PRELIMINARY
STORM
DRAINAGE REPORT

FOR

GRANDVIEW ADDITION

City of Spokane, Washington

March 23, 2022

2021-3017

Prepared by:

Whipple Consulting Engineers
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Spokane Valley, WA
PH: (509) 893-2617
FAX: (509) 926-0227

This report has been prepared by Whipple Consulting Engineers under the direction of the undersigned professional engineer whose seal and signature appears hereon:

Justin Penner, P.E.
INTRODUCTION:
The purpose of this drainage narrative is to identify drainage impacts resulting from the proposed development of Grandview Addition. This drainage narrative will determine the drainage infrastructure improvements that are necessary to control and treat the stormwater runoff from the project site. The report will demonstrate there is no negative impact to the adjacent properties with the proposed development. The proposed project lies within the City of Spokane and will be designed in accordance with the Spokane Regional Stormwater Manual (SRSM). As outlined in the SRSM, treatment methods will be based on equation 6-1d: $V=1815A$.

NARRATIVE:

PROJECT DESCRIPTION:
The proposed project is a 96-lot subdivision located near Grandview Ave and H Street. There are six (6) new roads. The proposed development of the site will result in 96 new lots, driveways, extension of public streets, and associated onsite storm drainage facilities. The proposed and existing stormwater facilities will adequately collect, treat, and discharge the stormwater runoff from the proposed development.

The subject property is located within the City of Spokane in a portion of the NE 1/4 of Section 26, T 25 N., R 42 E., W.M. The parcel numbers for the project are 25261.2606, 25261.2607, 25261.2901, 25261.2812, 25261.3001 thru 25261.3005, 25261.3101, 25261.3305, 25261.3301, 25261.3204, and 25261.3203. Please see the Vicinity Map attached in the Appendix.

GEOTECHNICAL INFORMATION:
Per a geotechnical report completed by Budinger and Associates dated 9/20/2021 the site is centered on a bluff of a remnant basalt lava plateau with steep sides eroded and undercut by glacial flood waters. Geologic mapping of this area shows Glacial Lake Missoula outburst flood deposits across but primarily along the lower reaches of middle Miocene Epoch Basalt lava belong to the Priest Rapids Member of the Wanapum Basalt, Columbia River Basalt Group.

Outflow rates were provided within the Geotech and ranged from a single depth drywell outflow rate of 0.3 cfs at TP-15 and the use of a gravel gallery elsewhere with a recommended outflow rate of 14cf/d/lf. See appendix for geotechnical recommendations.

PRE-DEVELOPMENT BASIN INFORMATION:
As shown on the pre-basin map the site consists of undeveloped land with abundant outcrop of rock and steep rock faces with accumulated talus. There are two benches above the overall plateau surface with a maximum relief of approximately 78 ft from the top of the benches towards 17th Ave. The site is currently covered with trees, field grass, weeds, etc. The site was divided into three (3) pre basins based on the contours of the existing site. The majority of the site drains both north and south gentler grades on the south and steeper grades on the north.

The offsite stormwater flow path to the north is generally directed towards H St where the stormwater sheet flows to the north and in the shallow ditch along H St before pooling and crossing 17th Ave to the north. From there the stormwater continues northwest where it is intersected by Interstate 90 stormwater facilities. The stormwater that flows offsite to the south is collected in various low points in the adjacent properties or pools in the unused F St right of way.
Table 1 – Pre-Development Project Site Basin Summary

<table>
<thead>
<tr>
<th></th>
<th>Total Basin Area (sf)</th>
<th>Impervious Area (sf)</th>
<th>Pervious Area (sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Basin A</td>
<td>475,334</td>
<td>0</td>
<td>475,334</td>
</tr>
<tr>
<td>Pre-Basin B</td>
<td>351,967</td>
<td>0</td>
<td>351,967</td>
</tr>
<tr>
<td>Pre-Basin C</td>
<td>140,622</td>
<td>0</td>
<td>140,622</td>
</tr>
</tbody>
</table>

POST-DEVELOPMENT BASIN INFORMATION:
The Post-Development stormwater was separated into four (4) major basins with additional subbasins to be developed in the design phase of the project.

The Basins were determined by the collection and discharge point for the stormwater. Due to the hillside nature of the project the stormwater will be collected via catch basin and pipe system.

Basins A and B utilized a pipe and catch basin system while Basin C and Basin D discharge offsite in the direction of the predeveloped condition.

While the SRSM requires analysis of the 10 and 25-year storm events, for this project due to its soils and hillside nature, we have provided bowstring calculations and pond sizing for the 100-year event for conservatism.

Table 2 – Post-Development Project Site Basin Summary

<table>
<thead>
<tr>
<th></th>
<th>Total Basin Area (sf)</th>
<th>Impervious Area (sf)</th>
<th>Pervious Area (sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post A</td>
<td>391,802</td>
<td>242,630</td>
<td>149,172</td>
</tr>
<tr>
<td>Post B</td>
<td>343,290</td>
<td>197,120</td>
<td>146,170</td>
</tr>
<tr>
<td>Post C</td>
<td>124,055</td>
<td>9,600</td>
<td>114,455</td>
</tr>
<tr>
<td>Post D</td>
<td>108,776</td>
<td>19,200</td>
<td>89,576</td>
</tr>
</tbody>
</table>

Table 3 – Post-Development Project Site Pond Summary

<table>
<thead>
<tr>
<th></th>
<th>PGIS Area (sf)</th>
<th>(Method 1815A (ac)) Treatment Area/Volume (square feet/cubic feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Required</td>
</tr>
<tr>
<td>Post A</td>
<td>98,130</td>
<td>4,089</td>
</tr>
<tr>
<td>Post B</td>
<td>71,520</td>
<td>2,980</td>
</tr>
<tr>
<td>Post C</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Post D</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Refer to basin calculations in Appendix for areas and peak flows for all basins.

Operational Characteristics:
The stormwater for the Grandview Addition development will be collected in proposed catch basins and pipes that will discharge into storm drainage ponds. The drainage ponds in turn will discharge underground via drywell of gravel gallery.
The stormwater pond for Basin B will act as cutoff ditch for stormwater flowing to the south while Pond C and proposed cutoff ditch will intercept stormwater flowing the southeast. Any excess stormwater flowing the north will continue in the same flow path as in the pre developed condition.

Methodology:
As required by the SRSM, the storm drainage facilities proposed for this site have been sized to attenuate the 10- and 25-year storm events using the Rational Method as outlined in Section 5.5 of the SRSM. It should be noted that due to the hillside nature of the project site, storage calculations have been completed using the 100-year storm event for conservatism. The peak flows and volumes for these storm events are shown in the calculations that are included within the Appendix of this report.

Water Quality Treatment:
The proposed storm drainage ponds have been designed to provide treatment volume based on Equation 6-1d (V=1815A) of the SRSM, as outlined in Section 6.7.1. Once the treated stormwater exceeds a height of 12 inches, it will spill into drywells, where it will be discharged underground. It is to be noted that the ponds are to be L.I.D. ponds.

Critical Areas:
Based on the Critical Area Maps provided by Spokane County, (DNR Streams, Fish and Wildlife, Wetlands, Geo-hazard Area and Critical Aquifer Resource Area), there are no critical areas onsite except steep slopes greater than 30% and the project site has a CARA susceptibility rating of high.

Results:
As shown in Table 3 within this report we have provided the required treatment volume for the improvements proposed for the development. Table 4 below shows the onsite pond/swale storage summary for the 100-year storm event.

### Table 4 – Project Site Pond/Swale Storage Summary

<table>
<thead>
<tr>
<th>Basin</th>
<th>100-YR Storm</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Required</td>
<td>Provided</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vol. (cf)</td>
<td>Vol. (cf)</td>
<td></td>
</tr>
<tr>
<td>Basin A</td>
<td>35,747</td>
<td>42,072</td>
<td></td>
</tr>
<tr>
<td>Basin B</td>
<td>15,535</td>
<td>29,800</td>
<td></td>
</tr>
<tr>
<td>Basin C</td>
<td>3,877</td>
<td>5,841</td>
<td></td>
</tr>
<tr>
<td>Basin D</td>
<td>0</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

Perpetual Maintenance of Facilities:
This is a residential development with public roads as access. The surface maintenance of the ponds, pond structure maintenance, and pond replacement will be provided by the Homeowners Association while street structure maintenance and replacement are to be done by the City of Spokane. A maintenance plan will be provided to the owner if requested.

Offsite Easements:
There are no offsite easements required for this property.
**Regional Facilities:**
There are no known regional facilities that lie within the project site. However, the project does have offsite stormwater that will be passed the project site.

