CONCEPTUAL DRAINAGE REPORT

For

CRYSTAL RIDGE SOUTH
2500 W 17TH AVENUE
PARCEL # 25252.0032

CITY OF SPOKANE, WASHINGTON

Prepared for:

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August 7, 2021
Conceptual Drainage Report
Crystal Ridge South
Parcel # 25252.0032
City of Spokane, WA.

The data, calculations, text and graphic information contained in this document were compiled and published under the supervision and direction of the undersigned, whose seal as a professional engineer licensed to practice as such in the State of Washington, is affixed below.

(Seal)

Date 8-7-21

(Consultant/Professional Engineer)
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APPENDIX B – PRE-DEVELOPED MAP & DRAINAGE ANALYSIS
APPENDIX C – POST-DEVELOPED MAP & DRAINAGE ANALYSIS
I. Introduction

I.1. Site Description

The project is located at 2500 W 17th Avenue, Spokane, Washington. It is bordered by the Fish Lake Trail on the east side, which runs parallel with Highway 195, and the Union Pacific Railway on the west side. The subject site is identified as Tax Assessor Parcel 25252.0032. The size of the property is approximately 14.25 acres.

I.2. Proposed Project

The proposed project will divide the site into (56) residential lots for construction of single family residence. Construction will include clearing and grading of the site, installation of underground utilities and on-site paving. Appendix C – Post-Development Conditions shows the layout of the development and proposed improvements.
II. Background Information

II.1. Topography

The site generally sloped towards the east and slopes ranged from 7 percent to vertical. The steepest slopes were along the eastern margin of the site adjacent to the Fish Lake Trail. The highest points of elevation were observed along the western margin of the site at 2024 and 2028 feet in the south and north, respectively, while the lowest point of elevation was observed in the northeast corner of 1931 feet.

The elevations presented in Appendix B – Pre-Development Conditions are based on a topographic survey conducted by Gordon Surveying for this project.

The site is generally covered with brush, grasses, other vegetation and scattered trees.

II.2. Soils

Please refer to the geotechnical report prepared by Budinger and Associates in Appendix “A” for information on the soils and drainage determination of the site.

II.3. Drainage System Determination

The best means to deal with runoff appears to be the use of bio-infiltration pond in conjunction with drywells consistent with the geotechnical report recommendations.

II.4. Critical Areas

The subject property does not contain critical areas.

II.5. Down-Gradient Analysis

Stormwater runoff generated by the proposed development will be directed into the stormwater drainage ponds. The stormwater will be treated and stored in the drainage ponds and drywells.

The stormwater runoff generated by the proposed project will treated and stored on site and will not have any down-gradient adverse impacts.

II.6. Operational Characteristics

The operational characteristics of this project are simple and straightforward. Stormwater runoff will flow cross the paved surface to the stormwater drainage pond. The runoff will then fill
the grassy pond up to the rim of the drywell and then overflow into the drywell where it will be stored and infiltrate into the subsurface soil.

II.7. Perpetual Maintenance of Facilities

A maintenance agreement will be developed for the perpetual operation and maintenance of the stormwater system.
III. Drainage Narrative

III.1. Theory

The storm drainage facilities on this project have been designed to dispose of runoff from a ten-year design storm, as required by the Spokane Regional Stormwater Manual SRSM. For this project, the 10-year intensity curves from the SRSM Section 5.5.3 were used, as well as the SCS isopluvial rainfall curves. An intensity of 2.62 in/hr is used in the 10-year design storm event.

This development is within the Aquifer Sensitive Area of Spokane County and the ‘208’ requirements were followed. The Bowstring Method was used to verify the designed swale/pond volumes are adequate for storage of the onsite runoff generated during the design storm event.

III.2. Off Site

Based upon the general geographic tendencies surrounding this site, there will be no offsite flows entering the development.

III.3. Pre-Developed

In the pre-developed condition, the site will be considered as three basins. The basins were determined by the natural topography of the plat. Calculations for the 10- and 50-year storm events were performed.

III.4. Post-Developed

All runoff within the proposed drainage basins will be collected and treated using the ‘208’ runoff method as described in the SRSM. In the developed condition, the project includes two (2) onsite basins (see Figure 3). Weighted “C” Runoff Coefficients were calculated for each basin of less than 10 acres as required by the SRMS. Table 1 provides the basin size, total impervious areas, and runoff coefficients for the post developed condition.

