Geotechnical Investigation

and

Geologic Landslide Hazard Assessment

Proposed Single-Family Residential Home Site

Tax Lot No. 300

4th Avenue and Ganong Street

Oregon City (Clackamas County), Oregon

for

Iselin Architects

Project No. 1477.003.G
December 6, 2017
January 6, 2017

Mr. Todd Iselin
Iselin Architects
1307 Seventh Street
Oregon City, Oregon 97045

Dear Mr. Iselin:

Re: Geotechnical Investigation and Geologic Landslide Hazard Assessment, Proposed Single-Family Residential Home Site, Tax Lot No. 300, 4th Avenue and Ganong Street, Oregon City (Clackamas County), Oregon

Submitted herewith is our report entitled “Geotechnical Investigation and Geologic Landslide Hazard Assessment, Proposed Single-Family Residential Home Site, Tax Lot No. 300, 4th Avenue and Ganong Street, Oregon City (Clackamas County), Oregon”. The scope of our services was outlined in our formal proposal to Mr. Todd Iselin dated October 24, 2016. Written authorization of our services was provided by Mr. Todd Iselin on November 1, 2016.

During the course of our investigation, we have kept you and/or others advised of our schedule and preliminary findings. We appreciate the opportunity to assist you with this phase of the project. Should you have any questions regarding this report, please do not hesitate to call.

Sincerely,

Daniel M. Redmond, P.E., G.E.
President/Principal Engineer
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**Redmond Geotechnical Services**
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INTRODUCTION

Redmond Geotechnical Services, LLC is pleased to submit to you the results of our Geotechnical Investigation and Geologic Landslide Hazard Assessment at the site of the proposed new single-family residential home located to the east of the intersection of 4th Avenue and Ganong Street in Oregon City (Clackamas County), Oregon. The general location of the subject site is shown on the Site Vicinity Map, Figure No. 1. The purpose of our geotechnical investigation and geologic landslide hazard study services at this time was to explore the existing subsurface soils and/or groundwater conditions across the subject site and to evaluate any potential concerns with regard to past and/or current landslide activity at the site as well as to develop and/or provide appropriate geotechnical design and construction recommendations for the proposed new single-family residential development project.

PROJECT DESCRIPTION

We understand that present plans are to develop the subject property into a new single-family residential home. Based on a review of the proposed site development plan, we understand that the proposed new residential project will consist of the construction of a new single-family residential home with a base footprint of about 1,000 square feet (see Site Exploration Plan, Figure No. 2). The new residential home is anticipated to be a two-story structure constructed with wood framing and a raised wooden post and beam floor system. Additionally, we understand that development of the site will also include the construction of an approximate 400 to 500 square feet detached wood-frame garage. Support of the new residential and/or detached garage structure is anticipated to consist primarily of conventional shallow strip (continuous) footings although some individual (column) footings may also be required. Structural loading information, although unavailable at this time, is anticipated to be fairly typical and light for this type of wood-frame single-family residential structure and is expected to result in maximum dead plus live continuous (strip) and individual (column) footing loads on the order of about 1.5 to 2.5 kips per lineal foot (klf) and 10 to 30 kips, respectively.

Although a site grading plan is not available at this time, we understand that only minor cuts and/or fills are presently planned for the residential project. In general, relatively minor cuts and/or fills (i.e., 5-feet or less) will be required across the proposed residential home site.
In this regard, due to the existing sloping site and/or finish grades as well as the proposed use of a raised wooden post and beam floor system, the proposed new single-family residential structure will not likely include the construction of any partial below grade floor(s) and/or retaining wall(s). However, due to the anticipated use of a concrete slab-on-grade floor within the proposed detached garage, we anticipate that a small concrete retaining wall will likely be required along the rear and/or southerly upslope portion of the garage structure.

Other associated site improvements for the project will include construction of a new gravel and/or paved private access drive extending southward off of 4th Avenue. Additionally, the project will include the construction of new underground utility services as well as the construction of an approximate four (4) feet high rockery wall to the south of the proposed single-family residential home.

**SCOPE OF WORK**

The purpose of our geotechnical and/or geologic studies was to evaluate the overall subsurface soil and/or groundwater conditions underlying the subject site with regard to the proposed new single-family residential development and construction at the site and any associated impacts or concerns with respect to existing and/or previous landslide activity at the site as well as provide appropriate geotechnical design and construction recommendations for the project. Specifically, our geotechnical investigation and landslide hazard study performed as a collaboration with Northwest Geological Services, Inc. (NWGS, Inc.) included the following scope of work items:

1. Review of available and relevant geologic and/or geotechnical investigation reports for the subject site and/or area including a previous Geotechnical Investigation and Geologic Hazard Report for the subject property prepared by PBS Engineering and Environmental and dated March 29, 2007.

2. A detailed field reconnaissance and subsurface exploration program of the soil and groundwater conditions underlying the site by means of three (3) exploratory test pit excavations. The exploratory test pits were excavated to depths ranging from about five (5) to ten (10) feet beneath existing site grades at the approximate locations as shown on the Site Exploration Plan, Figure No. 2.

3. Laboratory testing to evaluate and identify pertinent physical and engineering properties of the subsurface soils encountered relative to the planned site development and construction at the site. The laboratory testing program included tests to help evaluate the natural (field) moisture content and dry density, maximum dry density and optimum moisture content, gradational characteristics and Atterberg Limits as well as direct shear strength tests.
4. A literature review and engineering evaluation and assessment of the regional seismicity to evaluate the potential ground motion hazard(s) at the subject site. The evaluation and assessment included a review of the regional earthquake history and sources such as potential seismic sources, maximum credible earthquakes, and reoccurrence intervals as well as a discussion of the possible ground response to the selected design earthquake(s), fault rupture, landsliding, liquefaction, and tsunami and seiche flooding.

5. Engineering analyses utilizing the field and laboratory data as a basis for furnishing recommendations for foundation support of the proposed new residential and/or detached garage structure(s). Recommendations include maximum design allowable contact bearing pressure(s), depth of footing embedment, estimates of foundation settlement, lateral soil resistance, and foundation subgrade preparation. Additionally, construction and/or permanent subsurface water drainage considerations have also been prepared. Further, our report includes recommendations regarding site preparation, placement and compaction of structural fill materials, suitability of the on-site soils for use as structural fill, criteria for import fill materials, and preparation of foundation, pavement and/or floor slab subgrades.

SITE CONDITIONS

Site Geology

The subject site and/or area is underlain by highly weathered Basalt bedrock deposits and/or residual soils of the Columbia River Basalt formation. A more detailed description of the site geology across and/or beneath the site is presented in the Geologic Hazard Study in Appendix B.

Surface Conditions

The subject proposed new residential development property consists of Tax Lot No. 300 which is a rectangular shaped (100 feet by 100 feet) tax lot encompassing a plan area of approximately 0.23 acres. The proposed residential development property is roughly located to the south of 4th Avenue and/or west of the intersection with Ganong Street. The subject site is unimproved and consists of existing open land. Surface vegetation across the site generally consists of a moderate growth of grass, weeds and brush as well as several to numerous small to large sized trees.

Topographically, the subject site is characterized as moderately sloping terrain (i.e., 25 to 30 percent) descending downward towards the north/northwest with overall topographic relief across the entire site estimated at about thirty (30) feet and ranges from a low about Elevation 195 feet near the northeasterly corner of the subject site to a high of about Elevation 225 near the southeasterly portion of the site.
Subsurface Soil Conditions

Our understanding of the subsurface soil conditions underlying the site was developed by means of three (3) exploratory test pits excavated to depths ranging from about five (5) to ten (10) feet beneath existing site grades on December 1, 2016 with a John Deere track-mounted excavator. The location of the exploratory test pits were located in the field by marking off distances from existing and/or known site features and are shown in relation to the proposed new residential structure and/or site improvements on the Site Exploration Plan, Figure No. 2. Detailed logs of the test pit explorations, presenting conditions encountered at each location explored, are presented in the Appendix, Figure No’s. A-4 and A-5.

The exploratory test pit excavations were observed by staff from Redmond Geotechnical Services, LLC who logged each of the test pit explorations and obtained representative samples of the subsurface soils encountered across the site. Additionally, the elevation of the exploratory test pit excavations were referenced from the proposed Site Development Plan prepared by Iselin Architects and should be considered as approximate. All subsurface soils encountered at the site and/or within the exploratory test pit excavations were logged and classified in general conformance with the Unified Soil Classification System (USCS) which is outlined on Figure No. A-3.

The test pit explorations revealed that the subject site is underlain by native soil deposits comprised of highly weathered bedrock and/or residual soils composed of a surficial layer of dark brown, very moist to wet, soft to very soft, organic to highly organic, clayey, sandy silt topsoil materials to depths of about 12 inches. These surficial topsoil materials were in turn underlain by medium to light orangish-brown, very moist, medium stiff to loose becoming stiff to medium dense at depth, clayey, sandy silt to silty sand to a depth of about eight (8) to nine (9) feet beneath the existing site and/or surface grades. These upper clayey, sandy silt to silty sand subgrade soils contain some rock fragments and cobbles to boulder size and are best characterized by relatively low to moderate strength and moderate compressibility. These upper clayey, sandy silt to silty sand subgrade soils were in turn underlain by gray, very dense, slightly weathered and fractured Basalt bedrock deposits to the maximum depth explored of about ten (10) feet beneath the existing site and/or surface grades. These slightly weathered and fractured Basalt bedrock deposits are best characterized by relatively moderate to high strength and low to very low compressibility.

Groundwater

Groundwater was generally not encountered within any of the exploratory test pit explorations (TH-#1 through TH-#3) at the time of excavation to depths of at least ten (10) feet beneath existing surface grades. However, an existing seasonal drainage basin and/or feature is located to the east/northeast of the subject property. Additionally, although ponding of surface water was generally not present across the site at the time of our field work, the presence of the clayey, sandy silt to silty sand soils beneath the site is generally believed to be associated with very low infiltration rates of the area.
EXISTING STONE WALL TO REMAIN

LEGEND

TH-#3 Indicates approximate location of exploratory test hole

Approximate Scale: 1" = 18'

SITE EXPLORATION PLAN

TAX LOT NO. 300

4TH AVENUE & GANONG STREET

Figure No. 2
In this regard, although groundwater elevations at the site may fluctuate seasonally in accordance with rainfall conditions and/or associated with runoff of the westerly drainage basin as well as changes in site utilization, we are generally of the opinion that the static water levels and/or surface water ponding not observed during our recent field exploration work generally reflect a low seasonal groundwater level(s) at and/or beneath the site.

LABORATORY TESTING

Representative samples of the on-site subsurface soils were collected at selected depths and intervals from various test pit excavations and returned to our laboratory for further examination and testing and/or to aid in the classification of the subsurface soils as well as to help evaluate and identify their engineering strength and compressibility characteristics. The laboratory testing consisted of visual and textural sample inspection, moisture content and dry density determinations, maximum dry density and optimum moisture content, gradation analyses and Atterberg Limits as well as (undisturbed) direct shear strength tests. Results of the various laboratory tests are presented in the Appendix, Figure No's. A-6 through A-8.

SEISMICITY AND EARTHQUAKE SOURCES

The seismicity of the southwest Washington and northwest Oregon area, and hence the potential for ground shaking, is controlled by three separate fault mechanisms. These include the Cascadia Subduction Zone (CSZ), the mid-depth intraplate zone, and the relatively shallow crustal zone. Descriptions of these potential earthquake sources are presented below.

The CSZ is located offshore and extends from northern California to British Columbia. Within this zone, the oceanic Juan de Fuca Plate is being subducted beneath the continental North American Plate to the east. The interface between these two plates is located at a depth of approximately 15 to 20 kilometers (km). The seismicity of the CSZ is subject to several uncertainties, including the maximum earthquake magnitude and the recurrence intervals associated with various magnitude earthquakes. Anecdotal evidence of previous CSZ earthquakes has been observed within coastal marshes along the Washington and Oregon coastlines. Sequences of interlayered peat and sands have been interpreted to be the result of large Subduction zone earthquakes occurring at intervals on the order of 300 to 500 years, with the most recent event taking place approximately 300 years ago. A study by Geomatrix (1995) and/or USGS (2008) suggests that the maximum earthquake associated with the CSZ is moment magnitude (Mw) 8 to 9. This is based on an empirical expression relating moment magnitude to the area of fault rupture derived from earthquakes that have occurred within Subduction zones in other parts of the world. An Mw 9 earthquake would involve a rupture of the entire CSZ. As discussed by Geomatrix (1995) this has not occurred in other subduction zones that have exhibited much higher levels of historical seismicity than the CSZ. However, the 2008 USGS report has assigned a probability of 0.67 for a Mw 9 earthquake and a probability of 0.33 for a Mw 8.3 earthquake. For the purpose of this study an earthquake of Mw 9.0 was assumed to occur within the CSZ.
The intraplate zone encompasses the portion of the subducting Juan de Fuca Plate located at a depth of approximately 30 to 50 km below western Washington and western Oregon. Very low levels of seismicity have been observed within the intraplate zone in western Oregon and western Washington. However, much higher levels of seismicity within this zone have been recorded in Washington and California. Several reasons for this seismic quiescence were suggested in the Geomatrix (1995) study and include changes in the direction of Subduction between Oregon, Washington, and British Columbia as well as the effects of volcanic activity along the Cascade Range. Historical activity associated with the intraplate zone includes the 1949 Olympia magnitude 7.1 and the 1965 Puget Sound magnitude 6.5 earthquakes. Based on the data presented within the Geomatrix (1995) report, an earthquake of magnitude 7.25 has been chosen to represent the seismic potential of the intraplate zone.

The third source of seismicity that can result in ground shaking within the Vancouver and southwest Washington area is near-surface crustal earthquakes occurring within the North American Plate. The historical seismicity of crustal earthquakes in this area is higher than the seismicity associated with the CSZ and the intraplate zone. The 1993 Scotts Mills (magnitude 5.6) and Klamath Falls (magnitude 6.0), Oregon earthquakes were crustal earthquakes.