**CONCLUSION:**
As required by the City of Spokane and the Spokane Regional Stormwater Manual, the onsite storm drainage facilities for this project will adequately collect, treat, and discharge stormwater runoff generated by the site during the 10-year storm event. Also, the storm drainage facilities will contain and discharge the 100-year storm. Therefore, this project will have no adverse impact to adjacent and/or downstream properties.
APPENDIX
VICINITY MAP
DRAINAGE REPORT
GRAND VIEW ADDITION
GRANDVIEW AVE & H ST
SPOKANE, WASHINGTON

FIGURE 1
VICINITY MAP
BASIN MAPS
BASIN SUMMARY SHEET
Whipple Consulting Engineers

Basin Calculation Worksheet

Intensities from SRSM eqn. 5-13, per Table 5-7, Assumes Tc = 5 min

<table>
<thead>
<tr>
<th>WCE No.</th>
<th>Project Name</th>
<th>2 yr</th>
<th>10 yr</th>
<th>25 yr</th>
<th>50 yr</th>
<th>100 yr</th>
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</thead>
</table>

NOTE:

- Per 0.15
- Imp 0.9

SPOKANE COUNTY - SRSM - GRASSED PERCOLATION METHOD

<table>
<thead>
<tr>
<th>Basin</th>
<th>Total sf</th>
<th>Access/Parking sf</th>
<th>Sidewalk sf</th>
<th>DV sf</th>
<th>Buildings sf</th>
<th>Total Impervious sf</th>
<th>Total Pervious &quot;C&quot; sf</th>
<th>PGIS Pond Area (sf)</th>
<th>PGIS Pond Vol (cf)</th>
<th>Pre Total sf</th>
<th>2 yr</th>
<th>10 yr</th>
<th>25 yr</th>
<th>50 yr</th>
<th>100 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre A</td>
<td>475,334</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>475,334</td>
<td>0.15</td>
<td>0</td>
<td>0</td>
<td>2.32</td>
<td>4.29</td>
<td>5.43</td>
<td>6.29</td>
<td>7.17</td>
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<tr>
<td>Pre B</td>
<td>351,967</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>351,967</td>
<td>0.15</td>
<td>0</td>
<td>0</td>
<td>1.72</td>
<td>3.17</td>
<td>4.02</td>
<td>4.66</td>
<td>5.31</td>
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<tr>
<td>Pre C</td>
<td>140,622</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>140,622</td>
<td>0.15</td>
<td>0</td>
<td>0</td>
<td>0.69</td>
<td>1.27</td>
<td>1.61</td>
<td>1.86</td>
<td>2.12</td>
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<tr>
<td>Pre Total</td>
<td>967,923</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>967,923</td>
<td>0.15</td>
<td>0</td>
<td>0</td>
<td>4.73</td>
<td>8.73</td>
<td>11.06</td>
<td>12.81</td>
<td>14.60</td>
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</tr>
</tbody>
</table>

Post Onsite Flow

<table>
<thead>
<tr>
<th>Basin</th>
<th>Total sf</th>
<th>Access/Parking sf</th>
<th>Sidewalk sf</th>
<th>DV sf</th>
<th>Buildings sf</th>
<th>Total Impervious sf</th>
<th>Total Pervious &quot;C&quot; sf</th>
<th>PGIS Pond Area (sf)</th>
<th>PGIS Pond Vol (cf)</th>
<th>Post Total sf</th>
<th>2 yr</th>
<th>10 yr</th>
<th>25 yr</th>
<th>50 yr</th>
<th>100 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post A</td>
<td>391,802</td>
<td>80,850</td>
<td>24,500</td>
<td>17,280</td>
<td>120,000</td>
<td>242,630</td>
<td>149,172</td>
<td>98,130</td>
<td>8,178</td>
<td>4,089</td>
<td>7.84</td>
<td>14.47</td>
<td>18.34</td>
<td>21.24</td>
<td>24.21</td>
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<tr>
<td>Post B</td>
<td>343,290</td>
<td>58,080</td>
<td>44,000</td>
<td>13,440</td>
<td>81,600</td>
<td>197,120</td>
<td>146,170</td>
<td>71,520</td>
<td>5,960</td>
<td>2,980</td>
<td>6.49</td>
<td>11.98</td>
<td>15.19</td>
<td>17.59</td>
<td>20.05</td>
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<tr>
<td>Post C</td>
<td>124,055</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9,600</td>
<td>114,455</td>
<td>114,455</td>
<td>114,455</td>
<td>0</td>
<td>0.84</td>
<td>1.55</td>
<td>1.97</td>
<td>2.28</td>
<td>2.60</td>
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<tr>
<td>Post D</td>
<td>108,776</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>19,200</td>
<td>19,200</td>
<td>19,200</td>
<td>19,200</td>
<td>0</td>
<td>1.00</td>
<td>1.85</td>
<td>2.34</td>
<td>2.71</td>
<td>3.09</td>
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<tr>
<td>Total</td>
<td>967,923</td>
<td>138,930</td>
<td>68,500</td>
<td>30,720</td>
<td>230,400</td>
<td>468,550</td>
<td>499,373</td>
<td>169,650</td>
<td>14,138</td>
<td>7,069</td>
<td>16.17</td>
<td>29.86</td>
<td>37.84</td>
<td>43.81</td>
<td>49.95</td>
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</table>
POND VOLUME & INFILTRATION
<table>
<thead>
<tr>
<th>Basins</th>
<th>Ponds/ Swales</th>
<th>Bottom Area sf</th>
<th>Treatment Area (w/ Side Slopes)</th>
<th>Squared Side lf</th>
<th>Pond Bottom Elevation at Drywell</th>
<th>Pond Drywell Elevation</th>
<th>Pond Outlet Elevation (avg)</th>
<th>Conic Volume to Rim cf</th>
<th>Side Slope Volume cf</th>
<th>Total Volume to Rim cf</th>
<th>Conic Volume to Inlet cf</th>
<th>Side Slope Volume cf</th>
<th>Total Volume to Inlet cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A1</td>
<td>7,140</td>
<td>8,209</td>
<td>84.50</td>
<td>1000.00</td>
<td>1001.00</td>
<td>1004.00</td>
<td>7,140</td>
<td>507</td>
<td>7,647</td>
<td>28,560</td>
<td>8,112</td>
<td>36,672</td>
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<tr>
<td>B</td>
<td>B1</td>
<td>3,700</td>
<td>4,469</td>
<td>60.83</td>
<td>1000.00</td>
<td>1001.00</td>
<td>1003.00</td>
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<td>365</td>
<td>4,065</td>
<td>11,100</td>
<td>3,285</td>
<td>14,385</td>
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<tr>
<td></td>
<td>B2</td>
<td>4,000</td>
<td>4,800</td>
<td>63.25</td>
<td>1000.00</td>
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<td>379</td>
<td>4,379</td>
<td>12,000</td>
<td>3,415</td>
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<tr>
<td>B TOTAL</td>
<td></td>
<td>7,700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28,560</td>
<td>8,112</td>
<td>36,672</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>C</td>
<td>5,400</td>
<td>5,865</td>
<td>73.48</td>
<td>1000.00</td>
<td>1000.50</td>
<td>1001.00</td>
<td>2,700</td>
<td>110</td>
<td>2,810</td>
<td>5,400</td>
<td>441</td>
<td>5,841</td>
</tr>
</tbody>
</table>
WHIPPLE CONSULTING ENGINEERS

GRAVEL GALLERY CALC SHEET

3/23/2022

21-3017 Grandview Addition
DESIGNER JPP

Porsity: 0.3
Infiltration Rate: 14 gpd/lf
Convert gpd to cfs: 1.5472E-06

Note: infiltration rates per Budinger Geotechnical Report Dated December 1, 2021
14 gpd/lf of gallery

<table>
<thead>
<tr>
<th>BASIN</th>
<th>Number of Galleries</th>
<th>Length</th>
<th>Width</th>
<th>Depth</th>
<th>Ground Water EL.</th>
<th>Gravel Gallery Bott. EL</th>
<th>Volume</th>
<th>Storage Volume</th>
<th>Outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>5</td>
<td>120.00</td>
<td>3.00</td>
<td>3.00</td>
<td>-</td>
<td>1000.00</td>
<td>5,400</td>
<td>1,620</td>
<td>0.013</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,400</td>
<td>1,620</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Storage Volume = Volume* Porosity
Sidewall Area= Perimeter*Depth
OutFlow = Sidewall Area+ Bottom Area * Infiltration Rate

Note: Outflow Assumes a Full Gallery
100-YEAR STORM EVENT BOWSTRING CALCULATIONS
### PEAK FLOW CALCULATION

**100-Year Design Storm**

<table>
<thead>
<tr>
<th>BASIN: A</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tot. Area</td>
<td>391,802 SF</td>
</tr>
<tr>
<td>Imp. Area</td>
<td>242,630 SF</td>
</tr>
<tr>
<td>Per. Area</td>
<td>149,172 SF</td>
</tr>
<tr>
<td>Wt. C</td>
<td>0.61</td>
</tr>
<tr>
<td>PGIS Area</td>
<td>98,130</td>
</tr>
</tbody>
</table>

#### Flow (weighted c)

- **K (ft/min)**
- **Outflow (cfs)**
- **Area (acres)**

#### Design Year Flo T

- **Impervious Area**
- **Pervious Area**
- **Short Pasture**
- **Nearly Bare Ground**

#### Storage

- **Reach**
- **Flow**
- **Area (acres)**

#### WCE Applicable Travel Time Ground Cover Coefficients

- **Per Table 5-6 SRSM**
- **Type of Cover**
- **Short Pasture**
- **Nearly Bare Ground**
- **Small Roadside Ditch/Grass**
- **Paved Area (use for parking lots)**

#### Reaches

- **Reach 1**
- **Reach 2**
- **Reach 3**
- **Reach 4**
- **Reach 5**

#### Travel Time

- **Travel Time**
- **Time**
- **Travel Time (Minutes)**

#### Storage

- **Storage Required by Bowstring**
- **Minimum Storage Required by Bowstring**
- **Provided Storage Volume**

