depth (ft)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>136.3</td>
<td></td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subsurface Log:** Test Pit No. 9

**Date Performed:** January 25, 2007

**Exploration Method:** 320C Trackhoe

**Surface Elevation:** N/A

## Narrative and Description

- Dirt with lots of aggregate – 12 minus
  - Red in color
  - (No Sample Taken)

- Gravel with aggregate – 8” minus
  - Dark grey in color
  - (No Sample Taken)

- Sand with aggregate – 1 1/2” minus
  - Grey in color
  - (No Sample Taken)

---

**Excavation Limit**

---

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**Enetzar Development**

Spanish Castle Project
Test Pit Log

**Drawn By:** CAB
**Checked By:** NDN
**Date:** April 06, 2007

**WPE Project #:** 07611
**Scale:** 1” = N/A
**Plate No.:** 12
## FIELD TESTS AND PROCEEDURES

<table>
<thead>
<tr>
<th>Torvane (psi)</th>
<th>Penetrometer (tsf)</th>
<th>Dry Density (pcf)</th>
<th>Moisture Content (%)</th>
<th>Maximum Dry Density (lbs/cu.ft)</th>
<th>% Compaction</th>
<th>Depth (ft)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>99.4</td>
<td>8.4</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Narrative and Description**

- Poor graded sand with silt and clay (SP–SM) 25% gravel, 65% sand, 10% silt & clay
  - Dirt with some aggregate – 8" minus

- Poor graded gravel with sand (GP)
  - 71% gravel, 26% sand, 3% silt & clay
  - Gravel with little dirt. (Aggregate 8" minus)
    - Dark grey in color

- Very large rock – 5’
  - Rocky outcrop area.
    - (No Sample Taken)

- Solid Rock – Excavation Limit

---

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**Entezar Development**

Spanish Castle Project
Test Pit Log

**Drawn by:** CAB  **Date:** April 06, 2007

**Checked by:** NDN  **WPE Project #:** 07611

**Scale:** 1” = N/A  **Plate No.:** 13
### Field Tests and Procedures

<table>
<thead>
<tr>
<th>TORVANE (psf)</th>
<th>PENETROMETER (tsf)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/cu.ft)</th>
<th>% COMPACTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
</table>

**Subsurface Log:** Test Pit No. 11  
**Date Performed:** January 25, 2007  
**Exploration Method:** 320C Trackhoe  
**Surface Elevation:** N/A

**Narrative and Description**

- Dirt with some aggregate – 8” minus
  - Red/Brown in color
  (No Sample Taken)

- Dirt with a lot of rock – 10” minus
  - Red/Brown in color
  (No Sample Taken)

- Well – Graded gravel (GW)
  92% gravel, 7% sand, 1% silt & clay
  Basalt/Gravel/Sand with aggregate
  8” – 10”
  - Grey in color

Excavation Limit

---

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Moses Lake, WA 98837  
(509) 785-1023

**Entezar Development**  
Spanish Castle Project  
Test Pit Log

**Drawn by:** CAB  
**Checked by:** NDN  
**Date:** April 06, 2007  
**WPE Project #:** 07611  
**Scale:** 1” = N/A  
**Plate No.:** 14
FIELD TESTS AND PROCEDURES

<table>
<thead>
<tr>
<th>TOPVANE (psf)</th>
<th>PENETROMETER (tsf)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lb/s-cu.ft)</th>
<th>% COMPACTION</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
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</thead>
<tbody>
<tr>
<td>106.7</td>
<td>5.2</td>
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</table>

SUBSURFACE LOG: Test Pit No. 12
DATE PERFORMED: January 25, 2007
EXPLORATION METHOD: 320C Trackhoe
SURFACE ELEVATION: N/A

NARRATIVE AND DESCRIPTION

Poorly graded sand with gravel (SP)
19% gravel, 77% sand, 4% silt & clay
Dirt with few aggregate – 8" minus
   - Red / Brown in color

Well graded gravel (GW)
92% gravel, 7% sand, 1% silt & clay
Dirt with lots of large aggregate 18" and smaller. – Brown in color

Sand with smaller aggregate – 8" minus
   - Grey in color
   (No Sample Taken)

Excavation Limit

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ENTEZAR DEVELOPMENT
Spanish Castle Project
Test Pit Log

DRAWN BY: CAB  DATE: WPE PROJECT #  Scale: 1" = N/A
CHECKED BY: NDN  April 06, 2007  07611  PLATE NO.: 15
<table>
<thead>
<tr>
<th>TORMVNE (psf)</th>
<th>PENETROMETER (l/ft)</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (lbs/cu.ft)</th>
<th>% COMPACT.</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
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</thead>
<tbody>
<tr>
<td>108.2</td>
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<td>2.6</td>
<td></td>
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</tr>
</tbody>
</table>

**SUBSURFACE LOG:** Test Pit No. 13  
**DATE PERFORMED:** January 25, 2007  
**EXPLORATION METHOD:** 320C Trackhoe  
**SURFACE ELEVATION:** N/A

**NARRATIVE AND DESCRIPTION**

- **Well graded gravel (GW)**  
  89% gravel, 10% sand, 1% silt & clay  
  Dirt with lots of aggregate, mostly 8’ minus with a few larger 1’  
  - Red / Brown in color

- **Well graded gravel (GW)**  
  93% gravel, 6% sand, 1% silt & clay  
  Sand with lots of gravel, same rock as above. Digging easy after frost line  
  - Grey in color

---

**ENTEZAR DEVELOPMENT**  
Spanish Castle Project  
Test Pit Log

**DRAWN BY:** CAB  
**CHECKED BY:** NDN  
**DATE:** April 06, 2007  
**WPE PROJECT #** 07611  
**SCALE:** 1” = N/A  
**PLATE NO.:** 16
<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYM.</th>
<th>TYPICAL NAMES</th>
<th>FIELD IDENTIFICATION PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;excluding particles larger than 75mm (3&quot;) and basing fractions on estimated weights&lt;</td>
</tr>
<tr>
<td></td>
<td>GW</td>
<td>Well-graded gravels, gravel-sand mixtures, little or no fines.</td>
<td>Wide range in grain sizes and substantial amounts of all intermediate particle sizes.</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Poorly-graded gravels, gravel-sand mixtures, little or no fines.</td>
<td>Predominately one size or a range of sizes with some intermediate sizes missing.</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty gravels, gravel-sand-silt mixtures.</td>
<td>Nonplastic fines or fines with low plasticity. &gt;for identification procedures see ML below&lt;</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey gravels, gravel-sand-clay mixtures.</td>
<td>Plastic fines. &gt;for identification procedures see CL below&lt;</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Well-graded sands, gravelly sands, little or no fines.</td>
<td>Wide range in grain sizes and substantial amounts of all intermediate particle sizes.</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>Poorly-graded sands, gravelly sands, little or no fines</td>
<td>Predominately one size or a range of sizes with some intermediate sizes missing.</td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td>Silty sands, sand-silt mixtures.</td>
<td>Nonplastic fines or fines with low plasticity. &gt;for identification procedures see ML below&lt;</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>Clayey sands, sand-clay mixtures.</td>
<td>Plastic fines. &gt;for identification procedures see CL below&lt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identification procedures on Fraction Smaller than .425 mm &gt;No. 40 Sieve Size&lt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry Strength &gt;crushing reaction characteristics&lt;, Dilatancy &gt;reaction to shaking&lt;</td>
<td>Dilatancy &gt;reaction to shaking&lt;</td>
</tr>
<tr>
<td></td>
<td>ML</td>
<td>Inorganic silts and very fine sands rock flour, silty or clayey fine sands or clayey silts with slight plasticity.</td>
<td>None to Slight Slow to Quick None</td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Inorganic clays of low to medium plasticity, gravity clays, sandy clays, silty clays, lean clays.</td>
<td>Medium to High None to Very Slow Medium</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic silts and organic silt clays of low plasticity.</td>
<td>Slight to Medium Slow Slight</td>
</tr>
<tr>
<td></td>
<td>MH</td>
<td>Inorganic silts, micaceous or diatomaceous, fine sandy or silty soils, elastic silts.</td>
<td>Slight to Medium None to Slow Slight to Medium</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>Inorganic clays of high plasticity, fat clays.</td>
<td>High to Very High None High</td>
</tr>
<tr>
<td></td>
<td>OH</td>
<td>Organic clays of medium to high plasticity, organic silts.</td>
<td>Medium to High None to Very Slow Slight to Medium</td>
</tr>
<tr>
<td></td>
<td>Pt</td>
<td>Peat and other highly organic soils.</td>
<td>Readily identified by color, odor, spongy feel and frequently by fibrous texture.</td>
</tr>
</tbody>
</table>