<table>
<thead>
<tr>
<th>Basin</th>
<th>Total Area (SF)</th>
<th>Total Area (AC)</th>
<th>‘208’ Impervious Area (SF)</th>
<th>Total Impervious Area (SF)</th>
<th>Runoff Coefficient “C”</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>204296</td>
<td>4.69</td>
<td>46260</td>
<td>94260</td>
<td>0.52</td>
</tr>
<tr>
<td>B</td>
<td>187308</td>
<td>4.3</td>
<td>49060</td>
<td>111060</td>
<td>0.62</td>
</tr>
</tbody>
</table>
In calculating the ‘208’ impervious area (PGIS) the assumed driveway area was 400 square feet. An assumed roof area of 2,000 square feet per lot was used in the total impervious area.

III.5. ‘208’ Calculations

The ‘208’ storage volume for each basin was designed to adequately contain the runoff created by the first half-inch of rainfall upon the ‘208’ impervious areas within the basin it serves. The provided ‘208’ treatment volume shown in Table 2 is based on pond bottom areas and 3:1 side slopes at a maximum six-inch treatment depth of the swale. See Appendix “C” for swale volume calculations.

Table 2 summarizes the requirements and designs of the ponds by basin.

<table>
<thead>
<tr>
<th>Pond</th>
<th>Pond Bottom Area (SF)</th>
<th>‘208’ Volume Required (CF)</th>
<th>Provided Pond ‘208’ Volume (CF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2400</td>
<td>1200</td>
<td>1277</td>
</tr>
<tr>
<td>B</td>
<td>2400</td>
<td>1280</td>
<td>1277</td>
</tr>
</tbody>
</table>

III.6. Total Stormwater Storage Calculations

Since the contributing area is from the on-site area, the minimum storage volumes of the swales are designed for the 10-year storm event. Bowstring calculations have been included for each basin to determine the extent of storm drainage required for the 10-year storm event. The provided storm/storage volume shown in Table 3 is based on pond bottom areas and 3:1 side slopes at a maximum twelve-inch depth. See Appendix “C” for swale volume calculations.

Table 3 summarizes the total storage volume proposed for each basin.

<table>
<thead>
<tr>
<th>Basin</th>
<th>10-Year Volume Required (CF)</th>
<th>Storage Volume Provided (CF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2508</td>
<td>2718</td>
</tr>
<tr>
<td>B</td>
<td>2500</td>
<td>2718</td>
</tr>
</tbody>
</table>
III.7  Larger Storm Events

An analysis was done to evaluate the affects of larger storm events or failure of proposed facilities. A visual inspection was conducted and the following was concluded:

- The proposed project engineering plans will neither aggravate an existing drainage problem nor create a new drainage problem.
- All storm water runoff from the proposed project will discharge at the natural, pre-developed location and will not adversely affect any private property.
IV. Conclusion

As demonstrated by the calculations and body of this report the '208' volume can be treated on site within the proposed drainage swale, and the 10-year storm events can be stored and disposed of on site with the drainage swale.

Therefore, the drainage facilities proposed within this design will adequately remove the streets, treat, store and dispose of the stormwater from the site for the 10-year design storm as required by the Spokane Regional Stormwater Manual SRSM.
APPENDIX A – GEOTECHNICAL REPORT
APPENDIX B – PRE-DEVELOPED MAP & DRAINAGE ANALYSIS
PEAK FLOW CALCULATION  PROJECT: **Crystal Ridge South**  
**10-Year Design Storm**

Basin: Pre-A  
Total Area 4.4 Acres  
Per. C 0.35 (for Hilly Meadows and Pasture Land)  

\[
I (10 \text{ yr}) = 2.62 \text{ in/hr.}
\]

\[
Q_{10} = CIA = 0.35 \times 2.62 \text{ in/hr.} \times 4.4 \text{ acres} = 4.0 \text{ cfs}
\]

---

PEAK FLOW CALCULATION  PROJECT: **Crystal Ridge South**  
**50-Year Design Storm**

Basin: Pre-A  
Total Area 4.4 Acres  
Per. C 0.35 (for Hilly Meadows and Pasture Land)  

\[
I (50 \text{ yr}) = 3.2 \text{ in/hr.}
\]

\[
Q_{50} = CIA = 0.35 \times 3.2 \text{ in/hr.} \times 4.4 \text{ acres} = 4.9 \text{ cfs}
\]
PEAK FLOW CALCULATION  PROJECT: **Crystal Ridge South**

**10-Year Design Storm**

Basin: Pre-B

Tot. Area  4.6 Acres

Per. C  0.35 (for Hilly Meadows and Pasture Land)

I (10 yr) = 2.62 in/hr.

Q10 = CIA = 0.35 x 2.62 in/hr. x 4.6 acres = 4.2 cfs

---

PEAK FLOW CALCULATION  PROJECT: **Crystal Ridge South**

**50-Year Design Storm**

Basin: Pre-B

Tot. Area  4.6 Acres

Per. C  0.35 (for Hilly Meadows and Pasture Land)

I (50 yr) = 3.2 in/hr.