### Rainfall Intensity Coefficients for **Spokane**

- **M_{100}** = 12.33
- **N_{DP}** = 0.643

#### Flow (time of concentration)

- **Qwc** = 24.21 cfs

#### Maximum Storage Required by Bowstring

- **Provided Pond Storage Volume to Inlet - Min.**
- **Provided Drywell/Gallery Storage Volume**

#### Total Provided Volume

- **Drywell/Gallery Storage Volume**

### Treatment Requirements

- **Minimum "1815" Volume Required**
- **Provided Treatment Volume - Min.**

### Whipple Consulting Engineers

1
### Project: 21-3017
#### 100-Year Design Storm

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tot. Area: 343,290 SF</td>
<td>DETENTION BASIN</td>
<td>Spread</td>
<td>23-Mar-22</td>
</tr>
<tr>
<td>Imp. Area: 197,120 SF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per. Area: 146,170 SF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wt. C: 0.58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PGIS Area = 71,520</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rainfall Intensity Coefficients for Spokane

<table>
<thead>
<tr>
<th>M_100 = 12.33</th>
<th>Flow (weighted c)</th>
<th>N_20 = 0.643</th>
<th>Qwc= 20.05 cfs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (time of concentration)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qtc= 17.02 cfs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Project Details

- **Spokane PROJECT:** 21-3017
- **Basin:** B
- **Design:** JPP
- **Date:** 23-Mar-22

#### Design Details

- **Basin Area:** 343,290 SF
- **Immersive Area:** 237,000 SF
- **Pervious Area:** 106,290 SF

#### Impervious Area Details

<table>
<thead>
<tr>
<th>Code</th>
<th>Area</th>
<th>Impervious Area Coefficient</th>
<th>Storage</th>
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<td>0.60</td>
<td>21000</td>
<td>8826</td>
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<td>150</td>
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<tr>
<td>600</td>
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#### Storage Details

- **Storage:** 29,800 cu ft
- **Maximum Storage:** 15,535 cu ft
- **Provided Pond Storage Volume to Inlet:** 29,800 cu ft
- **Provided Drywell/Gallery Storage Volume:** 0 cu ft

---

### Whipple Consulting Engineers
## Project: 21-3017
### Basin: C

<table>
<thead>
<tr>
<th>Tot. Area</th>
<th>124,055 SF</th>
<th>2.85 Acres</th>
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<td>Imp. Area</td>
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<td>Perv. Area</td>
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### Spokane Project:

#### Peak Flow Calculation

- **Design Year Flow:** 100
- **Area (acres):** 2.85
- **Impervious Area (sq ft):** 9600
- **'C' Factor:** 0.21
- **Area C:** 0.592

#### Design Details

- **Design Basin:** JPP M100
- **DATE:** 23-Mar-22
- **DESIGNER:** JPP M100

##### WCE Applicable Travel Time Ground Cover Coefficients

<table>
<thead>
<tr>
<th>Per Table 5-6 SRSRM</th>
<th>Type of Cover</th>
<th>Short Pasture</th>
<th>Nearly Bare Ground</th>
<th>Small Roadside Ditch/Grass</th>
<th>Paved Area (use for parking lots)</th>
<th>Gutter - 4 inches deep</th>
<th>Gutter - 6 inches deep</th>
<th>Pipe - 12-inch PVC/DI</th>
<th>Pipe - 15/18-inch PVC/DI</th>
<th>Pipe - 24-inch PVC/DI</th>
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<td></td>
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<td>420</td>
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#### Reaches

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<thead>
<tr>
<th>Reach 1</th>
<th>Offsite</th>
<th>Also applicable for Pre-Developed Tc</th>
<th>Length</th>
<th>100.00</th>
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<tr>
<td>Reach 2</td>
<td>Finished Lot from House to Street</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Reach 3</td>
<td>Gutter Flow to Inlet/Catch Basin</td>
<td>Length</td>
<td>300.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reach 4</td>
<td>Pipe Flow 1</td>
<td>Pipe Reach One (only need one if no DRA change)</td>
<td>Length</td>
<td>1500.00</td>
</tr>
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<td></td>
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</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach 5</td>
<td>Pipe Flow 2</td>
<td>Add additional pipe reached for other DRA's</td>
<td>Length</td>
<td>1500.00</td>
</tr>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Rainfall Intensity Coefficients for Spokane

- **M<sub>100</sub> = 12.33**
- **N<sub>100</sub> = 0.643**
- **Flow (weighted c): 41700**
- **Time of concentration:** 695
- **C= 0.11**
- **Qwc= 2.60 cfs**

#### Flood Calculations

- **Flow (time of concentration):** 41700
- **Time Increment (min):** 10
- **Time of Conc. (min):** 7.24
- **Outflow (cfs):** 0.0
- **Design Year Flow:** 100
- **Area (acres):** 2.85

---

**1815A TREATMENT REQUIREMENTS**

- **Minimum "1815A" Volume Required:** 0 cu ft
- **Provided Treatment Volume - Min.:** 0 cu ft

**Storage Req. - 100 Year Design Storm**

- **Maximum Storage Required by Bowstring:** 3,877 cu ft
- **Provided Pond Storage Volume to Inlet - Min.:** 5,841 cu ft
- **Provided Drywell/Gallery Storage Volume:** 0 cu ft

**Total Provided Volume:** 5,841 cu ft
Geotechnical Conditions Report
Grandview 92-Lot Development
Spokane County, WA

Prepared for:
David Morse
Toll Brothers
8815 122nd Ave NE, Suite 200
Kirkland, WA 98033

Prepared by:
Budinger & Associates, Inc.
1101 N. Fancher Road
Spokane Valley, WA 99212

John Finnegan, PE, LHG
Geotechnical Engineer, Principal

David Lehn, PG
Senior Geologist

Budinger & Associates
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ATTACHED FIGURES

Figure 1: Vicinity Map
Figures 2-1 to 2-2: Site Plan and Geo/LIDAR Overview Plan
Figure 3: Guide to Soil & Rock Descriptions
Figures 4-1 to 4-13: Test Pit Logs
Figure 5: Laboratory Summary
Figure 6: Grain Size Distributions
Appendix: Important Information about Your Geotechnical-Engineering Report
CONTEXT

This conceptual phase geotechnical conditions report (GCR) presents the results of limited
geotechnical exploration and analysis for design of the proposed development. Our work was
contracted and coordinated with Toll Brothers, Inc., represented by David Morse.

Project Considerations

A single-family residential housing development is planned in the Grandview Avenue-17th Avenue
neighborhood in the City of Spokane, WA. It will consist of approximately 92 residential lots and 6
Tracts. The proposed site occupies approximately 22.4 acres. Preliminary plans for the lot layout
were provided by Whipple Consulting Engineers, dated May 8, 2021.

This report addresses general geotechnical information needed to complete planning, layout, and
conceptual design. Additional geotechnical services will be needed to complete a geotechnical
engineering report (GER) appropriate for civil design, structural design, and construction.

Location

The site is approximately ½-mile south of Sunset Highway at Rustle Road and ½-mile east on
Grandview at 17th. It is positioned on the south side of 17th between H and D Streets, to the west
and east, respectively. The site occupies 15 Spokane County Parcels, numbered 25261.2606, .2607,
.2710, .2812, .2901, .3001, .3002, .3003, .3004, .3005, .3101, .3203, .3204, .3301, and .3305. It is in
the SW ¼ of the NE ¼ of Section 26, Township 25N, Range 42E WM, Washington, as illustrated
in the Vicinity Map and Site Plan.

Scope

This geotechnical study involved interpretation of subsurface soil conditions to assess the suitability
of the site for the overall conceptual design phase. We endeavored to conduct these services in
accordance with generally accepted geotechnical engineering practices as outlined in proposal,
S21702, dated August 19, 2021. The following scope was completed:

Conceptual Phase Evaluation

The first Task included exploring subsurface conditions with 13 test pits excavated to depths
ranging from 1 to 17 feet deep. Test pits were excavated by your earthwork contractor and
backfilled in compacted lifts upon completion.

Subsurface conditions were logged by a qualified geologist.

Limited laboratory testing was completed on representative soil samples. The testing included
moisture content, Atterberg Limits, and gradation.

Characterization of subsurface conditions encountered included:
- Layering (stratification);
- Soil texture and classification;
- Risks from existing, undocumented fill soils;
- Soil moisture, capillarity, and groundwater; and,
- Seismic considerations.
This report presents conclusions and recommendations limited to engineering parameters for general site development including depth to bedrock, and potential infiltration areas. Parameters to complete design of individual lot foundations, earthwork, retaining walls, slabs, pavements, and stormwater infiltration rates are beyond the scope of this proposed phase. Recommendations for determining which individual lots should be scheduled for specific geotechnical engineering exploration and analysis, if any, are included.

Further subsurface exploration, not authorized at this time, includes: borings for exploration and analysis with additional soil testing for stormwater infiltration in accordance with Spokane Regional Stormwater Manual (SRSM), dynamic cone penetrometer soundings for soil density estimates, and pavement DCP for subgrade soil strength analysis and pavement section design. These results can be presented as addenda to this report.

**Design Phase Evaluation**

Information needed to complete design-level geotechnical services includes anticipated structural loads, anticipated pavement traffic loads, anticipated finish floor elevations, and locations and heights of retaining walls, if required.

