November 27, 2017

Mr. Jim Wiggins
Salishan Hills Homeowners Association
Via email: vipaddress@centurytel.net

RE: GEOTECHNICAL EVALUATION & REMEDIATION DESIGN
VARIOUS SECTIONS OF DISTRESSED ROADWAY
SALISHAN HILLS – GLENEDEN BEACH, OREGON
Branch Engineering Inc. Project No. 17-260

Introduction: After Branch Engineering, Inc. (BEI) completed the pavement distress survey for the private roads within the Salishan Hills residential community, four locations were selected by the homeowner's association for subsurface investigation and evaluation of stability. It is our understanding that the road system for the community is a combination of developed roads specifically for the subdivision development and former logging roads converted to permanent access roads during subdivision construction approximately 50-years ago. Logging roads were typically constructed to be used for temporary access and were not constructed to any engineering standard for long-term stability. It appears that the distressed portions of Salishan Hills Drive and Spruce Burl Lane are former logging roads on either side of the drainage channel and are comprised of either a cut/fill transition or completely of fill generated from on-site material to create the road surface grade. The Siletz View Lane investigation location appears to be a former logging road crossing a slope near the head of a drainage way and the Bluffs Drive investigation site consists of a likely former logging road traversing the upper portion of a hillside.

Scope of Work: Our scope of work included a subsurface investigation and site reconnaissance at the selected work locations. On August 14, 2017 and August 15, 2017 exploratory borings were advanced with a trailer mounted Simco 2400 drill rig using solid flight augers. Standard penetration testing (SPT) was used for material sampling and to assess the consistency of the subsurface soil. The soil was visually classified in accordance with the American Society of Testing and Materials (ASTM) Method D-2488, representative soil samples were collected for laboratory in-situ moisture content, and Free Swell (IS 2720) testing. Boring log summaries with soil descriptions are attached for review and the attached Figure 1 Site Exploration Map displays the general locations of the individual investigation sites within the development. Site specific figures are also attached displaying more precise boring locations and cross section views with estimated subsurface soil conditions.

Site Geology: The geology of the site is mapped as Oligocene and upper Eocene age Alsea Formation consisting of siltstone, sandstone, and claystone bedrock material that has been weathered to silty clay or clayey silt soil to depths of 15- to 20-feet before encountering a siltstone with identifiable bedrock structure.

Findings: At all four sites, visible pavement distress of surface cracking with varying amounts of settlement was observed at the time of our investigation. At each of the selected sites, BEI found fill material overlying native soil primarily consisting of wet, soft, silt and clay. The fill material encountered in most of the site borings was on-site derived soil mixed with organic debris, wood fragments, and rock fragments. The fill had Standard Penetration Test (SPT) blow counts generally less than 10 with more than half being 5 or less. In-situ moisture contents of the fill exceeded 50% in comparison to an optimum moisture content of 20% to 25% for proper compaction of the soil. The presence of organics in the fill, its placement over former topsoil, and the relative lack of compaction and high moisture contents indicate that the fill was likely pushed ahead of a dozer onto existing sloped ground to create a level roadway. The native slopes in the area are generally about 2:1 (horizontal:vertical) (27°) and the fill slopes created are steepened to between 1:1 (45°) and 1.5:1 (34°).

SPT samples retrieved from depths up to 10-feet in borings located at Salishan Hills and Spruce Burl Lane indicate that a significant amount of organics/wood is present underneath current road structures and above native subgrade soil.
At the Siletz View and Bluffs Drive locations sections of rock fill consisting of rip-rap to boulder size stone up to approximately 10-feet in thickness were found overlying soft, wet native topsoil and silt. The stone fill appears to have placed in the downslope portions of the roadway fill and was found to be relatively loose/unconsolidated in our borings. The underlying native soil is soft and the weight of the stone fill on the native subgrade soil over time may have resulted in settlement throughout the fill section.

**Conclusions:** Based on our field investigation findings, laboratory testing, and data analysis, the fill slopes created from road building are marginally unstable due to poor construction techniques, improper drainage, slope erosion, and undercutting of slopes. BEI has not determined a specific cause(s) of the roadway distress at each of the four-site investigated in this report other than the combination of those previous mentioned. Although there are no mapped landslides within the Salishan Hills development (Oregon Department of Geology and Mineral Industries HazVu mapping), there are mapped landslides nearby to the east in the same geologic formation and Light Detection and Ranging (LiDAR) mapping shows steep slopes along drainage ways. The improper placement of fill on steep slopes can cause landsliding.

Additional sections of the road system likely exhibit the same conditions as those with visible distress, but at this time do not currently show indications of such distress; these sections may never do so or could begin show distress in the near future. Road reconstruction measures described below will not guarantee that other sections of the road system will not fail or become distressed in the future.

**Recommendations:** Of the four sites investigated, the two sites located on Salishan Hills Drive and Spruce Burl Lane were identified as the highest priority for reconstruction measures. Both of these sites appear to have potential to pose vehicle safety and access concerns; Spruce Burl Lane is the only access route for several homes. Salishan Hills Drive is exhibiting signs of road fill slope failure and sliding towards the adjacent drainage. Spruce Burl Lane has organics within the fill sections at depths up to 10-feet. Bluffs Drive and Siletz View sites exhibit surface cracking indicating fill settlement has taken place and will likely continue; however, settlement or fill failure that will impact homeowner safety or access does not appear imminent.