Q50 = CIA = 0.35 x 3.2 in/hr. x 4.6 acres = 5.2 cfs
PEAK FLOW CALCULATION  
**PROJECT: Crystal Ridge South**  
**10-Year Design Storm**  
Basin: Pre-C  
Tot. Area  5.25 Acres  
Per. C  0.35 (for Hilly Meadows and Pasture Land)  
\[ I(10 \text{ yr}) = 2.62 \text{ in/hr.} \]  
\[ Q_{10} = CIA = 0.35 \times 2.62 \text{ in/hr.} \times 5.25 \text{ acres} = 4.8 \text{ cfs} \]  

PEAK FLOW CALCULATION  
**PROJECT: Crystal Ridge Second Addition**  
**50-Year Design Storm**  
Basin: Pre-C  
Tot. Area  5.25 Acres  
Per. C  0.35 (for Hilly Meadows and Pasture Land)  
\[ I(50 \text{ yr}) = 3.2 \text{ in/hr.} \]  
\[ Q_{50} = CIA = 0.35 \times 3.2 \text{ in/hr.} \times 5.25 \text{ acres} = 5.9 \text{ cfs} \]
APPENDIX C – POST-DEVELOPED MAP & DRAINAGE ANALYSIS
FIGURE 3 - POSTDEVELOPMENT CONDITIONS

NOT TO SCALE
CONTOUR INTERVAL = 1'
BASIN “A”
Total Area = 4.69 acres.

Roof Area

24 x 2000 = 48,000 Ft²

Paved Area + Concrete Curb & Gutter

780' x 37' = 28,860 Ft²

Total Paved Area = 28,860 Ft² = 0.6625 acres.

Concrete Driveways

24 x 400 = 9600 Ft²

Concrete Sidewalk

780' x 10 = 7800 Ft²

Lawns

4.69 - 2.16 = 2.53 acres

Weighted “C” Factor

(0.9 x 2.16) + (0.20 x 2.53) divided by 4.69

= 0.52

Required Swale Volume

V = 1133 A, where
V= Volume of swale (cubic feet)
A= Pollution generating impervious surface (acres)

V = 1133 x 1.06 acres

= 1200 CF
**BOWSTRING METHOD**  
**DETENTION BASIN DESIGN**  

**PROJECT:** Crystal Ridge South  
**Basin:** A

- Time Increment (min.): 5
- Time of Conc. (min.): 5.0
- Outflow (cfs): 0.9
- Design Year Flow: 10
- Area (acres): 4.69
- Impervious Area (sf): 94260
- ‘C’ Factor: 0.52
- Area x C: 2.44

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Time (sec)</th>
<th>I (in/hr)</th>
<th>Qdev (cfs)</th>
<th>Vin (cu. ft.)</th>
<th>Vout (cu. Ft.)</th>
<th>Storage (cu. Ft.)</th>
</tr>
</thead>
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<td>2.62</td>
<td>6.39</td>
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<td>270</td>
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<td>10</td>
<td>600</td>
<td>1.72</td>
<td>4.19</td>
<td>2945</td>
<td>540</td>
<td>2405</td>
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<td>900</td>
<td>1.34</td>
<td>3.27</td>
<td>3275</td>
<td>810</td>
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<td>3829</td>
<td>1350</td>
<td>2479</td>
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<tr>
<td>30</td>
<td>1800</td>
<td>0.88</td>
<td>2.15</td>
<td>4082</td>
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<tr>
<td>35</td>
<td>2100</td>
<td>0.8</td>
<td>1.95</td>
<td>4296</td>
<td>1890</td>
<td>2406</td>
</tr>
<tr>
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<td>0.74</td>
<td>1.80</td>
<td>4515</td>
<td>2160</td>
<td>2355</td>
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<td>2142</td>
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<td>1.49</td>
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<td>2970</td>
<td>2091</td>
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<td>1562</td>
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<td>0.48</td>
<td>1.17</td>
<td>5738</td>
<td>4320</td>
<td>1418</td>
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<td>1.15</td>
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<td>4590</td>
<td>1373</td>
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<td>90</td>
<td>5400</td>
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<td>1.10</td>
<td>6038</td>
<td>4860</td>
<td>1178</td>
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<td>95</td>
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<td>1.07</td>
<td>6226</td>
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<td>1096</td>
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<td>100</td>
<td>6000</td>
<td>0.42</td>
<td>1.02</td>
<td>6250</td>
<td>5400</td>
<td>850</td>
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</tbody>
</table>