**ENCOUNTERED CONDITIONS**

**Physical Setting**

The site is centered on a bluff of a remnant basalt lava plateau with steep sides eroded and undercut by glacial flood waters. Geologic mapping of this area shows Glacial Lake Missoula outburst flood deposits (Qfg) across but primarily along the lower reaches of middle Miocene Epoch Basalt lava (Mwp) belonging to the Priest Rapids Member of the Wanapum Basalt, Columbia River Basalt Group. (WSDNR, 2004). An interflow of lacustrine sediments of the Latah Formation occurs between the Priest Rapids Basalt and underlying Grande Ronde Basalt.

Qfg is described as “thick-bedded to massive mixture of boulders, cobbles, pebbles, granules, and sand; contains beds and lenses of sand and silt; gray, yellowish gray, or light brown; poorly to moderately sorted; both matrix and clast supported; locally composed of boulders and cobbles in a matrix of mostly pebbles and coarse sand” (WSDNR, 2004).

The Mwp unit is described as “Dark gray to black, fine-grained, dense basalt. [It] lies directly on pre-Miocene rocks, Latah Formation, or Grande Ronde Basalt; contact with the underlying Grande Ronde Basalt occurs between 2,200 and 2,300 ft elevation” (WSDNR, 2004).

Soil types at the site, as mapped by the USDA Web Soil Survey, consist of Rockly-Fourmound complex, 0 to 15 percent slopes (unit 3114), Northstar-Rock outcrop complex, 3 to 15 percent slopes (Unit 3115), Rock outcrop-Northstar complex, 15 to 30 percent slopes (Unit 3126), and Urban land-Northstar, disturbed complex, 3 to 8 percent slopes (unit 7131) (NRCS, 2020).

Units 3114 and 3115 are rated by the NRCS as hydrologic soil groups D and C, respectively. The saturated hydraulic conductivity for units 3114 and 3115 is approximately 1.3 and 7.7 inches per hour, respectively (NRCS, 2020).
Surface Conditions

The site consisted of undeveloped land with abundant outcrop of rock and steep rock faces with accumulated talus. Site topography is best described as two relatively level benches above the overall plateau surface. Maximum total relief across the site was 78 feet from the top of the benches down to the plateau surface to the north at 17th. Elevations of the top of the benches were 2,270 feet (City Datum). Steep slopes ranging from 36 to 100 percent inclinations at heights of 20 to 40 feet were observed along the margins of the benches. Steeper slopes were generally observed along southern exposures.

The benches are bisected by a northwest-southeast trending saddle between two small basins as illustrated in the Geo-LIDAR Overview Plan. Two meadows occupy the basins containing a wide assemblage of vegetation including shrubs and Ponderosa Pine trees. The basins sloped gently from the saddle at elevation of 2,264 feet down to elevation 2,240 feet at 15 percent inclinations. The remainder of the site sloped gently down to the plateau surface.

Subsurface Conditions

Conditions encountered in the test pits are described in the Test Pit Logs in accordance with methods described in Field Exploration. The following groups of subsurface materials were differentiated based on characteristics relevant to this project:

soil

Log symbols:

Silt with sand was the predominant soil encountered across the site. It was present between outcrop and directly overlying rock in 5 test pits. Where encountered, the silt with sand ranged from 2 to 6 feet thick beginning at the ground surface. It averaged 4.5 feet thick. Fines content (percent, by weight, passing the US #200 sieve) was 79 percent for one representative sample tested. Fines were non-plastic. At Test Pit 13 (TP-13), it overlayed two horizons consisting of silty gravel overlying sand with gravel, with rock beginning 6 feet below ground surface (BGS).

Silty sand with gravel varying to silty gravel with sand and cobbles was encountered in 4 test pits directly overlying rock. It ranged from 1.5 to 5.5 feet thick and averaged 3.5 feet thick. At TP-5 and TP-13, it was 2 feet thick. This stratum was likely coarse alluvium originally deposited on rock with fines washed into the open graded deposit as described in the following paragraph.

TP-5 encountered 2 feet of surficial colluvium consisting of angular gravel and cobbles in a matrix of silt and sand beginning at the ground surface. A thick deposit of gravel with silt, sand, and cobbles extended from 2 feet BGS to greater than 17 feet BGS, the maximum reach of the excavator. The characteristic differing this horizon from the surficial silty gravel was in the fines content of 7.7 percent.

An isolated deposit of sand with gravel and cobbles with 3.3 percent fines was encountered in TP-13. It was only 2 feet thick between 4 and 6 feet BGS laying directly on rock. This appears to be the only occurrence of permeable soil. However, it lacks sufficient thickness and lateral extent to qualify as an infiltration stratum as follows:
The primary relevant stormwater design documents are the *Spokane Regional Stormwater Manual* (SRSM, 2008) and *Stormwater Management Manual for Eastern Washington* (SMMEW, 2019). The SRSM includes Geotechnical Site Characterization (GSC) requirements for characterizing the suitability of soil units for receiving stormwater by infiltration structures. Use of infiltration structures requires a suitable target soil of adequate thickness, extent, and permeability. Extensive thick permeable soils for rapid infiltration appear to be lacking across this site.

**basalt**

Log symbol

Extrusive *basalt* lava rock was observed as outcrop across the site and in all but one test pit beginning at depths ranging from 0 to 6 feet BGS. TP-5 did not encounter rock to the depth of reach of the excavator at 17 feet BGS. Encountered *basalt* was moderately to highly weathered in the top 0.5 to 6 feet with an average weathered surface less than 2 feet thick. The exposed *basalt* comprises the upper, entablature, portion of the flow. Unlike columnar *basalt* found at lower elevations, it generally contains randomly oriented very close to closely spaced jointing in good condition. As such, it may require significant hoe-ram breaking to remove competent segments.

**Surface and Groundwater Hydrology**

Surface waters were not observed on site. A 12.98-acre Freshwater Emergent Wetland occurred in a topographic basin 100 feet to the southwest of the site. Although surface water was not observed during the dry summer, the area is classified as PEM1C (USFWS). The classification PEM1C includes, but is not limited to, the presence of herbaceous hydrophytes for most of the growing season and visible surface water for extended periods.

Groundwater was not encountered during explorations which were primarily up on the rock benches. Mottled textures in the soil that would indicate the presence of fluctuating groundwater over long periods of time were not observed. Local well reports obtained through the Washington State Department of Ecology website show ground water levels beginning at depths greater than 60 feet BGS in the within 0.75-mile of the site.

**PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS**

Soils are generally thin across the site with the exception of TP-5 which extended below the depth of reach of the excavator, 17 feet BGS. Predominant soil is silt with fine sand. Limited thickness and extent of gravel was encountered in 4 test pits.

The subgrade contains abundant *basalt* rock.

With the exception of TP-5, the depth to *basalt* ranged in depth from outcrop to 6 feet BGS. The condition of *basalt* varied throughout the site. Weathered rock segments were excavatable to depths of up to 8 feet with the 50 to 60-ton excavator used during the subsurface explorations. Excavation in the fresh rock was as little as 1 foot.

Some areas were fresh, competent, and contained randomly oriented very close to closely spaced
jointing in good condition. As such, it may require significant hoe-ram breaking to remove fresh rock segments. The fine-grained silty soils are not suitable for re-use as structural fill. These soils are also susceptible to frost heave and capable of wicking moisture throughout the soil profile.

Suitable stormwater infiltration areas require a suitable target soil of adequate thickness, extent, and permeability. Such soil was not found on the site during this task. Alternative systems (infiltration galleries, under-drain systems, etc) may be required. Test pit infiltration test methods in accordance with the SRSM can be used for alternative design.

The site includes topography that exhibits slopes of 30 percent or greater. The Spokane County Critical Areas Ordinance, Chapter 11.20, defines such slopes as geologically hazardous areas and further delineation and characterization will apply.

**Seismic Considerations**

The recommended seismic site class designation is Site Class C, “very dense soil and soft rock.” Spectral response acceleration parameters, adjusted for Site Class C, were calculated using USGS, U.S. Seismic Design Web Services through the Applied Technology Council website (ATC, 2019). The values of predicted earthquake ground motion for short period structural elements (0.2 second spectral response acceleration, $S_s$) and for long period structural elements (1.0 second spectral response acceleration, $S_1$) are provided in the table below. The design parameters ($S_{DS}$ and $S_{D1}$) are equal to $\frac{2}{3}$ of the maximum earthquake spectral response accelerations ($S_{MS}$ and $S_{M1}$).

<table>
<thead>
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<th>Site Class</th>
<th>Latitude</th>
<th>Longitude</th>
<th>PGA</th>
<th>$S_s$</th>
<th>$S_1$</th>
<th>$S_{DS}$</th>
<th>$S_{D1}$</th>
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<tbody>
<tr>
<td>C</td>
<td>47.64 N</td>
<td>-117.46 W</td>
<td>0.142g</td>
<td>0.329g</td>
<td>0.115g</td>
<td>0.264g</td>
<td>0.129g</td>
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Due to the presence of relatively shallow rock, the low probability of high ground acceleration, and absence of shallow groundwater, estimated liquefaction potential is very low.

**Earthwork**

Development in the northeast and southwest portions of the site will involve the most basalt excavation but settlement risks will be minimized in this area. Rock will be difficult to excavate and may require breaking hammers and blasting. The remainder of the site will offer the least amount of basalt excavation, but there may be settlement risks associated with loose soil conditions. Foundations that span both soil and basalt should be over-excavated to avoid differential settlement risks.

The overburden soils are generally granular in nature, consistent with Type C materials per WISHA excavation criteria. WISHA specifies a maximum inclination of 1-½ horizontal to 1 vertical (1-½ H:1V) in the temporary condition for Type C.

