# FINAL TECHNICAL INFORMATION REPORT

## Riverside Neighborhood Park

La Center, Washington


*Prepared by:*
**PLS Engineering**
**Consulting Engineers and Planners**
**604 W. Evergreen Blvd**
**Vancouver, WA 98660**
**PH: (360) 944-6519**
**PM@plsengineering.com**


*Prepared for:*
**9317 LLC**
**Luke Sasse**
**1921 NE 72nd Ave. Bldg C #7**
**Vancouver, WA 98665**
**(360) 449-0099**
**luke@timberlandinc.com**


Submitted: July, 2021

# TABLE OF CONTENTS

## CERTIFICATE OF ENGINEER

***Riverside Neighborhood Park***
***Drainage Report***

The technical information and data contained in this report were prepared by the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.


7-1-21

This document was:

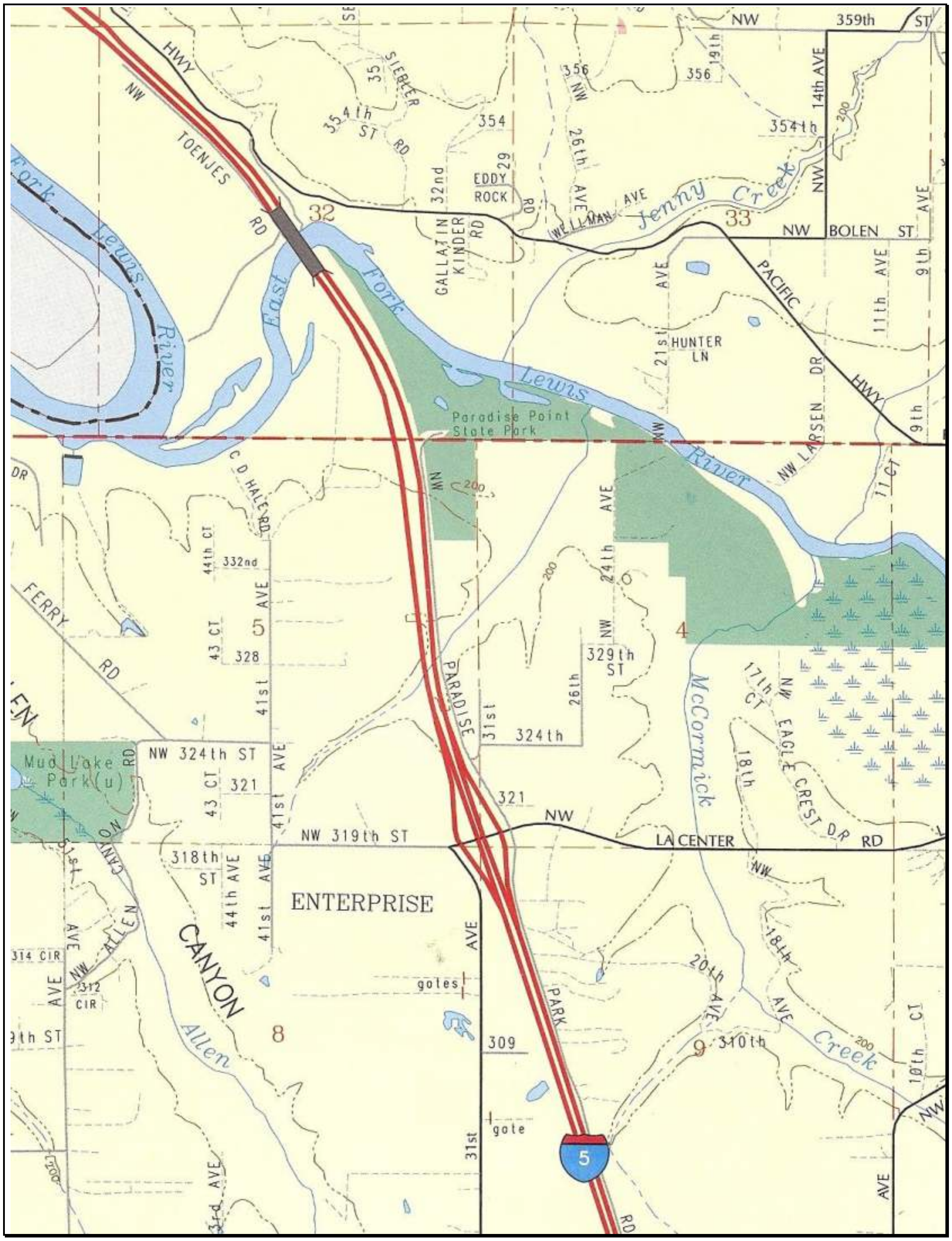
Prepared by: Matthew J Muller

Matthew J Muller, EIT

# VICINITY MAPS

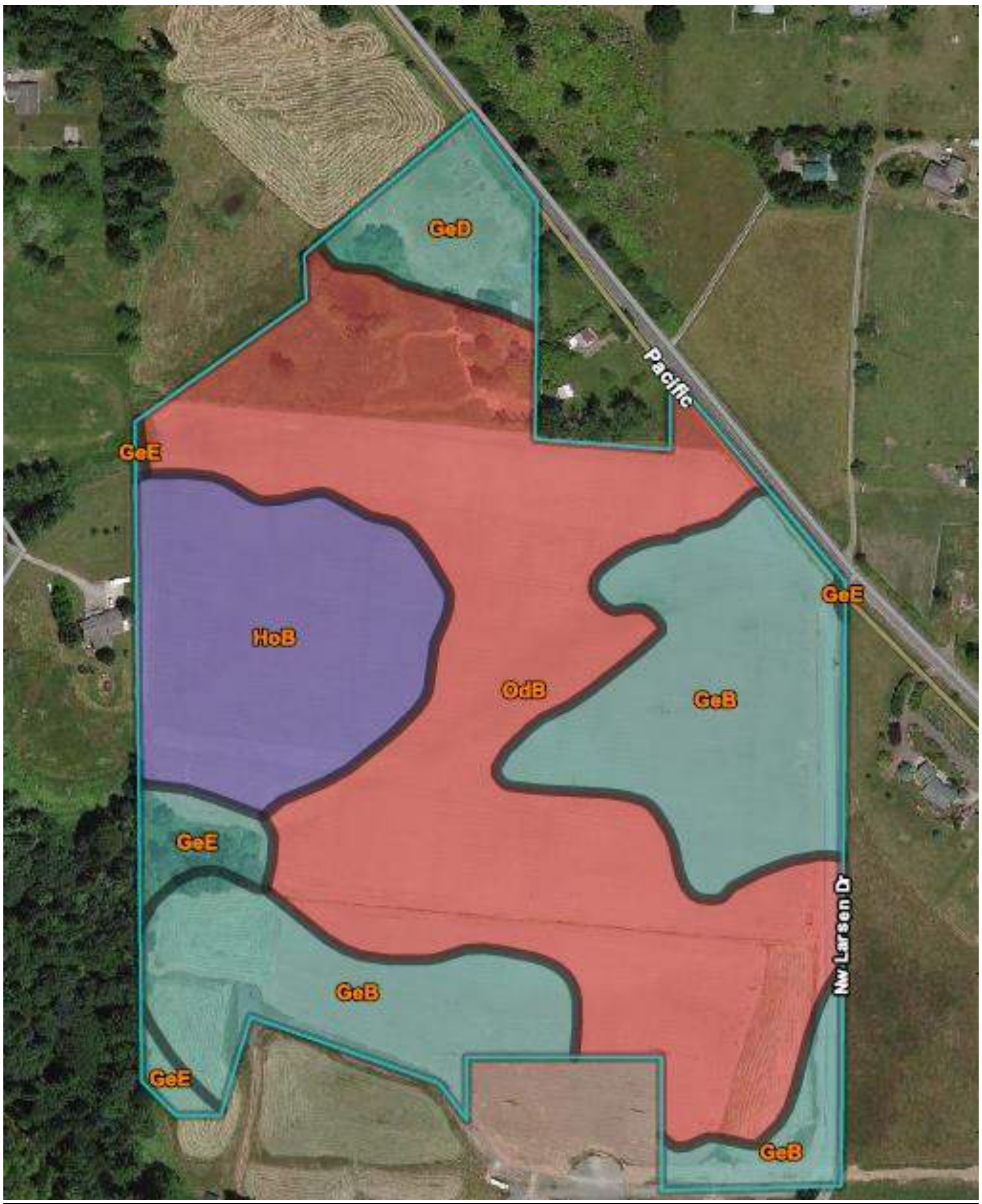
## (a) Site Location Map

Clark County Atlas
Sec 33, T5N, R1E, W.M.



**(b). Soils Map**

USDA SCS Map 1" = 3550'
Site Soils Include: Gee silt loam, Hydrologic soils group (HSG) C; Hillsboro silt loam, HSG B; and Odne silt loam, HSG D



## SECTION A – PROJECT OVERVIEW

The Riverside Neighborhood Park is a 5.19-acre site located on the southwest side of Old Pacific Highway directly west of Larson Road in La Center, WA. The site address is 34512 NW Pacific Highway and is located in the SE ¼ of Section 33, T5N, R1E, Willamette Meridian. It is identified as Parcel Number 986028825 per the Clark County Assessor's records. The site currently consists of vacant fields, wetlands, and a stock watering pond. In addition, the site was previously used for residential purposes with an existing home having been removed sometime around 2014. A drainage ditch traverses along the south line of the parcel.

The site's existing topography is generally rolling with some steep areas near NW Pacific Hwy. It slopes down from the highway towards the drainage ditch, with the SW corner of the site as a low point. There is a high point near the south property line that separates the site into two drainage basins. The proposed development will maintain these drainage patterns by routing water to two separate facilities.

Riverside Neighborhood Park will include picnic tables, play equipment, a basketball court, pedestrian paths, open space, and a drinking fountain. Infrastructure improvements to support the park will include lighting, a water lateral for the drinking fountain, paved driveway and parking area.

## SECTION B – APPROVAL CONDITIONS SUMMARY

Per LCMC 18.320.410 (6) it is required that the stormwater control, wetlands, floodplains, and other water-related issues in the conditions of approval are listed in the Technical Information Report with an explanation on how the proposed design addresses the condition. There were not any conditions provided for the Park phase of this project. Listed below are the conditions provided in the Hearing Examiner's Decision dated October 3, 2017 for the subdivision phase of the project with their corresponding explanation.

*The design and construction of storm drainage shall be in accordance with the LCMC and applicable city engineering standards for public works.*

Per Chapter 18.320 of the La Center Municipal Code (LCMC), the subdivision will be required to mitigate for stormwater runoff impacts generated as a result of the proposed improvements. The hydrologic analysis of this site was performed in accordance with the guidelines contained in LCMC and Chapters III-1 and III-2 of the Puget Sound Manual.

*The project shall not increase the rate of stormwater runoff entering the Larson Road Storm pond serving the East Fork Estates development.*

It is assumed that the same criteria would be in affect for the Wetlands and Ditch running on the south side of the Park property. In the HydroCAD calculations provided in Appendix B, you can see that the post-developed flows for the 2,10,25, and 100-year storm events are less than the pre-developed flows entering the existing Wetlands and Ditch.

*Site improvements shall not proceed without an approved erosion control plan. All erosion control measures shall be designed, approved, installed and maintained consistent with Chapter 18.320 LCMC and City Engineering Standards. The applicant is required to have a construction stormwater permit in place with a SWPPP per D.O.E. before construction begins. Where these standards differ, the more stringent shall apply. All erosion control measures shall be in place prior to removal of vegetation or any construction activity and shall be maintained during all phases of construction.*

A grading & erosion control plan is provided with the construction drawings. A SWPPP has been prepared (see Appendix F) and will be provided to the contractor on-site. The Construction stormwater permit was acquired for all phases of the Riverside Development, and is still in effect for the Park project.

*The developer shall dispose of stormwater on-site per LCMC. The applicant is required to treat stormwater and detain on-site meeting the city ordinance. The applicant's engineer shall review the existing pond for structural stability and leakage prior to approval of the final stormwater design.*

Per Chapter 18.320 of the La Center Municipal Code (LCMC), the subdivision will be required to mitigate for stormwater runoff impacts generated as a result of the proposed improvements. The hydrologic analysis of this site was performed in accordance with the guidelines contained in LCMC and Chapters III-1 and III-2 of the Puget Sound Manual. The existing cow pond located north of the existing drainage ditch that separates the future phases 3 & 4 will no longer be utilized as a stormwater facility as part of this development.

*The Developer shall:*

*a. Undertake a new delineation in the early part of the growing season to avoid the effects of drought in order to achieve a more accurate wetland delineation. That field mowing shall be suspended prior to preforming a reevaluation so that the delineator will be able to determine the species and area of cover; or*

*b. Reimburse the City for the cost of hiring a 3rd party wetland biologist identified by the City to evaluate the entire site for critical areas prior to undertaking any land disturbing activities within potential critical areas on the site and comply with that 3rd party determination.*

A new delineation was done on the wetland by a 3rd party wetland biologist. This delineation has been accepted by the Army Corps of Engineers and the Washington State Department of Ecology.

## SECTION C – OFFSITE ANALYSIS

On the cool mostly sunny day of October 22, 2020, PLS Engineering visited the Riverside Neighborhood Park project site and its corresponding downstream discharge areas in order to perform the required off-site analysis for the proposed stormwater discharges from the site. The entire site drains to the South and eventually the SW corner of the site. There do not appear to be any existing erosion control issues on the site. The existing ditch running along the south side of the site flows from East to West, and appears to be sized sufficiently to handle the flow passing through it. Approximately 70' West of the SW property corner the ditch turns 90 degrees and flows South. From there it travels approximately 110' before angling to the SW for approximately 270' where it passes under NW Hunter Lain via a culvert. From there it travels through a natural ravine for approximately 1000' until it is eventually discharged into East Fork Lewis River.