**Liquefaction**

Seismic induced soil liquefaction is a phenomenon in which loose, granular soils and some silty soils, located below the water table, develop high pore water pressures and lose strength due to ground vibrations induced by earthquakes. Soil liquefaction can result in lateral flow of material into river channels, ground settlements and increased lateral and uplift pressures on underground structures. Buildings supported on soils that have liquefied often settle and tilt and may displace laterally. Soils located above the ground water table cannot liquefy, but granular soils located above the water table may settle during the earthquake shaking.

Our review of the subsurface soil test pit logs from our exploratory field explorations (TH-#1 through TH-#3) and laboratory test results indicate that the site is generally underlain by medium stiff to stiff and/or loose to medium dense, clayey, sandy silt to silty sand soils and/or very dense, slightly weathered and fractured basalt bedrock deposits to depths of at least 10.0 feet beneath existing site grades. Additionally, groundwater was generally not encountered within any of the exploratory test pit excavations (TH-#1 through TH-#3) at the site during our field exploration work to depths of at least 10.0 feet.

As such, due to the medium stiff to stiff and/or cohesive nature of the clayey, sandy silt subgrade soils and/or the very dense characteristics of the slightly weathered and fractured basalt bedrock deposits beneath the site, it is our opinion that the native clayey, sandy silt to silty sand subgrade soils and/or slightly weathered and fractured basalt bedrock deposits located beneath the subject site have a very low potential for liquefaction during the design earthquake motions previously described.
Landslides

Although the subject property is located within a large ancient landslide deposit, no active landslides were observed or are known to be present on the subject site. Additionally, development of the subject site into the planned residential home site does not appear to present a potential and/or serious geologic and/or landslide hazard risk provided that the site grading and development activities conform with the recommendations presented within this report. A more detailed assessment of the potential landslide hazard of the subject site is presented in the Geologic Hazard Study in Appendix B.

Surface Rupture

Although the site is generally located within a region of the country known for seismic activity, no known faults exist on and/or immediately adjacent to the subject site. As such, the risk of surface rupture due to faulting is considered negligible.

Tsunami and Seiche

A tsunami, or seismic sea wave, is produced when a major fault under the ocean floor moves vertically and shifts the water column above it. A seiche is a periodic oscillation of a body of water resulting in changing water levels, sometimes caused by an earthquake. Tsunami and seiche are not considered a potential hazard at this site because the site is not near to the coast and/or there are no adjacent significant bodies of water.

Flooding and Erosion

Stream flooding is a potential hazard that should be considered in lowland areas of Clackamas County and Oregon City. The FEMA (Federal Emergency Management Agency) flood maps should be reviewed as part of the design for the proposed new residential structures and site improvements. Elevations of structures on the site should be designed based upon consultants reports, FEMA (Federal Emergency Management Agency), and Clackamas County requirements for the 100-year flood levels of any nearby creeks, streams and/or drainage basins.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our field explorations, laboratory testing, and engineering analyses, it is our opinion that the site is presently stable and generally suitable for the proposed new single-family residential development and its associated site improvements provided that the recommendations contained within this report are properly incorporated into the design and construction of the project.
The primary features of concern at the site are 1) the presence of moisture sensitive clayey, sandy silt to silty sand subgrade soils across the site, 2) the presence of moderately sloping site conditions across the subject site, and 3) the relatively low infiltration rates anticipated within the near surface clayey, sandy silt to silty sand subgrade soils.

With regard to the moisture sensitive clayey, sandy silt to silty sand subgrade soils, we are generally of the opinion that all site grading and earthwork activities be scheduled for the drier summer months which is typically June through September.

In regards to the moderately sloping site conditions across the proposed new residential home site, we are of the opinion that site grading and/or structural fill placement should be minimized where possible and should generally limit cuts and/or fills to about five (5) feet or less unless approved by the Geotechnical Engineer. Additionally, where existing site slopes and/or surface grades exceed about 20 percent (1V:5H), proper benching and keying of all fills into the natural site slopes may be required (see Typical Fill Slope Detail, Figure No. 3).

With regard to the relatively low infiltration rates anticipated within the clayey, sandy silt to silty sand subgrade soils beneath the site, we generally do not recommend any concentrated storm water infiltration within structural and/or embankment fills. However, some limited storm water infiltration may be feasible if diffused within the lower northerly portion of the residential lot and/or area of the site where the existing and/or finish slope gradients are no steeper than about 20 percent (1V:5H). In this regard, we recommend that all proposed storm water detention and/or infiltration systems for the project be reviewed and approved by Redmond Geotechnical Services, LLC.

The following sections of this report provide specific recommendations regarding subgrade preparation and grading as well as foundation and floor slab design and construction for the new single-family residential development project.

**Site Preparation**

As an initial step in site preparation, we recommend that the proposed new residential building site and/or lot as well as any associated structural and/or site improvement area(s) be stripped and cleared of any existing improvements, any existing unsuitable and/or undocumented fill materials, surface debris, existing vegetation, topsoil materials, and/or any other deleterious materials present at the time of construction. In general, we envision that the site stripping to remove existing vegetation and topsoil materials will generally be about 12 inches. However, localized areas requiring deeper removals, such as any existing undocumented and/or unsuitable fill materials as well as old tree stump areas, may be encountered and should be evaluated at the time of construction by the Geotechnical Engineer. The stripped and cleared materials should be properly disposed of as they are generally considered unsuitable for use/reuse as fill materials.
Following the completion of the site stripping and clearing work and prior to the placement of any required structural fill materials and/or structural improvements, the exposed subgrade soils within the planned structural improvement area(s) should be inspected and approved by the Geotechnical Engineer. Areas found to be soft or otherwise unsuitable should be over-excavated and removed or scarified and recompacted as structural fill. During wet and/or inclement weather conditions, proof rolling and/or scarification and re-compaction may not be appropriate.

The on-site native clayey, sandy silt to silty sand subgrade soil materials are generally considered suitable for use/reuse as structural fill materials provided that they are free of organic materials, debris, and rock fragments in excess of about 6 inches in dimension. However, if site grading is performed during wet or inclement weather conditions, the use of some of the on-site native soil materials which contain significant silt and clay sized particles will be difficult at best. In this regard, during wet or inclement weather conditions, we recommend that an import structural fill material be utilized which should consist of a free-draining (clean) granular fill (sand & gravel) containing no more than about 5 percent fines. Representative samples of the materials which are to be used as structural fill materials should be submitted to the Geotechnical Engineer and/or laboratory for approval and determination of the maximum dry density and optimum moisture content for compaction.

In general, all site earthwork and grading activities should be scheduled for the drier summer months (June through September) if possible. However, if wet weather site preparation and grading is required, it is generally recommended that the stripping of topsoil materials be accomplished with a tracked excavator utilizing a large smooth-toothed bucket working from areas yet to be excavated. Additionally, the loading of strippings into trucks and/or protection of moisture sensitive subgrade soils will also be required during wet weather grading and construction. In this regard, we recommend that areas in which construction equipment will be traveling be protected by covering the exposed subgrade soils with a geotextile fabric such as Mirafi 140N followed by at least 12 inches or more of crushed aggregate base rock. Further, the geotextile fabric should have a minimum Mullen burst strength of at least 250 pounds per square inch for puncture resistance and an apparent opening size (AOS) between the U.S. Standard No. 70 and No. 100 sieves.

All structural fill materials placed within the new building and/or pavement areas should be moistened or dried as necessary to near (within 3 percent) optimum moisture conditions and compacted by mechanical means to a minimum of 92 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Structural fill materials should be placed in lifts (layers) such that when compacted do not exceed about 8 inches. Additionally, all fill materials placed within three (3) lineal feet of the perimeter (limits) of the proposed residential or detached garage structure and/or access drive should be considered structural fill. Additionally, due to the sloping site conditions, we recommend that all structural fill materials planned in areas where existing surface and/or slope gradients exceed about 20 percent (1V:5H) be properly benched and/or keyed into the native (natural) slope subgrade soils. In general, a bench width of between eight (8) and ten (10) feet and a keyway depth of between one (1) and two (2) feet is generally recommended. However, the actual bench width and keyway depth should be determined at the time of construction by the Geotechnical Engineer.
Further, all fill slopes should be constructed with a finish slope surface gradient no steeper than about 2H:1V. A typical fill slope detail is presented on Figure No. 3. All aspects of the site grading, including a review of the proposed site grading plan(s), should be approved and/or monitored by a representative of Redmond Geotechnical Services, LLC.

**Foundation Support**

Based on the results of our investigation, it is our opinion that the site of the proposed new residential development is suitable for support of the two-story wood-frame residential structure and detached garage provided that the following foundation design recommendations are followed. The following sections of this report present specific foundation design and construction recommendations for the planned new residential and/or garage structure(s).

**Shallow Foundations**

In general, conventional shallow continuous (strip) footings and individual (spread) column footings may be supported by approved native (untreated) sandy silt to silty sand subgrade soil materials and/or sandy silt to silty sand structural fill soils based on an allowable contact bearing pressure of about 2,000 pounds per square foot (psf). This recommended allowable contact bearing pressure is intended for dead loads and sustained live loads and may be increased by one-third for the total of all loads including short-term wind or seismic loads. In general, continuous strip footings should have a minimum width of at least 16 inches and be embedded at least 18 inches below the lowest adjacent finish grade (includes frost protection). Individual column footings (where required) should be embedded at least 18 inches below grade and have a minimum width of at least 24 inches. Additionally, we recommend that all downslope footings for the proposed new single-family residential structure as well as the proposed detached garage be sufficiently embedded such that at least eight (8) feet is developed between the face of the existing and/or finish slope face and the outer bearing edge of the footing element. Further, if foundation excavation and construction work is planned to be performed during wet and/or inclement weather conditions, we recommend that a 3- to 4-inch layer of compacted crushed rock be used to help protect the exposed foundation bearing surfaces until the placement of concrete.

Total and differential settlements of foundations constructed as recommended above and supported by approved native subgrade soils or by properly compacted structural fill materials are expected to be well within the tolerable limits for this type of lightly loaded wood-frame structure and should generally be less than about 1-inch and 1/2-inch, respectively.

Allowable lateral frictional resistance between the base of the footing element and the supporting subgrade bearing soil can be expressed as the applied vertical load multiplied by a coefficient of friction of 0.30 and 0.45 for native silty subgrade soils and/or import gravel fill materials, respectively. In addition, lateral loads may be resisted by passive earth pressures on footings poured "neat" against in-situ (native) subgrade soils or properly backfilled with structural fill materials based on an equivalent fluid density of 250 pounds per cubic foot (pcf).
Structural Fill Placed in Horizontal Lifts and Compacted in Accordance with the Grading Recommendations

Intermediate Bench
Every 10 Vertical Feet
for Fill Slopes in Excess of 15 Feet in Height

Remove Vegetation, Topsoil and Disturbed Soil

4" or 6" Diameter Filter Fabric
Wrapped Perforated Pipe
Bedded in Drain Rock

TYPICAL FILL SLOPE DETAIL
TAX LOT NO. 300
4TH AVENUE & GANONG STREET
Project No. 1477.003.G
Figure No. 3
This recommended value includes a factor of safety of approximately 1.5 which is appropriate due to the amount of movement required to develop full passive resistance.

**Floor Slab Support**

In order to provide uniform subgrade reaction beneath concrete slab-on-grade floors, we recommend that the floor slab area be underlain by a minimum of 6 inches of free-draining (less than 5 percent passing the No. 200 sieve), well-graded, crushed rock. The crushed rock should help provide a capillary break to prevent migration of moisture through the slab. However, additional moisture protection can be provided by using a 10-mil polyolefin geo-membrane sheet such as StegoWrap.

The base course materials should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Where floor slab subgrade materials are undisturbed, firm and stable and where the underslab aggregate base rock section has been prepared and compacted as recommended above, we recommend that a modulus of subgrade reaction of 150 pci be used for design.

**Retaining/Below Grade Walls**

Retaining and/or below grade walls should be designed to resist lateral earth pressures imposed by native soils or granular backfill materials as well as any adjacent surcharge loads. For walls which are unrestrained at the top and free to rotate about their base, we recommend that active earth pressures be computed on the basis of the following equivalent fluid densities:

<table>
<thead>
<tr>
<th>Slope Backfill (Horizontal/Vertical)</th>
<th>Equivalent Fluid Density/Sand (pcf)</th>
<th>Equivalent Fluid Density/Gravel (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>3H:1V</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>2H:1V</td>
<td>90</td>
<td>80</td>
</tr>
</tbody>
</table>

For walls which are fully restrained at the top and prevented from rotation about their base, we recommend that at-rest earth pressures be computed on the basis of the following equivalent fluid densities:

**Restrained Retaining Wall Pressure Design Recommendations**

<table>
<thead>
<tr>
<th>Slope Backfill (Horizontal/Vertical)</th>
<th>Equivalent Fluid Density/Sand (pcf)</th>
<th>Equivalent Fluid Density/Gravel (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>3H:1V</td>
<td>65</td>
<td>60</td>
</tr>
<tr>
<td>2H:1V</td>
<td>95</td>
<td>90</td>
</tr>
</tbody>
</table>
The above recommended values assume that the walls will be adequately drained to prevent the buildup of hydrostatic pressures. Where wall drainage will not be present and/or if adjacent surcharge loading is present, the above recommended values will be significantly higher.

Backfill materials behind walls should be compacted to 90 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Special care should be taken to avoid over-compaction near the walls which could result in higher lateral earth pressures than those indicated herein. In areas within three (3) to five (5) feet behind walls, we recommend the use of hand-operated compaction equipment.