**Fill material.** The encountered coarse-grained soils may be suitable for re-use as structural fill provided that deleterious items (anthropogenic debris, organics, and over-sized materials, etc.) are removed prior to their re-use. However, these soils are comprised of fine sands and silts, are moisture-sensitive and may be difficult to compact. If imported fill is used a material such as Common Borrow in WSDOT Standard Specifications for Road, Bridge, and Municipal
Construction Section 9-03.14(3) is recommended.

**Additional Services**

Effective geotechnical services involve cooperation with the owner, designer, and constructor as follows:

1. Preliminary study to assist in planning and to economically adapt the project to its geologic environment.
2. Soil exploration and analysis to characterize subsurface conditions and recommend design criteria.
3. Consultation with the designer to adapt the specific design to the site in accordance with the recommendations.
4. Construction observation to verify the conditions encountered and to make recommendations for modifications as necessary.
5. Construction material testing, quality control, and special inspection.

This GCR satisfies Item 1 of the 5-phase endeavor. Additional geotechnical services will be needed to complete a GER when design-level information is available. We are eager to provide assistance with design and construction as appropriate to assist in completing a safe and economical project.

**FIELD EXPLORATION**

The fieldwork was conducted by lead geologist Jason Pritzl, GIT, and supervised by geotechnical engineer John Finnegan, PE, on August 9, 2021. The field activities generally consisted of the following:

- Reconnaissance of the site and surrounding area;
- Logging subsurface conditions for 13 test pits; and
- Obtaining bulk samples of the soils.

Results are presented in *Figures*.

**Test Pits**

Test pits were excavated with a Volvo EC480 excavator with a 48-inch bucket by Selland’s Construction, Inc. Criteria governing the depth to which test pits were excavated included limits of equipment reach and digging refusal with a 50-ton, 373hp excavator on competent basalt.

**Soil Samples**

Samples were obtained by capturing representative material from the bucket of the excavator or from within the excavation while less than 4 feet below grade.

**Soil and Rock Classification**

**WSDOT Soil and Rock Classification and Logging**. Field descriptions of soils and rock were completed in accordance with the current version of the Washington State Department of Transportation, *Geotechnical Design Manual* (GDM), M 46-03.11, except that fines (silt and clay) were described in accordance with ASTM D 2487. Whereas, the GDM uses the terms ‘silty’ and
‘clayey’ to describe a very broad range of fines from 10 to 49 percent; ASTM D 2487 uses those terms for percentages greater than 12 and the term ‘with’ for fines ranging from 5 to 12 percent, which is typically necessary to describe variations relevant to soil permeability per the SRSM. A key to the descriptions is provided in Guide to Soil and Rock Descriptions.

**Location**

**Horizontal & vertical control.** Plans were provided by the client. The Site Plan is based on measured offsets from existing site features at the time of exploration.

Elevations presented on the Test Pit Logs were correlated from topographical data illustrated on the provided plans. Horizontal and vertical locations can be considered accurate to within 5-foot and 1-foot, respectively, relative to the information provided.

**LABORATORY ANALYSIS**

Laboratory testing was performed on representative samples of the soils encountered to provide data used in our assessment of soil characteristics.

Tests were conducted, where practical, in accordance with nationally recognized standards (ASTM, AASHTO, etc.), which are intended to model in-situ soil conditions and behavior. The results are presented in Figures.

**Index Parameters**

**Moisture content – ASTM D2216.** Moisture contents were determined by direct weight proportion (weight of water/weight of dry soil) determined by drying soil samples in an oven until reaching constant weight.

**Gradation – ASTM D6913.** Gradation analysis was performed by the mechanical sieve method. The mechanical sieve method is utilized to determine particle size distribution based upon the dry weight of sample passing through sieves of varying mesh sizes. The results of gradation are provided in Grain Size Distribution Results.

**Atterberg Limits – ASTM D4318.** Atterberg limits describe the properties of a soil’s fine-grained constituents by relating the water content to the soil’s limits of engineering behavior. As the water content increases, the state of the soil changes from a brittle solid to a plastic solid and then to a viscous liquid.

The liquid limit (LL) is the water content above which the soil tends to behave as a viscous liquid. Similarly, the plastic limit (PL) is defined as the water content below which the soil tends to behave as a brittle solid. The plasticity index describes the range of water content over which a soil is plastic and is derived by subtracting the PL from the LL. The soil is classified as “non-plastic” if rolling a 1/8-inch bead is not possible at any water content.

**LIMITATIONS**

The conclusions and recommendations presented herein are based upon the results of field
explorations and laboratory testing results. They are predicated upon our understanding of the project, its design, and its location as defined in by the client. We endeavored to conduct this study in accordance with generally accepted geotechnical engineering practices in this area.

This GCR - presents our professional interpretation of exploration data developed, which we believe meets the standards of the geotechnical profession in this area; we make no other warranties, express or implied. Attached is a document titled “Important Information About Your Geotechnical Engineering Report,” which we recommend you review carefully to better understand the context within which these services were completed.

Unless test locations are specified by others or limited by accessibility, the scope of analysis is intended to develop data from a representative portion of the site. However, the areas tested are discreet. Interpolation between these discreet locations is made for illustrative purposes only but should be expected to vary. If a greater level of detail is desired, the client should request an increased scope of exploration.

REFERENCES

Applied Technology Council (ATC), Hazards by Location, Seismic Loads Application. Available online at https://hazards.atcouncil.org/#/.


Spokane County, Washington, Critical Areas Ordinance for the Protection of Wetlands, Fish and Wildlife Habitats, Geo-hazard Areas and Critical Aquifer Recharge Areas, Chapter 11.20.

USFWS, 2019, Wetland Mapper https://www.fws.gov/wetlands/Data/Mapper.html

USGS, 2014, Topographic Map of the Spokane NW, 7.5-Minute Quadrangle, Spokane County, Washington


Washington State Department of Transportation, 2019, Geotechnical Design Manual (WSDOT GDM).

GUIDE TO SOIL & ROCK DESCRIPTIONS

SOIL CLASSIFICATION

BOULDERS

12"

COBBLES

3"

GRANULES

3/4"

GRAVEL

COARSE

FINES

#4

SAND

#10

COARSE

MEDIUM

#40

FINE

SILT

#200

CLAY

.005 mm

SILTS

PEAT - BASED ON ORGANIC CONTENT

* SEE PLASTICITY CHART

CGS - COARSE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE

FGS - FINE GRAINED SOIL - 50% MORE PASSES, #200 SIEVE

FINES - PORTION FINEST THAN #200 SIEVE

ATTERBERG LIMITS

POSSIBLE STATES OF CONSISTENCY

SOLID, CONSTANT VOLUME

SOLID

PLASTIC

LIQUID

MOISTURE

PLASTICITY CHART

(LEAN CLAY)

(FAT CLAY)

(Organic Clay)

(Elastic Clay)

CL

OH

ML

MH

GUIDE TO SOIL DESCRIPTION MODIFIERS, MOISTURE, AND CONDITION PRESENTED ON LOGS

MODIFIER

ESTIMATED PERCENTAGE OF MATERIAL

SUFFIX "LY" OR "Y" ..................... 30% OR MORE FOR COARSE PARTS IN FGS

_GREATER THAN 12% FOR FINES IN CGS

WITH ......................... 15% - 29% FOR COARSE PARTS IN FGS

6% - 14% FOR FINES IN CGS

MOISTURE

CGS:

DRY

MOIST

SATURATED OR WET

SOIL CONDITION

VERY LOOSE

LOOSE

MEDIUM DENSE

DENSE

VERY DENSE

FGS:

VERY SOFT

SOFT

MEDIUM STIFF

STIFF

VERY STIFF

HARD

NOTE - VISUAL ESTIMATES OF MATERIAL PERCENTAGES TYPICALLY VARY 0 TO 10% FROM THOSE DETERMINED BY LABORATORY TESTING.

SAMPLES

STANDARD 2" PENETRATION TEST SAMPLER WITH BLOWS PER FOOT

3" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT

DRILL CUTTING SAMPLE

BULK SAMPLE

THIN-WALLED TUBE SAMPLE

DIAMOND CORE RUN WITH % RECOVERY & ROCK QUALITY DESIGNATION

2.5" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT

CONTINUOUS SOIL SAMPLE

REFUSAL OF SAMPLE (50+ BLOWS PER 6")

NOTE - CHART APPLIES TO FGS AND MINUS #40 SIEVE FRACTION OF CGS

FRESH

SLIGHTLY WEATHERED

MODERATELY WEATHERED

HIGHLY WEATHERED

COMPLETELY WEATHERED

RESIDUAL SOIL

ROCK WEATHERING

ROCK CONDITION

EXTREMELY WEAK

VERY WEAK

MODERATELY WEAK

MEDIUM STRONG

STRONG

VERY STRONG

FIGURE 3
**TEST PIT 1**

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>SAMPLES</th>
<th>MOISTURE</th>
<th>COLOR</th>
<th>CONDITION</th>
<th>DESCRIPTION</th>
<th>SOIL LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>dry, light brown</td>
<td></td>
<td></td>
<td>SILT with fine Sand, occasional angular to subangular Gravel and Cobbles, moderate amount of small roots to 0.5 feet.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>Basalt Fresh</td>
<td>(digging refusal on fresh Basalt) End of Excavation @ 4.5 ft</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
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<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**TEST RESULTS**

<table>
<thead>
<tr>
<th>ATTERBERG LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL</td>
</tr>
</tbody>
</table>