The stormwater design proposes to maintain the existing flow paths. The park landscaped area will be collected in area drains, and discharged at the base of the slope near the wetlands via a flow spreader. The flow spreader will be 40' long and include a 12" pipe to act as detention during the water quality event. The pollution generating impervious surfaces from the road and parking lot, along with some landscaped areas will be routed to a swale and detention pond located between the parking lot and the path near the low point of the developed area on the site. The detention pond will discharge via a 20' flow spreader near the edge of the wetlands, where the runoff will continue to follow the existing flow path.

During the site visit, there were no signs of erosion or flooding on or downstream of the site. There is a 6" culvert located in the ditch, otherwise there were no other conveyance systems found in the downstream analysis other than those mentioned above. There were also no signs that the ditch or natural drainage paths were over or near capacity.

## SECTION D – QUANTITY CONTROL ANALYSIS AND DESIGN

Per Chapter 18.320 of the La Center Municipal Code (LCMC), the subdivision will be required to mitigate for stormwater runoff impacts generated as a result of the proposed improvements. The hydrologic analysis of this site was performed in accordance with the guidelines contained in LCMC and Chapters III-1 and III-2 of the Puget Sound Manual. The storm events were assumed to have a 24-hour duration and follow a Type 1A storm distribution. Rainfall depth for the 2, 10, 25, and 100-year 24-hour storm events are 2.3, 3.25, 3.8, and 4.3 inches respectively, as obtained from the Isopluvial maps for Clark County included in Appendix A. The detention facilities have been designed to produce release rates for the entire site equal or less than the predevelopment peak runoff rates for the 2, 10, 25 and 100-year, 24-hour storm events as stated in LCMC Code Section 18.320.220 (3)(d)(i) . In addition, the facilities have been designed utilizing Figure III-1.1 Volume Correction Factor from the Puget Sound Manual. This resulted in a correction factor of 1.41 for the detention facilities.

The live storage area of the stormwater facilities were assumed to be empty at the beginning of the design storm event. The hydrological analysis was completed using HydroCAD v 10.0, which allows the SCS TR-20 method of hydrograph routing to be utilized and the TR-55 method to determine the times of concentration. The soil characteristics were obtained from USDA NRCS website. As can be seen on the soils map located in the appendix of this report, there are multiple soil types covering this site. These soil types consist of hydrologic soil groups (HSG) C and D. The Runoff Curve Numbers (RCNs) that were used in the design of the project were taken from Table III-1.3 of the Puget Sound Manual.

Because of the multiple soil types, different RCN values were used for modeling the pre-developed conditions for the pervious areas of the site. RCN values of 85 and 89 were used respectively for the HSG C and D soils covered in pasture areas. Impervious surfaces for both the pre- and post-developed conditions were modeled using a RCN of 98 for pavement and roofs.

Table 1 below shows a tabulation of the project site areas for pre- and post-developed conditions.

**Table 1- Summary of Pre- and Post-Developed Areas**

| | **Basin** | **Impervious (sq-ft)** | **Pervious (sq-ft)** | **Total (sq-ft)** | **Total (acres)** |
|---|---|---|---|---|---|
| **Pre-Developed Area** | | | | | |
| | **Onsite** | | | | |
| | A1 | 4,381 | 112,281 | 116,662 | 2.68 |

| | | | | | |
|---|---|---|---|---|---|
| **Post-Developed Area** | | | | | |
| | B1 | 15,263 | 70,000 | 85,263 | 1.96 |
| | B2 | 17,016 | 14,383 | 31,399 | 0.72 |
| | | | | | |
| | Total | 32,279 | 84,383 | 116,662 | 2.68 |

For the post-development prelim analysis only two basins were modeled (B1 and B2). B1 is routed to a flow spreader with enough detention to handle the WQ event, and B2 is routed to a small pond. RCN values of 86 for landscaping and 98 for the impervious areas were used.

Please refer to the HydroCAD stormwater model located in Appendix B, for tabulated acreage, imperviousness, curve numbers, length and grade of overland flow, and other hydrological parameters used in completing the analysis. Basin Maps are included in Appendix C.

Water quantity control for the development will be accomplished utilizing two separate facilities. Pond 1 will be constructed between the parking lot and the path near the low point for the developed area. It will include a simple control structure that will meter discharge to a flow spreader that will release the runoff in sheet flow towards the wetlands. The Park landscaping and sidewalk runoff will be conveyed directly to a flow spreader which will include a 12” pipe for WQ detention storage, and a 2.4” pipe discharge pipe out the bottom. The flow rate at the point of comparison (assumed to be the ditch) is equal to or less than the existing flow rates. See Appendix B for the Hydro Cad printout.

## SECTION E – CONVEYANCE SYSTEMS ANALYSIS AND DESIGN

The pipes for the conveyance system are designed for the 100-year storm event per LCMC 18.320.220, and are sized to carry flows from the contributing drainage areas upon full buildout while operating in an open flow regime. The conveyance calculations for the stormwater pipes were performed using Hydro Cad and are included in Appendix B.

## SECTION F – RUNOFF WATER QUALITY TREATMENT

The pollution generating surfaces will be conveyed to a Biofiltration Swale, prior to discharge to Pond 1. The swale design is modeled in Hydro CAD and has a time of concentration of 9 minutes during the Water Quality event. See Appendix B

## SECTION G – SOILS EVALUATION

There are two soil types located on this site. A soils map, obtained from USDA NRCS website, is located in Appendix A of this report. The soil types onsite consist of Gee silt loam, 8 to 20% slopes (GeD) and Odne silt loam, 0 to 5% slopes (OdB). The hydrologic soil groups (HSG) for these soils are C and D respectively.

## SECTION H – SPECIAL REPORTS AND STUDIES

A geotechnical report, a wetland and habitat report, and an archeological report were all completed for this site. All of these reports have been included as part of the subdivision application. The Geotechnical Report is provided in Appendix D.

## SECTION I – OTHER PERMITS

A JARPA was submitted to the Army Corps of Engineer's and Washington State Department of Ecology for wetland areas that are to be impacted as part of development of the site.

## SECTION J – MAINTENANCE AND OPERATIONS MANUAL

All of the stormwater facilities associated with this development are to be owned & maintained by the Riverside Estates Homeowner's Association. A maintenance and operations manual is provided in Appendix E.

# APPENDIX A

## Design Criteria

Curve Numbers
Manning's "n" Values
Isopluvial Maps (2-, 10-, and 100-Year)
NRCS Soils Map

Table III-1.3 SCS Western Washington Runoff Curve Numbers (Published by SCS in 1982) Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1A rainfall distribution, 24-hour storm duration.

| LAND USE DESCRIPTION | | CURVE NUMBERS BY HYDROLOGIC SOIL GROUP A | B | C | D |
|---|---|---|---|---|---|
| Cultivated land(1): | winter condition | 86 | 91 | 94 | 95 |
| Mountain open areas: | low growing brush & grasslands | 74 | 82 | 89 | 92 |
| Meadow or pasture: | | 65 | 78 | 85 | 89 |
| Wood or forest land: | undisturbed | 42 | 64 | 76 | 81 |
| Wood or forest land: | young second growth or brush | 55 | 72 | 81 | 86 |
| Orchard: | with cover crop | 81 | 88 | 92 | 94 |
| Open spaces, lawns, parks, golf courses, cemeteries, landscaping. | | | | | |
| Good condition: | grass cover on ≥75% of the area | 68 | 80 | 86 | 90 |
| Fair condition: | grass cover on 50-75% of the area | 77 | 85 | 90 | 92 |
| Gravel roads & parking lots: | | 76 | 85 | 89 | 91 |
| Dirt roads & parking lots: | | 72 | 82 | 87 | 89 |
| Impervious surfaces, pavement, roofs etc. | | 98 | 98 | 98 | 98 |
| Open water bodies: | lakes, wetlands, ponds etc. | 100 | 100 | 100 | 100 |
| Single family residential(2): | | Separate curve number shall be selected for pervious & impervious portions of the site or basin | | | |
| Dwelling Unit/Gross Acre | %Impervious(3) | | | | |
| 1.0 DU/GA | 15 | | | | |
| 1.5 DU/GA | 20 | | | | |
| 2.0 DU/GA | 25 | | | | |
| 2.5 DU/GA | 30 | | | | |
| 3.0 DU/GA | 34 | | | | |
| 3.5 DU/GA | 38 | | | | |
| 4.0 DU/GA | 42 | | | | |
| 4.5 DU/GA | 46 | | | | |
| 5.0 DU/GA | 48 | | | | |
| 5.5 DU/GA | 50 | | | | |
| 6.0 DU/GA | 52 | | | | |
| 6.5 DU/GA | 54 | | | | |
| 7.0 DU/GA | 56 | | | | |
| PUD's, condos, apartments, commercial businesses & industrial areas | %impervious must be computed | | | | |

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Sec. 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

Table III-1.4 "n" AND "k" Values Used in Time Calculations for Hydrographs

| "$n_s$" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel) | $n_s$ |
|---|---|
| Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil) 0.011 | |
| Fallow fields or loose soil surface (no residue) | 0.05 |
| Cultivated soil with residue cover ($s \leq 0.20$ ft/ft) | 0.06 |
| Cultivated soil with residue cover ($s > 0.20$ ft/ft) | 0.17 |
| Short prairie grass and lawns | 0.15 |
| Dense grasses | 0.24 |
| Bermuda grass | 0.41 |
| Range (natural) | 0.13 |
| Woods or forest with light underbrush | 0.40 |
| Woods or forest with dense underbrush | 0.80 |

*Manning values for sheet flow only, from Overton and Meadows 1976 (See TR-55, 1986)

"k" Values Used in Travel Time/Time of Concentration Calculations

| Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1) | $k_s$ |
|---|---|
| 1. Forest with heavy ground litter and meadows (n = 0.10) | 3 |
| 2. Brushy ground with some trees (n = 0.060) | 5 |
| 3. Fallow or minimum tillage cultivation (n = 0.040) | 8 |
| 4. High grass (n = 0.035) | 9 |
| 5. Short grass, pasture and lawns (n = 0.030) | 11 |
| 6. Nearly bare ground (n = 0.25) | 13 |
| 7. Paved and gravel areas (n = 0.012) | 27 |

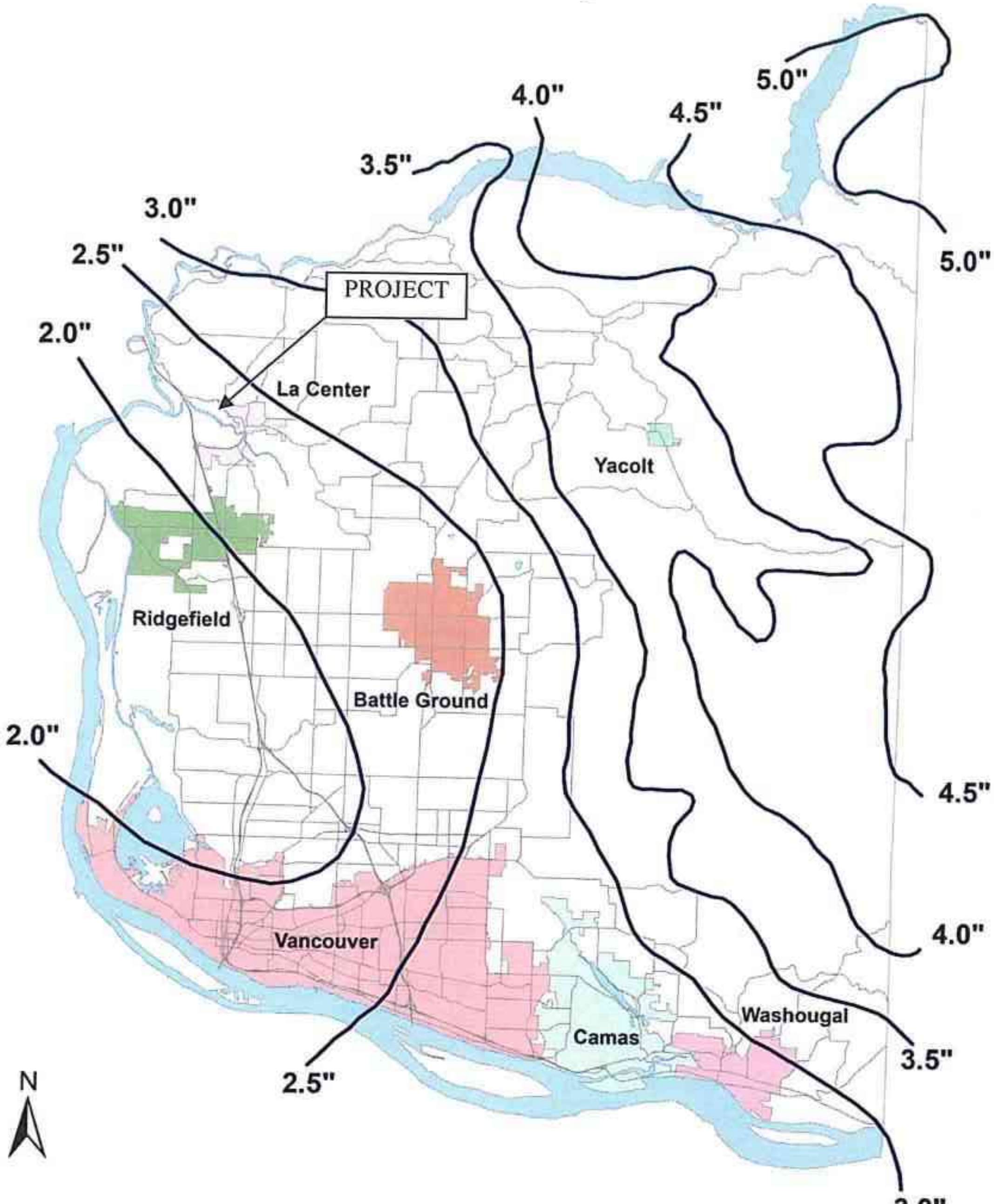
| Channel Flow (intermittent) (At the beginning of visible channels R = 0.2) | $k_c$ |
|---|---|
| 1. Forested swale with heavy ground litter (n = 0.10) | 5 |
| 2. Forested drainage course/ravine with defined channel bed (n = 0.050) | 10 |
| 3. Rock-lined waterway (n = 0.035) | 15 |
| 4. Grassed waterway (n = 0.030) | 17 |
| 5. Earth-lined waterway (n = 0.025) | 20 |
| 6. CMP pipe (n = 0.024) | 21 |
| 7. Concrete pipe (0.012) | 42 |
| 8. Other waterways and pipe 0.508/n | |

| Channel Flow (Continuous stream, R = 0.4) | $k_c$ |
|---|---|
| 9. Meandering stream with some pools (n = 0.040) | 20 |
| 10. Rock-lined stream (n = 0.035) | 23 |
| 11. Grass-lined stream (n = 0.030) | 27 |
| 12. Other streams, man-made channels and pipe 0.807/n** | |