**Salishan Hills Drive and Spruce Burl Lane:** BEI recommends remedial actions be undertaken to mitigate the progression of slope distress before complete failure. Several remedial options were evaluated, such as soil nailing, retaining walls, and compaction grouting; however, based on cost and capabilities of local contractors the following two options are presented:

1. The “Do Nothing” option would be to monitor the distressed areas for movement and repair in accordance with Option 2 below until such time as the site conditions become unsafe. It is unlikely that these sites will fail catastrophically, but more likely that continued downward movement of the fill soil will occur until conditions are deemed unsafe for vehicle travel, such as more than 4-inches of vertical displacement between pavement sections over a distance of 5-feet.

2. The “Reconstruction” option would be to remove and replace the unsuitable soil/debris material underlying the distressed road sections in accordance with the attached Figures 2 through 5. The lateral extent of repair at each site can be determined by the Salishan Home Owners Association (SHOA); however, BEI recommends at least 60-feet at the worst section on Salishan Hills Drive, and 140-feet along Spruce Burl Lane. As depicted on the figures, the estimated cross-sectional area of fill will require removal, the original native slope properly benched with a toe of fill keyway and a drain installed. The removed volume of material will be replaced with crushed aggregate not exceeding 1.5-inches in diameter compacted to at least 90% of its maximum dry density as determined by ASTM Method D-1557. The aggregate will be reinforced as shown with bi-axial geogrid and placed at a 1:1 slope to provide a wider shoulder at the top of slope for safety and lateral support of the road surface. The use of lightweight Geofoam fill material was evaluated but did not appear to provide any cost savings for the project and is likely not readily available to or used by the local contractors.
As an interim measure, BEI recommend that SHOA consider the possibility of an alternate/temporary access route for the homes on Spruce Burl and Beaver Pond Lanes, including a possible connection from the end of Beaver Pond Lane southeast around to Fairway Drive/Salishan Hills Drive.

**Siletz View Lane and Bluffs Drive:** BEI recommends the areas of distress be monitored for continued movement and as further settlement occurs increase the priority of undertaking repair work. We recommend repair work be planned similar to Option 2 described above; there is however, some volume of existing stone fill present at these locations in portions of the fill mass. As the upper level of fill is removed the underlying stone fill material may be evaluated for re-use as an opportunity for cost savings. After removal of the organics/topsoil and soft soil fill, the lower portions of existing stone maybe suitable for regrading and compaction in place before replacing the remaining fill slope with a compacted aggregate and geogrid system as shown on Figures 6 through 9. This would be considered a partial removal and replacement method of roadway stabilization.

**Cost Mitigation and Risk:** We understand the SHOA would like to review options intended to provide a low, middle, and high-level cost range for the road distress mitigation. Anticipated costs for the proposed repair options are discussed below. For the SHOA to determine the best suited method and level of repair to the roadways, we recommend that the members understand the construction costs associated with the proposed work as well as the maintenance and associated risk of long term settlement associated with the proposed work plan. Careful phasing of repair work to manage budgets, paired with a monitoring program in known areas of pavement distress may allow the SHOA some flexibility to develop a program to address the long-term stability of the roadways within the development.

The initial cost to “do nothing” is the lowest in the short-term and may be suitable until the time that roadways become impassible, which is somewhat subjective unless a complete failure occurs. A slightly upgraded option would be return the road surface to gravel and regrade as needed until a failure occurs. A costlier option would be to overlay existing pavement or remove and replace the existing road structures without removing underlying fill/organics that are causing the settlement/slope failure; therefore, not providing a long-term solution. The potential for these solutions to add weight to the top of the slope may exacerbate the underlying problem.

Complete removal of unsuitable fill material and replacement with engineered aggregate fill with geogrid reinforcement is considered the lowest risk method of stabilizing the existing distressed roadway areas, but also the costliest. As mentioned above, partial removal and replacement may be feasible at some locations, however this method does involve an increased risk of long-term settlement.

**Construction Access:** Of the sites evaluated Spruce Burl Lane appears to be a site that is the sole accessway for residences within the development. Construction work anticipated to repair the roadway is expected to cut off access to homes serviced by the roadway. Prior to beginning reconstruction work on the site or in the event of a fill failure that renders the road impassable we recommend that SHOA research the feasibility of a temporary access road connecting Fairway Drive through the clear-cut logging area to the south of the site or another possible route to access the homes on Spruce Burl Lane.

For the other sites evaluated the anticipated level of work required will likely lead to road closures at the specific work areas lasting weeks with a truck route used to access the site receiving significant traffic to remove and import the required materials. The Siletz View Lane site is also the only access route for several homes, but the pavement distress patterns and findings from our field investigation indicate that at least one lane of traffic could likely be maintained in the event of a road failure or reconstruction activities.