**Date:** 8-9-21  
**Excavator:** Selland’s Construction  
**Equipment:** Volvo EC480  
**Location:** Proposed road alignment CL; north of proposed Lot 52  
**Surface:** grass and weeds  

**Elevation:** 2270 ft  
**Logged by:** J. Pritzl  
**Size of hole:** 6 X 10 feet

---

**Budinger & Associates**  
1101 North Fancher Road  
Spokane Valley, WA 99212  

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702
### Test Pit 2

**Date:** 8-9-21  
**Excavator:** Selland's Construction  
**Equipment:** Volvo EC480  
**Location:** Center property line between proposed Lots 11 & 12  
**Logged by:** J. Pritzl  
**Size of hole:** 6 X 11 feet  
**Elevation:** 2242 ft

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Moisture, Color, Condition</th>
<th>Description</th>
<th>Soil Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dry, light brown</td>
<td>SILT with fine Sand, occasional angular to subangular Gravel and Cobbles, moderate amount of small roots to 0.5 feet.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>dark brownish gray</td>
<td>BASALT, moderately weathered</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt) End of Excavation @ 6 ft</td>
<td></td>
</tr>
</tbody>
</table>

**Test Results**

**Atterberg Limits**

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

**Water Content**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Water Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

**Test Pit Logs**

- **Project:** Grandview 92-Lot Housing Development  
- **Location:** Spokane, WA  
- **Number:** S21702
## TEST PIT 3

**Date:** 8-9-21  
**Excavator:** Selland’s Construction  
**Equipment:** Volvo EC480  
**Location:** Proposed road alignment CL; north of proposed Lot 10  
**Surface:** grass and weeds  

**Logged by:** J. Pritzl  
**Size of hole:** 6 X 13 feet  

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dry, light brown</td>
<td>SILT with Sand, Gravel, and Cobbles (colluvium)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dark brownish gray</td>
<td>BASALT, highly weathered with zones of saprolite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no free groundwater</td>
<td>(digging refusal on fresh Basalt)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>End of Excavation @ 8 ft</td>
<td></td>
</tr>
</tbody>
</table>

**Elevation:** 2240 ft  

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702
**TEST PIT 4**

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dry, light brown</td>
<td>SILT with Sand, Gravel and Cobbles (colluvium)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>dark brownish gray</td>
<td>BASALT, highly weathered with zones of saprolite</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>End of Excavation @ 5 ft</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Date:** 8-9-21  
**Excavator:** Selland's Construction  
**Equipment:** Volvo EC480  
**Location:** Proposed road alignment CL; south of proposed Lot 6  
**Surface:** grass and weeds  
**Elevation:** 2238 ft  
**Logged by:** J. Pritzl  
**Size of hole:** 6 X 12 feet  

---

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Spokane Valley, WA 99212  

---

**Test Pit Logs**  
**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702
### TEST PIT 5

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dry, light brown</td>
<td>SILT with Sand, Gravel and Cobbles (colluvium)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dry, grayish brown</td>
<td>GRAVEL with Silt, Sand, and Cobbles, coarse, angular (colluvium)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>no free groundwater observed</td>
<td>End of Excavation @ 17 ft</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Date:** 8-9-21  
**Excavator:** Selland's Construction  
**Equipment:** Volvo EC480  
**Location:** Center of proposed cul-de-sac south of proposed Lot 3  
**Surface:** grass and weeds  
**Elevation:** 2210 ft  
**Logged by:** J. Pritzl  
**Size of hole:** 6 X 14 feet

---

**TEST PIT LOGS**

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702  
---
### Test Pit 6

**Date:** 8-9-21  
**Excavator:** Selland's Construction  
**Equipment:** Volvo EC480  
**Location:** Center of proposed cul-de-sac south of proposed Lot 18  
**Surface:** grass and weeds

<table>
<thead>
<tr>
<th>Depth</th>
<th>Moisture, Color, Condition</th>
<th>Description</th>
<th>Soil Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dry, light brown</td>
<td>SILT with fine Sand</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>dark brownish gray</td>
<td>BASALT, moderately weathered</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt)</td>
<td>End of Excavation @ 6.5 ft</td>
</tr>
</tbody>
</table>

**Elevation:** 2266 ft  
**Logged by:** J. Pritzl  
**Size of hole:** 6 X 12 feet

---

**Test Pit Logs**

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702

---

**Figure 4-6**

---

**Budinger & Associates**

1101 North Fancher Road  
Spokane Valley, WA 99212
**TEST PIT 7**

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>SOIL LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>dark brownish gray</td>
<td>BASALT, moderately weathered</td>
<td><img src="image" alt="Soil Log" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt)</td>
<td>End of Excavation @ 1.5 ft</td>
</tr>
</tbody>
</table>

**Date:** 8-9-21  
**Excavator:** Selland's Construction  
**Equipment:** Volvo EC480  
**Location:** Proposed road alignment CL; south of proposed Lot 22  
**Surface:** grass and weeds  
**Elevation:** 2270 ft  
**Logged by:** J. Pritzl  
**Size of hole:** 5 X 8 feet  

**TEST PIT LOGS**

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702  

**FIGURE 4-7**
**TEST PIT 8**

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dark brownish gray</td>
<td>BASALT, moderately weathered</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>End of Excavation @ 1 ft</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Elevation:** 2271 ft

**Logged by:** J. Pritzl

**Size of hole:** 5 X 8 feet

**Date:** 8-9-21

**Excavator:** Selland's Construction

**Equipment:** Volvo EC480

**Location:** Proposed road alignment CL; west of proposed Lot 29

**Surface:** grass and weeds

---

**Budinger & Associates**

1101 North Fancher Road
Spokane Valley, WA 99212

**Project:** Grandview 92-Lot Housing Development

**Location:** Spokane, WA

**Number:** S21702
<table>
<thead>
<tr>
<th>DEPTH</th>
</tr>
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<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dry, dark orangish brown</td>
<td>SILT with fine Sand</td>
</tr>
<tr>
<td></td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt)</td>
</tr>
<tr>
<td></td>
<td>Basalt, fresh</td>
<td>End of Excavation @ 6 ft</td>
</tr>
</tbody>
</table>

**TEST RESULTS**

**SOIL LOG**

**FIGURE 4-9**

**TEST PIT LOGS**

**Project:** Grandview 92-Lot Housing Development

**Location:** Spokane, WA

**Number:** S21702
## TEST PIT 10

**Date:** 8-9-21  
**Excavator:** Selland's Construction  
**Equipment:** Volvo EC480  
**Location:** Proposed road alignment CL; west of proposed Lot 75  
**Surface:** grass and weeds  
**Logged by:** J. Pritzl  
**Size of hole:** 6 X 10 feet  
**Elevation:** 2268 ft

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Moisture, Color, Condition</th>
<th>Description</th>
<th>Soil Log</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dry, dark orangish brown</td>
<td>SILT with fine Sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>dark brownish gray</td>
<td>BASALT, moderately weathered</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>no free groundwater</td>
<td>(digging refusal on fresh Basalt)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>End of Excavation @ 6.5 ft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Budinger & Associates**  
1101 North Fancher Road  
Spokane Valley, WA 99212  
Project: Grandview 92-Lot Housing Development  
Location: Spokane, WA  
Number: S21702  
**Figure 4-10**
**Test Pit 11**

**Date:** 8-9-21  
**Excavator:** Selland’s Construction  
**Equipment:** Volvo EC480  
**Location:** Proposed road alignment CL; west of proposed Lot 80  
**Surface:** grass and weeds

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>SOIL LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>dry, grayish brown</td>
<td>SILTY GRAVEL with Sand, Cobbles and Boulders, coarse, angular (colluvium)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Basalt, fresh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt) End of Excavation @ 6 ft</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Elevation:** 2263 ft  
**Logged by:** J. Pritzl  
**Size of hole:** 6 x 9 feet

---

**Test Pit Logs**

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702
**TEST PIT 12**

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
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<tbody>
<tr>
<td>0</td>
<td>dry, grayish brown</td>
<td>SILTY GRAVEL with Sand and Cobbles, coarse, angular (colluvium)</td>
</tr>
<tr>
<td>5</td>
<td>dark grayish brown</td>
<td>BASALT, moderately to highly weathered</td>
</tr>
<tr>
<td>10</td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt)</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>End of Excavation @ 7.5 ft</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TEST RESULTS**

<table>
<thead>
<tr>
<th>ATTERBERG LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL</td>
</tr>
<tr>
<td>LL</td>
</tr>
</tbody>
</table>

**Excavator:** Selland's Construction
**Equipment:** Volvo EC480
**Location:** Proposed road alignment CL; south of proposed Tract E
**Surface:** grass and weeds

**(unittest) Budinger & Associates**
1101 North Fancher Road
Spokane Valley, WA 99212

**PROJECTS**

**Project:** Grandview 92-Lot Housing Development
**Location:** Spokane, WA
**Number:** S21702
## TEST PIT 13

**Date:** 8-9-21  
**Excavator:** Selland's Construction  
**Equipment:** Volvo EC480  
**Location:** Proposed road alignment CL; north of proposed Lot 43  
**Surface:** grass and weeds

### TEST RESULTS

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>dry, light brown</td>
<td>SILT with fine Sand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dry, grayish brown</td>
<td>SILTY GRAVEL with Sand and Cobbles, coarse, angular (colluvium)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dry, gray</td>
<td>SAND with Gravel and Cobbles, coarse, angular to subangular, micaceous</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>dark grayish brown</td>
<td>BASALT, moderately weathered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no free groundwater observed</td>
<td>(digging refusal on fresh Basalt) End of Excavation @ 7.5 ft</td>
</tr>
</tbody>
</table>