PLS ENGINEERING

## Isopluvial Map for Clark County

2-Year, 24-Hour Design Storm

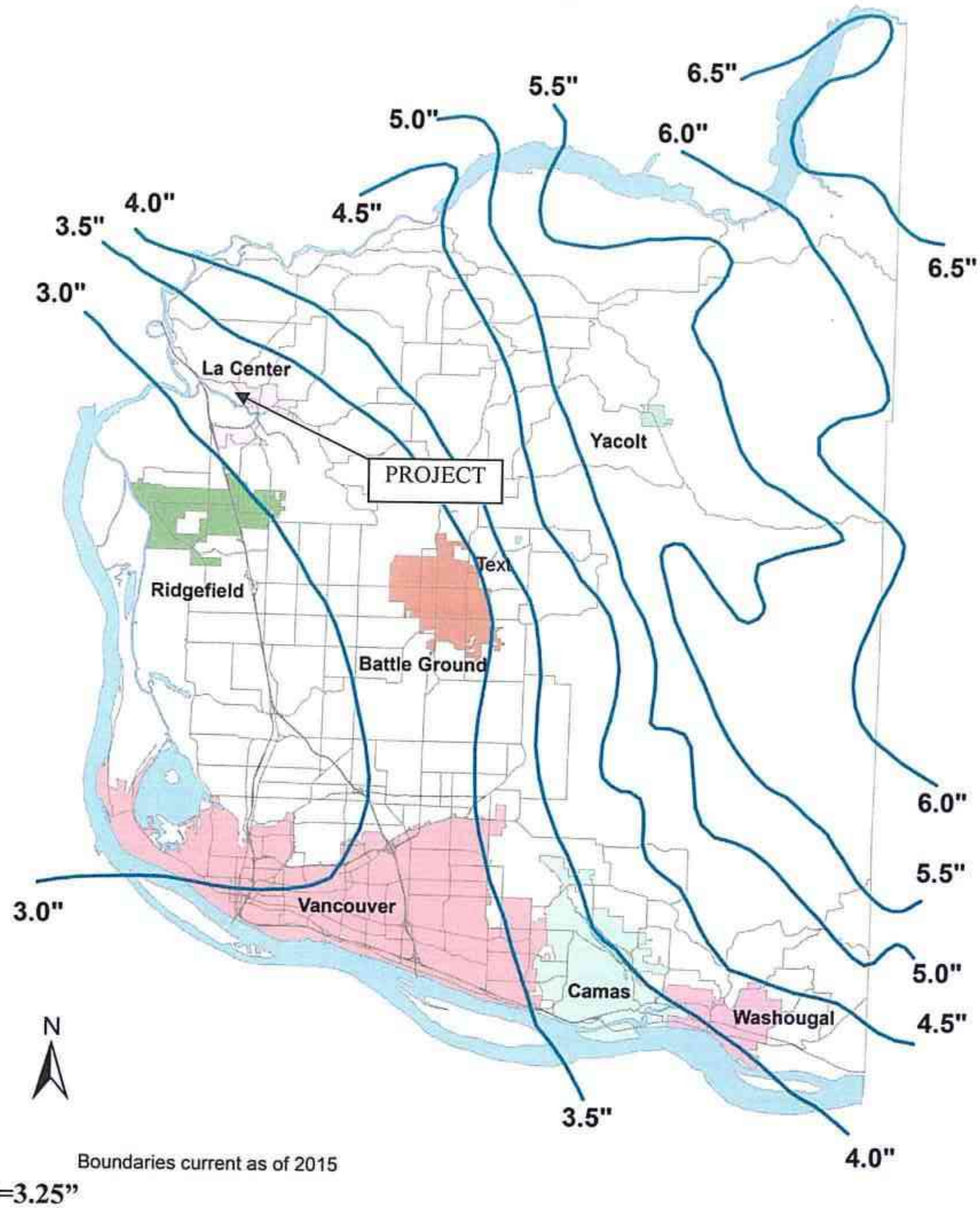



Boundaries current as of 2015

**P=2.3"**

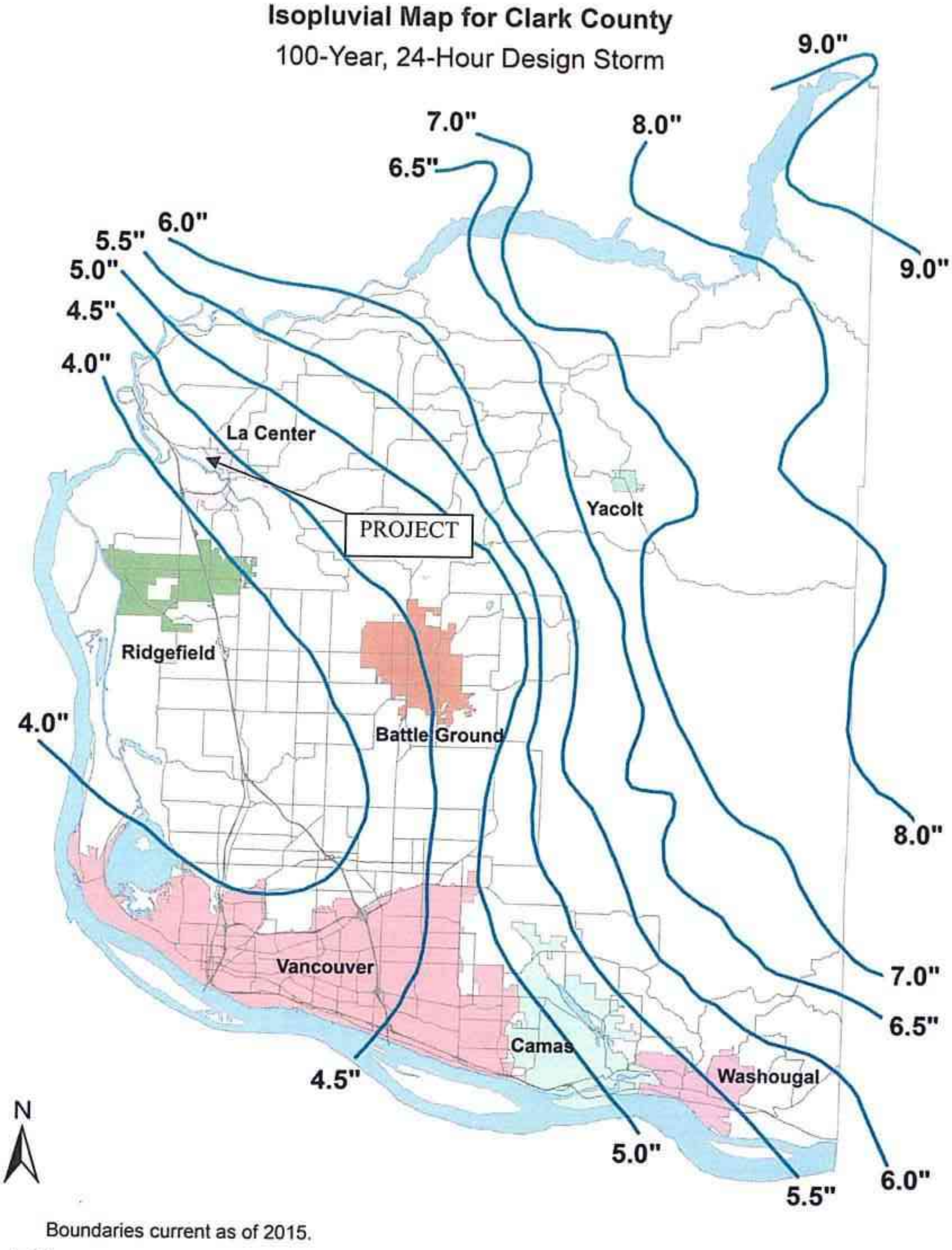
PLS ENGINEERING

# Isopluvial Map for Clark County
10-Year, 24-Hour Design Storm



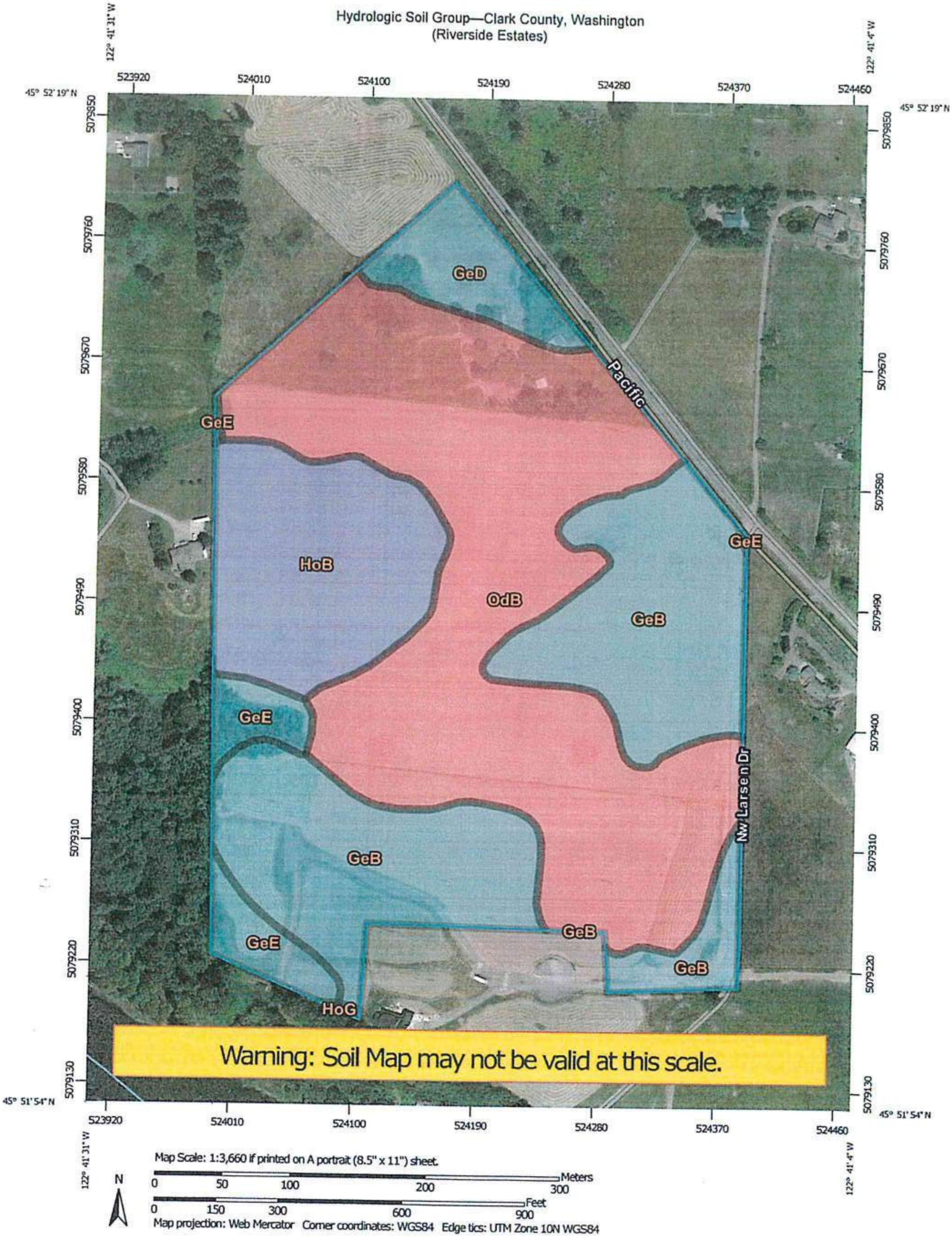

P=3.25"

PLS ENGINEERING




**P=4.3"**

Hydrologic Soil Group—Clark County, Washington
(Riverside Estates)



## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Clark County, Washington
Survey Area Data: Version 13, Sep 14, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 8, 2010—Sep 4, 2011

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

# Hydrologic Soil Group

| Hydrologic Soil Group— Summary by Map Unit — Clark County, Washington (WA011) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| GeB | Gee silt loam, 0 to 8 percent slopes | C | 14.1 | 30.4% |
| GeD | Gee silt loam, 8 to 20 percent slopes | C | 2.2 | 4.8% |
| GeE | Gee silt loam, 20 to 30 percent slopes | C | 2.0 | 4.3% |
| HoB | Hillsboro silt loam, 3 to 8 percent slopes | B | 6.5 | 14.1% |
| HoG | Hillsboro silt loam, 30 to 65 percent slopes | B | 0.0 | 0.1% |
| OdB | Odne silt loam, 0 to 5 percent slopes | D | 21.5 | 46.3% |
| **Totals for Area of Interest** | | | **46.4** | **100.0%** |