**Existing Utilities:** As-Built drawings of existing utility alignments were not reviewed at the time of this report. We observed utilities at all four sites with gravity sewer and storm drain lines present in at least one of the four site’s required work areas (Salishan Hills Drive). The required depth of excavation at the sites will likely expose underground utilities adjacent or within the sites. These utilities may require temporary by-passing or re-routing while the construction work is performed. If accurate as-built drawings are not available for review prior to construction; exploratory work to map and determine the depth of utilities within, or adjacent to the work areas is recommended.
Estimated Quantities & Cost Estimates: The estimated quantities of removal and replacement per linear foot (LF) of reconstructed roadway length are:

Salishan Hills Drive
11 cubic yards of removal/LF
15 cubic yards of replacement/LF

Spruce Burl Lane
11 cubic yards of removal/LF
16 cubic yards of replacement/LF

Siletz View Lane
20 cubic yards of removal/LF
26 cubic yards of replacement/LF

Bluffs Lane
11 cubic yards of removal/LF
12 cubic yards of replacement/LF

BEI has provided preliminary information for the full site repair option to a local contractor for preliminary construction cost estimates on the Salishan Hills Drive and Spruce Burl Lane sites. The cost estimates are based on the above quantity estimates for excavation and fill, and repair lengths of 60-feet for Salishan Hills Drive and 140-feet of Spruce Burl Lane.

The approximate unit costs for each site were similar and assume site construction activities will be independent of each other. The unit cost of excavation and removal is $25/cy, and the unit cost of placement and compaction of aggregate fill is $55/cy. An additional 15% of the total cost for excavation and fill shall be included to cover equipment mobilization, site supervision, erosion control, safety fencing, and miscellaneous items. The construction bid for Salishan Hills Drive for the above stated quantities was approximately $77,000 and the bid for Spruce Burl Lane was approximately $186,500, neither of which include repaving at a unit cost of $5/sf. The unit costs will vary as the extent and volume of repair work increases or decreases, availability of materials, bidding environment, and the time of year site work is performed. These construction costs were provided to BEI for use as informational/planning resources and should not be considered an actual quote for services.

Additional project costs may include permits, traffic control, utility line locating, rerouting, replacement, engineering oversight, quality control testing, and unanticipated site conditions. An additional 25% to 35% contingency of the estimated construction costs is recommended to cover such fees/costs.

Sincerely

Branch Engineering Inc.

Digitally signed by Ronald J. Derrick
Date: 2017.11.27 13:27:51 -08'00'
EXPIRES: 12/31/2017
Ronald J. Derrick, P.E., G.E.
Principal Geotechnical Engineer

Branch Engineering, Inc.
Attachments:

Figure 1 - Site Location Map
Figures 2-9 - Site Specific Exploration, Cross Sections, and Reconstruction Drawings
Exploratory Boring Log Summaries
LEGEND

- S-1: Indicates approximate location of exploratory boring
- Indicates areas of existing pavement with visible cracking/settlement/distress
- Indicates areas of likely fill with organics (cross section view)

NOTES

1. Elevations are taken from assumed datum for topographic mapping
2. Existing utilities are not shown
NOTES
1. ELEVATIONS ARE TAKEN FROM ASSUMED DATUM FOR TOPOGRAPHIC MAPPING
2. EXISTING SANITARY SEWER/STORM DRAIN GRAVITY LINES NOT SHOWN.
   RECONSTRUCTION OF ROADWAY MAY REQUIRE TEMPORARY BY-PASS
CUT/FILL VOLUME ESTIMATE
Spruce Burl Lane
Cut: 11 CY/LF
Fill: 36 CY/LF

RECONSTRUCTION NOTES/SEQUENCE
1. REMOVE FAILING ROAD FILL MATERIAL TO SUITABLE SUBGRADE FREE OF
   ORGANICS, TOPSOIL, OR SATURATED CLAY
2. ESTABLISH LEVEL BENCHING INTO SUITABLE SUBGRADE PRIOR TO PLACING
   COMPACTED AGGREGATE FILL, MINIMUM WIDTH OF BENCHES 6-4 FEET,
   BENCHING NOT TO EXCEED 1:1 (V: H) SLOPING
3. ESTABLISH KEYWAY AT BASE OF NEW FILL SLOPE WITH A MIN. DEPTH OF 0.5 FEET
   INTO SUITABLE SUBGRADE MATERIAL AND INSTALL 6 INCH DIAMETER PERFORATED
   DRAIN PIPE WRAPPED IN FILTER FABRIC AND OPEN-GRADED ROCK. OUTLET TO
   BASE OF EXISTING DRAINAGE
4. PLACE COMPACTED AGGREGATE FILL IN LOOSE UTS NOT EXCEEDING
   12 INCHES IN THICKNESS. COMPACT TO 95% RELATIVE COMPACTION AS
   DETERMINED BY AASHO T-189 (MODIFIED PROCEDURE)
5. INSTALL BIAXIAL GEORGRID. ALL GEOFABRICS BY GEORGRID OR
   APPROVED EQUAL ON SUBGRADE AT KEYWAY BASE AND AT THREE LOCATIONS
   AS SHOWN IN RECONSTRUCTED FILL SLOPE

TYPICAL ROAD RECONSTRUCTION CROSS SECTION (SCALE: 1:5)

NEW FILL SLOPE FACE SLOPE 1:1 (H:V)

SUITABLE SUBGRADE

COMPACTED AGGREGATE FILL

SLOPE BENCHEING

BIAXIAL GEORGRID

KEYWAY

MIN. DEPTH = 2 FEET

HEEL DRAIN AT KEYWAY BASE
OUTLET TO BASE OF DRAINAGE

LEGEND

B-1 INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

INDICATES AREAS OF EXISTING PAVEMENT
WITH VISIBLE CRACKING/SSETLEMENT/DISTRESS

INDICATES AREAS OF LIKELY FILL WITH ORGANICS (CROSS SECTION VIEW)