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Moses Lake, WA 98837
(509) 765-1023

GEOTECHNICAL DATA
GENERAL SOIL CLASSIFICATION

DRAWN BY: JTF DATE WPE PROJECT # Scale: N.T.S.
CHECKED BY: NDN April, 06, 2007 07611 PLATE NO.: 18
FIELD TESTS AND PROCEDURES

**SUBSURFACE LOG:** Test Pit No. 2

**DATE PERFORMED:** January 24, 2007

**EXPLORATION METHOD:** 320C Trackhoe

**SURFACE ELEVATION:** N/A

---

**NARRATIVE AND DESCRIPTION**

- **136.3 ft**

  - Dirt with some aggregate – 10" minus
    - Brown in color
    - (No Sample Taken)

  - Dirt / Sand with aggregate – 2" minus
    - Red in color
    - (No Sample Taken)

- **15 ft**

  - Well graded Gravel. (GW) 88% gravel,
    11% sand, 1% silt & clay. Dirt & sand
    with aggregate – 2" minus – Grey in color

---

**Excavation Limit**

---

**WESTERN PACIFIC ENGINEERING, INC.**

Pioneer Professional Center
1326 Hunter Place
Moses Lake, WA 98837
(509) 765-1023

**ENTEZAR DEVELOPMENT**

Spanish Castle Project
Test Pit Log

**DRAWN BY:** CAB
**DATE:** April 06, 2007

**WPE PROJECT #**
**07611**

**CHECKED BY:** NDN

**Scale:** 1" = N/A
**PLATE NO.:** 5
Date Received: 01/24/07  
Sample #: 3  
Project No.: 07611  
Source: Test Pit #1 12' - 18'

ASTM D-2487 Unified Soils Classification System
GW, Well-graded Gravel with Sand

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<th>Metric</th>
<th>Percent Passing</th>
<th>Percent Passing</th>
<th>Percent Passing</th>
<th>Spec Max</th>
<th>Spec Min</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Fracility Index</th>
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**Grain Size Distribution**

- % Passing
- Particle Size (mm)

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Western Pacific Engineering & Testing Services Inc. 3176-3337
Date Received: 01/24/07
Sample #: 4
Project No.: 07611
Source: Test Pit #2 5'-15'

Specifications:
No Spec

Sample Meets Spec? Yes

ASTM D-2487 Unified Soils Classification System
GW, Well-graded Gravel

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% Passing

Grain Size Distribution

Coef. of Curvature, Cc = 2.20
Coef. of Uniformity, Cu = 13.82
Fineness Modulus = 7.80
**Western Pacific Engineering, Inc.**

**Pioneer Way Professional Center**
1228 E. Hunter Place
Moses Lake, Washington 98837
Office: (509) 765-1023
Fax: (509) 765-1298
E-Mail: fskinner@wpeinc.biz

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### Date Received: 01/24/07
Sample #: 5
Project #: 07611

**Source:** Test Pit #3 0'-7.5'

**Specifications:**
- No Spec

**Sample Meets Spec:** Yes

**Liquid Limit:** 9.0%

**Plastic Limit:** 5.0%

**Plasticity Index:** 4.0%

### ASTM D-2487 Unified Soils Classification System
- SM, Silty Sand
  - Coef. of Curvature, $C_c = 1.18$
  - Coef. of Uniformity, $C_u = 2.66$
  - Fineness Modulus = 0.93

#### Grain Size Distribution

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Copyright: [Western Pacific Engineers & Technicians, Inc.](1990-2000)
**ASTM D-2487 Unified Soils Classification System**

**SP, Poorly graded Sand**

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**Grain Size Distribution**

- **% Passing**
- **% Gravel = 0.6%**
- **% Sand = 94.7%**
- **% Silt & Clay = 4.7%**

**Coeff. of Curvature, C_C = 1.03**

**Coeff. of Uniformity, C_U = 2.99**

**Fineness Modulus = 1.14**

**Plastic Limit = 0.0%**

**Liquid Limit = 0.0%**

**Plasticity Index = 0.0%**
Date Received: 01/24/07
Sample #: 6
Project No.: 07611
Source: Test Pit #6 1'-4.5'

Specifications
No Spec

Sample Meets Specs? Yes
Liquid Limit: 0.0%

ASTM D-2487 Unified Soils Classification System
SM, Silty Sand

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Grain Size Distribution

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D_{100} = 0.037 mm  % Gravel = 2.4%
D_{50} = 0.100 mm  % Sand = 77.4%
D_{60} = 0.176 mm  % Silt & Clay = 20.1%

Coeff. of Curvature, C_c = 1.53
Coeff. of Uniformity, C_u = 4.73
Fines content, M_f = 0.99
Plasticity Index, I_p = 0.0%

Copyright © 2007 Western Pacific Engineering, Inc.
Date Received: 01/24/07
Sample #: 7
Project No.: 07611
Source: Test Pit #6 4.5' - 14'
Specifications: No Spec
Sample Meets Specs? Yes
Liquid Limit= 0.0%
ASTM D-2487 Unified Soils Classification System
GW, Well-graded Gravel

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<th>Sieve Size Metric</th>
<th>Actual Cumulative</th>
<th>Interpolated Cumulative</th>
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<th>Percent Passing</th>
<th>Spec Max</th>
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% Gravel = 88.3%
% Sand = 11.2%
% Silt & Clay = 0.5%
Coef. of Curvature, $C_v = 1.41$
Coef. of Uniformity, $C_u = 9.24$
Fineness Modulus = 7.54
Plastic Limit = 0.0%
Plasticity Index = 0.0%
Date Received: 01/24/07
Sample #: 8
Project No.: 07611
Source: Test Pit #7 6'-9.5'
Specifications
No Specs
Sample Meets Specs? Yes

ASTM D-2487 Unified Soils Classification System
GP, Poorly graded Gravel with Sand