# APPENDIX B

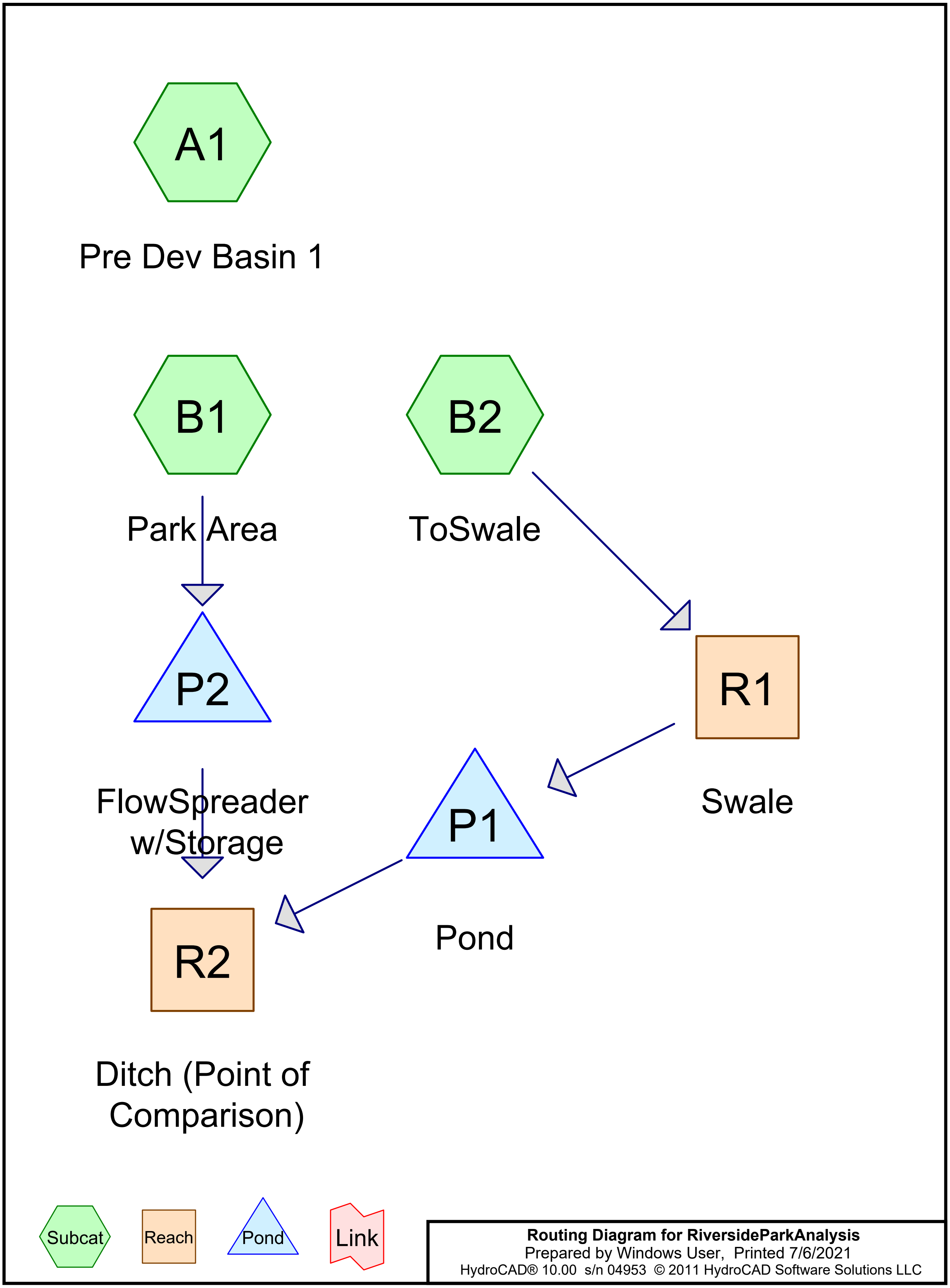
## Stormwater Models

| TIR Area Info for Sunlight: | | |
|---|---|---|
| | Total | |
| | **sqft** | **acre** |
| Existing Hard Surface: | 116,662.01 | 2.68 |
| New Hard Surface: | 32,278.70 | 0.74 |
| Replaced Hard Surface: | - | - |
| Native Vegetation Converted to Landscape: | 84,383.30 | 1.94 |
| Native Vegetation Converted to Pasture: | 0 | 0 |
| Existing Site Area: | 225943.664 | 5.19 |
| RoW Dedication: | 0 | - |
| Developed Site Area: | 225943.664 | 5.19 |
| Land Disturbing Activity: | 116,662.01 | 2.68 |
| Redevelopment Cost Basin: | 0 | 0 |
| Pollution Generating Surfaces: | 17,015.93 | 0.39 |
| Pollution Generating Pervious Surface: | 0 | 0 |
| Non-Pollution Generating Surfaces: | 99,646.07 | 2.29 |

| | | |
|---|---|---|
| Percentage of total site area covered with impervious surfaces: | 4% | 14% |
| Percentage of disturbed site area covered with impervious surfaces: | 28% | 28% |

| Design Point of Compliance 1 | | |
|---|---|---|
| | **sqft** | **acre** |
| **Total Basin** | **116,662.01** | **2.6782** |
| | | |
| Road | 7,331.27 | 0.1683 |
| Sidewalk | 15,262.77 | 0.3504 |
| Roof | - | - |
| Driveway | 9,684.67 | 0.2223 |
| Landscape | 84,383.30 | 1.9372 |
| | | |
| Impervious Area | 32,278.70 | 0.7410 |
| Pervious Area | 84,383.30 | 1.9372 |
| Polution Generating Impervious Area | 17,015.93 | 0.3906 |
| Total Site | 116,662.01 | 2.6782 |

| Extg Point of Compliance 1 | | |
|---|---|---|
| | **sqft** | **acre** |
| **Total Basin** | **116,662.01** | **2.6782** |
| | | |
| **Existing Frontage Road** | **2,580.03** | **0.0592** |
| Existing Driveway | 1,800.55 | **0.0413** |
| Existing Pasture | 112,281.43 | **2.5776** |
| | | |
| **Existing Impervious** | **4,380.58** | **0.1006** |


A1
Pre Dev Basin 1
B1
Park Area
B2
ToSwale
P2
FlowSpreader w/Storage
R1
Swale
P1
Pond
R2
Ditch (Point of Comparison)
Subcat
Reach
Pond
Link
**Routing Diagram for RiversideParkAnalysis**
Prepared by Windows User, Printed 7/6/2021
HydroCAD® 10.00 s/n 04953 © 2011 HydroCAD Software Solutions LLC

## Area Listing (all nodes)

| Area (sq-ft) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 80,000 | 85 | Pasture/grassland/range, Poor, HSG C (A1) |
| 84,383 | 86 | Landscaping (B1, B2) |
| 32,281 | 89 | Pasture/grassland/range, Poor, HSG D (A1) |
| 9,685 | 98 | Driveway (B2) |
| 4,381 | 98 | Impervious (A1) |
| 7,331 | 98 | Road (B2) |
| 15,263 | 98 | Sidewalk (B1) |
| **233,324** | **88** | **TOTAL AREA** |

## Summary for Subcatchment A1: Pre Dev Basin 1

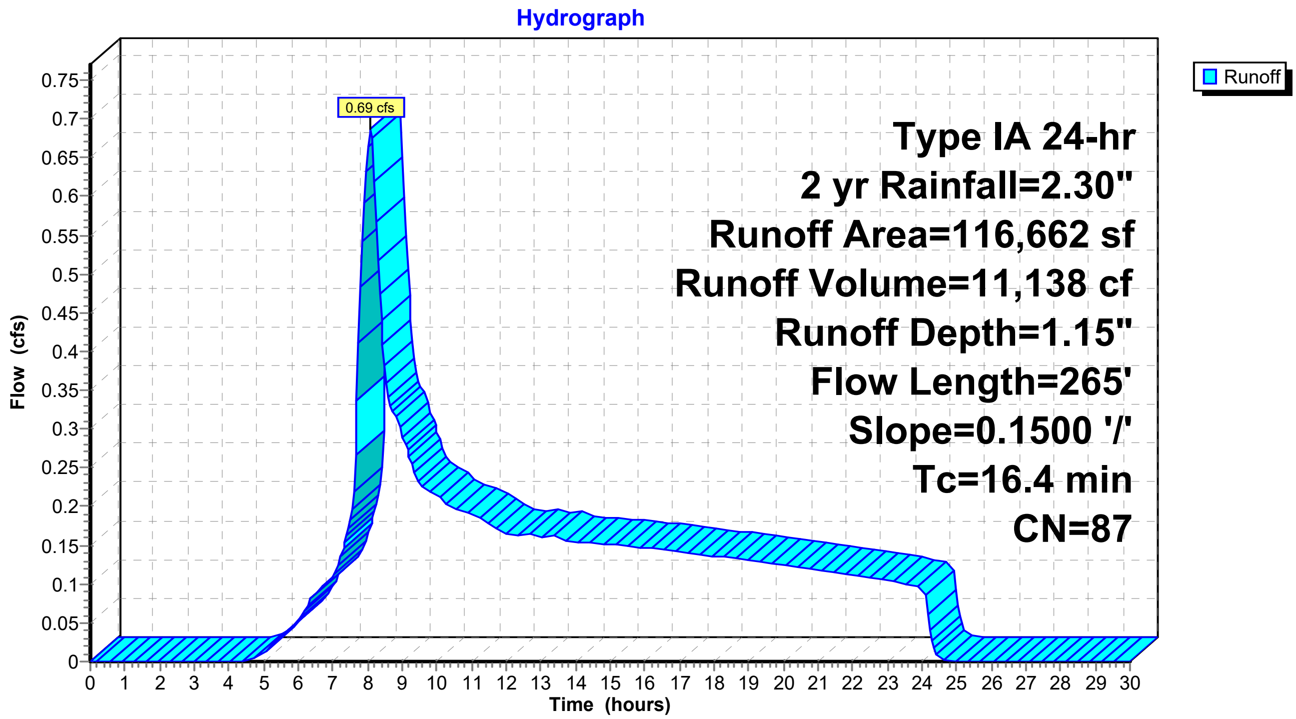
Runoff = 0.69 cfs @ 8.08 hrs, Volume= 11,138 cf, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 yr Rainfall=2.30"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,281 | 89 | Pasture/grassland/range, Poor, HSG D |
| * | 80,000 | 85 | Pasture/grassland/range, Poor, HSG C |
| * | 4,381 | 98 | Impervious |
| | 116,662 | 87 | Weighted Average |
| | 112,281 | | 96.24% Pervious Area |
| | 4,381 | | 3.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.4 | 265 | 0.1500 | 0.27 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 2.30" |

### Subcatchment A1: Pre Dev Basin 1



## Summary for Subcatchment B1: Park Area

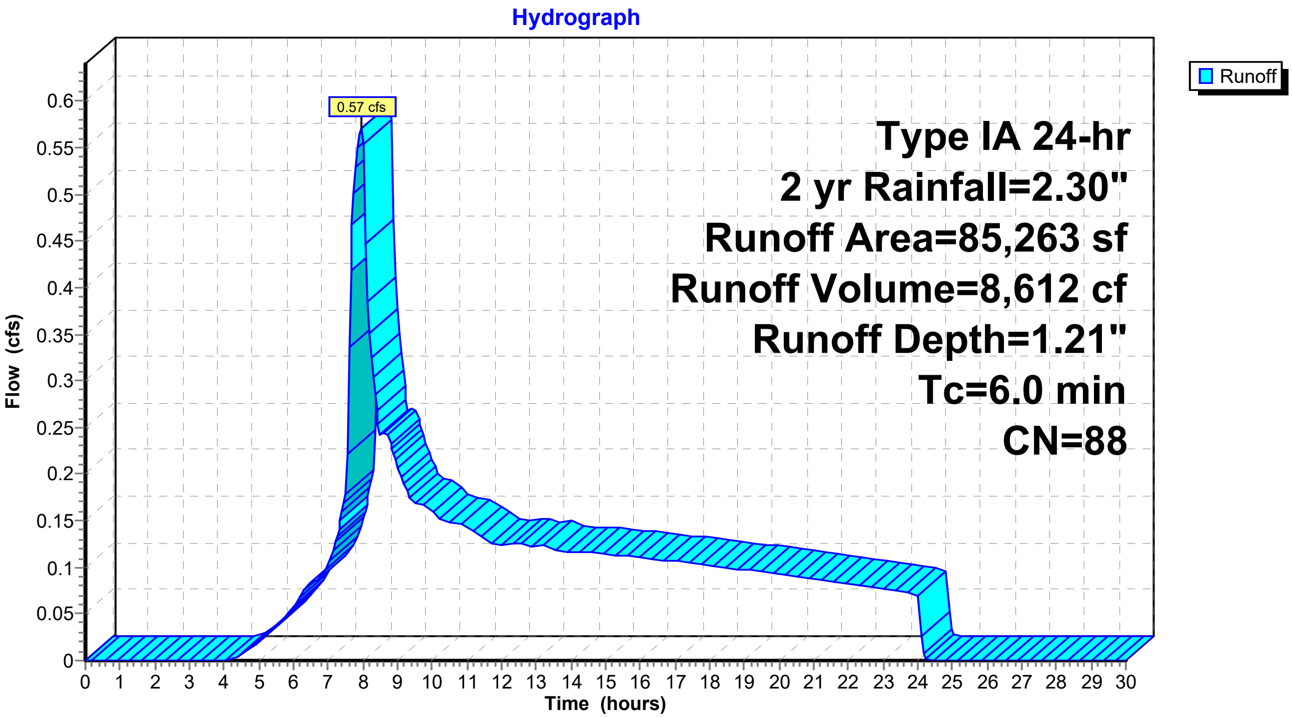
Runoff = 0.57 cfs @ 7.97 hrs, Volume= 8,612 cf, Depth= 1.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 yr Rainfall=2.30"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 70,000 | 86 | Landscaping |
| * | 15,263 | 98 | Sidewalk |
| | 85,263 | 88 | Weighted Average |
| | 70,000 | | 82.10% Pervious Area |
| | 15,263 | | 17.90% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