**Elevation:** 2243 ft  
**Logged by:** J. Pritzl  
**Size of hole:** 6 X 12 feet

---

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702

---

**Budinger & Associates**  
1101 North Fancher Road  
Spokane Valley, WA 99212

**FIGURE 4-13**  
**TEST PIT LOGS**
### SOIL MECHANICS

#### LABORATORY SUMMARY

<table>
<thead>
<tr>
<th>LABORATORY NUMBER</th>
<th>Units</th>
<th>Test Methods</th>
<th>21-5581</th>
<th>21-5582</th>
<th>21-5583</th>
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<td>TP-2</td>
<td>TP-5</td>
<td>TP-13</td>
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<tr>
<td>DEPTH</td>
<td></td>
<td></td>
<td>TOP feet</td>
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<td>10</td>
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<td></td>
<td></td>
<td></td>
<td>BOTTOM feet</td>
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<td>GP-GM</td>
<td>SP</td>
</tr>
<tr>
<td>SIEVE ANALYSIS</td>
<td></td>
<td>ASTM D6913</td>
<td></td>
<td>100</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 1/2&quot;</td>
<td>72</td>
<td>95</td>
</tr>
<tr>
<td>S</td>
<td>1&quot;</td>
<td>%</td>
<td>59</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>3/4&quot;</td>
<td>%</td>
<td>55</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1/2&quot;</td>
<td>P</td>
<td>47</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>3/8&quot;</td>
<td>A</td>
<td>43</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>#4</td>
<td>S</td>
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<tr>
<td></td>
<td>#16</td>
<td>#10</td>
<td>S</td>
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<td></td>
<td>#30</td>
<td>#10</td>
<td>I</td>
<td>98</td>
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<tr>
<td></td>
<td>#40</td>
<td>#10</td>
<td>N</td>
<td>97</td>
<td>16</td>
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<td></td>
<td>#100</td>
<td>#10</td>
<td>G</td>
<td>94</td>
<td>14</td>
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<tr>
<td></td>
<td>#200</td>
<td>#10</td>
<td>A</td>
<td>91</td>
<td>11</td>
</tr>
</tbody>
</table>

*NP= Non Plastic

+7% Cobbles +6% Cobbles

**FIGURE 5**

Budinger & Associates, Inc.
Geotechnical & Environmental Engineers
Construction Materials Testing & Special Inspection
**GRAIN SIZE DISTRIBUTION RESULTS**

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702

**US GRAIN SIZE S21702.GPJ  BUDINGER.GDT  8/18/21**

**FIGURE 6**

---

**Specimen Identification**  
**Classification**  
- **2** 3.0  
  SILT with SAND(ML)  
  LL  | NP  
  PL  | NP  
  PI  | NP  
  Cc  | 3.59  
  Cu  | 215.49  

- **5** 10.0  
  POORLY GRADED GRAVEL with SILT and SAND(GP-GM)  
  LL  | NP  
  PL  | NP  
  PI  | NP  
  Cc  | 1.11  
  Cu  | 3.49  

- **13** 4.5  
  POORLY GRADED SAND with GRAVEL(SP)  
  LL  | NP  
  PL  | NP  
  PI  | NP  
  Cc  | 1.25  
  Cu  | 3.17  

---

**Specimen Identification**  
**Classification**  
- **2** 3.0  
  SILT with SAND(ML)  
  D100 | 3.0  
  D60 | 9.5  
  D30 | 1.60  
  D10 | 13.5  
  %Gravel | 13.5  
  %Sand | 79.0  
  %Silt | 20.5  
  %Clay | 79.0  

- **5** 10.0  
  POORLY GRADED GRAVEL with SILT and SAND(GP-GM)  
  D100 | 10.0  
  D60 | 26.2  
  D30 | 76.2  
  D10 | 219  
  %Gravel | 219  
  %Sand | 65.5  
  %Silt | 26.2  
  %Clay | 7.7  

- **13** 4.5  
  POORLY GRADED SAND with GRAVEL(SP)  
  D100 | 4.5  
  D60 | 1.277  
  D30 | 1.048  
  D10 | 10.0  
  %Gravel | 10.0  
  %Sand | 79.6  
  %Silt | 79.6  
  %Clay | 10.0
Appendix A: GBC - Important Information About Your Geotechnical Report
Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects
Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared solely for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. And no one — not even you — should apply this report for any purpose or project except the one originally contemplated.

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

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors
Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client’s goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:
• not prepared for you;
• not prepared for your project;
• not prepared for the specific site explored; or
• completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:
• the function of the proposed structure, as when it’s changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
• the elevation, configuration, location, orientation, or weight of the proposed structure;
• the composition of the design team; or
• project ownership.

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

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

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

A Report’s Recommendations Are Not Final
Do not overrely on the confirmation-dependent recommendations included in your report. Confirmation-dependent recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report’s confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations’ applicability.

A Geotechnical-Engineering Report Is Subject to Misinterpretation
Other design-team members’ misinterpretation of geotechnical-engineering reports has resulted in costly
problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team’s plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

**Do Not Redraw the Engineer’s Logs**
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

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

**Read Responsibility Provisions Closely**
Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

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

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

**Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance**
Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

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

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This addendum to the Geotechnical Conditions Report (GCR) presents the results of field testing and analysis of infiltration potential at 3 locations. The target areas were delineated in an updated site plan provided by Whipple Consulting Engineers, dated August 25, 2021.

**Scope**

Infiltration tests were completed in accordance with the Test Pit Infiltration Method of the *Spokane Regional Stormwater Manual* (SRSM Appendix 4-C). Due to subsurface conditions observed in the initial field exploration, test pit infiltration tests were conducted in lieu of borings as outlined in Task 2 of proposal S21702, revised August 6, 2021. Limited depth of explorations and infiltration testing provide results suitable for single-depth drywell design.

We logged the subsurface conditions in 3 test pits prior to performing infiltration tests. A site plan with test locations, test pit logs, infiltration test results, and laboratory test results are presented in *Figures*.

**Subsurface Conditions**

Test Pit 14 (TP-14) was excavated at the proposed infiltration basin in the eastern portion of the site which is located west of D Street and approximately 160 feet south of 19th Avenue. Stratified colluvium consisting of clast-supported, angular basalt gravel and cobbles in a matrix of silt was encountered from 1 to 10 feet below ground surface (BGS). A lacustrine silt horizon was encountered beginning below 10 feet and extended to greater than 11 feet BGS.

TP-15 was excavated near the southeast corner of the site. Stratified colluvium, similar to that observed in TP-14, was encountered to 4 feet BGS. Below that, clean gravel with sand was encountered to greater than 9 feet BGS. Fines content (percent passing the US#200 sieve) for one representative sample tested was 1.1 percent (very low fines). The excavation was terminated due to excessive caving of the gravel and sand below the overlying silty soil. Infiltration was rapid with complete drawdown in less than 10 minutes.

TP-16 was excavated near the northwest corner of the site. It consisted of 1.5 feet of stratified colluvium overlying 3 feet of gravel with sand and cobbles. The sand within the gravel and cobbles was relatively clean, similar to TP-15. A 6-inch-thick stratum of volcanic ash was
encountered from 5 to 5.5 feet BGS. It was underlain by dense gravel with silt and sand that extended below the bottom of the test pit at 7 feet. Testing of one representative sample of the gravel with silt and sand sediments yielded a fines content of 8.4 percent. Excavation refusal occurred in the very dense gravel with silt and sand. Infiltration was moderately low at about 8 gallons per minute.

**Table 1: Test Pit Infiltration Results**

<table>
<thead>
<tr>
<th>Test Pit ID</th>
<th>Q</th>
<th>H</th>
<th>qN³</th>
<th>qND³</th>
<th>H_D⁵</th>
<th>qA⁶</th>
<th>FS⁷</th>
<th>qD⁸</th>
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<tbody>
<tr>
<td>TP-14</td>
<td>0.0038</td>
<td>4.5</td>
<td>0.00085</td>
<td>0.0040</td>
<td>6</td>
<td>0.024</td>
<td>NS⁹</td>
<td>NS</td>
</tr>
<tr>
<td>TP-15</td>
<td>0.056</td>
<td>2.2</td>
<td>0.026</td>
<td>0.065</td>
<td>6</td>
<td>0.39</td>
<td>1.4</td>
<td>0.28</td>
</tr>
<tr>
<td>TP-16</td>
<td>0.019</td>
<td>2.8</td>
<td>0.0068</td>
<td>0.018</td>
<td>6</td>
<td>0.11</td>
<td>2.1</td>
<td>0.051</td>
</tr>
</tbody>
</table>

1. Stabilized flow rate observed near the end of the constant-head portion of the test in cubic feet per second (cfs).
2. Level of water within the test pit in feet.
3. Normalized outflow rate of the test pit in cfs per foot.
4. Normalized outflow rate of the drywell in cfs per foot.
5. Maximum design drywell head in feet.
6. ‘Actual’ (calculated by SRSM method) outflow rate in cfs.
7. Factor of safety from the SRSM, Table 4C-1.
8. Calculated design drywell outflow rate in cfs.
9. Not suitable for drywell disposal per SRSM design criteria.