SCALE: VARIES
ROADWAY RECONSTRUCTION - SPRUCE BURL LANE, SALISHAN HILLS RESORT
GLEDENED BEACH, OREGON

FIGURE 5
11-9-2017
PROJECT NO. 17-288
NOTES
1. ELEVATIONS TAKEN FROM ASSUMED DATUM FOR TOPOGRAPHIC MAPPING
2. EXISTING UTILITIES NOT SHOWN

LEGEND
- INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING
- INDICATES AREAS OF EXISTING PAVEMENT WITH VISIBLE CRACKING/SETTLEMENT/DISTRESS
- INDICATES AREAS OF LIKELY Fill, RAP AND BOULDERS (CROSS SECTION VIEW)

CROSS SECTION A-A'

SCALE: 1/20 (1" = 1')
SITE EXPLORATION MAP, CROSS SECTION - SILETZ VIEW LANE, SALISHAN HILLS RESORT
GLENEDEN BEACH, OREGON

FIGURE-6
8-14-2017
PROJECT NO. 17-266
NOTES

1. ELEVATIONS TAKEN FROM ASSUMED DATUM FOR TOPOGRAPHIC MAPPING
2. EXISTING SANITARY SEWER/STORM DRAIN GRAVITY LINES NOT SHOWN. RECONSTRUCTION OF ROADWAY MAY REQUIRE TEMPORARY BY-PASS

CUT/FILL VOLUME ESTIMATE

<table>
<thead>
<tr>
<th>Siletz View Lane</th>
<th>Cut: 20 CY/YD*</th>
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</thead>
<tbody>
<tr>
<td>Fill: 20 CY/YD*</td>
<td></td>
</tr>
</tbody>
</table>

*Quantities shown reflect complete fill removal and may be reduced by approved use of onsite rip-rap/boulder fill

RECONSTRUCTION NOTES/SEQUENCE

1. NOTE: FULL REMOVAL OF EXISTING FILL SHOWN IN CROSS SECTION VIEW. QUANTITY OF MATERIAL REQUIRING REMOVAL MAY BE REDUCED IF PARTIALLY REMOVED AND RE-GRADED/COMPACTED IN PLACE UNDER THE SUPERVISION OF THE GEOFICNICAL ENGINEER OF RECORD.
2. REMOVE FAILING ROAD FILL MATERIAL TO SUITABLE SUBGRADE FREE OF ORGANICS, TOPSOIL, & SATURATED CLAY
3. ESTABLISH LEVEL BENCHING INTO SUITABLE SUBGRADE PRIOR TO PLACING COMPACTED AGGREGATE FILL. MINIMUM WIDTH OF BENCHES IS 4 FEET. BENCHING NOT TO EXCEED 1:1 (HY) SLOPES
4. ESTABLISH KEYWAY AT BASE OF NEW FILL SLOPE WITH A MIN. DEPTH OF 2 FT INTO SUITABLE SUBGRADE MATERIAL AND INSTALL 1 INCH DIAMETER PERFORATED DRAIN PIPE WRAPPED IN FILTER FABRIC AND OPEN GRADED ROCK, OUTLET TO BASE OF EXISTING DRAINAGE
5. PLACE COMPACTED AGGREGATE FILL IN LOOSE LIFTS NOT EXCEEDING 12 INCHES IN THICKNESS, COMPACT TO 95% RELATIVE COMPACTION AS DETERMINED BY AASHO T-180 (MODIFIED PROCTOR)
6. INSTALL BIAXIAL GEOGRID (ALLIANCE GEOSYNTHETICS BX GEOGRID OR APPROVED EQUAL) ON SUBGRADE AT KEYWAY BASE AND AT THREE LOCATIONS AS SHOWN IN RECONSTRUCTED FILL SLOPE

TYPICAL ROAD RECONSTRUCTION CROSS SECTION (SCALE: 1:10)
LEGEND

- B-1: Indicates approximate location of exploratory boring
- INDICATES AREAS OF EXISTING PAVEMENT WITH VISIBLE CRACKING/SETTLEMENT/DETRISSION
- INDICATES AREAS OF LIKELY FILL WITH ORGANICS [CROSS SECTION VIEW]

NOTES

1. ELEVATIONS TAKEN FROM ASSUMED DATUM FOR TOPOGRAPHIC MAPPING
2. EXISTING UTILITIES ARE NOT SHOWN

SCALE: 1:20 (11X17)

EXISTING CONDITIONS - CROSS SECTIONS - BLUFFS DRIVE, SALISHAN HILLS RESORT

GLENEDEN BEACH, OREGON

8-14-2017

PROJECT NO. 17-286
LEGEND

- B-1 INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING
- INDICATES AREAS OF EXISTING PAVEMENT WITH VISIBLE CRACKING/SETTLEMENT/DISTRESS
- INDICATES AREAS OF LIKELY FILL WITH ORGANIC(S) (CROSS SECTION VIEW)

NOTES

1. ELEVATIONS TAKEN FROM ASSUMED DATUM FOR TOPOGRAPHIC MAPPING
2. EXISTING FEATURES ARE NOT SHOWN. RECONSTRUCTION OF ROADWAY MAY REQUIRE TEMPORARY BY-PASS