### Subcatchment B1: Park Area



## Summary for Subcatchment B2: ToSwale

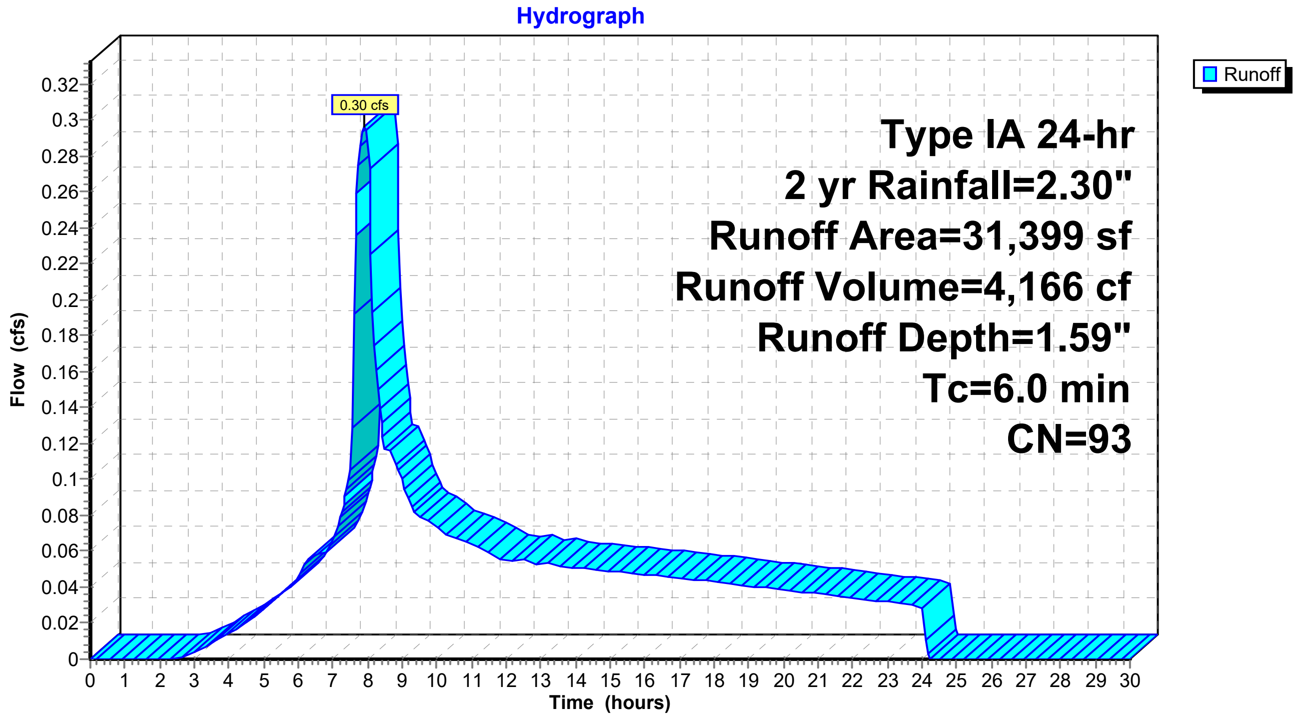
Runoff = 0.30 cfs @ 7.92 hrs, Volume= 4,166 cf, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 yr Rainfall=2.30"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 14,383 | 86 | Landscaping |
| * | 7,331 | 98 | Road |
| * | 9,685 | 98 | Driveway |
| | 31,399 | 93 | Weighted Average |
| | 14,383 | | 45.81% Pervious Area |
| | 17,016 | | 54.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

### Subcatchment B2: ToSwale



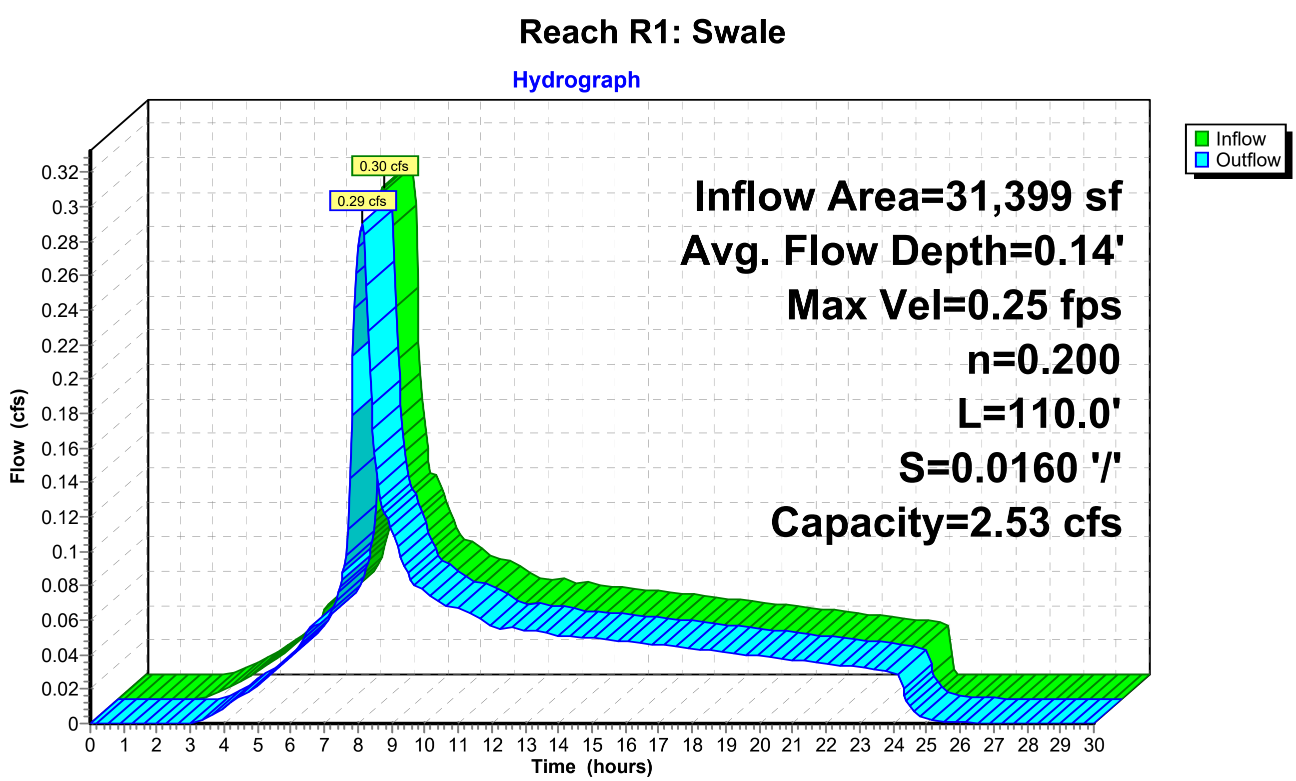
## Summary for Reach R1: Swale

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 1.59" for 2 yr event
Inflow = 0.30 cfs @ 7.92 hrs, Volume= 4,166 cf
Outflow = 0.29 cfs @ 8.12 hrs, Volume= 4,165 cf, Atten= 2%, Lag= 11.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.25 fps, Min. Travel Time= 7.5 min
Avg. Velocity = 0.10 fps, Avg. Travel Time= 18.1 min

Peak Storage= 131 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 0.50' Flow Area= 4.8 sf, Capacity= 2.53 cfs

8.00' x 0.50' deep channel, n= 0.200
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 110.0' Slope= 0.0160 '/'
Inlet Invert= 192.00', Outlet Invert= 190.24'

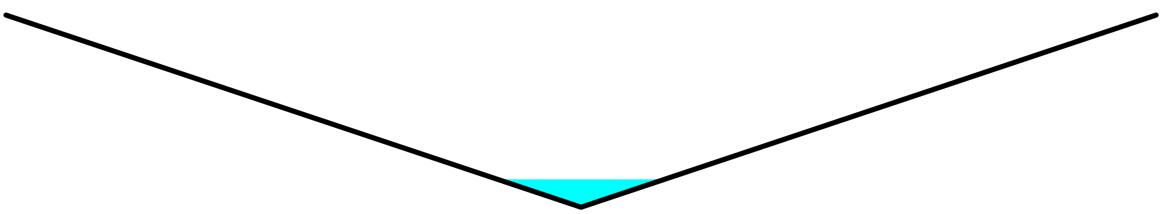
## Summary for Reach R2: Ditch (Point of Comparison)

Inflow Area = 116,662 sf, 27.67% Impervious, Inflow Depth = 1.31" for 2 yr event
Inflow = 0.70 cfs @ 8.02 hrs, Volume= 12,777 cf
Outflow = 0.69 cfs @ 8.09 hrs, Volume= 12,777 cf, Atten= 1%, Lag= 4.5 min

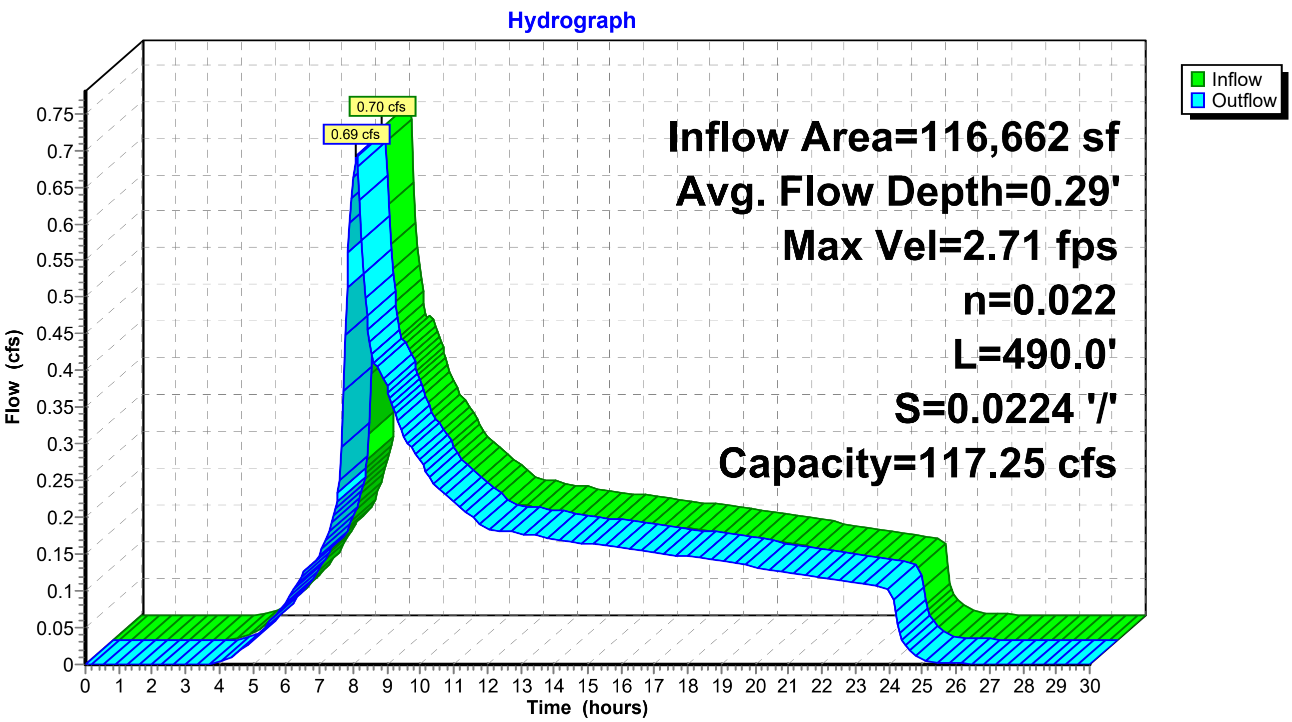
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.71 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 5.3 min

Peak Storage= 125 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.29'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 117.25 cfs

0.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 490.0' Slope= 0.0224 '/'
Inlet Invert= 177.00', Outlet Invert= 166.00'



### Reach R2: Ditch (Point of Comparison)



## Summary for Pond P1: Pond

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 1.59" for 2 yr event
Inflow = 0.29 cfs @ 8.12 hrs, Volume= 4,165 cf
Outflow = 0.16 cfs @ 8.48 hrs, Volume= 4,165 cf, Atten= 44%, Lag= 21.5 min
Primary = 0.16 cfs @ 8.48 hrs, Volume= 4,165 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 187.27' @ 8.48 hrs Surf.Area= 383 sf Storage= 335 cf

Plug-Flow detention time= 16.5 min calculated for 4,165 cf (100% of inflow)
Center-of-Mass det. time= 16.5 min ( 780.7 - 764.2 )