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Liquid Limit= 0.0%  Plastic Limit= 0.0%  Plasticity Index= 0.0%

Grain Size Distribution
Date Received: 01/24/07
Sample #: 10
Project No.: 07611

Source: Test Pit #10 1' - 3'

Specifications
No Specs

Sample Meets Specs? Yes

Liquid Limit: 0.0%

ASTM D-2487 Unified Soils Classification System
SP-SS4, Poorly graded Sand with Silt and Gravel

D_{10} = 0.076 mm
D_{50} = 0.147 mm
D_{90} = 0.370 mm
Gravel % = 24.9
Sand % = 65.4
Silt & Clay % = 9.7

Coef. of Curvature, Cc = 0.77
Coef. of Uniformity, Cu = 4.87

Plasticity Index = 0.0%

Grain Size Distribution Diagram

Particle Size (mm)

% Passing

0.01 0.10 1.00 10.00 100.00

Sieve Sizes
Max Spec
Min Spec
Sieve Results

% Passing

0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 90.0 100.0

Cumulative Percent Passing

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Sieve Size (US) Percent Passing

6.00 4.00 3.00 2.50 2.00 1.75 1.50 1.25 1.00 7/8 5/8 3/4 1/2 3/8 1/4 #4 #8 #10 #16 #20 #30 #40 #50 #60 #80 #100 #140 #170 #200

150.00 100.00 75.00 63.00 50.00 45.00 37.50 31.50 25.00 22.40 19.00 16.00 12.50 9.50 6.30 4.75 2.36 2.00 1.18 0.85 0.60 0.42 0.30 0.25 0.18 0.15 0.10 0.09 0.075

100% 100% 100% 100% 100% 100% 100% 100% 97% 99% 92% 89% 84% 84% 81% 77% 75% 72% 71% 69% 68% 67% 66% 52% 47% 39% 31% 18% 14% 9.7% 9.7% 99.0% 0.0%
Date Received: 01/24/07
Sample #: 11
Project No.: 07611
Source: Test Pit #11 3' - 6'
Specifications
No Spec
Sample Meets Spec? Yes

ASTM D-2487 Unified Soils Classification System
GP, Poorly graded Gravel with Sand

D<sub>50</sub> = 0.170 mm  % Gravel = 71.0%
D<sub>60</sub> = 5.422 mm  % Sand = 26.0%
D<sub>15</sub> = 39.472 mm  % Silt & Clay = 3.0%

Liquid Limit = 0.0%
Plastic Limit = 0.0%
Plasticity Index = 0.0%

Grain Size Distribution

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<tr>
<th>Sieve Size</th>
<th>% Passing</th>
</tr>
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Copyright © 2007 Western Pacific Engineering & Technical Services P.C., 1996-2007
Date Received: 01/24/07
Sample #: 12
Project No.: 07611
Source: Test Pit #11 6.5' - 11.5'
Specifications
No Spec

Sample Meets Specs? Yes

ASTM D-2487 Unified Soils Classification System
GW, Well-graded Gravel

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% Gravel = 91.7%
Coeff. of Curvature, C_v = 1.06

% Sand = 6.5%
Coeff. of Uniformity, C_u = 9.02

% Silt & Clay = 1.8%
Fines Modulus = 7.12

Liquid Limit = 0.0%
Plastic Limit = 0.0%
Plasticity Index = 0.0%

Grain Size Distribution
Date Received: 01/24/07
Sample #: 13
Project No.: 07611

Source: Test Pit #12 0" - 18"

Specifications
No Spec

Sample Meets Specs? Yes

ASTM D-2487 Unified Soils Classification System
SP, Poorly graded Sand with Gravel

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Liquid Limit: 0.0%
Plastic Limit: 0.0%
Plasticity Index: 0.0%

Coeff. of Curvature, Cc = 1.14
Coeff. of Uniformity, Cu = 3.33
Cleanliness, Cc = 2.54
Date Received: 01/24/07
Sample #: 14
Project No.: 07611

Source: Test Pit #12 1.5'-10'
Specifications
No Spec
Sample Meets Specs? Yes

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ASTM D-2487 Unified Soils Classification System
GW, Well-graded Gravel

Liquid Limit = 0.0%
Plastic Limit = 0.9%

Grain Size Distribution

Particle Size (mm)

% Passing

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**ASTM D-2487 Unified Soils Classification System**

- **GW, Well-graded Gravel**
  - $D_{50}=4.066$ mm
  - $D_{10}=12.842$ mm
  - $D_{60}=29.231$ mm
  - % Gravel = 88.7%
  - % Sand = 10.2%
  - % Silt & Clay = 1.1%
  - Coeff. of Curvature, $C_c = 1.39$
  - Coeff. of Uniformity, $C_u = 7.19$
  - Plasticity Index = 0.0%
  - Fineness Modulus = 7.34

**Sample Details**
- **Date Received:** 01/24/07
- **Sample #: 16**
- **Project No.: 07611**
- **Source:** Test Pit #13 0' - 3.5'
- **Specifications:** No Specs
- **Sample Meets Specs?** Yes

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</tr>
</tbody>
</table>

**Grain Size Distribution**

- **Liquid Limit:** 0.0%
- **Plastic Limit:** 0.0%
- **Plasticity Index:** 0.0%
Date Received: 01/24/07
Sample #: 17
Project No.: 07611
Source: Test Pit #13 3.5' - 13'
Specifications
No Specs
Sample Meets Specs? Yes
ASTM D-2487 Unified Soils Classification System
GW, Well-graded Gravel

D_{50} = 7.947 mm  % Gravel = 93.5%
D_{90} = 23.861 mm  % Sand = 6.0%
D_{99} = 51.019 mm  % Silt & Clay = 0.5%

Coef. of Curvature, Cc = 1.40
Coef. of Uniformity, Cu = 6.42
Finesse Modulus, M = 8.04
Plasticity Index = 0.0%

Grain Size Distribution

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
<th>Percent Passing Max</th>
<th>Percent Passing Min</th>
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<td>Cumulative</td>
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</tr>
<tr>
<td>#200</td>
<td>0.075</td>
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<td>100%</td>
</tr>
</tbody>
</table>
SOIL SURVEY OF DOUGLAS COUNTY, WASHINGTON

MAP INFORMATION

Source of Map: Natural Resources Conservation Service

Coordinate System: UTM Zone 10
Soil Survey Area: Douglas County, Washington
Spatial Version of Data: 2
Soil Map Compilation Scale: 1:12000

Map comprised of aerial images photographed on these dates:

The orthophoto or other base map on which the soil lines were compiled and
digitized probably differs from the background imagery displayed on these maps.
As a result, some minor shifting of map unit boundaries may be evident.
## Map Unit Legend Summary