**Conclusions and Recommendations**

Drywells do not appear to be feasible in the vicinity of TP-14 (east portion of site) due to high fines content and low infiltration test rates. Gravel galleries may be feasible, but at very limited rates.

Good infiltration potential was encountered at TP-15. We recommend sizing single-depth drywells at a maximum outflow rate of 0.3 cfs within a 50-foot radius of TP-15.

The volcanic ash stratum encountered in TP-16 represents a limiting layer and may render the use of single-depth drywells as infeasible. However, this area appears to be suitable for biofiltration utilizing a gallery approach with gravel trenches as follows:

- Perforated pipe in a 3-foot tall by 3-foot wide trench lined with filter fabric and filled with rounded drain rock. The pipe should be placed at least 12 inches below the biofiltration bottom.
- The recommended infiltration gallery discharge rate is 14 cubic feet per day per foot of trench length.
  - It is based on hydraulic conductivity, K, of 9.2 inches per hour (18.4 feet per day) from correlation with grain size distribution. A safety factor of 3.5 was applied to Darcy’s equation \( q = k \times i \times A \) with \( i = 0.3 \) due to low gradient \( i \) from mounding above the lower permeability limiting layer and \( A = w + (2 \times h) \) where \( w \) and \( h \) are the gallery height and width, respectively.
**Monitoring.** We recommend installing and measuring water levels in a minimum of 3 monitoring wells near property lines in the downgradient direction from infiltration structures. The minimum recommended measurement frequency is 2 per year.

This report is subject to the limitations stated in the original report, to which it should be permanently affixed.

**Attachments:**
- Figure A1-1: Site Plan
- Figure A1-2: Guide to soil and rock descriptions
- Figure A1, 3-14 to A1, 3-16: Infiltration Test Pit Logs
- Figures A1, 4-1 to A1, 4-6: Infiltration Test Results
- Figure A1-5: Laboratory Summary
- Figure A1-6: Grain Size Distributions
GUIDE TO SOIL & ROCK DESCRIPTIONS

SOIL CLASSIFICATION

BOULDER
12"

COBBLES
3"  

3/4" ---- GRAVEL ---- COARSE FINE

#4  
#10 ---- SAND ---- MEDIUM FINE

#200  

SILT  
.005 mm*

CLAY  

ABOVE "A" LINE*

PEAT* BASED ON ORGANIC CONTENT

* SEE PLASTICITY CHART
CGS - COARSE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE
FGS - FINE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE
FINES - PORTION FINEER THAN #200 SIEVE

ATTERBERG LIMITS

LIQUID

P.L. = L.L. + P.L.

SOLID, CONSTANT VOLUME

PLASTICITY CHART

CH
FAT CLAY

CL
LEAN CLAY

OH
ORGANIC SILT

ML
SILT

CL-ML

MH
ELASTIC SILT

LIQUID LIMIT

PLASTICITY INDEX

NOTE - CHART APPLIES TO FGS AND MINUS #40 SIEVE FRACTION OF CGS

GUIDE TO SOIL DESCRIPTION MODIFIERS, MOISTURE, AND CONDITION PRESENTED ON LOGS

MODIFIER

ESTIMATED PERCENTAGE OF MATERIAL

SUFFIX "LY" OR "Y" .................. 30% OR MORE FOR COARSE PARTS IN FGS
GREATER THAN 12% FOR FINES IN CGS

WITH .......................... 15% - 29% FOR COARSE PARTS IN FGS
6% - 14% FOR FINES IN CGS

MOISTURE

SOIL CONDITION

DRY

CGS:

VERY LOOSE
LOOSE
MEDIUM DENSE
DENSE
VERY DENSE

MOIST

FGS:

VERY SOFT
SOFT
MEDIUM STIFF
STIFF
VERY STIFF

SATURATED OR WET

HARD

NOTE - VISUAL ESTIMATES OF MATERIAL PERCENTAGES TYPICALLY VARY 0 TO 10% FROM THOSE DETERMINED BY LABORATORY TESTING.

SAMPLES

STANDARD 2" PENETRATION TEST SAMPLER WITH BLOWS PER FOOT

3" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT

DRILL CUTTING SAMPLE

BULK SAMPLE

THIN-WALLED TUBE SAMPLE

DIAMOND CORE RUN WITH % RECOVERY & ROCK QUALITY DESIGNATION

4" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT

R REFUSAL OF SAMPLE (50+ BLOWS PER 6")

ROCK WEATHERING

FRESH
SLIGHTLY WEATHERED
MODERATELY WEATHERED
HIGHLY WEATHERED
COMpletely WEATHERED
RESIDUAL SOIL

ROCK CONDITION

EXTREMELY WEAK
VERY WEAK
MODERATELY WEAK
MODERATELY STRONG
STRONG
VERY STRONG
TEST PIT 14

Date: 11-2-21  Elevation: 2215 ft
Excavator: B. Anderson  Logged by: D. Lehn
Equipment: CASE Extendahoe  Size of hole: 2.5 x 8
Location: Infiltration 1
Surface: pine needles and grass

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>SOIL LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>moist, dark brown, loose</td>
<td>SILT with Sand and Gravel and organics</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>dry, tan, medium dense</td>
<td>SILT with Sand, Gravel, and Cobbles, non-plastic (Colluvium)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stratified cobbles below 5 ft.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>dry, light gray, medium dense</td>
<td>SANDY SILT, stratified, blocky, lacustrine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no free groundwater observed</td>
<td>End of Excavation @ 11 ft</td>
<td></td>
</tr>
</tbody>
</table>

TEST RESULTS

ATTERBERG LIMITS

WATER CONTENT

PL  LL

10  20  30  40  50  60  70  80  90

Figure A1, 3-14

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702
**TEST PIT 15**

**Date:** 11-2-21  
**Excavator:** B. Anderson  
**Equipment:** CASE Extendahoe  
**Location:** Infiltration 2  
**Surface:** pine needles and grass

<table>
<thead>
<tr>
<th>DEPTH SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
<th>TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>moist, dark brown, loose</td>
<td>SILT with Sand and Gravel and organics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dry, tan, medium dense</td>
<td>SILTY GRAVEL with Sand and Cobbles, coarse, subangular (Colluvium)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>moist, gray, medium dense</td>
<td>GRAVEL with Sand, fine, angular</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refusal due to excessive caving</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>no free groundwater observed</td>
<td>End of Excavation @ 9 ft</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Elevation:** 2225 ft  
**Logged by:** D. Lehn  
**Size of hole:** 2.5 x 6

---

**Budinger & Associates**  
1101 North Fancher Road  
Spokane Valley, WA 99212

**TEST PIT LOGS**  
**FIGURE A1, 3-15**

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702
## TEST PIT 16

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>SAMPLES</th>
<th>MOISTURE, COLOR, CONDITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>moist, dark brown, loose</td>
<td>SILT with Sand and Gravel and organics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dry, tan, medium dense</td>
<td>GRAVEL with Silt, Sand, and Cobbles, coarse, subangular (Colluvium)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>moist, tan, medium dense</td>
<td>GRAVEL with Sand and Cobbles, coarse, subangular, alluvial</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>moist, white, medium dense</td>
<td>SILT (volcanic ash)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>moist, white, very dense</td>
<td>GRAVEL with Silt and Sand, coarse to fine, subangular, alluvial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no free groundwater observed</td>
<td>End of Excavation @ 7 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Excavation refusal on very dense gravel with silt and sand</td>
</tr>
</tbody>
</table>

**TEST RESULTS**

**SOIL LOG**

**PL**

**WATER CONTENT**

**ATTERBERG LIMITS**

**FIGURE A1, 3-16**

**TEST PIT LOGS**

**Project:** Grandview 92-Lot Housing Development

**Location:** Spokane, WA

**Number:** S21702
## Infiltration Test Results

### TP-14

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Time (min)</th>
<th>meter 1 (gal)</th>
<th>Cumulative Volume (gal)</th>
<th>Rate (gpm)</th>
<th>Head</th>
</tr>
</thead>
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Infiltration Test Results

TP-15

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INfiltration Test Results TP-15

Flow (gpm) vs. Head (ft) over time (min).

Budinger & Associates, Inc.
Geotechnical & Environmental Engineers
Construction Materials Testing & Special Inspection

Figure A1, 4-4
Infiltration Test Results

TP-16

Total Depth (ft) 6.70

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Budinger & Associates, Inc.
Geotechnical & Environmental Engineers
Construction Materials Testing & Special Inspection

Figure A1, 4-5
INfiltration Test Results TP-16

Flow (gpm)

Head (ft)

Time (min)

Budinger & Associates, Inc.
Geotechnical & Environmental Engineers
Construction Materials Testing & Special Inspection

Figure A1, 4-6
### Soil Mechanics

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**Units**

| MOISTURE CONTENT % ASTM D2216 | 8.2 | 2.3 | 7.5 |
| PLASTICITY INDEX % ASTM D4318 | NP | NP |
| UNIFIED CLASSIFICATION ASTM D2487 | ML | GP | GP-GM |

**Sieve Analysis**

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*NP= Non Plastic*
### GRAIN SIZE DISTRIBUTION RESULTS

**Project:** Grandview 92-Lot Housing Development  
**Location:** Spokane, WA  
**Number:** S21702  

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#### Specimen Identification and Grain Size Distribution

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#### Notes
- **Figure A1-6**
- **Project:** Grandview 92-Lot Housing Development  
- **Location:** Spokane, WA  
- **Number:** S21702