CUT/FILL VOLUME ESTIMATE

Bluffs Drive

Cut: 11 CY/LF*
Fill: 12 CY/LF*

*QUANTITIES SHOWN REFLECT COMPLETE FILL REMOVAL AND MAY BE REDUCED BY APPROVED USE OF ON-SITE R&R/RAP/Boulder Fill

RECONSTRUCTION NOTES/SEQUENCE

1. NOTE: FULL REMOVAL OF EXISTING FILL SHOWN IN CROSS SECTION VIEW. QUANTITY OF MATERIAL REQUIRING REMOVAL MAY BE REDUCED IF PARITALLY REMOVED AND RE-GRADED/COMPACTED IN PLACE UNDER THE SUPERVISION OF THE GEO-TECHNICAL ENGINEER OF RECORD
2. REMOVE FAILING ROAD FILL MATERIAL TO SUITABLE SUBGRADE FREE OF ORGANICS, TOPSOIL, & SATURATED CLAY
3. ESTABLISH LEVEL BENCHING INTO SUITABLE SUBGRADE PRIOR TO PLACING COMPACTED AGGREGATE FILL. MINIMUM WIDTH OF BENCHES IS 6-FeET. BENCHING NOT TO EXCEED 1:1 (H:V) SLOPING
4. ESTABLISH KEYWAY AT BASE OF NEW FILL SLOPE WITH A MIN. DEPTH OF 2 FEET INTO SUITABLE SUBGRADE MATERIAL AND INSTALL 4-INCH DIAMETER PERFORATED DRAIN PIPE WRAPPED IN FIBER FABRIC AND OPEN GRADED ROCK, OUTLET TO BASE OF EXISTING DRAINAGE
5. PLACE COMPACTED AGGREGATE FILL IN LOOSE LITTS NOT EXCEEDING 12-INCHES IN THICKNESS, COMPACT TO 95% RELATIVE COMPACTION AS DETERMINED BY AASHO T-180 (MODIFIED PROCTOR)
6. INSTALL BIAXIAL GEOGRID (ALLIANCE GEOSYNTHETICS/BX GEOGRID OR APPROVED EQUAL) ON SUBGRADE AT KEYWAY BASE AND AT THREE LOCATIONS AS SHOWN IN RECONSTRUCTED FILL SLOPE

TYPICAL ROAD RECONSTRUCTION CROSS SECTION (SCALE: 1:5)

REMOVED SETTING/TAILING ROAD FILL

BIAXIAL GEOGRID

HEEL DRAIN AT KEYWAY BASE OUTLET TO BASE OF DRAINAGE

BIAXIAL GEOGRID

COMPACTED AGGREGATE FILL

KEYWAY MIN. DEPTH = 2 FEET

SLOPE BENCHING

SUITE GRADGRDE MATERIAL

BIAXIAL GEOGRID

HELMAN ARM

FIGURE-9
B-14-2017
PROJECT NO. 17-286
### Relative Density - Coarse Grained Soils

<table>
<thead>
<tr>
<th>RELATIVE DENSITY</th>
<th>SPT N-VALUE</th>
<th>D&amp;M SAMPLER (140 lbs hammer)</th>
<th>D&amp;M SAMPLER (300 lbs hammer)</th>
<th>USCS GRAIN SIZE</th>
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</thead>
<tbody>
<tr>
<td>VERY LOOSE</td>
<td>&lt; 4</td>
<td>&lt; 11</td>
<td>&lt; 4</td>
<td>FINES</td>
</tr>
<tr>
<td>LOOSE</td>
<td>4 - 10</td>
<td>11 - 26</td>
<td>4 - 10</td>
<td>SAND</td>
</tr>
<tr>
<td>MEDIUM DENSE</td>
<td>10 - 30</td>
<td>26 - 74</td>
<td>10 - 30</td>
<td>#200 - #40 (.425 mm)</td>
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<tr>
<td>DENSE</td>
<td>30 - 50</td>
<td>74 - 120</td>
<td>30 - 47</td>
<td>Medium</td>
</tr>
<tr>
<td>VERY DENSE</td>
<td>&gt; 50</td>
<td>&gt; 120</td>
<td>&gt; 47</td>
<td>Coarse</td>
</tr>
</tbody>
</table>

### Coarse Grained Soils:
- More than 50% retained on No. 200 sieve
- Gravels: 50% or more retained on the No. 4 sieve
- Sands: 50% or more passing the No. 4 sieve

### Fine Grained Soils:
- Less than 50% retained on No. 200 sieve
- Silts and clays
- Liquid limit less than 50
- Liquid limit 50 or greater

### Structure
- Stratifed: Alternating layers of material or color > 6mm thick.
- Laminated: Alternating layers < 6mm thick.
- Fissured: Breaks along definite fracture planes.
- Slickensided: Striated, polished, or glossy fracture planes.
- Blocky: Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
- Lenses: Has small pockets of different soils, note thickness.
- Homogeneous: Same color and appearance throughout.

### Moisture Content
- Dry: Absence of moisture, dusty, dry to the touch.
- Damp: Some moisture but leaves no moisture on hand.
- Moist: Leaves moisture on hand.
- Wet: Visible free water, usually saturated.