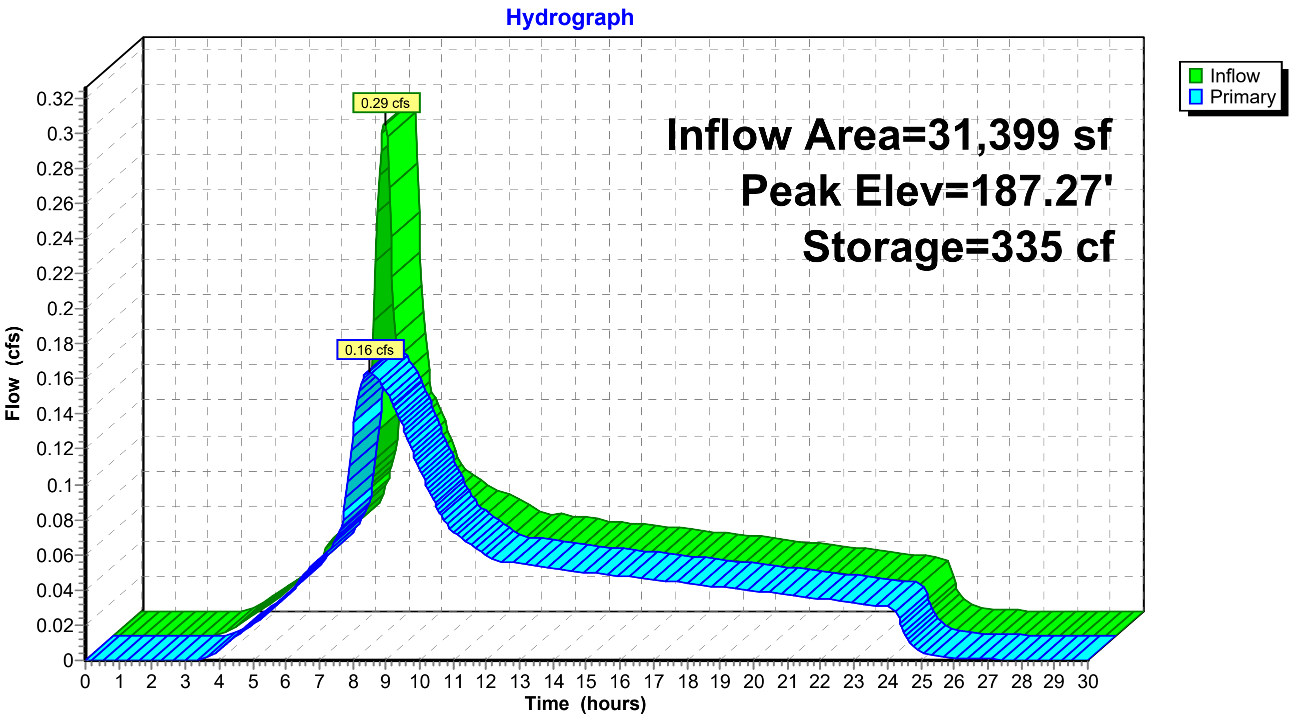
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 186.00' | 1,278 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71 |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 186.00 | 200 | 0 | 0 |
| 189.00 | 1,000 | 1,800 | 1,800 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 186.00' | **8.0" Round Culvert**<br>L= 70.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 186.00' / 184.60' S= 0.0200 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 186.00' | **2.4" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 188.00' | **2.3' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |

**Primary OutFlow** Max=0.16 cfs @ 8.48 hrs HW=187.27' (Free Discharge)
└─**1=Culvert** (Passes 0.16 cfs of 1.63 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.16 cfs @ 5.22 fps)
  └─**3=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond P1: Pond


Hydrograph
Inflow
Primary
0.29 cfs
0.16 cfs
Inflow Area=31,399 sf
Peak Elev=187.27'
Storage=335 cf
Flow (cfs)
Time (hours)

## Summary for Pond P2: FlowSpreader w/Storage

Inflow Area = 85,263 sf, 17.90% Impervious, Inflow Depth = 1.21" for 2 yr event
Inflow = 0.57 cfs @ 7.97 hrs, Volume= 8,612 cf
Outflow = 0.57 cfs @ 7.99 hrs, Volume= 8,612 cf, Atten= 1%, Lag= 1.6 min
Primary = 0.57 cfs @ 7.99 hrs, Volume= 8,612 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 181.99' @ 7.99 hrs Surf.Area= 85 sf Storage= 56 cf

Plug-Flow detention time= 1.1 min calculated for 8,597 cf (100% of inflow)
Center-of-Mass det. time= 1.1 min ( 793.6 - 792.5 )

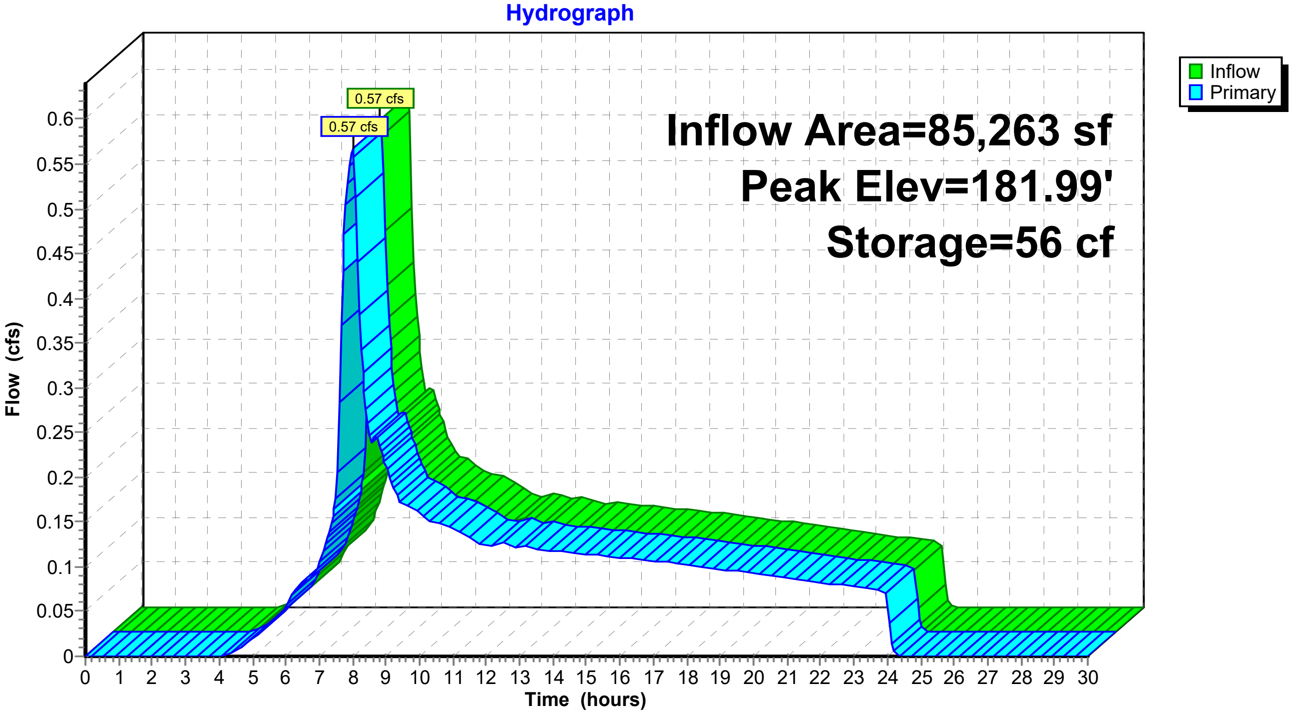
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 180.00' | 84 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71<br>256 cf Overall x 33.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 180.00 | 120 | 0 | 0 |
| 183.00 | 120 | 360 | 360 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 180.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 183.00' | **40.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=0.57 cfs @ 7.99 hrs HW=181.99' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.57 cfs @ 6.50 fps)
└—**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond P2: FlowSpreader w/Storage



## Summary for Subcatchment A1: Pre Dev Basin 1

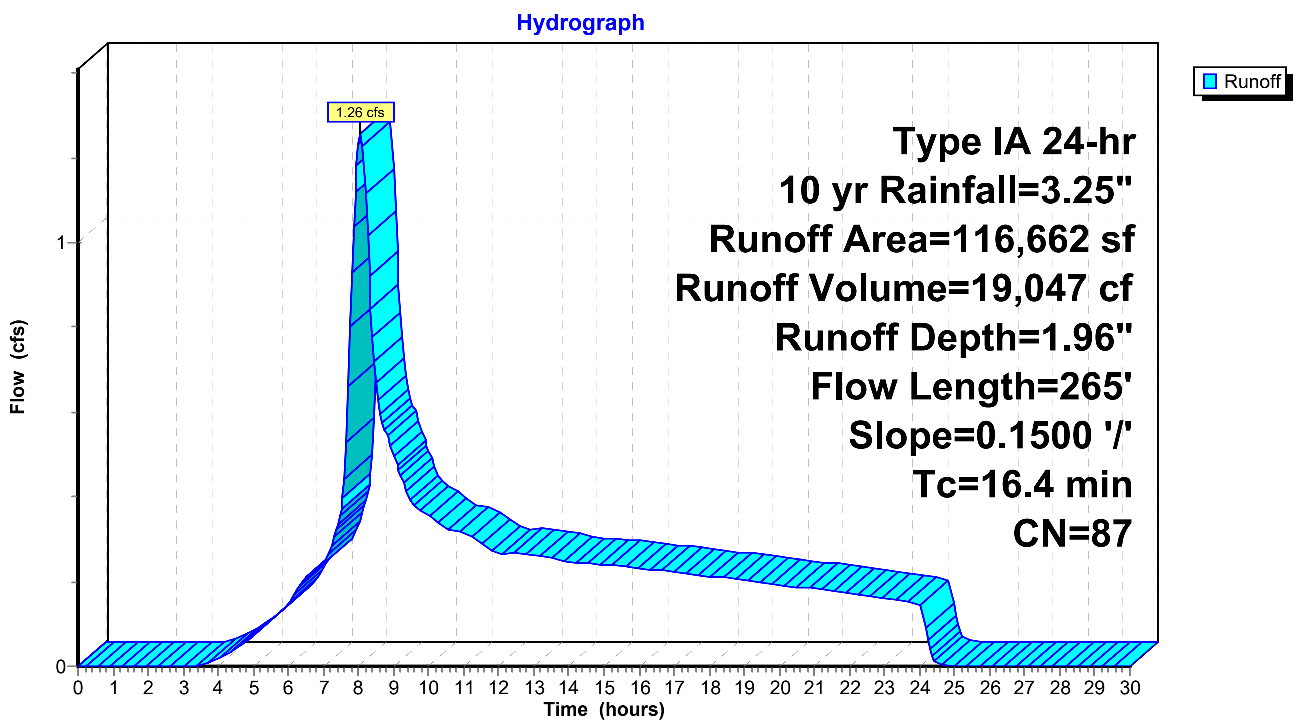
Runoff = 1.26 cfs @ 8.07 hrs, Volume= 19,047 cf, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 yr Rainfall=3.25"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,281 | 89 | Pasture/grassland/range, Poor, HSG D |
| * | 80,000 | 85 | Pasture/grassland/range, Poor, HSG C |
| * | 4,381 | 98 | Impervious |
| | 116,662 | 87 | Weighted Average |
| | 112,281 | | 96.24% Pervious Area |
| | 4,381 | | 3.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.4 | 265 | 0.1500 | 0.27 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 2.30" |

### Subcatchment A1: Pre Dev Basin 1



## Summary for Subcatchment B1: Park Area

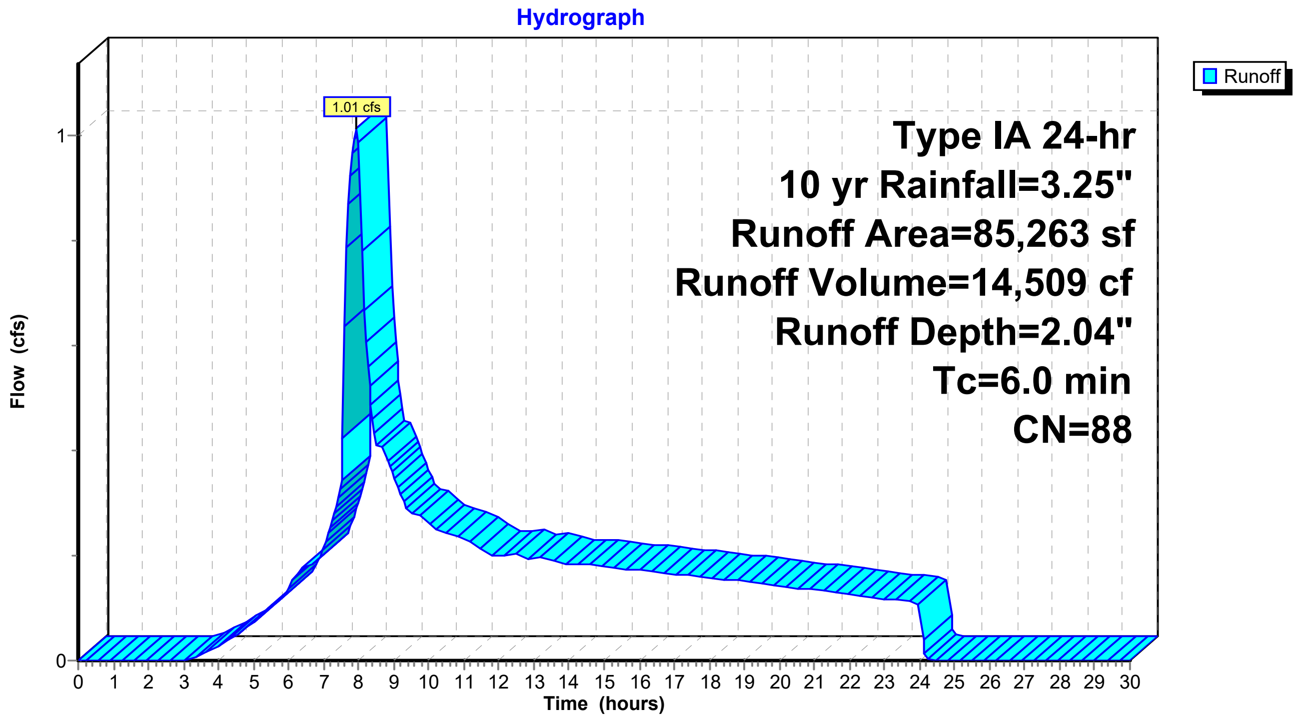
Runoff = 1.01 cfs @ 7.94 hrs, Volume= 14,509 cf, Depth= 2.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 yr Rainfall=3.25"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 70,000 | 86 | Landscaping |
| * | 15,263 | 98 | Sidewalk |
| | 85,263 | 88 | Weighted Average |
| | 70,000 | | 82.10% Pervious Area |
| | 15,263 | | 17.90% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