**Douglas County, Washington**

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>74</td>
<td>Burch loam, 0 to 3 percent slopes</td>
<td>8.5</td>
<td>2.2</td>
</tr>
<tr>
<td>75</td>
<td>Burch loam, 3 to 8 percent slopes</td>
<td>13.0</td>
<td>3.4</td>
</tr>
<tr>
<td>79</td>
<td>Cashmere fine sandy loam, 0 to 3 percent slopes</td>
<td>5.4</td>
<td>1.4</td>
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<td>80</td>
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<td>6.5</td>
<td>1.7</td>
</tr>
<tr>
<td>81</td>
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<td>8.6</td>
<td>2.3</td>
</tr>
<tr>
<td>262</td>
<td>Pogue fine sandy loam, 3 to 8 percent slopes</td>
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<td>7.7</td>
</tr>
<tr>
<td>264</td>
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<td>80.9</td>
<td>21.2</td>
</tr>
<tr>
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<td>Pogue gravelly fine sandy loam, 15 to 25 percent slopes</td>
<td>7.5</td>
<td>2.0</td>
</tr>
<tr>
<td>266</td>
<td>Pogue cobbly fine sandy loam, 0 to 15 percent slopes</td>
<td>47.1</td>
<td>12.4</td>
</tr>
<tr>
<td>268</td>
<td>Pogue extremely stony fine sandy loam, 3 to 25 percent slopes</td>
<td>3.7</td>
<td>1.0</td>
</tr>
<tr>
<td>270</td>
<td>Pogue loam, 8 to 15 percent slopes</td>
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<td>12.7</td>
</tr>
<tr>
<td>274</td>
<td>Quincy loamy fine sand, 0 to 15 percent slopes</td>
<td>21.7</td>
<td>5.7</td>
</tr>
<tr>
<td>427</td>
<td>Torriorthents, very steep</td>
<td>81.8</td>
<td>21.5</td>
</tr>
<tr>
<td>458</td>
<td>Water</td>
<td>18.8</td>
<td>4.9</td>
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</table>
## Tables - Saturated Hydraulic Conductivity (Ksat), Standard Classes

**Summary by Map Unit - Douglas County, Washington**

<table>
<thead>
<tr>
<th>Soil Survey Area Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Rating (micrometers per second)</th>
<th>Total Acres in AOI</th>
<th>Percent of AOI</th>
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</thead>
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<tr>
<td>74</td>
<td>Burch loam, 0 to 3 percent slopes</td>
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<td>2.2</td>
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<td>75</td>
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<td>1.4</td>
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<td>Cashmere fine sandy loam, 3 to 8 percent slopes</td>
<td>28.2300</td>
<td>6.5</td>
<td>1.7</td>
</tr>
<tr>
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<td>Cashmere fine sandy loam, 8 to 15 percent slopes</td>
<td>28.2300</td>
<td>8.6</td>
<td>2.3</td>
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<td>274</td>
<td>Quincy loamy fine sand, 0 to 15 percent slopes</td>
<td>91.7400</td>
<td>21.7</td>
<td>5.7</td>
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<td>427</td>
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<td>458</td>
<td>Water</td>
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<td>4.9</td>
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</table>
Description - Saturated Hydraulic Conductivity (Ksat), Standard Classes

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits. The classes are:

- Very low: 0.00 to 0.01
- Low: 0.01 to 0.1
- Moderately low: 0.1 to 1.0
- Moderately high: 1 to 10
- High: 10 to 100
- Very high: 100 to 705

Parameter Summary - Saturated Hydraulic Conductivity (Ksat), Standard Classes

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Component" returns the attribute value associated with the component with the highest percent composition in the map unit. If more than one component shares the highest percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher attribute value should be returned in the case of a percent composition tie.

The result returned by this aggregation method may or may not represent the dominant condition throughout the map unit.

Component Percent Cutoff:

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Fastest

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Interpret Nulls as Zero: No

This option indicates if a null value for a component should be converted to zero before aggregation occurs. This will be done only if a map unit has at least one component where this value is not null.

Layer Options: All Layers

For an attribute of a soil horizon, a depth qualification must be specified. In most cases it is probably most appropriate to
specify a fixed depth range, either in centimeters or inches. The Bottom Depth must be greater than the Top Depth, and the Top Depth can be greater than zero. The choice of "inches" or "centimeters" only applies to the depth of soil to be evaluated. It has no influence on the units of measure the data are presented in.

When "Surface Layer" is specified as the depth qualifier, only the surface layer or horizon is considered when deriving a value for a component, but keep in mind that the thickness of the surface layer varies from component to component.

When "All Layers" is specified as the depth qualifier, all layers recorded for a component are considered when deriving the value for that component.

Whenever more than one layer or horizon is considered when deriving a value for a component, and the attribute being aggregated is a numeric attribute, a weighted average value is returned, where the weighting factor is the layer or horizon thickness.
### Tables - Hydrologic Soil Group

**Summary by Map Unit - Douglas County, Washington**

<table>
<thead>
<tr>
<th>Soil Survey Area Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Rating</th>
<th>Total Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>74</td>
<td>Burch loam, 0 to 3 percent slopes</td>
<td>B</td>
<td>8.5</td>
<td>2.2</td>
</tr>
<tr>
<td>75</td>
<td>Burch loam, 3 to 8 percent slopes</td>
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<td>3.4</td>
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<tr>
<td>79</td>
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<td>1.4</td>
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<td>3.7</td>
<td>1.0</td>
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<td>12.7</td>
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<td>458</td>
<td>Water</td>
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<td>4.9</td>
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</table>

### Description - Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

**Group A.** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

**Group B.** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
Hydrologic Soil Group Rating

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Parameter Summary - Hydrologic Soil Group

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components." A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff:

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Lower

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.
May 14, 2007

Douglas County Department of Transportation and Land Services
140 NW 19th Street
East Wenatchee, WA 98802

RE: Critical Area Analysis – Geologic Risk Assessment
Columbia Feeders Subdivision, Spanish Castle Road
Douglas County, Washington

Gentlemen:

This letter addresses critical areas located on and near the Columbia Feeders parcel immediately north of Spanish Castle Road (Figure 1). Columbia Feeders, Inc. owns this parcel, which has seen prior use as a feedlot for cattle. The lot has ranch style amenities such as storage sheds, housing, well, pens, corrals, fences, farm roads and trails, stored agricultural machinery and other similar devices. A gravel pit has been excavated out of a natural bank at one location. Munson Engineers evaluated the critical areas on May 13, 2007 for erosion hazard and landslide potential. This assessment is submitted in accordance with Douglas Code Chapter 19.18D RESOURCE LANDS / CRITICAL AREAS – GEOLOGICALLY HAZARDOUS AREAS.

Columbia Feeders plans a cluster subdivision of 14 lots (Figure 2). The lots will range between 18,000 and 21,780 square feet of area. The remainder of the 135.04 acre parcel will be a single contiguous tract and private access road.

SITE TOPOGRAPHY

The parcel is located on two benches that overlook the Columbia River (Figure 3). The parcel rises from the easterly margin of the Burlington Northern – Santa Fe property at a slope averaging about 9 percent to the toe of an embankment. A portion of the embankment has been excavated to create a gravel pit approximately 50 feet deep (Figure 4). This lower terrace has on it fenced livestock pens, a store yard (Figure 5) and includes an abandoned railroad grade of the Great Northern Railway to which title has passed to Columbia Feeders. The embankment rises at a slope averaging about 30 percent to the upper bench achieving an elevation gain of 60 feet (Figure 6). The upper
bench rises at 2 percent and increases to 5 percent as it approaches State Highway 28. The upper bench features fenced livestock pens and three farm buildings (Figure 7). Spanish Castle Road leading to the shore of the Columbia River forms the southerly boundary of the parcel (Figure 8).