### Group Symbols and Typical Names
- G: Well graded gravels and gravel-sand mixtures, little or no fines.
- GP: Poorly graded gravels and gravel-sand mixtures, little or no fines.
- GC: Clayey gravels, gravel-sand-clay mixtures.
- SW: Well graded sands and gravelly sands, little or no fines.
- SP: Poorly graded sands and gravelly sands, little or no fines.
- SM: Silty sands, sand-silt mixtures.
- SC: Clayey sands, sand-clay mixtures.
- ML: Inorganic silts, rock flour, clayey silts.
- CL: Inorganic clays of low to medium plasticity, lean clays.
- OL: Organic silt and organic silty clays of low plasticity.
- MH: Inorganic silts, clayey silts.
- CH: Inorganic clays of high plasticity, fat clays.
- OH: Organic clays of medium to high plasticity.

### List of Abbreviation & Explanations
- SPT: Standard Penetration Test split barrel sampler
- LL: Atterberg Liquid Limit
- PL: Atterberg Plastic Limit
- PP: Pocket Penetrometer
- VS: Vane Shear
- G: Grab sample
- MC: Moisture Content
- MD: Moisture Density
- UC: Unconfined Compressive Strength
- DCP: Dynamic Cone Penetrometer Testing
- BGS: Below Ground Surface
## Material Description

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Graphic Log</th>
<th>Surface Elevation = N/A</th>
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</thead>
<tbody>
<tr>
<td>1.5'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**AC Pavement [5" thick]**
Crushed Rock Fill, Angular, medium dense

**[CL-SC/FILL]** Soft, moist, gray clayey silt, with organics (roots) and zones of brown oxidation staining

**SAMPLE @ 5' BGS:** IN-SITU MOISTURE CONTENT = 64.5%
FREE SWELL POTENTIAL = 45%
-Wood/organic content in sample

**[ML]** Medium Stiff, Gray Weathered Siltstone

**[ML]** Gray Weathered Siltstone

Total Depth = 15'
No Groundwater Encountered

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**Client:** Salishan Hills Homeowners Association  
**Logged By:** MWR  
**Checked By:** RJD  
**Date of Boring:** 8-14-17  
**Groundwater Level:** None Encountered

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**Drilling Contractor:** Greg Vandehey Soil Sampling  
**Drilling Method:** Solid Flight Auger

**Notes:**

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**Branch Engineering**  
Salishan Hills HOA, Gleneden Beach, OR 97388  
Project No. 17-260

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**Graphic Log:**

- **Standard Penetration Resistance (140-lb weight, 30-in. drop):**
  - Blows per foot
  - Moisture content%
  - Percent passing No. 200 sieve

---

**Atterberg Limits:**

- **PL:**
- **LL:**

---

**Material Description:**

- **AC Pavement (5" thick):**
- **Crushed Rock Fill, Angular, medium dense:**
- **[CL-SC/FILL]:** Soft, moist, gray clayey silt, with organics (roots) and zones of brown oxidation staining
- **SAMPLE @ 5' BGS:** IN-SITU MOISTURE CONTENT = 64.5%
  - FREE SWELL POTENTIAL = 45%
  - Wood/organic content in sample
- **[ML]:** Medium Stiff, Gray Weathered Siltstone
- **[ML]:** Gray Weathered Siltstone

Total Depth = 15'
No Groundwater Encountered
**MATERIAL DESCRIPTION**

- **AC Pavement (5" thick)**
- Crushed Rock Fill, Angular, medium dense
- [CL] Light Brown, moist, soft Clay
- Zones of stiff and blocky decomposed sandstone encountered through boring

**SAMPLE @ 10' BGS:**
- **IN-SITU MOISTURE CONTENT = 58.1%**
- **FREE SWELL POTENTIAL = 45%**

**SAMPLE @ 15' BGS:**
- **IN-SITU MOISTURE CONTENT = 56.5%**
- **FREE SWELL POTENTIAL = 70%**

**Total Depth = 21'**
- Static water level at approximately 19' BGS

---

**NOTES:**

- ZONES OF STIFF AND BLOCKY DECOMPOSED SANDSTONE ENCOUNTERED THROUGH BORING
- [CL] SOFT, MOIST, REDDISH BROWN CLAY WITH WEATHERED SANDSTONE
- [ML] GRAY WEATHERED SILTSTONE

---

**CLIENT:** SALISHAN HILLS HOMEOWNERS ASSOCIATION
**LOGGED BY:** MWR

**DRILLING CONTRACTOR:** GREG VANDEHEY SOIL SAMPLING
**DATE OF BORING:** 8-14-17

**DRILLING METHOD:** SOLID FLIGHT AUGER
**CHECKED BY:** RJD

**NOTES:**

- Zones of stiff and blocky decomposed sandstone encountered through boring
- [CL] Soft, moist, Reddish Brown Clay with weathered sandstone
- [ML] Gray Weathered Siltstone

---

**PROJECT NO. 17-260**
Salishan Hills HOA, Gleneden Beach, OR 97388

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**GEOTECHNICAL INVESTIGATION**
EXPLORATORY BORING

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**310 5th Street Springfield, Oregon | p: 541.779.2577 | www.branchengineering.com**
MATERIAL DESCRIPTION

SURFACE ELEVATION = N/A

- AC Pavement [6' thick]
- Crushed Rock Fill, Angular, medium dense
- [FILL] Soft, wet, silt and organic material, fine roots and wood chips in sampler