**Rockery Walls**

Based on the results of our field explorations, laboratory testing and engineering analysis as well as our past experience with similar types of rockery walls, we are of the opinion that a rockery wall constructed as recommended herein and to heights no greater than eight (8) feet will have a factor of safety against global instability of at least 1.5. This factor of safety assumes that the rockery wall backfill materials will be free draining and will be compacted to at least 85 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Additionally, it assumes that no building foundations and/or surcharge loads are constructed closer than ten (10) feet to the top of the rockery wall and/or are located behind and/or below a 2H:1V (theoretical) plane projected upward from the base of the rockery wall to the ground surface behind the rockery wall. Further, it assumes that the base of the rockery wall is constructed directly adjacent to and/or above a relatively flat and/or level grade and not above a descending slope.

As such, we recommend that the rockery wall for the project be constructed in accordance with the following details and/or specifications and as shown on the attached Typical Rockery Wall Details, Figure No. 4:

1. Base of rockery shall be embedded into approved native subgrade soils a minimum of at least 12 inches and/or bear directly on approved Basalt bedrock;
2. Rockery shall be constructed with a batter of at least 6V:1H;
3. Backfill slope shall be constructed no steeper than 1V:2H;
4. No rockery shall be constructed higher than eight (8) feet;
5. Wall backfill shall consist of free draining granular materials and/or rock spalls compacted to a minimum of at least 85 percent of ASTM D-1557 (AASHTO T-180), and;
6. No footings of structures shall be constructed within about ten (10) feet to the rockery and/or located within a theoretical 1H:1V plane extended upward from the base of the rockery wall. Additionally, the base of the rockery shall not be constructed directly adjacent to sloping ground and/or a descending slope.
ROCKERY WALL NOTES:

1. Long dimension of the rocks shall extend into earth to provide maximum stability.
2. Rock shall be placed so as to lock into two rocks in the lower tier.
3. Rockeries higher than 5 ft. shall be constructed of rocks graduated from 5 man to 2 man.
4. Rockeries lower than 5 ft shall be constructed of rocks graduated from 3 man to 2 man.
5. No rockery shall be constructed higher than eight (8) feet.
6. Rock used for rockery shall be sound ledge rock free of seams and minimum density of 145 pcf.

ROCK SIZES:

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>MIN. WEIGHT</th>
<th>MAX. WEIGHT</th>
<th>DIMENSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 MAN</td>
<td>300#</td>
<td>800#</td>
<td>13-18</td>
</tr>
<tr>
<td>3 MAN</td>
<td>600#</td>
<td>1500#</td>
<td>18-24</td>
</tr>
<tr>
<td>4 MAN</td>
<td>1500#</td>
<td>2100#</td>
<td>24-32</td>
</tr>
<tr>
<td>5 MAN</td>
<td>2100#</td>
<td>3000#</td>
<td>32-38</td>
</tr>
</tbody>
</table>

TYPICAL ROCKERY WALL DETAILS

TAX LOT NO. 300

4TH AVENUE & GANONG STREET

Figure No. 4
All aspects of the subgrade preparation, placement and compaction of the base course and/or drainage backfill materials as well as the finished rockery wall should be inspected and approved by the Geotechnical Engineer.

Pavements

Flexible pavement design for the proposed private access drive for the single-family residential project was determined on the basis of projected (anticipated) traffic volume and loading conditions relative to an assumed subgrade "R"-value characteristic. Based on an assumed subgrade "R"-value of 30 and using the design procedures contained within the AASHTO 1993 Design of Pavement Structures Manual, a Structural Number (SN) of 2.5 was determined. In this regard, we recommend the following flexible pavement section for the construction of new private access drive:

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Pavement Section (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphaltic Concrete</td>
<td>3.0</td>
</tr>
<tr>
<td>Aggregate Base Rock</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Wet Weather Grading and Soft Spot Mitigation

Construction of the proposed new private access drive is generally recommended during dry weather. However, during wet weather grading and construction, excavation to subgrade can proceed during periods of light to moderate rainfall provided that the subgrade remains covered with aggregate. A total aggregate thickness of 12-inches or more may be necessary to protect the subgrade soils from heavy construction traffic. Construction traffic should not be allowed directly on the exposed subgrade but only atop a sufficient compacted base rock thickness to help mitigate subgrade pumping. If the subgrade becomes wet and pumps, no construction traffic shall be allowed on the access drive alignment. Positive site drainage away from the street shall be maintained if site paving will not occur before the on-set of the wet season.

Depending on the timing for the project, any soft subgrade found during proof-rolling or by visual observations can either be removed and replaced with properly dried and compacted fill soils or removed and replaced with compacted crushed aggregate. However, and where approved by the Geotechnical Engineer, the soft area may be covered with a bi-axial geogrid and covered with compacted crushed aggregate.

Soil Shrink-Swell and Frost Heave

The results of the laboratory tests indicate that the native subgrade soils possess a low expansion potential. As such, the exposed subgrade soils should not be allowed to completely dry and should be moistened to near optimum moisture content (plus or minus 3 percent) at the time of the placement of the crushed aggregate base rock materials. Additionally, exposure of the subgrade soils to freezing weather may result in frost heave and softening of the subgrade.
As such, all subgrade soils exposed to freezing weather should be evaluated and approved by the Geotechnical Engineer prior to the placement of the crushed aggregate base rock materials.

**Excavation/Slopes**

Temporary excavations of up to about five (5) feet in depth may be constructed and/or excavated with inclinations of at least 1 to 1 (horizontal to vertical) or properly braced/shored. Where excavations are planned to exceed about five (5) feet, this office should be consulted. All shoring systems and/or temporary excavation bracing for the project should be the responsibility of the excavation contractor. Permanent cut and/or slopes should be constructed no steeper than about 2H to 1V unless approved by the Geotechnical Engineer.

Depending on the time of year in which trench excavations occur, trench dewatering may be required in order to maintain dry working conditions if the invert elevations of the proposed utilities are located at and/or below the groundwater level. If groundwater is encountered during utility excavation work, we recommend placing trench stabilization materials along the base of the excavation. Trench stabilization materials should consist of 1-foot of well-graded gravel, crushed gravel, or crushed rock with a maximum particle size of 4 inches and less than 5 percent fines passing the No. 200 sieve. The material should be free of organic matter and other deleterious material and placed in a single lift and compacted until well keyed.

**Surface Drainage/Groundwater**

We recommend that positive measures be taken to properly finish grade the site so that drainage waters from the residential structure and landscaping areas as well as adjacent properties or buildings are directed away from the new residential structure foundations and/or floor slabs. All roof drainage should be directed into conduits that carry runoff water away from the residential and/or garage structure(s) to a suitable outfall. Roof downspouts should not be connected to foundation drains. A minimum ground slope of about 2 percent is generally recommended in unpaved areas around the proposed new residential structure and/or detached garage.

Groundwater was not encountered at the site in any of the exploratory test pits (TH-#1 through TH-#3) at the time of excavation to depths of at least 10 feet beneath existing site grades. Additionally, surface water ponding was not observed at the site during our field exploration work. However, an existing seasonal drainage basin feature is located to the east/northeast of the subject property. Further, groundwater elevations in the area and/or across the subject property may fluctuate seasonally and may temporarily pond/perch near the ground surface during periods of prolonged rainfall.

As such, based on our current understand of the possible site grading required to bring the subject site and/or residential building pad to finish design grade(s), we are of the opinion that an underslab drainage system is generally not required for the proposed single-family residential structure.
However, a perimeter foundation drain is recommended for any perimeter footings and/or below grade retaining walls. A typical recommended perimeter footing/retaining wall drain detail is shown on Figure No. 5. Further, due to the relatively low infiltration rates of the near surface clayey, sandy silt and/or silty sand subgrade soils as well as the moisture sensitivity of the site to disposal of storm water in a relatively concentrated area, we are generally of the opinion that storm water detention and/or disposal systems should not be utilized within the residential lot and/or around the proposed residential structure unless it consists of a diffusion type system approved by the Geotechnical Engineer.

**Seismic Design Considerations**

Structures at the site should be designed to resist earthquake loading in accordance with the methodology described in the latest edition (2014) of the State of Oregon Structural Specialty Code (OSSC) and/or Amendments to the 2015 International Building Code (IBC). The maximum considered earthquake ground motion for short period and 1.0 period spectral response may be determined from the Oregon Structural Specialty Code and/or from the National Earthquake Hazard Reduction Program (NEHRP) “Recommended Provisions for Seismic Regulations for New Buildings and Other Structures” published by the Building Seismic Safety Council. We recommend Site Class “C” be used for design. Using this information, the structural engineer can select the appropriate site coefficient values (Fa and Fv) from the 2015 IBC to determine the maximum considered earthquake spectral response acceleration for the project. However, we have assumed the following response spectrum for the project:

**Table 1. Recommended Seismic Design Parameters**

<table>
<thead>
<tr>
<th>Site Class</th>
<th>Ss</th>
<th>S1</th>
<th>Fa</th>
<th>Fv</th>
<th>S_{MS}</th>
<th>S_{M1}</th>
<th>S_{DS}</th>
<th>S_{D1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.933</td>
<td>0.403</td>
<td>1.027</td>
<td>1.397</td>
<td>0.958</td>
<td>0.563</td>
<td>0.639</td>
<td>0.375</td>
</tr>
</tbody>
</table>

Notes: 1. Ss and S1 were established based on the USGS 2015 mapped maximum considered earthquake spectral acceleration maps for 2% probability of exceedence in 50 years.

2. Fa and Fv were established based on IBC 2015 tables using the selected Ss and S1 values.
Underslab drain 5' from wall line

Asphalt or landscaping soil as required (slope surface to drain) – see Note 3

6" seal of compacted native soil (landscaped areas only)

General Backfill

Chimney Drainage Zone

12" minimum cover over pipe, 6" minimum cover over footing

Filter Fabric

Drain Gravel

Preferred Perforated Drain Pipe Location

12" min.

NOTES:

1. Filter Fabric to be non-woven geotextile (Amoco 4545, Mirafi 140N, or equivalent)

2. Lay perforated drain pipe on minimum 0.5% gradient, widening excavation as required. Maintain pipe above 2:1 slope, as shown.

3. All-granular backfill is recommended for support of slabs, pavements, etc. (see text for structural fill).

4. Drain gravel to be clean, washed ¾" to 1¾" gravel.

5. General backfill to be on-site gravels, or ¾"-0 or 1¾"-0 crushed rock compacted to 92% Modified Proctor (AASHTO T-180).

6. Chimney drainage zone to be 12" wide (minimum) zone of clean washed, medium to coarse sand or drain gravel if protected with filter fabric. Alternatively, prefabricated drainage structures (Miradrain 6000 or similar) may be used.
CONSTRUCTION MONITORING AND TESTING

We recommend that Redmond Geotechnical Services, LLC be retained to provide construction monitoring and testing services during all earthwork operations for the proposed new residential project. The purpose of our monitoring services would be to confirm that the site conditions reported herein are as anticipated, provide field recommendations as required based on the actual conditions encountered, document the activities of the grading contractor and assess his/her compliance with the project specifications and recommendations. It is important that our representative meet with the contractor prior to any site grading to help establish a plan that will minimize costly over-excavation and site preparation work. Of primary importance will be observations made during site preparation and stripping, structural fill placement, footing excavations and construction as well as retaining wall backfill.

CLOSURE AND LIMITATIONS

This report is intended for the exclusive use of the addressee and/or their representative(s) to use to design and construct the proposed new single-family residential and/or detached garage structure(s) and their associated site improvements described herein as well as to prepare any related construction documents. The conclusions and recommendations contained in this report are based on site conditions as they presently exist and assume that the explorations are representative of the subsurface conditions between the explorations and/or at other locations across the study area. The data, analyses, and recommendations herein may not be appropriate for other structures and/or purposes. We recommend that parties contemplating other structures and/or purposes contact our office. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. Additionally, the above recommendations are contingent on Redmond Geotechnical Services, LLC being retained to provide all site inspections and construction monitoring services for this project. Redmond Geotechnical Services, LLC will not assume any responsibility and/or liability for any engineering judgment, inspection and/or testing services performed by others.

It is the owners/developers responsibility for insuring that the project designers and/or contractors involved with this project implement our recommendations into the final design plans, specifications and/or construction activities for the project. Further, in order to avoid delays during construction, we recommend that the final design plans and specifications for the project be reviewed by our office to evaluate as to whether our recommendations have been properly interpreted and incorporated into the project.

If during any future site grading and construction, subsurface conditions different from those encountered in the explorations are observed or appear to be present beneath excavations, we should be advised immediately so that we may review these conditions and evaluate whether modifications of the design criteria are required. We also should be advised if significant modifications of the proposed site development are anticipated so that we may review our conclusions and recommendations.
LEVEL OF CARE

The services performed by the Geotechnical Engineer for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in the area under similar budget and time restraints. No warranty or other conditions, either expressed or implied, is made.
REFERENCES


Geologic Map Series (GMS-119), Geologic Map of the Oregon City 7.5 Quadrangle, Clackamas County, Oregon dated 2009.


Appendix "A"
Test Pit Logs and Laboratory Test Data
APPENDIX

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATION

Subsurface conditions at the site were explored by excavating three (3) exploratory test pits (TH-#1 through TH-#3) on December 1, 2016. The approximate location of the test pit explorations are shown in relation to the proposed new residential and/or detached garage structure(s) and the associated site improvements on the Site Exploration Plan, Figure No. 2.

The test pits were excavated using track-mounted excavating equipment in general conformance with ASTM Methods in Vol. 4.08, D-1586-94 and D-1587-83. The test pits were excavated to depths ranging from about 5.0 to 10.0 feet beneath existing site grades. Detailed logs of the test pits are presented on the Log of Test Pits, Figure No’s. A-4 and A-5. The soils were classified in accordance with the Unified Soil Classification System (USCS), which is outlined on Figure No. A-3.