The only area on or adjacent to the site that satisfies the Douglas County definition of an area of interest under DCC 19.18D is the backslope of the gravel pit, which has a slope of repose of 80 percent.

SOIL CLASSIFICATIONS

The U. S. Department of Agriculture Soil Conservation Service publication “Soil Survey of Douglas County, Washington” classifies soil types and identifies their properties and characteristics. The soil survey identified ten unique soil types on site (Figure 9). The classifications are Burch loam, 0 to 3 percent slopes; Burch loam 3 to 8 percent slopes; Cashmere fine sandy loam, 8 to 15 percent slopes; Pogue fine sandy loam, 3 to 8 percent slopes; Pogue gravelly fine sandy loam, 8 to 15 percent slopes; Pogue gravelly fine sandy loam, 15 to 25 percent slopes; Pogue cobbly fine sandy loam, 0 to 15 percent slopes; Pogue extremely stony fine sandy loam, 3 to 25 percent slopes; Pogue loam, 8 to 15 percent slopes; and Xerorthents, very steep.

Lower Bench

Pogue gravelly fine sandy loam, 8 to 15 percent slopes covers most of the lower bench within the boundaries of the site. An isolated pocket of Pogue extremely stony fine sandy loam occupies a small area on the lower bench. No subdivision activity is proposed on this bench.

Pogue gravelly fine sandy loam, 8 to 15 percent slopes is a very deep, somewhat excessively drained soil. It formed in alluvium mixed with loess overlying glacial outwash. The typical surface layer is grayish brown gravelly fine sandy loam about 6 inches thick. The subsoil is brown and yellowish brown cobbly fine sandy loam about 25 inches thick. The substratum is very cobbly sand that extends to a depth of 60 inches or more. Depth to the very cobbly sand ranges from 24 to 38 inches. Permeability is moderately rapid to a depth of about 31 inches and very rapid below that. Available water capacity is moderate. Surface runoff is medium, water erosion hazard is moderate and the hazard of soil blowing is moderate. Slope is the main limitation for homesites. This soil is a poor filter for septic tank absorption fields due to excessive permeability.

Pogue extremely stony fine sandy loam, 3 to 25 percent slopes is a very deep, somewhat excessively drained soil. It formed in alluvium mixed with loess overlying glacial
outwash. The typical surface layer is grayish brown extremely stony fine sandy loam about 6 inches thick. The subsoil is brown cobbly fine sandy loam about 25 inches thick. The substratum is very cobbly sand to a depth of 60 inches or more. Depth to very cobbly sand ranges from 24 to 38 inches. Permeability is moderately rapid to a depth of about 31 inches and very rapid below that. Available water capacity is moderate. Surface runoff is medium, water erosion hazard is moderate and the hazard of soil blowing is moderate. The main limitations for urban development are the stones in the soil profile and slope. This soil is a poor filter for septic tank absorption fields due to excessive permeability.

**Embankment**

The embankment rises from the lower bench at a slope averaging about 30 percent. The soil survey classifies the embankment soil material as Xerorthents, very steep.

Xerorthents, very steep are very deep, somewhat excessively drained soils on terrace escarpments. They formed in glacial outwash mixed with loess in the upper part. No one pedon represents this soil, but a common one is a brown gravelly fine sandy loam surface layer 10 inches thick underlain by a cobbly sand that extends to a depth of 60 inches or more. The surface layer ranges to sandy loam or gravelly sandy loam and the underlying material from very cobbly sand to extremely cobbly sand. Texture varies widely within short distances. Permeability is very rapid. Available water capacity is low. Surface runoff is very rapid, and the hazard of water erosion is very high.

A fifty-foot deep face of the embankment has been exposed by excavation of a gravel pit. The surface layer in this section is a gravelly fine sandy loam, and the subsoil is a cobbly sand that holds a slope of repose of 80 percent.

**Upper Bench**

Soil mapping of the upper bench shows ribbons of soil types oriented north to south. Closest to the embankment is a ribbon composed of Pogue fine sandy loam, 3 to 8 percent slopes to the north and Pogue loam, 8 to 15 percent slopes to the south. The preponderance of the cluster development of single family lots occupies the area designated as Pogue loam, 8 to 15 percent slopes.

Pogue fine sandy loam, 3 to 8 percent slopes is a very deep, somewhat excessively drained soil on terraces. If formed in alluvium mixed with loess overlying glacial outwash. Individual areas of this soil are somewhat oblong in shape. Typically, the surface layer is grayish brown fine sandy loam about 6 inches thick. The subsoil is brown cobbly fine sandy loam about 25 inches thick. The substratum is very cobbly sand that extends to a depth of 60 inches or more. Depth to the very cobbly sand ranges from
24 to 38 inches. Permeability of this Pogue soil is moderately rapid to a depth of about 31 inches and very rapid below that. Available water capacity is moderate. Surface runoff is slow, and the water erosion hazard is slight. There is a high hazard of soil blowing. The soil is well suited to homesites, but is a poor filter for septic tank absorption fields due to rapid permeability.

Pogue loam, 8 to 15 percent slopes is a very deep, somewhat excessively drained soil located mainly on terraces. It formed in alluvium mixed with loess overlying glacial outwash. Individual areas of this soil are somewhat oblong in shape. Typically, the surface layer is brown loam about 10 inches thick. The subsoil is brown loam and gravelly loam about 15 inches thick. The substratum is very cobbly sand to a depth of 60 inches or more. Depth to the sand ranges from 20 to 40 inches. Permeability of this Pogue soil is moderately rapid to a depth of about 25 inches and very rapid below that. Available water capacity is moderate. The surface runoff is medium, and the hazard of water erosion is moderate. Slope is the main limitation for homesites. This soil is a poor filter for septic tank absorption fields due to excessive permeability.

Immediately east of this soil ribbon is a parallel ribbon composed of Pogue loam, 8 to 15 percent slopes to the north and Pogue gravelly fine sandy loam, 15 to 25 percent slopes to the south.

Pogue loam, 8 to 15 percent slopes has been described previously.

Pogue gravelly fine sandy loam, 15 to 25 percent slopes is a very deep, somewhat excessively drained soil located mainly on terraces and side slopes of terraces. It formed in alluvium mixed with loess overlying glacial outwash. Individual areas of this soil are somewhat oblong in shape. Typically, the surface layer is brown gravelly fine sandy loam about 6 inches thick. The subsoil is brown and yellowish brown cobbly fine sandy loam about 25 inches thick. The substratum is very cobbly sand to a depth of 60 inches or more. Depth to the very cobbly sand ranges from 20 to 36 inches. Permeability of this Pogue soil is moderately rapid to a depth of about 31 inches and very rapid below that. Available water capacity is moderate. The surface runoff is medium, and the hazard of water erosion is moderate. There is a moderate hazard of soil blowing. The main limitation for homesites is slope. The slope and poor filtering properties are the main limitations for septic tank absorption fields.