**“208” TREATMENT REQUIREMENTS**

<table>
<thead>
<tr>
<th>Minimum “208” Volume Required</th>
<th>1200 cu. Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provided Treatment Volume</td>
<td>1277 cu.ft.</td>
</tr>
</tbody>
</table>

**DRYWELL REQUIREMENTS – 10 YEAR DESIGN STORM**

| Maximum Storage Required by Bowstring | 2508 cu. Ft. |
| Provided Storage Volume at 12” depth | 2718 cu. Ft. |
| Number and type of Drywells Required | 3 Single |
|                                      | 0 Double    |
Provided Treatment/Storage Volume:

A stormwater pond will be constructed to provide the required treatment and storage volume. The pond will have a bottom area of 2400 square feet and will be at least one foot deep:

<table>
<thead>
<tr>
<th>DRAINAGE POND DIMENSIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond Side Slope</td>
<td>3 :1</td>
</tr>
<tr>
<td>Bottom Length (ft)</td>
<td>60</td>
</tr>
<tr>
<td>Bottom Width (ft)</td>
<td>40</td>
</tr>
<tr>
<td>Bottom Area (SF)</td>
<td>2400</td>
</tr>
<tr>
<td>Treatment Depth (ft)</td>
<td>0.5</td>
</tr>
<tr>
<td>Treatment Area (SF)</td>
<td>2709</td>
</tr>
<tr>
<td>Treatment Volume (CF)</td>
<td>1,277</td>
</tr>
<tr>
<td>Storage Depth (ft)</td>
<td>1</td>
</tr>
<tr>
<td>Storage Area (SF)</td>
<td>3036</td>
</tr>
<tr>
<td>Storage Volume (CF)</td>
<td>2718</td>
</tr>
</tbody>
</table>
BASIN “B”
Total Area = 4.3 acres.

Roof Area

$$31 \times 2000 = 62,000 \text{ Ft}^2$$

Paved Area + Concrete Curb & Gutter

$$780' \times 37' = 28,860 \text{ Ft}^2$$

Total Paved Area = 28,860 Ft$^2$ = 0.6625 acres.

Concrete Driveways

$$31 \times 400 = 12400 \text{ Ft}^2$$

Concrete Sidewalk

$$780' \times 10 = 7800 \text{ Ft}^2$$

Lawns

$$4.3 - 2.55 = 1.75 \text{ acres}$$

Weighted "C" Factor

$$\frac{(0.9 \times 2.55) + (0.20 \times 1.75)}{4.3}$$

$$= 0.62$$

Required Swale Volume

$$V = 1133 \text{ A}, \text{ where}$$

$$V= \text{ Volume of swale (cubic feet)}$$

$$\Lambda= \text{ Pollution generating impervious surface (acres)}$$

$$V = 1133 \times 1.13 \text{ acres}$$

$$= 1280 \text{ CF}$$
### BOWSTRING METHOD
**DETENTION BASIN DESIGN**

<table>
<thead>
<tr>
<th>Time Increment (min.)</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Conc. (min.)</td>
<td>5.0</td>
</tr>
<tr>
<td>Outflow (cfs)</td>
<td>1.2</td>
</tr>
<tr>
<td>Design Year Flow</td>
<td>10</td>
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<tr>
<td>Area (acres)</td>
<td>4.3</td>
</tr>
<tr>
<td>Impervious Area (sf)</td>
<td>111060</td>
</tr>
<tr>
<td>‘C’ Factor</td>
<td>0.62</td>
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<tr>
<td>Area x C</td>
<td>2.666</td>
</tr>
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</table>

<table>
<thead>
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<th>Time (min)</th>
<th>Time (sec)</th>
<th>I (in/hr)</th>
<th>Qdev (cfs)</th>
<th>Vin (cu. ft.)</th>
<th>Vout (cu. Ft.)</th>
<th>Storage (cu. Ft.)</th>
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<td>1693</td>
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### "208" TREATMENT REQUIREMENTS

- Provided Treatment Volume: 1277 cu.ft.

### DRYWELL REQUIREMENTS – 10 YEAR DESIGN STORM

- Maximum Storage Required by Bowstring: 2500 cu. Ft.
- Provided Storage Volume at 12" depth: 2718 cu. Ft.
- Number and type of Drywells Required:
  - 4 Single
  - 0 Double
**Provided Treatment/Storage Volume:**

A stormwater pond will be constructed to provide the required treatment and storage volume. The pond will have a bottom area of 2400 square feet and will be at least one foot deep:

<table>
<thead>
<tr>
<th>DRAINAGE POND DIMENSIONS</th>
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<tr>
<td>Pond Side Slope</td>
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<tr>
<td>Bottom Length (ft)</td>
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<td>Bottom Width (ft)</td>
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<td>Bottom Area (SF)</td>
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