### Subcatchment B1: Park Area



## Summary for Subcatchment B2: ToSwale

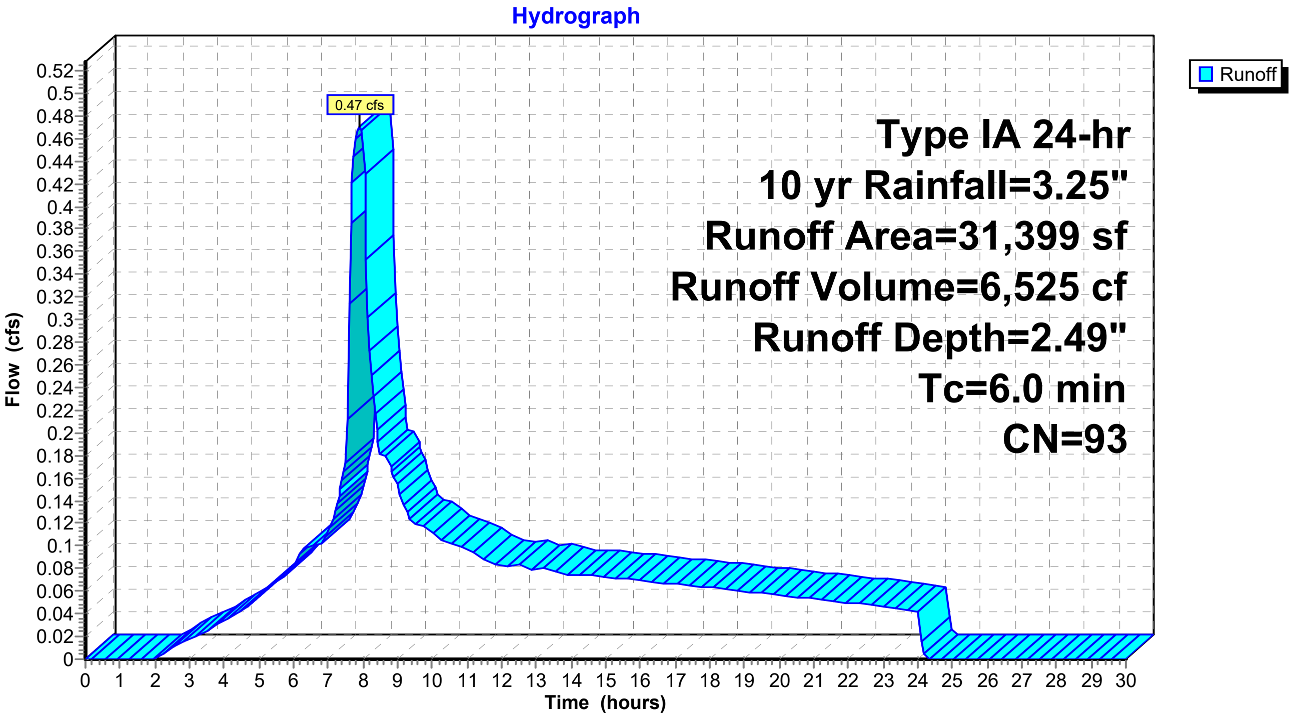
Runoff = 0.47 cfs @ 7.90 hrs, Volume= 6,525 cf, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 yr Rainfall=3.25"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 14,383 | 86 | Landscaping |
| * | 7,331 | 98 | Road |
| * | 9,685 | 98 | Driveway |
| | 31,399 | 93 | Weighted Average |
| | 14,383 | | 45.81% Pervious Area |
| | 17,016 | | 54.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

### Subcatchment B2: ToSwale



## Summary for Reach R1: Swale

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 2.49" for 10 yr event
Inflow = 0.47 cfs @ 7.90 hrs, Volume= 6,525 cf
Outflow = 0.47 cfs @ 8.08 hrs, Volume= 6,525 cf, Atten= 1%, Lag= 10.4 min

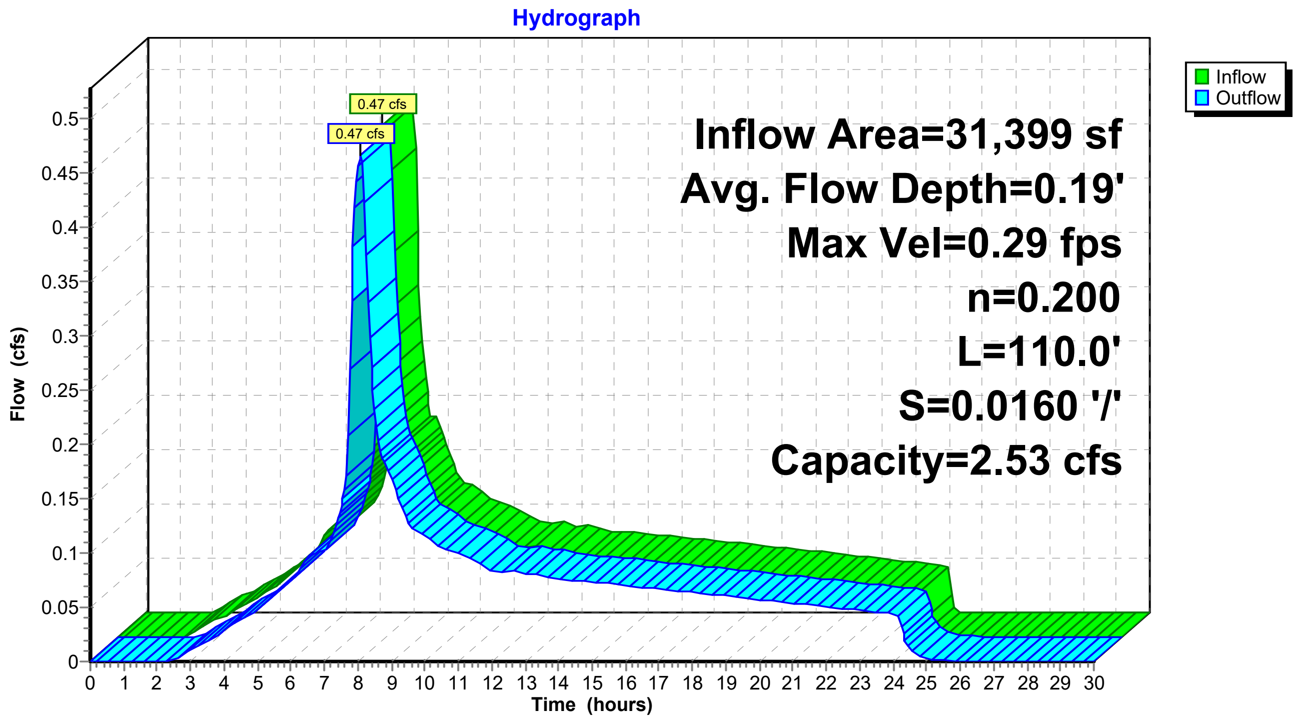
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.29 fps, Min. Travel Time= 6.3 min
Avg. Velocity = 0.12 fps, Avg. Travel Time= 15.4 min

Peak Storage= 175 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 0.50' Flow Area= 4.8 sf, Capacity= 2.53 cfs

8.00' x 0.50' deep channel, n= 0.200
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 110.0' Slope= 0.0160 '/'
Inlet Invert= 192.00', Outlet Invert= 190.24'

‡

## Reach R1: Swale



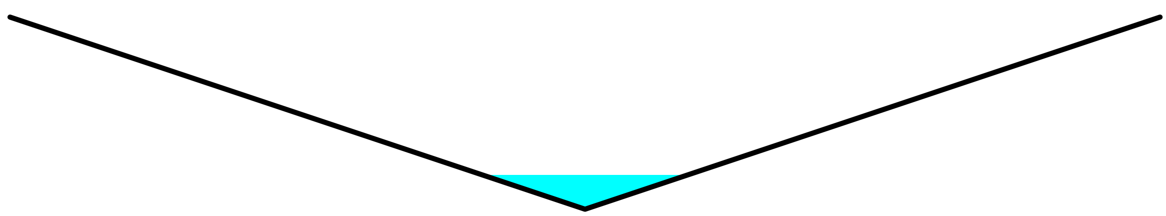
## Summary for Reach R2: Ditch (Point of Comparison)

Inflow Area = 116,662 sf, 27.67% Impervious, Inflow Depth = 2.16" for 10 yr event
Inflow = 1.20 cfs @ 7.95 hrs, Volume= 21,034 cf
Outflow = 1.18 cfs @ 8.03 hrs, Volume= 21,034 cf, Atten= 2%, Lag= 4.7 min

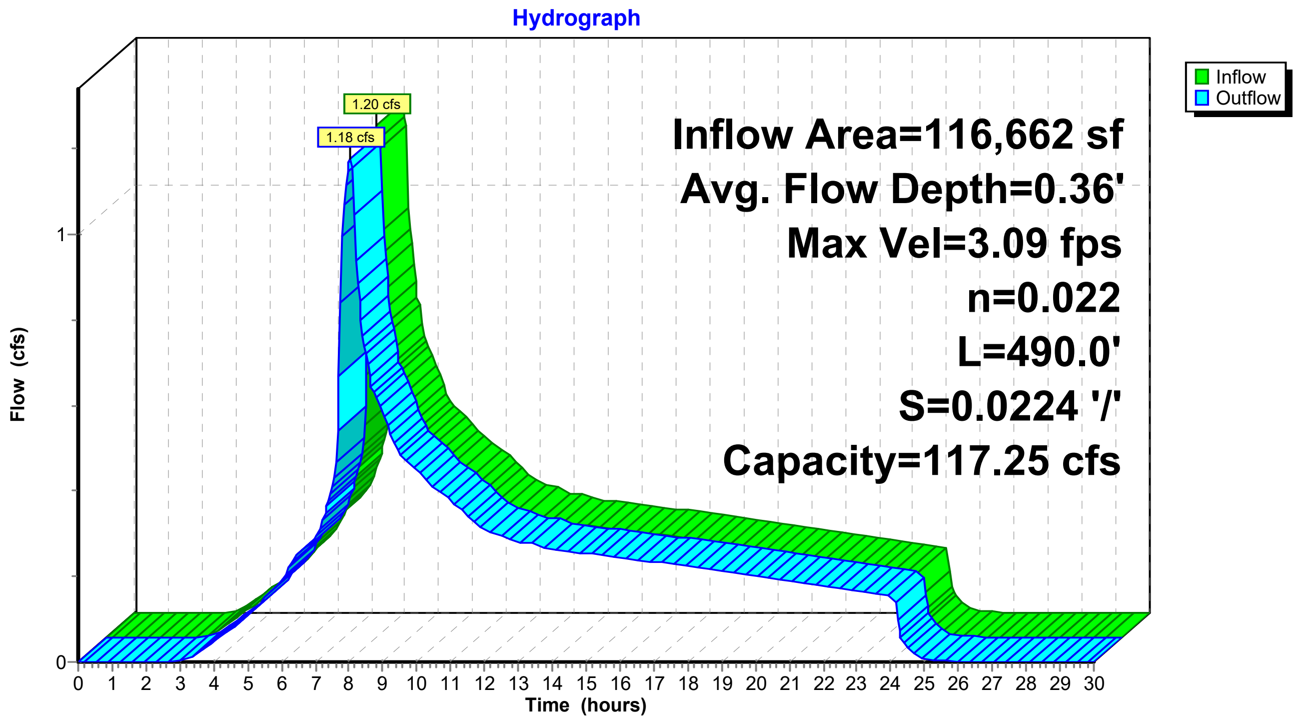
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.09 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 4.7 min

Peak Storage= 186 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 117.25 cfs

0.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 490.0' Slope= 0.0224 '/'
Inlet Invert= 177.00', Outlet Invert= 166.00'



### Reach R2: Ditch (Point of Comparison)



## Summary for Pond P1: Pond

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 2.49" for 10 yr event
Inflow = 0.47 cfs @ 8.08 hrs, Volume= 6,525 cf
Outflow = 0.25 cfs @ 8.45 hrs, Volume= 6,525 cf, Atten= 46%, Lag= 22.4 min
Primary = 0.25 cfs @ 8.45 hrs, Volume= 6,525 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 188.03' @ 8.45 hrs Surf.Area= 526 sf Storage= 679 cf

Plug-Flow detention time= 23.8 min calculated for 6,514 cf (100% of inflow)
Center-of-Mass det. time= 23.8 min ( 762.0 - 738.1 )