West of and adjacent to Highway 28 is the last parallel ribbon of soil types on the subject parcel. Descending from north to south, the soils in this stratification are classified as Cashmere fine sandy loam, 8 to 15 percent slopes; Burch loam, 0 to 3 percent slopes; Pogue cobbly fine sandy loam, 0 to 15 percent slopes; and Burch loam, 3 to 8 percent slopes.
Cashmere fine sandy loam, 8 to 15 percent slopes is a very deep well drained soil located on terraces. It formed in alluvium mixed with loess. Individual areas of this soil are somewhat oblong in shape. Typically the surface layer is brown fine sandy loam about 11 inches thick. The subsoil is pale brown fine sandy loam about 13 inches thick, and the substratum is pale brown fine sandy loam to a depth of 60 inches or more. Some pedons are up to 10 percent pebbles. Permeability of this Cashmere soil is moderately rapid. Available water capacity is high. Surface runoff is medium, and the water erosion hazard is moderate. The hazard of blowing soil is high. The main limitation for homesites is slope. The steepness of slope is a concern in installing septic tank absorption fields.

Burch loam, 0 to 3 percent slopes is a very deep well drained soil located on terraces. It formed in alluvium mixed with loess. Individual areas of this soil are somewhat oblong in shape. Typically, the surface layer is brown loam about 10 inches thick. The subsoil is yellowish brown and light brownish gray loam about 20 inches thick. The substratum is pale brown loam to a depth of 60 inches or more. Permeability of this Burch soil is moderate. Available water capacity is high. Surface runoff is slow, and the water erosion hazard is slight. A compacted layer can develop in the upper part of this soil as a result of continual use of heavy equipment. This soil is well suited to homesites. The restricted permeability is the main limitation for septic tank absorption fields.

Pogue cobbly fine sandy loam, 0 to 15 percent slopes is a very deep somewhat excessively drained soil found mainly on lower terraces. It formed in alluvium mixed with loess overlying glacial outwash. Individual areas of this soil are somewhat oblong in shape. Typically, the surface layer is grayish brown cobbly fine sandy loam about 6 inches thick. The subsoil is brown cobbly fine sandy loam about 25 inches thick. The substratum is very cobbly sand to a depth of 60 inches or more. Depth to the very cobbly sand ranges from 24 to 38 inches. Permeability of this Pogue soil is moderately rapid to a depth of about 31 inches and very rapid below that. Available water capacity is moderate. The surface runoff is medium, and the water erosion hazard is moderate. The hazard of blowing soil is moderate. The slope and cobbles in the soil profile are the main limitations for homesites. This soil is a poor filter for septic tank absorption fields due to excessive permeability.

Burch loam, 3 to 8 percent slopes is a very deep well drained soil located on terraces. It formed in alluvium mixed with loess. Individual areas of this soil are somewhat oblong in shape. Typically, the surface layer is brown loam about 10 inches thick. The subsoil is yellowish brown and light brownish gray loam about 20 inches thick. The substratum is pale brown loam to a depth of 60 inches or more. Permeability of this Burch soil is moderate. Available water capacity is high. Surface runoff is medium, and the water erosion hazard is moderate. A compacted layer can develop in the upper part of this soil as a result of continual use of heavy equipment. This soil is well suited to homesites. The restricted permeability is the main limitation for septic tank absorption fields.
PROPOSED IMPROVEMENTS

Columbia Feeders plans to subdivide the property into a cluster development of fourteen residential lots. The location of the cluster, encompassing all of the residential lots, is at the edge of the upper bench where it begins to roll over into the embankment. A private road access will connect to Spanish Castle Road. The private road will be gated. Drainage improvements will be installed to intercept storm water runoff in this cluster area.

Potable water will be provided by an on-site well and community water system. Individual septic tanks and absorption fields will provide wastewater treatment. Utility districts and service purveyors will provide the remaining utility services.

The reserve area of the cluster development will be managed to provide an equestrian center and trails, pasture, agriculture, a winery, a wine sales facility, golf, miniature golf, an ice skating facility, and a swimming pool – water park facility.

CONCLUSIONS

The on-site soils are well suited for building sites. When properly graded, the site will have no limitations related to slope stability.

The Pogue soils have rapid permeability characteristics that will affect drainfield design, and the Burch soils have restricted permeability that will affect drainfield design. The residential cluster is proposed to be located in an area of Pogue soils. Drainfield design that complies with the requirements of the Chelan – Douglas Health District provides safeguards that take into account the nature of the soils.

The site shows no evidence of erosive activity. Some of the soils are susceptible to erosion. A storm water control design and related sedimentation and erosion control design will protect the susceptible soils from erosion.

Although the site is in a lightly inhabited agricultural area, provisions should be made to control dust that may be generated as ground cover is removed.

Construction of the proposed residential neighborhood and accompaniments will have no significant impact on the soils and slopes on the site or surrounding the site in terms of landslide potential and erosion potential if construction is performed in accordance with building code requirements for residential construction and standard practices. Foundation depths must be below the frost depth and the native vegetation should be disturbed as little as possible during construction.
The proposed construction will not significantly change the hydraulic or hydrologic characteristics of the site. The lack of evidence of past erosive events indicates future erosion is improbable. However, because the construction site is located on a side hill slope, there is a small potential for a failure that could cause damage to the property. The risk of such an event is minimal and would require an exceptional climatic or geologic event, or significant change in the land use or hydrologic characteristics from those that currently exist or are anticipated by the proposed improvements. It is unlikely such an event would occur. The usability of the site should not be limited by such an unlikely event.

Sincerely,

Robert H. Culp

Robert H. Culp, P.E., President
MUNSON ENGINEERS, INC.
Figure 2 – Site Map
Figure 3 – Two Benches

Figure 4 – Gravel Pit
June 25, 2014

Douglas County Department of Transportation and Land Services
140 NW 19th Street
East Wenatchee, WA 98802

Attn: Mr. Curtis Lillquist

RE: Critical Area Analysis - Geologic Risk Assessment
Spanish Castle North Parcel
Douglas County, Washington

Dear Mr. Lillquist:

In accordance with your instruction, this Critical Area Analysis - Geologic Risk Assessment investigates areas located on and near the Spanish Castle property north of the former boundary of the Columbia Feeders parcel, west of Washington State Sign Route 28 (Figure 1). This land is the property of Big River Investors. It was not included in a previous critical area report prepared for the parcel formerly owned by Columbia Feeders. The westerly portion of the land is vacant and no disturbance is apparent except for some road building and removal of sagebrush. A vineyard is being planted on the easterly portion. Munson Engineers evaluated the potential for the existence of critical areas-geologically hazardous areas at this property on June 24, 2014. This assessment is submitted in accordance with Douglas Code Chapter 19.18D RESOURCE LANDS / CRITICAL AREAS - GEOLOGICALLY HAZARDOUS AREAS.

SITE TOPOGRAPHY

The property occupies a dome shaped terrain of approximately 55 acres. It is bounded on the north by an irrigated orchard parcel, and runs from the westerly margin of Sign Route 28 toward the Columbia River to the west for more than 2000 feet. The westerly portion of the parcel runs along an old railroad grade on which a primitive road has been built.
The contours of the topography map show that the west hillside of the dome is located on two benches that overlook the Columbia River (Figure 2). The benches are separated by slightly steeper terrain falling at about a 20 percent slope (Figure 3). The slope steepens offsite to the south as the river begins a bend toward the east. A portion of the embankment has been excavated to create an access road across the property (Figure 4). The east side of the dome undulates gently toward the highway (Figure 5).