The exploration program was coordinated by a field engineer who monitored the excavating and exploration activity, obtained representative samples of the subsurface soils encountered, classified the soils by visual and textural examination, and maintained continuous logs of the subsurface conditions. Disturbed and/or undisturbed samples of the subsurface soils were obtained at appropriate depths and/or intervals and placed in plastic bags and/or with a thin walled ring sample.

Groundwater was not encountered in any of the exploratory test pits (TH-#1 through TH-#3) at the time of excavating to depths of at least 10.0 feet beneath existing surface grades.

LABORATORY TESTING

Pertinent physical and engineering characteristics of the soils encountered during our subsurface investigation were evaluated by a laboratory testing program to be used as a basis for selection of soil design parameters and for correlation purposes. Selected tests were conducted on representative soil samples. The program consisted of tests to evaluate the existing (in-situ) moisture-density, maximum dry density and optimum moisture content, gradational characteristics, and Atterberg Limits as well as direct shear strength tests.

Dry Density and Moisture Content Determinations

Density and moisture content determinations were performed on both disturbed and relatively undisturbed samples from the test pit explorations in general conformance with ASTM Vol. 4.08 Part D-216. The results of these tests were used to calculate existing overburden pressures and to correlate strength and compressibility characteristics of the soils. Test results are shown on the test pit logs at the appropriate sample depths.
Maximum Dry Density

One (1) Maximum Dry Density and Optimum Moisture Content test was performed on a representative samples of the near surface clayey, sandy silt to silty sand subgrade soils in accordance with ASTM Vol. 4.08 Part D-1557. The test results were conducted to help establish various engineering and/or strength properties. The test results are presented on Figure No. A-6.

Atterberg Limits

One (1) Liquid Limit (LL) and Plastic Limit (PL) test was performed on a representative sample of the sandy, clayey silt subgrade soils in accordance with ASTM Vol. 4.08 Part D-4318-85. These tests were conducted to facilitate classification of the soils and for correlation purposes. The test results appear on Figure No. A-7.

Gradation Analysis

One (1) Gradation analyses was performed on a representative sample of the subsurface soils in accordance with ASTM Vol. 4.08 Part D-422. The test results were used to classify the soil in accordance with the Unified Soil Classification System (USCS). The test results are shown graphically on Figure No. A-8.

Direct Shear Strength Test

One (1) Direct Shear Strength test was performed on an undisturbed sample at a continuous rate of shearing deflection (0.02 inches per minute) in accordance with ASTM Vol. 4.08 Part D-3080-79. The test results were used to determine engineering strength properties and are shown graphically on Figure No. A-9.

The following figures are attached and complete the Appendix:

- Figure No. A-3
- Figure No’s. A-4 and A-5
- Figure No. A-6
- Figure No. A-7
- Figure No. A-8
- Figure No. A-9

Key To Exploratory Test Pit Logs

- Log of Test Pits
- Maximum Density Test Results
- Atterberg Limits Test Results
- Gradation Test Results
- Direct Shear Strength Test Results
### PRIMARY DIVISIONS

<table>
<thead>
<tr>
<th>GRAVELS</th>
<th>CLEAN GRAVELS (LESS THAN 5% FINES)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SANDS</th>
<th>CLEAN SANDS (LESS THAN 5% FINES)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SILTS AND CLAYS</th>
<th>LIQUID LIMIT IS LESS THAN 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

### SECONDARY DIVISIONS

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>GRAVELS</th>
<th>GRAVEL WITH FINES</th>
<th>GRAVEL WITH SILT</th>
<th>GRAVEL WITH CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW</td>
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<td>Sand</td>
<td>Silt and Sand</td>
<td>Silt and Clay</td>
</tr>
<tr>
<td>GP</td>
<td>Sand</td>
<td>Gravel</td>
<td>Gravel and Sand</td>
<td>Gravel and Clay</td>
</tr>
<tr>
<td>GM</td>
<td>Gravel</td>
<td>Silt</td>
<td>Silt and Gravel</td>
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<tr>
<td>GC</td>
<td>Silt</td>
<td>Sand</td>
<td>Silt and Sand</td>
<td>Silt and Clay</td>
</tr>
</tbody>
</table>

### GRAIN SIZES

**SANDS, GRAVELS AND NON-PLASTIC SILTS**

- **Very Loose**: 0 - 4
- **Loose**: 4 - 10
- **Medium Dense**: 10 - 30
- **Dense**: 30 - 50
- **Very Dense**: OVER 50

**CLAYS AND PLASTIC SILTS**

- **Very Soft**: 0 - 1/4
- **Soft**: 1/4 - 1/2
- **Firm**: 1/2 - 1
- **Stiff**: 1 - 2
- **Very Stiff**: 2 - 4
- **Hard**: OVER 4

### RELATIVE DENSITY

- **Very Loose**: 0 - 4
- **Loose**: 4 - 10
- **Medium Dense**: 10 - 30
- **Dense**: 30 - 50
- **Very Dense**: OVER 50

### CONSISTENCY

- **Very Soft**: 0 - 1/4
- **Soft**: 1/4 - 1/2
- **Firm**: 1/2 - 1
- **Stiff**: 1 - 2
- **Very Stiff**: 2 - 4
- **Hard**: OVER 4

### DEFINITION OF TERMS

- **U.S. STANDARD SERIES SIEVE**
- **CLEAR SQUARE SIEVE OPENINGS**

### KEY TO EXPLORATORY TEST PIT LOGS

**Unified Soil Classification System (ASTM D-2487)**

**TL 300, 4TH AVENUE & ganong street**

**Oregon City, Oregon**

**PROJECT NO.** | **DATE** | **Figure**
<table>
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<tbody>
<tr>
<td>1477.003.G</td>
<td>Jan 6, 2017</td>
<td>A-3</td>
</tr>
</tbody>
</table>
## Soil Description

### Test Pit No. TH-#1

<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Bag Sample</th>
<th>Density Test</th>
<th>Dry Density (pcf)</th>
<th>Moisture Content (%)</th>
<th>Soil Class (USCS)</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>X</td>
<td>ML</td>
<td>26.6</td>
<td></td>
<td>ML</td>
<td>Dark brown, wet, very soft, highly organic, clayey, sandy SILT (Topsoil)</td>
</tr>
<tr>
<td>5</td>
<td>X</td>
<td>ML</td>
<td>24.9</td>
<td></td>
<td>ML</td>
<td>Medium to light orangish-brown, very moist, medium stiff to loose, clayey, sandy SILT to silty SAND with rock fragments and cobbles to boulder size Becomes stiff to medium dense at 5 feet</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>RK</td>
<td></td>
<td></td>
<td>RK</td>
<td>Gray, very dense, slightly weathered and fractured, BASALT bedrock Total Depth = 10.0 feet No groundwater encountered at time of exploration</td>
</tr>
</tbody>
</table>

### Test Pit No. TH-#2

<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Bag Sample</th>
<th>Density Test</th>
<th>Dry Density (pcf)</th>
<th>Moisture Content (%)</th>
<th>Soil Class (USCS)</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>X</td>
<td>ML</td>
<td>27.4</td>
<td></td>
<td>ML</td>
<td>Dark brown, wet, very soft, highly organic, clayey, sandy SILT (Topsoil)</td>
</tr>
<tr>
<td>5</td>
<td>X</td>
<td>ML/SM</td>
<td>23.8</td>
<td></td>
<td>ML/SM</td>
<td>Medium to light orangish-brown, very moist, medium stiff to loose, clayey, sandy SILT to silty SAND with rock fragments and cobbles to boulder size Becomes stiff to medium dense at 5 feet</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>RK</td>
<td></td>
<td></td>
<td>RK</td>
<td>Gray, very dense, slightly weathered and fractured, BASALT bedrock Total Depth = 9.0 feet No groundwater encountered at time of exploration</td>
</tr>
</tbody>
</table>

## Log of Test Pits

**Project No. 1477.003.G**  
**TL 300, 4th Ave & Ganong St**  
**Figure No. A-4**

**Redmond Geotechnical Services**
**SOIL DESCRIPTION**

<table>
<thead>
<tr>
<th>TEST PIT NO.</th>
<th>TH-#3</th>
<th>ELEVATION 195'±</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEPTH (FEET)</strong></td>
<td><strong>BAG SAMPLE</strong></td>
<td><strong>DENSITY TEST</strong></td>
</tr>
<tr>
<td>0</td>
<td>ML</td>
<td>Dark brown, very moist to wet, very soft, highly organic, clayey, sandy SILT (Topsoil)</td>
</tr>
<tr>
<td>5</td>
<td>ML</td>
<td>Medium to light orangish-brown, very moist, medium stiff to medium dense, clayey, sandy SILT to silty SAND with forck fragments and cobbles to boulder size</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Total Depth = 5.0 feet</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>No groundwater encountered at time of exploration</td>
</tr>
</tbody>
</table>

**LOG OF TEST PITS**

<table>
<thead>
<tr>
<th>PROJECT NO.</th>
<th>1477.003.G</th>
<th>TL 300, 4TH AVE &amp; GANONG ST</th>
</tr>
</thead>
</table>

**Redmond Geotechnical Services**
### Maximum Density Test Results

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Soil Description</th>
<th>Maximum Dry Density (pcf)</th>
<th>Optimum Moisture Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH-#1 @ 2.0'</td>
<td>Medium to light orangish-brown, clayey, sandy Silt to silty Sand with rock fragments (ML/SM)</td>
<td>112.0</td>
<td>14.0</td>
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</tbody>
</table>

### Expansion Index Test Results

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Initial Moisture (%)</th>
<th>Compacted Dry Density (pcf)</th>
<th>Final Moisture (%)</th>
<th>Volumetric Swell (%)</th>
<th>Expansion Index</th>
<th>Expansive Class.</th>
</tr>
</thead>
</table>

### Maximum Density & Expansion Index Test Results

Project No.: 1477.003.G  TL 300, 4th Ave & Ganong St  
Figure No.: A-6  

Redmond Geotechnical Services
<table>
<thead>
<tr>
<th>KEY SYMBOL</th>
<th>BORING NO.</th>
<th>SAMPLE DEPTH (feet)</th>
<th>NATURAL WATER CONTENT %</th>
<th>LIQUID LIMIT %</th>
<th>PLASTICITY INDEX %</th>
<th>PASSING NO. 200 SIEVE %</th>
<th>LIQUIDITY INDEX</th>
<th>UNIFIED SOIL CLASSIFICATION SYMBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH-1</td>
<td>2.0</td>
<td>26.6</td>
<td>28.2</td>
<td>3.9</td>
<td>55.2</td>
<td></td>
<td>ML/SM</td>
<td></td>
</tr>
</tbody>
</table>

**Figure A-7**

REDMOND GEOTECHNICAL SERVICES
PO BOX 20547 • PORTLAND, OREGON 97294

PLASTICITY CHART AND DATA
TAX LOT 300, 4TH AVE & GANONG ST
Oregon City, Oregon

PROJECT NO. DATE
1477.003.G Jan 6, 2017
UNIFIED SOIL CLASSIFICATION SYSTEM

ASTM D 422-72

U.S. STANDARD SIEVE SIZES

<table>
<thead>
<tr>
<th>Gravel</th>
<th>Sand</th>
<th>Silts and Clays</th>
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</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>Fine</td>
<td>Coarse</td>
</tr>
</tbody>
</table>

PARTICLE SIZE IN MILLIMETERS

<table>
<thead>
<tr>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 90 80 70 60 50 40 30 20 10 5 2 1</td>
</tr>
</tbody>
</table>

KEY BORING SAMPLE ELEV.
SYMBOL NO. DEPTH (feet)

- TH-#1 2.0

UNIFIED SOIL CLASSIFICATION SYMBOL
ML/SM

SAMPLE DESCRIPTION
Medium to light orangish-brown, clayey, sandy SILT to silty SAND with rock fragments

GRADATION TEST DATA
TAX LOT 300, 4TH AVE & GANONG ST
Oregon City, Oregon

PROJECT NO. 1477.003.G
DATE Jan 6, 2017
FIGURE A-8
SAMPLE DATA

DESCRIPTION: Medium to light
orangish-brown, clayey, sandy
SILT to silty SAND (ML/SM)

BORE NO.: TH-#1
DEPTH (ft.): 2.0'

TEST RESULTS
APPEARANT COHESION (C): 100 psf
APPEARANT ANGLE OF INTERNAL FRICTION (\(\phi\)): 29°

TEST DATA

<table>
<thead>
<tr>
<th>TEST NUMBER</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tr>
<td>NORMAL PRESSURE (KSF)</td>
<td>0.5</td>
<td>1.5</td>
<td>2.5</td>
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</tr>
<tr>
<td>SHEAR STRENGTH (KSF)</td>
<td>0.3</td>
<td>1.0</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>INITIAL H2O CONTENT (%)</td>
<td>14.0</td>
<td>14.0</td>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>FINAL H2O CONTENT (%)</td>
<td>14.2</td>
<td>11.3</td>
<td>7.7</td>
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<tr>
<td>INITIAL DRY DENSITY (PCF)</td>
<td>99.0</td>
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<tr>
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<td>102.6</td>
<td>105.8</td>
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<tr>
<td>STRAIN RATE:</td>
<td>0.02 inches per minute</td>
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</tbody>
</table>
The purpose of this letter is to present Northwest Geological Services, Inc. (NGS) Landslide Hazard Study for the above referenced property. Figures 1 and 2 show the location of the site about ¼ miles south of the Willamette River.

We understand that our services are in support of your client’s efforts to develop the property for a residential dwelling. Our study is intended to meet Oregon City Chapter 17.44 US Geologic Hazards Development Permit requirements for the Engineering Geology portions of a Type II land use application.