SAMPLE @ 7.5' BGS: IN-SITU MOISTURE CONTENT = 64.1%
FREE SWELL POTENTIAL = 60%

[C1] Soft to Medium-Stiff, light brown, moist, Clay with Claystone Fragments

[C1] Stiff, light brown-tan weathered Claystone with red mottling, stiffness increasing with depth

[ML] Very Stiff to Hard Gray Siltstone

Total Depth = 19.5'
No Groundwater Encountered

BLOG COUNT (N VALUE)
SAMPLE AND SAMPLER TYPE
STANDARD PENETRATION RESISTANCE (140-LB WEIGHT, 30-IN. DROP)

DEEPER ELEVATION

0.5' 5-1.0 15' SPT
1.5' 8-1.1 18' SPT
5' 5-1.0 20' SPT
7.5' 2-4.7 25' SPT
10' 7-9.9 30' SPT
15' 7-9.10 35' SPT
18' 21-38-50 40' SPT

PERCENT PASSING NO. 200 SIEVE

TOTAL DEPTH = 19.5’
No Groundwater Encountered

CLIENT: SALISHAN HILLS HOMEOWNERS ASSOCIATION
LOGGED BY: MWR
DATE OF BORING: 8-14-17
NOTES: Boring located along northern shoulder of Spruce Buri Road
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Graphic Log</th>
<th>Material Description</th>
<th>Surface Elevation</th>
<th>Blow Count Value</th>
<th>BLOW COUNT N VALUE</th>
<th>Moisture Content %</th>
<th>Percent Passing No. 200 Sieve</th>
<th>Atterberg Limits</th>
<th>Standard Penetration Resistance (140-lb weight, 30-in. drop)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>2</td>
<td>2-2-2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>2-2-1</td>
<td>SPT</td>
<td></td>
<td></td>
<td></td>
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<td>100</td>
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<tr>
<td>7.5</td>
<td>1-1-2</td>
<td>SPT</td>
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<td></td>
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<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>2-3-4</td>
<td>SPT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>3-3-4</td>
<td>SPT</td>
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<td></td>
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<td></td>
<td></td>
<td>50</td>
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<tr>
<td>20</td>
<td>6-11-16</td>
<td>SPT</td>
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<td></td>
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<td>100</td>
</tr>
</tbody>
</table>

**Notes:**

- ** Crushed Rock Fill, Angular, medium dense
- ** Soft, wet, silt and organic material, fine roots and wood chips in sampler
- ** Soft material observed by easy drilling progress, low blow counts, and organic material in samplers indicating fill
- ** Sample @ 10' BGS: In-Situ moisture content = 60.1%
  Free swell potential = 30%
- ** Soft, organic clay material transitioning to (MH) soft, moist, light brown Clayey Silt
- ** Sample @ 15' BGS: In-Situ moisture content = 57.3%
  Free swell potential = 60%
- ** MH Stiff, tan Siltstone with reddish brown bands of fine grain sand, friable
- ** Total depth = 21.5'
- ** No groundwater encountered

**Client:** Salishan Hills Homeowners Association  
**Logged by:** MWR  
**Checked by:** RJD  
**Date of Boring:** 8-14-17  
**Groundwater Level:** None Encountered

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**Branch Engineering**  
Salishan Hills HOA, Gleneden Beach, OR 97388  
310 5th Street Springfield, Oregon  |  p: 541.779.2577  |  www.branchengineering.com
**MATERIAL DESCRIPTION**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

**Surface Elevation = N/A**

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Depth (ft)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Pavement (6&quot; thick)</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Crushed Rock Fill, Angular, dense</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Transition to [MH] Stiff, tan Siltstone with reddish brown bands of fine grain sand, friable</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Total Depth = 6.5</strong></td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>No Groundwater Encountered</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Standard Penetration Resistance (140-lb Weight, 30-in. Drop)**

<table>
<thead>
<tr>
<th>Blows Per Foot</th>
<th>Moisture Content %</th>
<th>Percent Passing No. 200 Sieve</th>
<th>Atterberg Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

**EXPLORATORY BORING**

- **Drilling Contractor:** GREG VANDEHEY SOIL SAMPLING
- **Drilling Method:** SOLID FLIGHT AUGER
- **Client:** SALISHAN HILLS HOMEOWNERS ASSOCIATION
- **Logged By:** MWR
- **Checked By:** RJD
- **Date of Boring:** 8-14-17
- **Groundwater Level:** NONE ENCOUNTERED
- **Notes:** Boring located along southern shoulder of Spruce Buri Road
MATERIAL DESCRIPTION

SURFACE ELEVATION = N/A

<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7'</td>
<td></td>
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<tr>
<td>5'</td>
<td></td>
</tr>
<tr>
<td>10'</td>
<td></td>
</tr>
<tr>
<td>15'</td>
<td></td>
</tr>
<tr>
<td>20'</td>
<td></td>
</tr>
<tr>
<td>25'</td>
<td></td>
</tr>
<tr>
<td>21.5'</td>
<td></td>
</tr>
<tr>
<td>26.5'</td>
<td></td>
</tr>
<tr>
<td>30'</td>
<td></td>
</tr>
</tbody>
</table>

AC Pavement [8' thick]

(FILL) Base Rock [3/4" to 1" Ø] with soft, moist brown Clay and rip-rap boulder fragments