Native grasses predominate as ground cover. Sagebrush has been removed. The slope of the property creates no risk under any of the criteria listed in Douglas County Code Chapter 19.18D.

SOIL CLASSIFICATIONS

The U.S. Department of Agriculture Natural Resources Conservation Service “Soil Survey of Douglas County, Washington” classifies soil types and identifies their properties and characteristics. The soil survey identified five unique soil types on site (Figure 6). The classifications are Pogue cobble fine sandy loam, 0 to 15 percent slopes; Torriorhents, very steep; Cashmere fine sandy loam, 3 to 8 percent slopes; Pogue loam, 8 to 15 percent slopes; and Cashmere fine sandy loam, 0 to 3 percent slopes.

Lower Bench

The lower bench is composed of Pogue cobble fine sandy loam, 0 to 15 percent slopes. Pogue cobble fine sandy loam, 0 to 15 percent slopes is a very deep, somewhat excessively drained soil. It formed in alluvium mixed with loess overlying glacial outwash. The typical surface layer is neutral grayish brown cobble fine sandy loam about 8 inches thick. The subsoil is neutral brown and yellowish brown cobble fine sandy loam about 10 inches thick over a layer of neutral brown and yellowish brown gravelly sandy loam 6 inches thick. The substratum is slightly alkaline very cobbly sand that extends to a depth of 60 inches or more. Permeability is moderately rapid to a depth of about 31 inches and very rapid below that. Available water storage in the profile is very low, about 3.00 inches. Surface runoff is medium, water erosion hazard is moderate and the hazard of soil blowing is moderate. This soil is classified as Hydrologic Soil Group A.

Embankment

The embankment between the upper and lower terraces is diminished at this location. It rises from the lower bench at a slope averaging less than 20 percent. The soil survey classifies the embankment soil material as Torriorhents, very steep.
Torriorthents, very steep are very deep, excessively drained soils on terrace escarpments. They formed in glacial outwash. No one pedon represents this soil, but a common one is a neutral brown gravelly fine sandy loam surface layer 10 inches thick underlain by a neutral very cobbly coarse sand that extends to a depth of 60 inches or more. Texture varies widely within short distances. Permeability is very rapid. Available water storage in the profile is very low, about 1.1 inches. The soil is classified in Hydrologic Soil Group A.

Upper Bench (Dome)

The upper terrace or dome is composed of Cashmere fine sandy loam, 3 to 8 percent slopes. There is a depression on the southeast side of the dome that leads to a drainage channel further down the hillside but is not developed enough contribute as an intermittent stream. The soil type underlying this depression is Pogue loam, 8 to 15 percent slopes. Rising up to Sign Route 97 to the east is a ribbon of Cashmere fine sandy loam, 0 to 3 percent slopes.

Cashmere fine sandy loam, 3 to 8 percent slopes is a very deep well drained soil located on terraces. It formed in glaciofluvial deposits. Typically the surface layer is neutral brown fine sandy loam about 11 inches thick. The subsoil is neutral pale brown fine sandy loam about 13 inches thick, and the substratum is slightly alkaline pale brown fine sandy loam to a depth of 60 inches or more. Permeability of this Cashmere soil is moderately rapid. Available water storage in the profile is moderate, about 8.1 inches. Surface runoff is medium, and the water erosion hazard is moderate. The hazard of blowing soil is high. To reduce soil blowing, care should be taken not to leave areas of this soil unprotected. The soil is classified in Hydrologic Soil Group A.

Pogue loam, 8 to 15 percent slopes is a very deep, somewhat excessively drained soil located mainly on terraces. It formed in loess over glacial outwash. Individual areas of this soil are somewhat oblong in shape. Typically, the surface layer is neutral brown loam about 18 inches thick. The subsoil is neutral brown gravelly loam about 7 inches thick. The substratum is slightly alkaline very cobbly sand to a depth of 60 inches or more. Depth to the sand ranges from 20 to 40 inches. Permeability of this Pogue soil is moderately rapid to a depth of about 25 inches and very rapid below that. Available water storage in the profile is low, about 3.6 inches. The surface runoff is medium, and the hazard of water erosion is moderate. The soil is classified in Hydrologic Soil Group B.

Cashmere fine sandy loam, 0 to 3 percent slopes is a very deep well drained soil located on terraces. It formed in glaciofluvial deposits. Typically the surface layer is neutral brown fine sandy loam about 11 inches thick. The subsoil is neutral pale brown fine sandy loam about 13 inches thick, and the substratum is slightly alkaline pale brown fine
sandy loam to a depth of 60 inches or more. Permeability of this Cashmere soil is moderately rapid. Available water storage in the profile is moderate, about 8.1 inches. Surface runoff is very slow, and the water erosion hazard is slight. The surface layer is very friable and easily tilled. The soil is classified in Hydrologic Soil Group A.

PROPOSED IMPROVEMENTS

The upper portion of the dome and the land to the east of it is being planted as a vineyard (Figure 5). Use will consist of access and amenities necessary to plant, grow, nurture and harvest the crop. Water pipes to provide irrigation to the vineyard are part of the improvements. A road network to access to the vineyard ties in to Spanish Castle Road.

The remainder of the property will remain in a substantially natural grassland status. Roads will be located for access and fire protection, and varieties of plants will be monitored for weed control and unwanted species purposes.

CONCLUSIONS

The site has no limitations related to slope stability. The soils are permeable. No drainage channel or surface anomaly was observed at the site.

The site shows no evidence of erosive activity since its formation. The susceptibility of the soils to erosion is moderate or less. Storm water control should be incorporated into future road design to mitigate concentration of overland flow.

Although the site is in a lightly inhabited agricultural area, provisions should be made to control dust that may be generated if ground cover is removed.

Development and accompaniments will have no significant impact on the soils and slopes on the site or surrounding the site in terms of landslide potential and erosion potential if construction is performed in accordance with applicable statutes, codes and ordinances. The proposed construction will not significantly change the hydraulic or hydrologic characteristics of the site. The lack of evidence of past erosive events indicates future erosion is improbable. In the absence of an exceptional climatic or geologic event, or significant change in the land use or hydrologic characteristics from those that currently exist or are anticipated by the proposed improvements, this site should bear a “no risk” classification in accordance with the designations of Douglas County Code Chapter 19.18D.020B.
Sincerely,

Robert H. Culp, P.E.
MUNSON ENGINEERS, INC.
Sincerely,

Robert H. Culp, P.E.
MUNSON ENGINEERS, INC.
Figure 4 - Access Road Crossing Parcel Showing Sandy Loam Soil
Douglas County, Washington

266—Pogue cobbly fine sandy loam, 0 to 15 percent slopes

Map Unit Setting
- Elevation: 600 to 1,400 feet
- Mean annual precipitation: 9 to 10 inches
- Mean annual air temperature: 49 to 51 degrees F
- Frost-free period: 140 to 190 days

Map Unit Composition
- Pogue and similar soils: 85 percent
- Minor components: 15 percent

Description of Pogue

Setting
- Landform: Terraces
- Landform position (three-dimensional): Tread
- Parent material: Alluvium mixed with loess over glacial outwash

Typical profile
- H1 - 0 to 8 inches: neutral, cobbly fine sandy loam
- H2 - 8 to 18 inches: neutral, cobbly fine sandy loam
- H3 - 18 to 24 inches: neutral, gravelly sandy loam
- H4 - 24 to 60 inches: slightly alkaline, very cobbly sand