SUMMARY OF CONCLUSIONS

The site area below about elevation 400 ft was intensely scoured by the Missoula floods. That scour accounts for the thin overburden soil, minor topographic irregularities and relatively steep slopes in the site area. The detailed topographic survey of the site, the geologic reconnaissance, test pits and studies of nearby sites reveal that the site is underlain by competent bedrock with relatively thin soils. No evidence of slope failure is apparent at the site. In our opinion the proposed development can be accomplished without an adverse affect on the slope stability.

A scattering of boulders of Boring Lava within the colluvium is interpreted to have originated from rockfall from the cliffs south of the site. We found no evidence of a continuing rockfall hazard extending downhill to the site. However, there may be boulders remaining on the slope above the site that could mobilize during a strong earthquake.

Water from the slope uphill passes through the site soils. Surface or ground water that is collected or intercepted by footings, structures, pavements, fills, etc., should not be disposed in a concentrated area. Soil and rock properties indicate that diffusion across the lower slope, or disposal to a storm sewer, or a constructed drainage way are viable alternatives.\(^1\)

1. SCOPE OF STUDY

State hazard maps indicate the site may be located on an inactive, rotational, bedrock landslide. However, neither hazard from rapidly-moving landslides, nor more than low-moderate hazards from earthquakes are indicated. Additionally, geologic mapping indicates that two historic slope failures have occurred along the slopes above South End Rd, south of the site. Thus, the scope of our studies included the following engineering geologic tasks:

\(^1\) According to utility maps, the City disposes storm water from adjacent 5th Ave to an infiltration trench.

\(^2\) Inferred from LIDAR with “Moderate” confidence by Madin & Burns (2006) but not field checked by them.
Obtain and review historic aerial photographs, imagery and LIDAR of the site;
Review previous geologic investigations of the site area, including those required by the City;
Conduct a geologic reconnaissance of the site and adjacent area;
Review the test pit explorations conducted by Redmond Geotechnical Services;
Review the preliminary plans for the proposed development; and
Prepare this letter describing our work, findings and recommendations.

2. SITE SETTING

2.1 Location

The site is located at the south end of the Canemah District, in Oregon City, Oregon. Assessor’s maps show it astride the border between Donation Land Claims 47 and 37. It is at the NW 1/4 NW 1/4 Section 6, T3S/R2E Willamette Meridian (Figure 1). The site comprises Lot 300 of Block 17 of the historic Canemah District. The site is accessed from Fourth Ave and/or the unimproved right of way of Ganong St.

2.2 Physiography

As shown on Figures 1 and 3, the site lies at elevation 180’ to 225’ about halfway up the slope from the Willamette River to the upland plateau south of Oregon City. The site is near the south east margin of the Canemah District (Figures 2 and 3) and was developed before 1900 (see Section 2.3). Grading for construction of streets and building sites for development modified the natural hillside extensively.

Regional geologic mapping indicates the bedrock is Miocene age basalt that is overlain by younger rocks south of the site (Figure 4). As discussed in Section 3, the site was intensely scoured by multiple catastrophic Missoula floods towards the end of the last Ice Age.

Area topographic mapping (Figure 3) and LIDAR (see Section 5 and Figure 6) show Canemah is a series or alternating benches and moderate to steep slopes. The stepped topography was formed as the Willamette River cut through the conglomerate and lava flows forming the south end of the Tualatin Hills. More recently the catastrophic Missoula Floods repeatedly scoured the canyon walls (see Section 3), enhancing the benched nature of the topography.

Detailed topographic mapping\(^3\) of the site (Figure 5) shows natural slopes range from moderate (~30%) up to relatively steep (~50%). Additionally, small man made declivities occur at the sites of former structures and at holes of former root balls for large conifers. The slope north of the site is partially supported by a stone wall along 4th Ave (Figure 4). The slope south of the site up to SW 5\(^{th}\) Ave is relatively smooth and regular.

Most of the site is shaded by mature firs and false cedar. The conifers are straight and erect. Ground cover of ivy and berries mantle the slope and patches of understory maple and scrub occur locally. The site area appears to have been kept cleared of underbrush and immature trees until recently. Thus, the large trees are not crowded. However, English Ivy is attacking most trees. The ivy has felled a few trees south of the site and several large trees appear in peril from it.

\(^3\) From ~70,000 – 13,000 years ago (Waitt, 1981; Minervini & others, 2003).
2.3 Historical Development of the Site and Area

We looked for evidence of landslides by examination of historic aerial photographs and maps. The maps include USGS quadrangles and City GIS data. The USGS maps were published in 1904, 1951, 1961 and 1990 (the latter was used for Figures 1 and 4 right panel). Lowest return LIDAR was used by the City GIS to derive the elevation contours on Figures 3 and 4 (left panel).

The historic aerial photographs show the site mostly covered by forest canopy, as it is today. The 1952 and later photos show only small openings in the canopy over the streets. No slope failures are apparent on the aerial photos.

The historic maps also show no indication of slope failure. However, the 1900 – 1925 Sanborn map show a structure (probably house) located on the present lot line between TL 300 and TL 400. That location corresponds with the declivity beneath the west side of the proposed new residence (Figure 5).

3. GEOLOGY

3.1 Previous Studies of the Site Area Geology

The geology of the site area has been mapped by several geologists (Treasher, 1942; Trimble, 1963; Schlicker & Finlayson, 1979; Madin, 2009).\(^4\) Recently the site was evaluated for slope hazards by PBS (2007, 2014). Additionally, we evaluated landslide hazards for sites on nearby Block 52 (NGS, 2004b). All studies agree that the site area is underlain by the regionally extensive Columbia River Basalt which extends to depths of several hundred feet in the site area. The Columbia River Basalt is overlain by the sedimentary strata of the Troutdale Formation. These strata are in turn overlain by the Boring Lava, well exposed along South End Rd, south of the site. Strata dip gently to the SW at about 1º to 2º. The nearest major fault is the Bolton fault, about 1¼ miles NE. That fault extends NW-SE, parallel to the Willamette River, from Portland to Oregon City (Beeson and others, 1989; Liberty and others, 2002).

As discussed in Section 4, beyond, Madin (2009) inferred that the site is located on a prehistoric landslide (Figure 4). None of the earlier geologic maps indicates that the site has been affected by landslides. However, Schlicker and Finlayson (1979) mapped “landslide topography” in the NW ¼ of 3S/2E-1 (i.e., in the site area). The only adverse condition they identified was that the site is in an area of thin soils. They noted that in such areas, septic systems and utility excavation could be a problem.

The Missoula Floods drastically modified the landscape below 400 ft elevation (Minervini and others, 2003). The floods both scoured the land and, locally, deposited extensive glaciofluvial sediments. In main-channel areas flood velocities were many feet per second (Waitt, 1985) the scour was severe and deep, bedrock was scoured and plucked, and the sediments deposited are usually


\(^5\) PBS’ (2007) study also indicates a residence was present from the late 1800s through at least 1925. Note, however, we have only the text of the PBS reports. PBS would not provide copies of their report or 21014 update with Figures and Tables for the new property owner. Our review found no residence visible on the 1952 aerial photos.

\(^6\) The most comprehensive geologic maps are by Trimble, 1964, and, Schlicker and Finlayson’s, 1979, Bulletin 99. Although, Madin’s (2009) Geology Map covers the area, features are not referenced to culture or coordinates, so it is very difficult to use. Burns and Mikelson (2010) and Madin & Burns (2006) are remote interpretation of LIDAR and aerial photographs rather than on the ground geologic studies such as those by Treasher, Trimble or Schlicker & Finlayson. (Burns & others, 1998 was simply a compilation and reinterpretation of previous work by others.)
coarse grained. In backwater areas the floods scoured away soils and weathered rocks and deposited in their place a mantle of fine-grained sediment, generally referred to as the Willamette Silt.

The site is in the canyon of the Willamette River’s narrow channel through the south end of the Tualatin Mountains. Almost all of the Missoula flood waters that poured into Willamette Valley passed through this gap, so the scour from the rising floods was particularly severe. The site is also just downstream of the confluence of the Tualatin with the Willamette. The combined flow of the receding floods was aimed at the south bank of the Willamette from Canemah south to about river-mile 29 (just past lower left of Figure 1). So, the area was thoroughly scoured several times. Minervini & others (2003) estimated that at least 20 of the Missoula Floods rose to more than 200 ft in this area. They also estimate that 10 or more rose to over 260 ft. Waitt (1985) estimated flood velocities of several meters/second.

4. GOVERNMENT HAZARD ESTIMATES

As noted previously, Schlicker and Finlayson (1976) showed the site as an area of moderate slope with “landslide topography”. This interpretation was based on the USGS 7.5” Quadrangle map, aerial photo interpretation and limited field checking.

Three fairly recent DOGAMI studies show the site in a landslide area (Madin & Burns, 2006; Burns & Mickelson, 2010; Madin, 2009). The first two of these studies relied on interpretation of LIDAR and aerial photographs. The most detailed study - Madin (2009) - relied on the two other studies, detailed topography, previous geologic mapping and limited field checking.

Madin and Burns (2006) and Burns and Mickelson (2010) inferred from the LIDAR and aerial photos that the site is on a “moderate confidence” prehistoric landslide. Neither field checked their interpreted landslides.

Madin (2009) shows the site as in a Quaternary landslide (i.e., not recent) with the same extent as the earlier DOGAMI studies. Madin did limited field checking, including the basalt outcrops along South End Rd, south of the site. However, his database (Madin, 2009, Appendix A) indicates he did not examine the LIDAR interpreted landslide surrounding the site. Madin (2009) contains the following warning:

NOTICE

The Oregon Department of Geology and Mineral Industries is publishing this map because the subject matter is consistent with the mission of the Department. The map is not intended to be used for site-specific planning. The map cannot serve as a substitute for site-specific investigations by qualified practitioners. Site-specific data may give results that differ from those shown on the map. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

SLIDO7 compiles available landslide information in one place (Figure 6). Potential and known hazards can be mapped onto LIDAR, aerial photo or roadmap base maps, providing good location information for landslide features. Figure 6 shows the inferred-from-LIDAR prehistoric slide as well as the two historic rockfalls (Hofmeister, 2000) on South End Rd, south of the site.

The SLIDO site also compiles landslide susceptibility information. SLIDO shows the site in an area of potentially “High” landslide susceptibility. Typically, that rating is applied to areas shown by SLIDO as mapped landslide areas. All of the SLIDO maps carry the following disclaimer:

“For general information only; not to be used for planning purposes. http://www.oregongeology.org/slido”

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5. SITE EXPLORATIONS

5.1 Site Area Reconnaissance

Reconnaissance of the site and site area was conducted on 5 December 2016. The area reconnaissance covered the Canemah District and the uplands to the south. We found the site and area to be underlain by 3 or 4 flows of Frenchman Springs member of the Columbia River Basalt. The basalt flows are exposed in roadcuts along Fourth and Fifth Avenues south of the site, along Highway 99 north and south of the Canemah District, and along the SPRR tracks. The basalt is usually grey to dark grey and hard (RH-4). It is jointed in large columns and/or irregular, interlocking blocks. The bottom of the lowest Frenchman Spring flow is along the SPRR at about elevation 70 ft.

Several hundred feet of older, Grande Ronde Basalt flows underlie the 200+ feet of Frenchman Springs flows at the site. These older flows appear to dip northeast (Kienle, 1971) where exposed along the SPRR (Figure 3). However, the younger Frenchman Springs basalt flows appear to be nearly horizontal at the site or dip slightly SW. The upper surface of the basalt is irregular because it was eroded by the same streams that deposited the overlying Troutdale Formation. The top of the basalt is at about elevation 225 ft SW of the site (NGS, 2004b) and about 250 along South End Rd ENE of the site (Madin, 2009). We estimate the top of basalt - bottom of Troutdale contact is under the slope just uphill of the site.

The Troutdale formation extends uphill from the basalt to the Boring Lava (Figure 4). Thickness ranges from 100 up to 200 ft in the site area. Troutdale silty sandstone and pebbly sandstone are exposed along South End Rd northeast of the site. Similar strata are inferred to underlay the slope south and uphill of the site based on rounded Troutdale type cobbles and pebbles in the site colluvium. Usually, the Troutdale siltstones and silty sandstones are weathered to a depth of many feet. However, the weathered material appears to have been mostly removed by the Missoula floods in the site area.

The Boring Lava consists of one or two flows of grey, hard (RH-4) olivine basalt. Cuts along South End Road south of the site provide a good section through the Boring Lava. The nearly vertical cuts reveal it to be columnar jointed to blocky jointed and show that it will stand in steep cuts for many decades. However, the exposed face of the basalt is susceptible to frost wedging and topple failures. These processes can cause significant rockfalls from steep faces of the basalt such as the two historic road cut slides (rockfalls) shown on Figure 6.

5.2 Test Pit Explorations

Redmond Geotechnical Services, PC (RGS) excavated two test pits 1 December 2106 on TL 300 and two on TL 400 to explore site conditions. Figure 5 shows location of the three test pits on and near TL 300. The test pits were located to explore conditions along the access road and the proposed residence. The cuts, fills and retaining walls for the road and residence will be the only significant earthworks for site development (Figure 5).

Test pits TP-1 and TP-2 found Columbia River basalt bedrock at depths of 9 and 8 ft feet, respectively. The basalt is hard, red brown to gray, very dense, severely weathered and fractured.