-Poor Retrieval Sampling from 2.5' through 7.5': Easy drilling progress with caving conditions preventing sampling/SPT testing, loose rip-rap fill encountered

[OL/FL] Soft, moist-wet brown Clay with cinders/organics

SAMPLE @ 10' BGS: IN-SITU MOISTURE CONTENT = 57.9%
FREE SWELL POTENTIAL = 10%

[CL] Soft, wet light brown Clay

[ML] Medium Stiff, moist, tan clayey Silt

SAMPLE @ 15' BGS: IN-SITU MOISTURE CONTENT = 76.8%
FREE SWELL POTENTIAL = 25%

-Stiffens slightly with depth, occasional pockets of relict organics

Total Depth = 26.5'
No Groundwater Encountered

CLIENT: SALISHAN HILLS HOMEOWNERS ASSOCIATION
LOGGED BY: MWR
DATE OF BORING: 8-14-17

DRILLING CONTRACTOR: GREG VANDEHEY SOIL SAMPLING
DRILLING METHOD: SOLID FLIGHT AUGER

NOTES: Boring located in previously repaired/improved area with rip-rap slope down to tennis court area

EXPLORATORY BORING
PROJECT NO. 17-260

GEO TECHNICAL INVESTIGATION
Salishan Hills HOA, Gleneden Beach, OR 97388
310 5th Street Springfield, Oregon    |    p: 541.779.2577    |    www.branchengineering.com

B-6
**MATERIAL DESCRIPTION**

**SURFACE ELEVATION = N/A**

<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>GRAPHIC LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>16.5</td>
<td></td>
</tr>
</tbody>
</table>

**AC Pavement (6'+ thick)**

- (Hill) Base Rock (3/4" to 1" Ø) with soft, moist brown Clay and rip-rap boulder fragments
- Poor Retrieval Sampling from 1' to 9': Easy drilling progress with caving conditions preventing sampling/SPT testing, loose rip-rap fill encountered

**SAMPLE @ 9' BGS:** IN-SITU MOISTURE CONTENT = 65.3%
FREE SWELL POTENTIAL = 15%

**[ML]** Medium Stiff, moist, tan clayey Silt

**Total Depth = 16.5’**
No Groundwater Encountered
<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>MATERIAL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5'</td>
<td>AC Pavement 4&quot; thick</td>
</tr>
<tr>
<td></td>
<td>(FILL) Base Rock (3/4&quot; to 1&quot; Ø) with soft, moist brown Clay and rip-rap boulder fragments</td>
</tr>
<tr>
<td></td>
<td>- Poor retrieval and difficult drilling due to loose rip-rap larger than bore hole diameter/auger, caving conditions</td>
</tr>
<tr>
<td>2.5</td>
<td>5.93 [S]</td>
</tr>
<tr>
<td>5</td>
<td>5.93 [S]</td>
</tr>
<tr>
<td>7</td>
<td>5.93 [S]</td>
</tr>
<tr>
<td>10'</td>
<td>Total Depth = 10'</td>
</tr>
<tr>
<td></td>
<td>No Groundwater Encountered</td>
</tr>
<tr>
<td></td>
<td>Practical Refusal to drill due to loose rock fill (rip-rap) and caving conditions</td>
</tr>
</tbody>
</table>

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**NOTES:** Boring located on Siletz View Road above slope/drainage with boulder fill encountered by hand probing with a steel hand probe through near-surface vegetation and topsoil.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>AC Pavement (6&quot; thick)</td>
</tr>
<tr>
<td></td>
<td>(FILL) Base Rock (3/4&quot; to 1&quot; Ø) with soft, moist brown Clay and rip-rap boulder fragments</td>
</tr>
<tr>
<td></td>
<td>- Drilled to 5-feet to get through near surface loose rock fragments</td>
</tr>
<tr>
<td>5</td>
<td>(OL) Topsoil - Soft, moist clayey silt with trace organics</td>
</tr>
<tr>
<td></td>
<td>SAMPLE @ 5' BGS: IN-SITU MOISTURE CONTENT = 72.9%</td>
</tr>
<tr>
<td></td>
<td>FREE SWELL POTENTIAL = 30%</td>
</tr>
<tr>
<td>7.5</td>
<td>(MH) Soft, wet brown clayey Silt</td>
</tr>
<tr>
<td></td>
<td>SAMPLE @ 7.5' BGS: IN-SITU MOISTURE CONTENT = 66.3%</td>
</tr>
<tr>
<td></td>
<td>FREE SWELL POTENTIAL = 20%</td>
</tr>
<tr>
<td>10</td>
<td>Gray/Tan weathered Sandstone inclusions</td>
</tr>
<tr>
<td></td>
<td>SAMPLE @ 10' BGS: IN-SITU MOISTURE CONTENT = 66.1%</td>
</tr>
<tr>
<td></td>
<td>FREE SWELL POTENTIAL = 5%</td>
</tr>
<tr>
<td>15</td>
<td>(CL) Soft, wet, tan Clay with trace fine grain sand</td>
</tr>
<tr>
<td></td>
<td>SAMPLE @ 10' BGS: IN-SITU MOISTURE CONTENT = 41.2%</td>
</tr>
<tr>
<td></td>
<td>FREE SWELL POTENTIAL = 40%</td>
</tr>
</tbody>
</table>

Total Depth = 16.5' |
No Groundwater Encountered