Properties and qualities
- Slope: 0 to 15 percent
- Depth to restrictive feature: 20 to 35 inches to strongly contrasting textural stratification
- Natural drainage class: Somewhat excessively drained
- Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
- Depth to water table: More than 30 inches
- Frequency of flooding: None
- Frequency of ponding: None
- Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
- Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups
- Farmland classification: Farmland of unique importance
- Land capability classification (irrigated): 4e
- Land capability classification (nonirrigated): 3e
- Hydrologic Soil Group: A
- Ecological site: SANDY 10-16 PZ (R008XY501WA)

Minor Components

Quincy
- Percent of map unit: 5 percent
Map Unit Description: Pogue cobbly fine sandy loam, 0 to 15 percent slopes—Douglas County, Washington

Spanish Castle

Pogue, stony surface
  Percent of map unit: 5 percent

Burbank
  Percent of map unit: 3 percent

Cashmere
  Percent of map unit: 1 percent

Magallon
  Percent of map unit: 1 percent

Data Source Information

Soil Survey Area: Douglas County, Washington
Survey Area Data: Version 14, Dec 18, 2013
Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.
Soils that have profiles that are almost alike make up a soil series. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, storiness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into soil phases. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A complex consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An association is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An undifferentiated group is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include miscellaneous areas. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Douglas County, Washington

427—Torriorthents, very steep

Map Unit Setting

Elevation: 600 to 1,800 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 49 to 51 degrees F
Frost-free period: 140 to 160 days

Map Unit Composition
Torriorthents and similar soils: 90 percent
Minor components: 10 percent
Description of Torriorthents

Setting

Landform: Terraces
Landform position (three-dimensional): Riser
Parent material: Glacial outwash

Typical profile

H1 - 0 to 10 inches: neutral, gravely fine sandy loam
H2 - 10 to 60 inches: neutral, very cobbly coarse sand

Properties and qualities

Slope: 25 to 65 percent
Depth to restrictive feature: 10 to 14 inches to strongly contrasting textural stratification
Natural drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.1 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7a
Hydrologic Soil Group: A
Ecological site: SANDY 10-16 PZ (R008XY801WA)

Minor Components

Quincy
Percent of map unit: 5 percent

Pogue
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Douglas County, Washington
Survey Area Data: Version 14, Dec 18, 2013
Douglas County, Washington

80—Cashmere fine sandy loam, 3 to 8 percent slopes

Map Unit Setting
- Elevation: 700 to 1,400 feet
- Mean annual precipitation: 8 to 10 inches
- Mean annual air temperature: 49 to 51 degrees F
- Frost-free period: 145 to 190 days

Map Unit Composition
- Cashmere and similar soils: 85 percent
- Minor components: 15 percent

Description of Cashmere

Setting
- Landform: Terraces
- Landform position (three-dimensional): Tread
- Parent material: Glaciofluvial deposits

Typical profile
- H1 - 0 to 11 inches: neutral, fine sandy loam
- H2 - 11 to 24 inches: neutral, fine sandy loam
- H3 - 24 to 60 inches: slightly alkaline, fine sandy loam

Properties and qualities
- Slope: 3 to 8 percent
- Depth to restrictive feature: More than 80 inches
- Natural drainage class: Well drained
- Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
- Depth to water table: More than 80 inches
- Frequency of flooding: None
- Frequency of ponding: None
- Calcium carbonate, maximum in profile: 5 percent
- Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
- Sodium adsorption ratio, maximum in profile: 5.0
- Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups
- Farmland classification: Farmland of statewide importance
- Land capability classification (irrigated): 3e
- Land capability classification (nonirrigated): 3e
- Hydrologic Soil Group: A
- Ecological site: DRY LOAMY 10-16 PZ (RC08XY101WA)

Minor Components

Magallon
- Percent of map unit: 5 percent
Map Unit Description: Cashmere fine sandy loam, 3 to 8 percent slopes—Douglas County, Washington

Cashmere, steeper sloping
Percent of map unit: 5 percent

Pogue
Percent of map unit: 3 percent

Quincy
Percent of map unit: 2 percent

Data Source Information

Soil Survey Area: Douglas County, Washington
Survey Area Data: Version 14, Dec 18, 2013
Douglas County, Washington

270—Pogue loam, 8 to 15 percent slopes

Map Unit Setting
Elevation: 600 to 1,400 feet
Mean annual precipitation: 9 to 10 inches
Mean annual air temperature: 49 to 51 degrees F
Frost-free period: 140 to 190 days

Map Unit Composition
Pogue and similar soils: 85 percent
Minor components: 15 percent

Description of Pogue
Setting
Landform: Terraces
Landform position (three-dimensional): Riser
Parent material: Loess over glacial outwash

Typical profile
H1 - 0 to 18 inches: neutral, loam
H2 - 18 to 25 inches: neutral, gravelly loam
H3 - 25 to 60 inches: slightly alkaline, very cobby sand

Properties and qualities
Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 35 inches to strongly contrasting textural stratification
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups
Farmland classification: Farmland of unique importance
Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: CLAYEY 9-15 PZ (R008XY303WA)

Minor Components
Cheviot
Percent of map unit: 5 percent

Pogue, steeper sloping
Percent of map unit: 5 percent
Cashmere  
Percent of map unit: 3 percent

Magallon  
Percent of map unit: 2 percent

Data Source Information

Soil Survey Area: Douglas County, Washington
Survey Area Data: Version 14, Dec 18, 2013
Douglas County, Washington

79—Cashmere fine sandy loam, 0 to 3 percent slopes

Map Unit Setting
   Elevation: 700 to 1,400 feet
   Mean annual precipitation: 9 to 10 inches
   Mean annual air temperature: 49 to 51 degrees F
   Frost-free period: 145 to 190 days

Map Unit Composition
   Cashmere and similar soils: 85 percent
   Minor components: 15 percent

Description of Cashmere

Setting
   Landform: Terraces
   Landform position (three-dimensional): Tread
   Parent material: Glaciofluvial deposits

Typical profile
   H1 - 0 to 11 inches: neutral, fine sandy loam
   H2 - 11 to 24 inches: neutral, fine sandy loam
   H3 - 24 to 60 inches: slightly alkaline, fine sandy loam

Properties and qualities
   Slope: 0 to 3 percent
   Depth to restrictive feature: More than 80 inches
   Natural drainage class: Well drained
   Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
   Depth to water table: More than 80 inches
   Frequency of flooding: None
   Frequency of ponding: None
   Calcium carbonate, maximum in profile: 5 percent
   Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
   Sodium adsorption ratio, maximum in profile: 5.0
   Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups
   Farmland classification: Prime farmland if irrigated
   Land capability classification (irrigated): 2e
   Land capability classification (nonirrigated): 3c
   Hydrologic Soil Group: A
   Ecological site: DRY LOAMY 10-16 PZ (R008XY101WA)

Minor Components

   Magallon
   Percent of map unit: 7 percent
Cashmere, steeper sloping
Percent of map unit: 5 percent

Pogue
Percent of map unit: 3 percent

Data Source Information

Soil Survey Area: Douglas County, Washington
Survey Area Data: Version 14, Dec 18, 2013