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8 Kienle, 1971 found that the flows are of the Frenchman Springs Basalt Member of the Late Yakima Basalt. The flows are now grouped with the Wanapum Formation of the Columbia River Basalt Group. These flows are about 12-14 million years in age.
9 Panama Canal Scale of rock hardness: 1 = soft, 2 = medium, 3 = medium hard and 4 = hard.
10 Schlicker and Finlayson (1979) mapped Troutdale extending down to about elevation 210 ft. However, RGS’s TP-1 and TP-2 found basalt bedrock so the Troutdale must be higher.
11 Please see RGS’s Geotechnical report for the site, to which this report should be attached.
BASALT bedrock. Examination of spoils from the test pits during our reconnaissance confirmed Redmond’s description of the basalt found in the test pits. The bedrock was overlain by 1 to 1.5 ft of silty topsoil and then by colluvium. The colluvium is orange brown to brown, medium stiff to hard, clayey sandy SILT to silty SAND with pebbles, cobbles and boulders. TP-4 terminated at practical refusal in the colluvium at 6 ft.\textsuperscript{12}

5.3 Site Geologic Reconnaissance

The geologic reconnaissance of the site was done on 5 December 2016, immediately following the site area reconnaissance. During the reconnaissance we walked the perimeter of the site, and traversed the interior. We also traversed slopes south of the site up to about elevation 240 ft.

Columbia River Basalt - The basalt is not exposed at the site. It is present at shallow depth as described in Section 4.2.

Troutdale Formation - The Troutdale formation overlies the Columbia River Basalt and forms the slope uphill of the site. Although not exposed, it may underlie the southern most part of the site. The Troutdale appears to be silty sandstone and pebbly sandstone similar to that found throughout the area.

Colluvium - The site is mantled by colluvium. It contains scattered pebble-to boulder-sized angular fragments of Boring Lava and pebbles to cobbles derived from the Troutdale Formation. Many such fragments are found at the surface below the topographic bench. A few basalt fragments are similar in size range, shape and degree of weathering to the Columbia River basalt bedrock exposed in the site area and the test pits. In our experience these basalt fragments have worked up from the bedrock into the overlying soils by frost heave and soil creep.

The mature conifers are very slightly pistol-butt, indicating that soil creep of the colluvium is generally slow. English ivy is attacking almost all of the conifers at the site and some are showing signs of stress from this attack. The large conifers transpire soil moisture whenever air temperatures are above ~40º F. This removes soil moisture, thus improving slope stability during most of the wet season.

5.4 Surface Water / Natural Resources Overlay (NROD)

We observed no areas of standing water (lakes, ponds) or drainage ways (streams, rills) at the site. Oregon City GIS shows the nearest watercourse to be an unnamed drainage about 200 ft ENE of the site. The latest USGS (2014) topographic map shows it to be an ephemeral drainage.\textsuperscript{13} According to the City GIS it extends from the vicinity of Hazelwood Dr north across South End Rd to 5\textsuperscript{th} Ave and thence NW 3\textsuperscript{rd} Ave near Hedges St (Figure 3). The City NROD extends west and SW from the ephemeral drainage to and past the site.

Our reconnaissance, review of topography and City utilities maps indicate there is do direct surface drainage from the site to the drainage. Instead, most surface water infiltrates into the colluvium and thence by vadose or saturated flow downhill through the colluvium. A small percentage recharges aquifers in the bedrock basalt flows. What surface runoff exits the site is intercepted by the impervious pavement of 4\textsuperscript{th} Ave where it drains to the 8” storm sewer. Note that the City routes intercepted runoff to buried infiltration structures on SW 5\textsuperscript{th} south of the site.

\textsuperscript{12} TP-3 was similar to TP-4 and located near the NW corner of TL 400 west of the area shown on Figure 5.

\textsuperscript{13} An ephemeral drainage flows only during and immediately after precipitation. A stream-like topographic feature with no perennial or intermittent watercourse.
In summary, stormwater is captured uphill and downhill of Block 17 and routed into the soil or to the storm sewer. There is no surface discharge to the to the NDOD-protected drainage east of the site.

5.5 Ground Water Observations

No ground water was found in the test pits in December 2016 (RGS, 2016). We found locally moist soils during the reconnaissance. However, we found no seeps or springs, in spite of recent heavy precipitation.

6. INTERPRETATION OF SITE CONDITIONS

Review of aerial photos and topographic maps indicates that, historically, the site has been a normal hillside location with no obvious problems. A residence was present for many years.

Numerous landslides occurred along drainages inundated by the Missoula floods. Excess pore pressures during drawdown of the multiple floods destabilized slopes underlain by colluvium, loess, or fine grained sedimentary strata. Certainly, the area around the site has the aspect of such a slope failure, hence Madin & Burns’ (2006) interpretation. However, the reconnaissance and test pits found no landslide debris. Thus, the slide-like topography shown on Figures 3, 5 and 6 is explicable by fluvial erosion of the Willamette River canyon, possible landslides during the Missoula Floods, scouring of any slide debris by subsequent floods, and evolution of the colluvium by mass wasting and soil creep. We found no evidence of slope failure at or adjacent to the site.

As noted previously, soils in the test pits were moist. Soils uphill of the test pits were also moist during our reconnaissance. Based on the site vegetation and slope, it does not have standing water at any time. However, the soil is thin on the slope uphill of the site and the slope extends up to South End Road. Consequently considerable runoff from the slope must cross the site during precipitation. We suspect that the soil develops a transient zone of saturation above the bedrock during intense or prolonged storm events.

The closest potentially active fault is the Bolton Fault located about 1 ¼ NE of the site (Beeson and others, 1989; Liberty and others, 2002). NGS (1994; 2004a) estimated the fault could produce an Mw = 6.8 earthquake at relatively shallow depths.

7. CONCLUSIONS AND RECOMMENDATIONS

The bedrock slopes at the site appear stable. The colluvium also appears stable under present conditions. Based on the typical rock and soil properties and the plan for proposed cuts, fills and retaining walls (Figure 5) it, is our opinion that the site can be developed without creating any slope stability problems. However, the footing design for the wall and excavation plan for the cuts and fills should be reviewed by a qualified professional. We also recommend that the excavations for the work be inspected by a qualified professional prior to placing fills or drainage blanket material.

Considerable water will move across the site slopes during storms as noted previously. In our opinion this will not be a problem as long as the water that is intercepted by improvements (e.g., street, footing drains, roofs and pavements) is dispersed across the lower slopes. It should not be discharged to a concentrated or a few small areas such as dry wells. Alternatively runoff can be sent to the existing storm sewer or to a drainage way constructed along one of the adjacent unimproved street right-of-ways (Figures 3 and 5). Regardless of the choice (all are viable in our opinion), the plan should be reviewed by a qualified professional.
Excavation of some rock may be required to meet the planned footing elevations. The plans for this work should be reviewed by a qualified professional. Also, excavations for footings or structures should be inspected by the project geotechnical engineer or their qualified representative.

We recognize that development plans may change as development proceeds. In our opinion, there are many ways that the subject site could be developed without creating slope hazards. Regardless of what actual changes are made from the plan shown on Figure 5, we recommend that the final plans for footings, foundations, cuts, fills or other earthworks, and drainage be reviewed by the appropriate qualified professional engineers.

8. LIMITATIONS AND LIABILITY

We call your attention to the paragraphs on Warranty and Liability in the General Conditions (dated 1/2014) approved by you previously. Interpretations and recommendations presented herein are based on limited data and observations. Actual subsurface conditions may vary from those inferred from the limited information available to us. If site excavations for development find conditions that differ from those inferred herein, you should contact us and provide an opportunity for us to review our recommendations for the site. The conclusions and recommendations herein apply only to this specific project of to one of substantially the same scope and extent. Conclusions and recommendations should be updated if the proposed scope is not completed within three years of the date of this report.

We thank you for the opportunity to assist you with your property development. Please contact me if you have questions about the report.

Yours very truly,
Northwest Geological Services, Inc.

Reference NGS 235.89-1
9. REFERENCES


NGS, 2004a, Seismic Hazards, Willamette Falls Hospital, Appendix A – Engineering Geology Report in P. B. Kelly, 2004, Seismic Site Hazards Evaluation; Willamette Falls Hospital Expansion For Emergency, Imaging, and Pharmacy Services; Oregon City, Oregon, 6 February 2004 report to Clark/Kjos Architects.


SLIDO, 2016 and ongoing, Statewide Landslide Information Database of Oregon; web map application at http://www.oregongeology.org/sub/slido/.

Treasher, R. C., 1942, Geologic map of the Portland area, Oregon Dept of Geology and Mineral Industries Geologic Map Series No 7.


The City of Oregon City makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, surveying or navigation purposes. Notification of any errors is appreciated.

Map created 12/2/2016
Madin, 2009 (GMS-119)

Qls - prehistoric landslide, inferred from LIDAR, moderate confidence
Tbc - Basalt of Canemah, Pliocene Boring Lava
Tt - Troutdale Formation, Pliocene sandstone and conglomerate
Twfg - Gingko flows, Miocene Wanupum Basalt
Tgsb - Sentinel Bluff flows, Miocene Grande Ronde Basalt

1000 ft

Schlicker & Finlayson, 1979 (Bull 99)

Hal - Holocene alluvium
QTb - Boring Lava (flows of olivine basalt)
Tt - Troutdale Formation (sandstone, conglomerate & siltstone)
Tcr - Columbia River Basalt (basalt with intercalated soils)

2S/3E-6B Block 17 TL 300, Canemah
Oregon City, Oregon
Landslide Hazard Study
DOGAMI Geologic Maps
NGS, Inc. December 2016 Figure 4
Maps from: http://www.oregongeology.org/sub/slido/.
Arborist Report
4th and Ganong- Taxlot 300
Prepared July 3rd, 2017

Brian Horrigan- Certified Arborist # PN-1915
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Oregon CCB# 164110
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The Canemah National Historic district is an important location in Oregon's settlement history. For the indigenous people as well as the pioneer settlers, the site was desirable for its elevation above the floodplain and easy access to the Willamette river. The historical neighborhood and houses have remained mostly unchanged for the past 100 years. The first settlements in this area were notable as clearings in the midst of forest and brush. Many of the remaining trees have now grown up and filled in—there are some tall trees around but there are also spaces between the trees, wooded areas as well as clearings.

This report addresses the trees at the property at the SW corner of 4th and Ganong, a lot which has been previously undeveloped. It is marked by maturing second growth trees, a mixture of native Douglas-firs (Pseudotsuga menziesii) and Grand Firs (Abies grandis), as well as Big-leaf Maples (Acer macrophyllum). The Douglas Firs and Grand Firs are tall trees, dominating the landscape, and nearing their mature height. The Maple trees have grown in more recently, and have filled in as understory trees. Due to the trees being second growth on a previously cleared area, the trees are more crowded than ideal. This has led to the development of tall, slender trunks, with all of the growth at the tops of the trees. The growth of English ivy on the trunks for many years has not helped these trees—it has contributed to the dieback of lower limbs and has promoted more imbalanced, upward growth.

The lot is situated on a moderately steep slope, averaging about 15 degrees, with a naturally level area near the front, North end of the lot. In all there are 9 trees on the property to be removed, and 5 that are to be preserved. This does not count the trees in the right-of-way. Of the larger trees on site, 40 inches diameter or larger, 3 out of 5 trees will be preserved. There is a map attached with tree numbers and locations.

There are a number of trees which are designated to be removed in the process of development:

Starting in the Northwest corner, tree #224 is a Big-Leaf Maple. The tree has a trunk diameter at 4.5 ft. height (d.b.h.) of 14 inches and is about 50 ft in height. It has a slight lean due to competing with other trees. There are signs of some decay affecting at least 30% of the diameter in the lower portion of the trunk. The tree has a low live crown ratio—all of the branching is near the top of the canopy.

Tree 221 is another Big-Leaf Maple. The diameter is 12 inches and the height is about 50 ft. This tree has a previously broken top, and the re-growth looks poorly attached and unstable. There is a strong bow in the trunk structure and it has a low live crown ratio.

Tree 222 is a Big-leaf Maple with a diameter of 17 inches. It has been dominated and smothered by the growth of ivy for a long time. There are few low live branches. There is some basal wounding and decay, and the tree is “top-heavy” with a poor live crown ratio.

Tree 220, a Big-leaf Maple, has a very strong lean of over 25 degrees. It has a diameter of 8 inches and is about 50 ft. in height. There is basal wounding and signs of decay are present.

Tree 219 is a Maple tree that has a wide crown. The trunk diameter is 13 inches and the tree’s height is about 70 ft. There is some unusual swelling at the base of the trunk, perhaps from an old wound. It has a low live crown ratio, with the growth all in the top 1/3 of the canopy.
Further up the slope to the South, closer to the center of the lot, is another Big-Leaf Maple, tree 218. It has a diameter of 18 inches and a height near 80 ft. There is a noticeable degree of lean. There are furrows developed in the uphill side of the trunk due to tension. There is an old wound at about 3 ft in height, with some extra wood formed in response, as well as some notable decay in the trunk wood.

Tree 182 is a Douglas-Fir. The trunk diameter is 47 inches and the height about 150 ft. The tree has a full, heavy crown. There is an old basal wound on the downhill side of the trunk.

Tree 216 is another Douglas-Fir. This tree is 40 inches in diameter and about 120 ft in height. The trunk exhibits poor taper and is lacking a distinct root flare. There are some low co-dominant branches. The branching structure of this tree is all one-sided, due to being shaded out by other trees, making it poorly balanced.

Tree 186 is a Big-Leaf Maple. It is 18 inches diameter, and about 80 ft in height. The branches have been cut back hard previously for utility clearance. There are a number of latent sprouts low on the trunk, and the tree shows poor taper.

The Southern side of the lot contains a number of trees which are to be preserved during construction:

Tree 217 is a Big-leaf Maple. The tree has a diameter of 22 inches and a height of approximately 70 ft. It has a nice, wide crown and a good root flare.

Tree 181 is a Grand Fir. It is 40 inches diameter, and about 160 ft in height. The tree does not have strong taper due to growing together in a groove with other tightly spaced trees. There is a slight bow in the trunk.

Tree 177 is another Grand Fir, up towards the SE corner of the lot. It measures 36 inches diameter and is about 160 ft tall. The tree has a good root flare and a stout trunk, and is growing straight.

In amongst these True Firs is tree 176, a Big-Leaf Maple growing, with a 10 inch trunk. It is about 80 ft tall, with a significant lean. It has a low live-crown ratio.

Up in the SE corner of the lot is the largest tree of all and the most impressive. Tree 164 is a Grand Fir with a 56” trunk diameter. It stands about 160 ft tall and has a more even, balanced branch structure than the other trees. There is a slight lean in the uphill direction, due to it growing away from the other trees in the grove.

There are several other trees that are in the right of way, outside of the property itself but still potentially impacted by the construction. They will be included in the fencing procedure to protect the root zones of all of the trees in the nearby area.

There are 2 Grand Firs at the lower end of the Ganong St right of way next to the property, trees 194 & 195. One is 20 inches diameter, the other 28 inches. They are about 80 ft in height and
have a more balanced canopy than the other trees since there is an open area here with more direct sunlight.

Further up the slope is a grove of Big-leaf Maple trees, trees 170 through 173. These trees have grown up on the edge of a clearing with adequate sunlight. They have a more balanced canopy from top to bottom and trunks which are better tapered as well. There are 3 single trunked trees here, 8 inches, 12 inches and 24 inches. There is also one larger co-dominant tree. These Maple trees are about 80 ft in height.

Along the front of the property on 4th avenue, there are 2 small Big-leaf Maples, 8 inches and 10 inches in diameter - trees 226 & 227. These trees have small, previously broken crowns. These trees have grown up recently, and are unable to grow vertically for lack of light. They are about 40 ft in height.

As part of development, it will be necessary to protect these large and impressive Grand Firs and other trees from root damage and compaction. Most of the trees to be preserved are at the top of the slope, and the construction is to be taking place below. This will make it easier to protect the trees from runoff and soil accumulation. The hill itself and the markedly steep slope also provides a natural barrier to significant root growth. In preparation for the building process, it will be necessary to install 4 ft high protective fencing in a modified radius around the trees, coming no closer than edge of the drip line, but in most places offering even more protection. (See attached map) This allows for the maximum protection of the root zone for the remaining trees. The goal of fencing is to provide protection for the largest percentage of tree roots possible for the significant trees which are to remain on site, while still allowing for sensible development in the style and method appropriate for this Historical district.
Chapter 17.44 - US—GEOLOGIC HAZARDS

Footnotes:

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Editor's note—Ord. No. 08-1014, adopted July 1, 2009, repealed Chapter 17.44 in its entirety and enacted new provisions to read as herein set out. Prior to amendment, Chapter 17.44 pertained to similar subject matter. See Ordinance Disposition List for derivation.

17.44.010 - Intent and purpose.

The intent and purpose of the provisions of this chapter are:

A. To ensure that activities in geologic hazard areas are designed based on detailed knowledge of site conditions in order to reduce the risk of private and public losses;

B. To establish standards and requirements for the use of lands within geologic hazard areas;

C. To provide safeguards to prevent undue hazards to property, the environment, and public health, welfare, and safety in connection with use of lands within geologic hazard areas;

D. To mitigate risk associated with geologic hazard areas, not to act as a guarantee that the hazard risk will be eliminated, nor as a guarantee that there is a higher hazard risk at any location. Unless otherwise provided, the geologic hazards regulations are in addition to generally applicable standards provided elsewhere in the Oregon City Municipal Code.

This application for Geologic Hazard Review is intended to ensure that the proposed development on the site is safe and all risks for this property and neighboring properties are properly mitigated.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.025 - When required; regulated activities; permit and approval requirements.

No person shall engage in any of the following regulated activities within the adopted Oregon City Geologic Hazards Overlay Zone as defined in section 17.04.515 of the Oregon City Municipal Code without first obtaining permits or approvals as required by this chapter:

A. Installation or construction of an accessory structure greater than 500 square feet in area;

This application is for construction of a new home greater than 500 s.f. and requires approval per OCMC 17.04.

B. Development of land, construction, reconstruction, structural alteration, relocation or enlargement of any building or structure for which permission is required pursuant to the Oregon City Municipal Code;

This application is for construction of a new home greater than 500 s.f. and requires approval per OCMC 17.04.
C. Tree removal on slopes greater than 25 percent where canopy area removal exceeds 25 percent of the lot.

*This application requires approval of 9 trees for the proposed development. Refer to attached arborist report.*

D. Excavation which exceeds two feet in depth, or which involves twenty-five or more cubic yards of volume;

*The construction of this new home and driveway as proposed will require excavations up to 6' deep and require the removal of approximately 200 cu yds of material.*

The requirements of this chapter are in addition to other provisions of the Oregon City Municipal Code. Where the provisions of this chapter conflict with other provisions of the Oregon City Municipal Code, the provisions that are the more restrictive of regulated development activity shall govern.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.030 - Procedures.

No building or site development permit or other authorization for development shall be issued until the plans and other documents required by this chapter have been reviewed and found by the review authority to comply with the requirements of this chapter.

A. Where the development is part of a land use permit application, review shall occur in the manner established in Chapter 17.50 for review of land use decisions.

B. Where the development is part of a limited land use permit application, review shall occur in the manner established in Chapter 17.50 for review of limited land use decisions.

C. Where the development is solely part of a grading permit or building permit, the city engineer may allow review to occur in the manner established in Title 15, Chapters 15.04 and 15.48 if the application meets Section 17.44.060 development standards.

D. For any other proposed development not otherwise subject to review as a land use or limited land use permit application, review shall occur in the manner established in Chapter 17.50 for limited land use decisions.

*This application is being sought in conjunction with a building permit application for a single family residence. No new lots are being created as part of this application. A Type II review approval is being sought for the geologic Hazard overlay zone.*

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.035 - Exemptions.

The following activities, and persons engaging in same, are EXEMPT from the provisions of this chapter.

A. An excavation which is less than two feet in depth, or which involves less than twenty-five cubic yards of volume;
B. A fill which does not exceed two feet in depth or twenty-five cubic yards of volume;
C. Structural alteration of any structure of less than five hundred square feet that does not involve grading as defined in this chapter;
D. Installation, construction, reconstruction, or replacement of utility lines in city right-of-way, or public easement, not including electric substations;
E. The removal or control of noxious vegetation;
F. Emergency actions which must be undertaken immediately to prevent an imminent threat to public health or safety, or prevent imminent danger to public or private property. The person undertaking emergency action shall notify the building official on all regulated activities associated with any building permit or city engineer/public works director on all others within one working day following the commencement of the emergency activity. If the city engineer/public works director or building official determine that the action or part of the action taken is beyond the scope of allowed emergency action, enforcement action may be taken.

This proposal exceeds any listed above for exemptions and none are being requested.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.050 - Development—Application requirements and review procedures and approvals.

Except as provided by subsection B. of this section, the following requirements apply to all development proposals subject to this chapter:
A. A geological assessment and geotechnical report that specifically includes, but is not limited to:
   1. Comprehensive information and data regarding the nature and distribution of underlying geology, the physical and chemical properties of existing soils and groundwater; an opinion of site geologic stability, and conclusions regarding the effect of geologic conditions on the proposed development. In addition to any field reconnaissance or subsurface investigation performed for the site, the following resources, as a minimum, shall be reviewed to obtain this information and data:
      a. The State of Oregon Department of Geology and Mineral Industries (DOGAMI) in Bulletin 99, Geology and Geological Hazards of North Clackamas County, Oregon (1979), or in any subsequent DOGAMI mapping for the Oregon City area;
      b. Portland State University study entitled "Environmental Assessment of Newell Creek Canyon, Oregon City, Oregon" (1992);
      c. Portland State University study, "Landslides in the Portland, Oregon, Metropolitan Area Resulting from the Storm of February 1996: Inventory Map, Database and Evaluation" (Burns and others, 1998);
      d. DOGAMI Open File Report O-06-27, "Map of Landslide Geomorphology of Oregon City, Oregon, and Vicinity Interpreted from LIDAR Imagery and Aerial Photographs" (Madin and Burns, 2006);
      e. "Preliminary Geologic Map of the Oregon City Quadrangle, Clackamas County, Oregon" (Madin, in press);
   2. Information and recommendations regarding existing local drainage, proposed permit activity impacts on local drainage, and mitigation to address adverse impacts;
   3. Comprehensive information about site topography;
   4. Opinion as to the adequacy of the proposed development from an engineering standpoint;
5. Opinion as to the extent that instability on adjacent properties may adversely affect the project;

6. Description of the field investigation and findings, including logs of subsurface conditions and laboratory testing results;

7. Conclusions regarding the effect of geologic conditions on the proposed development, tree removal, or grading activity;

8. Specific requirements and recommendations for plan modification, corrective grading, and special techniques and systems to facilitate a safe and stable site;

9. Recommendations and types of considerations as appropriate for the type of proposed development:
   a. General earthwork considerations, including recommendations for temporary and permanent cut and fill slopes and placement of structural fill;
   b. Location of residence on lot;
   c. Building setbacks from slopes;
   d. Erosion control techniques applicable to the site;
   e. Surface drainage control to mitigate existing and potential geologic hazards;
   f. Subdrainage and/or management of groundwater seepage;
   g. Foundations;
   h. Embedded/retaining walls;
   i. Management of surface water and irrigation water; and
   j. Impact of the development on the slope stability of the lot and the adjacent properties.


10. Scaled drawings that describe topography and proposed site work, including:
   a. Natural physical features, topography at two or ten-foot contour intervals locations of all test excavations or borings, watercourses both perennial and intermittent, ravines and all existing and manmade structures or features all fully dimensioned, trees six-inch caliper or greater measured four feet from ground level, rock outcroppings and drainage facilities;
   b. All of the features and detail required for the site plan above, but reflecting preliminary finished grades and indicating in cubic yards whether and to what extent there will be a net increase or loss of soil.
   c. A cross-section diagram, indicating depth, extent and approximate volume of all excavation and fills.

Refer to architectural and civil drawings for existing topography and proposed grading.

[11.] For properties greater than one acre, a preliminary hydrology report, prepared by a suitably qualified and experienced hydrology expert, addressing the effect upon the watershed in which the proposed development is located; the effect upon the immediate area's stormwater drainage pattern of flow, the impact of the proposed development upon
downstream areas and upon wetlands and water resources; and the effect upon the groundwater supply.

**The site is less than 1 acre in area. Criterion does not apply.**

B. Review procedures and approvals require the following:

1. Examination to ensure that:
   a. Required application requirements are completed;
   b. Geologic assessment and geotechnical report procedures and assumptions are generally accepted; and
   c. All conclusions and recommendations are supported and reasonable.

2. Conclusions and recommendations stated in an approved assessment or report shall then be directly incorporated as permit conditions or provide the basis for conditions of approval for the regulated activity.

3. All geologic assessments and geotechnical reports shall be reviewed by an engineer certified for expertise in geology or geologic engineering and geotechnical engineering, respectively, as determined by the city. The city will prepare a list of prequalified consultants for this purpose. The cost of review by independent review shall be paid by the applicant.

   **The applicant is requesting the City review the submitted information and approve it with appropriate conditions so ground disturbing activity can be completed during this calendar year.**

B. The city engineer may waive one or more requirements of subsections A and B of this section if the city engineer determines that site conditions, size or type or development of grading requirements do not warrant such detailed information. If one or more requirements are waived, the city engineer shall, in the staff report or decision, identify the waived provision(s), explain the reasons for the waiver, and state that the waiver may be challenged on appeal and may be denied by a subsequent review authority.

   **No waiver of any requirements is requested for this application.**

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.060 - Development standards.

Notwithstanding any contrary dimensional or density requirements of the underlying zone, the following standards shall apply to the review of any development proposal subject to this chapter. Requirements of this chapter are in addition to other provision of the Oregon City Municipal Code. Where provision of this chapter conflict with other provision of the Oregon City Municipal Code, the provisions that are more restrictive of regulated development activity shall govern.

A. All developments shall be designed to avoid unnecessary disturbance of natural topography, vegetation and soils. To the maximum extent practicable as determined by the review authority, tree and ground cover removal and fill and grading for residential development on individual lots shall be confined to building footprints and driveways, to areas required for utility easements and for slope easements for road construction, and to areas of geotechnical remediation.
The proposed development has been designed to minimize the disturbance area of the site while allowing the construction of a new single family detached home with garage and vehicle maneuvering area on this sloping uphill site. The siting and design of the home has also been required to take the historic overlay district into consideration.

B. All grading, drainage improvements, or other land disturbances shall only occur from May 1 to October 31. Erosion control measures shall be installed and functional prior to any disturbances. The city engineer may allow grading, drainage improvements or other land disturbances to begin before May 1 (but no earlier than March 16) and end after October 31 (but no later than November 30), based upon weather conditions and in consultation with the project geotechnical engineer. The modification of dates shall be the minimum necessary, based upon the evidence provided by the applicant, to accomplish the necessary project goals. Temporary protective fencing shall be established around all trees and vegetation designed for protection prior to the commencement of grading or other soil disturbance.

All grading and ground disturbing activities are planned to occur from May 1 to October 31. All erosion control measures will be installed and inspected prior to beginning work and temporary tree protection fencing installed per the attached arborist report.

C. Designs shall minimize the number and size of cuts and fills.

The proposed design limits the proposed development to the lower portion of the site. The depth of the excavations have been determined by the maximum slope negotiable by a passenger automobile with a driveway meandering to minimize the amount of cutting necessary.

D. Cut and fill slopes, such as those for a street, driveway accesses, or yard area, greater than seven feet in height (as measured vertically) shall be terraced. Faces on a terraced section shall not exceed five feet. Terrace widths shall be a minimum of three feet and shall be vegetated. Total cut and fill slopes shall not exceed a vertical height of fifteen feet. Except in connection with geotechnical remediation plans approved in accordance with the chapter, cuts shall not remove the toe of any slope that contains a known landslide or is greater than twenty-five percent slope. The top of cut or fill slopes not utilizing structural retaining walls shall be located a minimum of one-half the height of the cut slope from the nearest property line.

The proposed design limits the proposed development to the lower portion of the site. The depth of the excavations have been determined by the maximum slope negotiable by a passenger automobile with a driveway meandering to minimize the amount of cutting necessary. Cut slopes are proposed to be less than seven feet in height to avoid terracing.

E. Any structural fill shall be designed by a suitably qualified and experienced civil or geotechnical engineer licensed in Oregon in accordance with standard engineering practice. The applicant's engineer shall certify that the fill has been constructed as designed in accordance with the provisions of this chapter.

No structural fill is proposed for this project.

F. Retaining walls shall be constructed in accordance with the Oregon Structural Specialty Code adopted by the State of Oregon.

Proposed retaining walls are all designed per OSSC requirements.
G. Roads shall be the minimum width necessary to provide safe vehicle and emergency access, minimize cut and fill and provide positive drainage control. The review authority may grant a variance from the city's required road standards upon findings that the variance would provide safe vehicle and emergency access and is necessary to comply with the purpose and policy of this chapter.

No new roads are proposed as part of this project.

H. Density shall be determined as follows:
   1. For those areas with slopes less than twenty-five percent between grade breaks, the allowed density shall be that permitted by the underlying zoning district;
   2. For those areas with slopes of twenty-five to thirty-five percent between grade breaks, the density shall not exceed two dwelling units per acre except as otherwise provided in subsection I of this section;
   3. For those areas with slopes over thirty-five percent between grade breaks, development shall be prohibited except as otherwise provided in subsection I.4. of this section.

Project does not create any new lots. Criteria do not apply.

I. For properties with slopes of twenty-five to thirty-five percent between grade breaks:
   1. For those portions of the property with slopes of twenty-five to thirty-five percent, the maximum residential density shall be limited to two dwelling units per acre; provided, however, that where the entire site is less than one-half acre in size, a single dwelling shall be allowed on a lot or parcel existing as of January 1, 1994 and meeting the minimum lot size requirements of the underlying zone;
   2. An individual lot or parcel with slopes between twenty-five and thirty-five percent shall have no more than fifty percent or four thousand square feet of the surface area, whichever is smaller, graded or stripped of vegetation or covered with structures or impermeable surfaces.
   3. No cut into a slope of twenty-five to thirty-five percent for the placement of a housing unit shall exceed a maximum vertical height of fifteen feet for the individual lot or parcel.

This lot is less than 1 acre and was existing prior to Jan 1, 1994. A single dwelling unit is proposed.

The proposed new home and site improvements will involve approximately 2,380 s.f. (24% of site area) be disturbed for construction.

3. No cut into a slope of twenty-five to thirty-five percent for the placement of a housing unit shall exceed a maximum vertical height of fifteen feet for the individual lot or parcel.

The proposed new home will be sited so that there will be 12’ of fall through the building envelope.

4. For those portions of the property with slopes over thirty-five percent between grade breaks:
   a. Notwithstanding any other city land use regulation, development other than roads, utilities, public facilities and geotechnical remediation shall be prohibited; provided, however, that the review authority may allow development upon such portions of land upon demonstration by an applicant that failure to permit development would deprive the property owner of all economically beneficial use of the property. This determination shall be made considering the entire parcel in question and contiguous parcels in common ownership on or after January 1, 1994, not just the portion where development is otherwise prohibited by this chapter. Where this showing can be made
on residentially zoned land, development shall be allowed and limited to one single-family residence. Any development approved under this chapter shall be subject to compliance with all other applicable city requirements as well as any applicable state, federal or other requirements;

**No portion of the site with slopes greater than 30% slope are proposed to be developed in any way.**

b. To the maximum extent practicable as determined by the review authority, the applicant shall avoid locating roads, utilities, and public facilities on or across slopes exceeding thirty-five percent.

**No new roads or public infrastructure is proposed. Criterion does not apply.**

J. The geotechnical engineer of record shall review final grading, drainage, and foundation plans and specifications and confirm in writing that they are in conformance with the recommendations provided in their report.

**The geotechnical engineer of record has reviewed final drainage and foundation plans and provided the attached supplemental letter stating proposed work is in conformance with his recommendations.**

K. At the city's discretion, peer review shall be required for the geotechnical evaluation/investigation report submitted for the development and/or lot plans. The peer reviewer shall be selected by the city. The applicant's geotechnical engineer shall respond to written comments provided by the city's peer reviewer prior to issuance of building permit.

**The applicant's geotechnical engineer will respond to any questions or comments from the City's peer reviewer.**

L. The review authority shall determine whether the proposed methods of rendering a known or potential hazard site safe for construction, including proposed geotechnical remediation methods, are feasible and adequate to prevent landslides or damage to property and safety. The review authority shall consult with the city's geotechnical engineer in making this determination. Costs for such consultation shall be paid by the applicant. The review authority may allow development in a known or potential hazard area as provided in this chapter if specific findings are made that the specific provisions in the design of the proposed development will prevent landslides or damage. The review authority may impose any conditions, including limits on type or intensity of land use, which it determines are necessary to assure that landslides or property damage will not occur.

**The applicant shall pay the City for all review costs associated with the geotechnical review.**

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.070 - Access to property.

A. Shared private driveways may be required if the city engineer or principal planner determines that their use will result in safer location of the driveway and lesser amounts of land coverage than would result if separate private driveways are used.

**The driveway for the new home will utilize a previously cut in construction road partially within the unimproved Ganong St right of way to minimize cut and fill and avoid damaging the historic rock wall along 4th Ave.**
C. Innovations in driveway design and road construction shall be permitted in order to keep grading and cuts or fills to a minimum and to achieve the purpose and policy of this chapter.

The driveway has been configured to minimize excavation and serve passenger vehicles.

D. Points of access to arterials and collectors shall be minimized.

Access is limited to the site to the single driveway previously approved for the site.

E. The city engineer or principal planner shall verify that adequate emergency services can be provided to the site.

The home is close enough to 4th Ave to allow emergency services. Large vehicles will not be able to easily negotiate the proposed private driveway.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.080 - Utilities.

All new service utilities, both on-site and off-site, shall be placed underground and under roadbeds where practicable. Every effort shall be made to minimize the impact of utility construction. Underground utilities require the geologic hazards permitting and review prescribed herein.

All new utilities to serve the project will be underground and will be constructed in accordance with the recommendations of the geotechnical engineer.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.090 - Stormwater drainage.

The applicant shall submit a permanent and complete stormwater control plan. The program shall include, but not be limited to the following items as appropriate: curbs, gutters, inlets, catch basins, detention facilities and stabilized outfalls. Detention facilities shall be designed to city standards as set out in the city's drainage master plan and design standards. The review authority may impose conditions to ensure that waters are drained from the development so as to limit degradation of water quality consistent with Oregon City's Title III section of the Oregon City Municipal Code Chapter 17.49 and the Oregon City Public Works Stormwater Management Design Manual and Standards Plan or other adopted standards subsequently adopted by the city commission. Drainage design shall be approved by the city engineer before construction, including grading or other soil disturbance, has begun.

Stormwater water quality and detention will be provided on site and has been designed to current LID standards adopted by the City.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.100 - Construction standards.

During construction on land subject to this chapter, the following standards shall be implemented by the developer:
A. All development activity shall minimize vegetation removal and soil disturbance and shall provide positive erosion prevention measures in conformance with OCMC Chapter 17.47—Erosion and Sediment Control.

**Soil disturbance will be limited to the minimum necessary to construction activities and erosion and sediment control will be in place prior to start of construction. A large portion of the site will be fenced off for tree preservation during construction to provide additional protection of vegetation.**

B. No grading, clearing or excavation of any land shall be initiated prior to approval of the grading plan, except that the city engineer shall authorize the site access, brush to be cleared and the location of the test pit digging prior to approval of such plan to the extent needed to complete preliminary and final engineering and surveying. The grading plan shall be approved by the city engineer as part of the city's review under this chapter. The developer shall be responsible for the proper execution of the approved grading plan.

**No site work will be undertaken prior to approval of grading plan by the City.**

C. Measures shall be taken to protect against landslides, mudflows, soil slump and erosion. Such measures shall include sediment fences, straw bales, erosion blankets, temporary sedimentation ponds, interceptor dikes and swales, undisturbed buffers, grooving and stair stepping, check dams, etc. The applicant shall comply with the measures described in the Oregon City Public Works Standards for Erosion and Sedimentation Control (Ordinance 99-1013).

**Erosion and sediment control measures shall be in place prior to any soil disturbing activities.**

D. All disturbed vegetation shall be replanted with suitable vegetation upon completion of the grading of the steep slope area.

**All disturbed vegetation will be replanted with non-invasive vegetation suitable for the site.**

E. Existing vegetative cover shall be maintained to the maximum extent practicable. No grading, compaction or change in ground elevation, soil hydrology and/or site drainage shall be permitted within the drip line of trees designated for protection, unless approved by the city.

**The site will be cleared of invasive plant species and non-invasive plants will be maintained to the extent possible. Fencing will be installed at tree preservation areas during construction to ensure minimal disturbance of site.**

F. Existing perennial and intermittent watercourses shall not be disturbed unless specifically authorized by the review authority. This includes physical impacts to the stream course as well as siltation and erosion impacts.

**No existing perennial or intermittent watercourses exist on the site. Downstream watercourses will be protected from siltation and erosion from the construction site as required.**

G. All soil erosion and sediment control measures shall be maintained during construction and for one year after development is completed, or until soils are stabilized by revegetation or other measures to the satisfaction of the city engineer. Such maintenance shall be the responsibility of the developer. If erosion or sediment control measures are not being properly maintained or are not functioning properly due to faulty installation or neglect, the City may order work to be stopped. (Ord. 03-1014, Att. B3 (part), 2003; Ord. 94-1001 §2(part), 1994)
All erosion and sediment control measures will be maintained during construction and for 1 year after completion to allow for new plantings to be established to prevent erosion.

H. All newly created lots, either by subdivision or partition, shall contain building envelopes with a slope of thirty-five percent or less.

No new lots are proposed as part of this development. Criterion does not apply.

I. The applicant's geotechnical engineer shall provide special inspection during construction to confirm that the subsurface conditions and assumptions made as part of their geotechnical evaluation/investigation are appropriate. This will allow for timely design changes if site conditions are encountered that are different from those anticipated.

The Owner will retain the geotechnical engineer to provide special inspection during construction to verify all site conditions are as anticipated.

J. Prior to issuing an occupancy permit, the geotechnical engineer shall prepare a summary letter stating that the soils- and foundation-related project elements were accomplished in substantial conformance with their recommendations.

The geotechnical engineer will provide a summary letter prior to occupancy being approved by the City.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.110 - Approval of development.

The city engineer shall review the application and verify, based on the applicant's materials and the land use record, whether the proposed development constitutes a hazard to life, property, natural resources or public facilities. If, in the city engineer's opinion, a particular development poses such a hazard, the city engineer shall recommend to the review authority permit conditions designed to reduce or eliminate the hazard. These conditions may include, but are not limited to, prohibitions on construction activities between November 1st and March 31st.

The applicant will comply with the City Engineers recommendation to reduce or eliminate any hazardous conditions.

(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

17.44.120 - Liability.

Approval of an application for development on land subject to this chapter shall not imply any liability on the part of the city for any subsequent damage due to earth slides. Prior to the issuance of a building permit, a waiver of damages and an indemnity and hold harmless agreement shall be required which releases the city from all liability for any damages resulting from the development approved by the city's decision.

The Owner agrees to hold the City harmless from any liability or damages resulting from development approved by the City.
17.44.130 - Compliance.

Nothing contained in this chapter shall relieve the developer of the duty to comply with any other provision of law. In the case of a conflict, the more restrictive regulation shall apply.

_The Owner/developer will comply with all provisions of the law and conform with the most restrictive provisions if conflicts exist._

17.44.140 - Appeal.

The review authority's decision may be appealed in the manner set forth in Chapter 17.50.
July 10, 2017

Mr. Todd Iselin
Iselin Architects, PC
1307 Seventh Street
Oregon City, Oregon 97045

Dear Mr. Iselin:

Re: Supplemental Geotechnical Consultation Services, Review of Proposed Architectural and Civil Engineering Plans, Proposed Ares Residence Project, Tax Lot No. 300, 4th Avenue and Ganong Street, Oregon City (Clackamas County), Oregon

In accordance with your request and as required by the City of Oregon City Planning and Community Department, we have completed our geotechnical review of the proposed Architectural and Civil Engineering plans for the above subject Ares residential home project. As you are aware, we previously performed a Geotechnical Investigation and Geologic Landslide Hazard Assessment for the site and project the results of which were presented in our formal report dated January 6, 2017.

As part of our supplemental Geotechnical Consultation Services, we have reviewed the Architectural Plan Sheet A1.1 prepared by Iselin Architects, PC and the proposed Civil Engineering Plan Sheets 1 and 2 prepared by Sisul Engineering. In general, our review has found that the site improvements for the proposed residential home and the proposed new private access drive have been designed in substantial conformance with the recommendations presented in the above subject report. Specifically, the proposed private access drive will require site excavations and/or cuts into the existing moderately steep slope generally less than five (5) feet. Additionally, both the north and south sides of the private access drive will be supported by a new 2-foot or 6-foot high rockery wall, respectively, constructed in accordance with the recommendations presented in the above subject report.
In this regard, we take no exceptions with the above subject Architectural and Civil Engineering plans and do not recommend any changes or modifications to the above subject Architectural and Civil Engineering plans for this project at this time. However, we recommend that all aspects of the site grading and earthwork operations for the proposed Ares residential home project be monitored by a representative of Redmond Geotechnical Services, LLC.

We appreciate this opportunity to be of service to you at this time and trust that the above information is suitable to your present needs.

Sincerely,

Daniel M. Redmond, P.E., G.E.
President/Principal Engineer

Cc: Mr. Tom Sisul
    Sisul Engineering