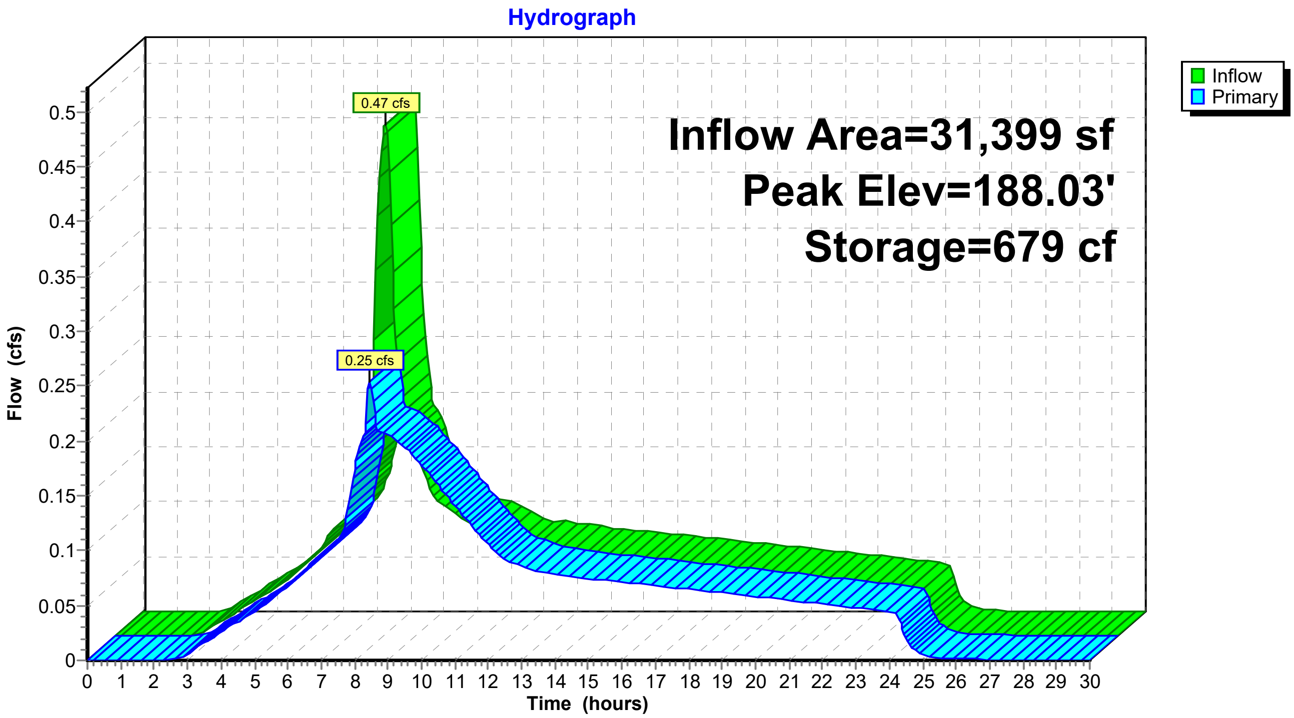
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 186.00' | 1,278 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71 |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 186.00 | 200 | 0 | 0 |
| 189.00 | 1,000 | 1,800 | 1,800 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 186.00' | **8.0" Round Culvert**<br>L= 70.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 186.00' / 184.60' S= 0.0200 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 186.00' | **2.4" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 188.00' | **2.3' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |

**Primary OutFlow** Max=0.25 cfs @ 8.45 hrs HW=188.03' (Free Discharge)
└─**1=Culvert** (Passes 0.25 cfs of 2.03 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.21 cfs @ 6.69 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.04 cfs @ 0.57 fps)

## Pond P1: Pond


Hydrograph
Inflow
Primary
0.47 cfs
0.25 cfs
Inflow Area=31,399 sf
Peak Elev=188.03'
Storage=679 cf
Flow (cfs)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Time (hours)

## Summary for Pond P2: FlowSpreader w/Storage

Inflow Area = 85,263 sf, 17.90% Impervious, Inflow Depth = 2.04" for 10 yr event
Inflow = 1.01 cfs @ 7.94 hrs, Volume= 14,509 cf
Outflow = 1.03 cfs @ 7.95 hrs, Volume= 14,509 cf, Atten= 0%, Lag= 0.5 min
Primary = 1.03 cfs @ 7.95 hrs, Volume= 14,509 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 183.02' @ 7.95 hrs Surf.Area= 85 sf Storage= 84 cf

Plug-Flow detention time= 1.1 min calculated for 14,485 cf (100% of inflow)
Center-of-Mass det. time= 1.1 min ( 763.1 - 762.0 )

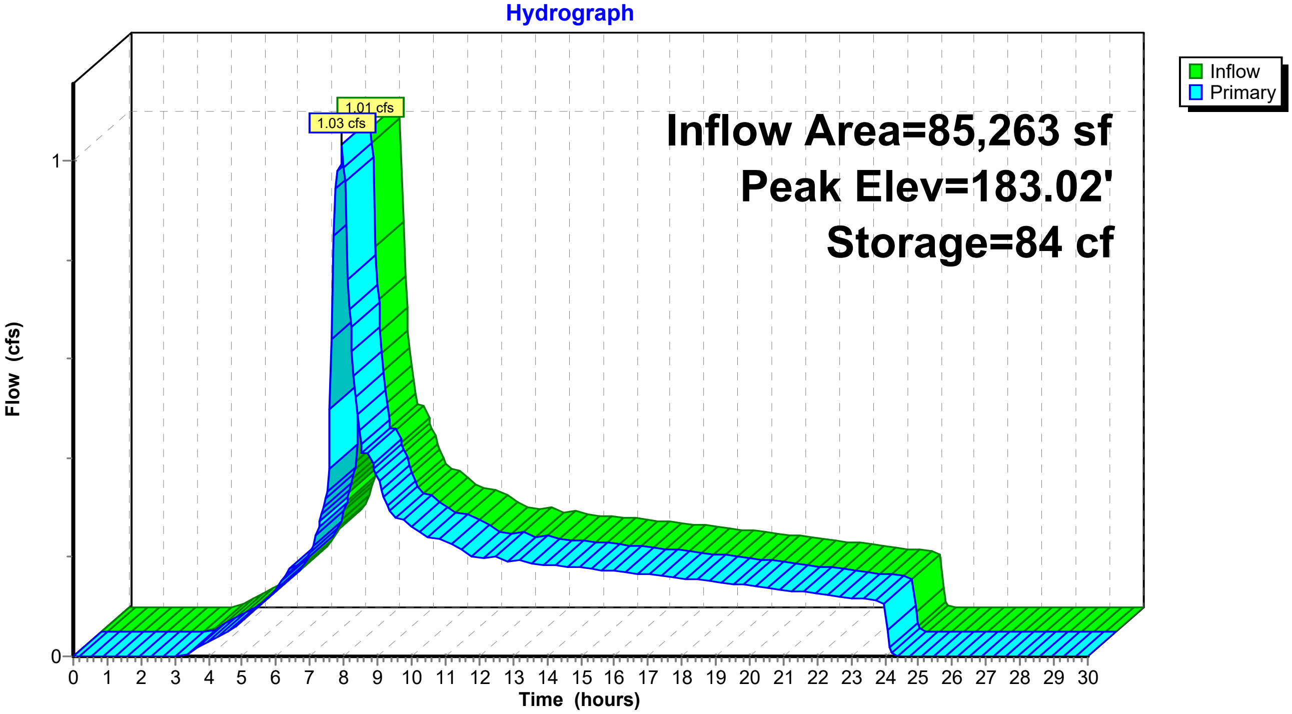
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 180.00' | 84 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71<br>256 cf Overall x 33.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 180.00 | 120 | 0 | 0 |
| 183.00 | 120 | 360 | 360 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 180.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 183.00' | **40.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=0.95 cfs @ 7.95 hrs HW=183.02' (Free Discharge)
├─**1=Orifice/Grate** (Orifice Controls 0.71 cfs @ 8.13 fps)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.24 cfs @ 0.36 fps)

## Pond P2: FlowSpreader w/Storage



## Summary for Subcatchment A1: Pre Dev Basin 1

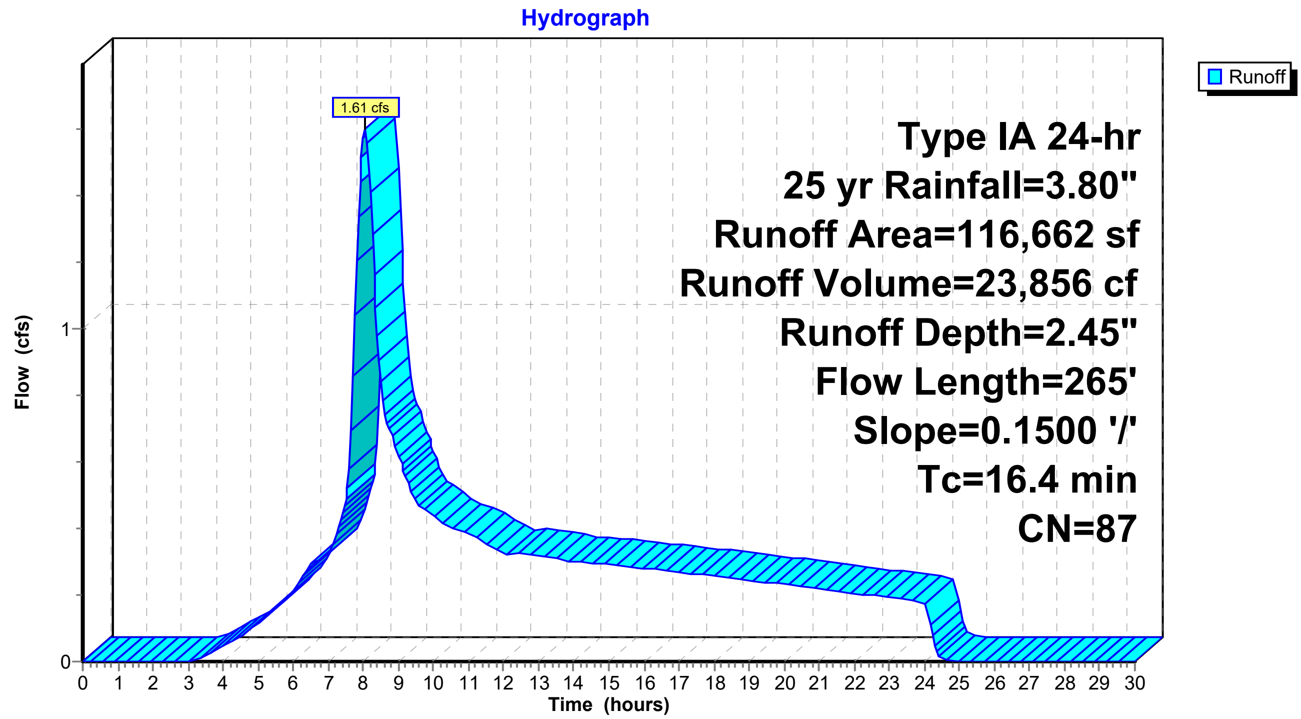
Runoff = 1.61 cfs @ 8.06 hrs, Volume= 23,856 cf, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 yr Rainfall=3.80"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,281 | 89 | Pasture/grassland/range, Poor, HSG D |
| * | 80,000 | 85 | Pasture/grassland/range, Poor, HSG C |
| * | 4,381 | 98 | Impervious |
| | 116,662 | 87 | Weighted Average |
| | 112,281 | | 96.24% Pervious Area |
| | 4,381 | | 3.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.4 | 265 | 0.1500 | 0.27 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 2.30" |

## Subcatchment A1: Pre Dev Basin 1



## Summary for Subcatchment B1: Park Area

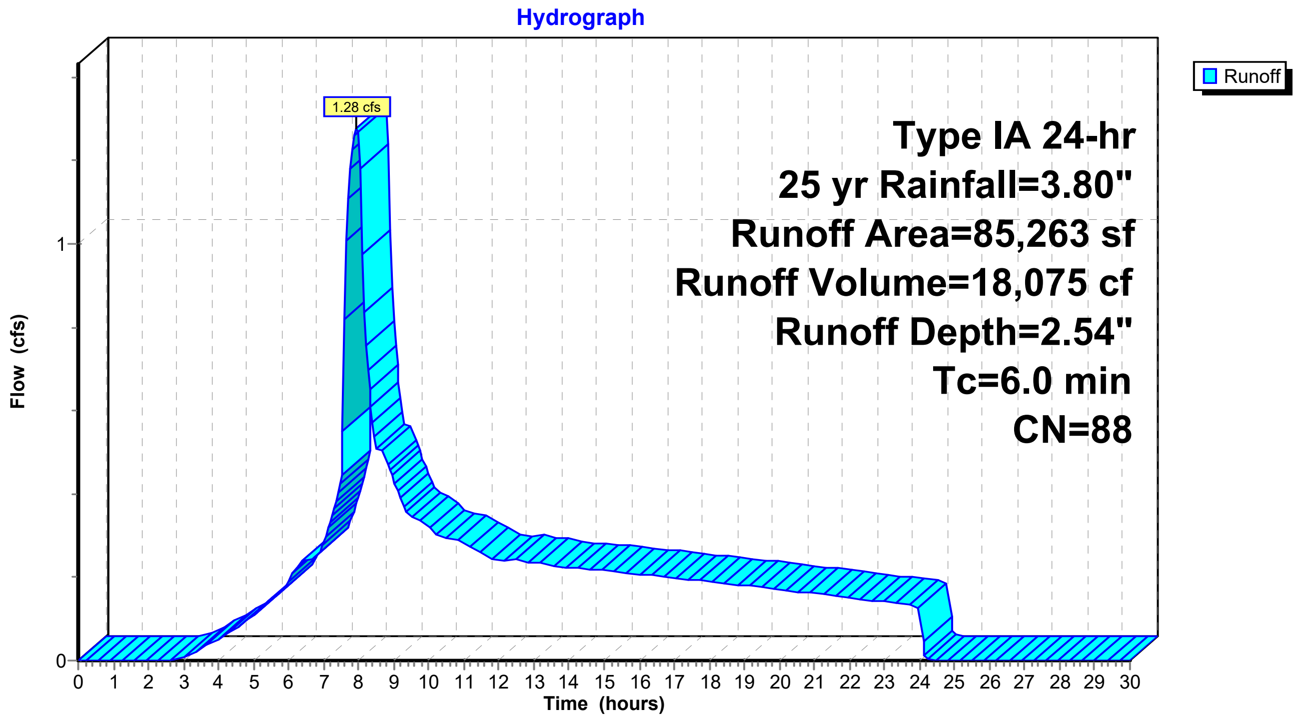
Runoff = 1.28 cfs @ 7.93 hrs, Volume= 18,075 cf, Depth= 2.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 yr Rainfall=3.80"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 70,000 | 86 | Landscaping |
| * | 15,263 | 98 | Sidewalk |
| | 85,263 | 88 | Weighted Average |
| | 70,000 | | 82.10% Pervious Area |
| | 15,263 | | 17.90% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Subcatchment B1: Park Area



## Summary for Subcatchment B2: ToSwale

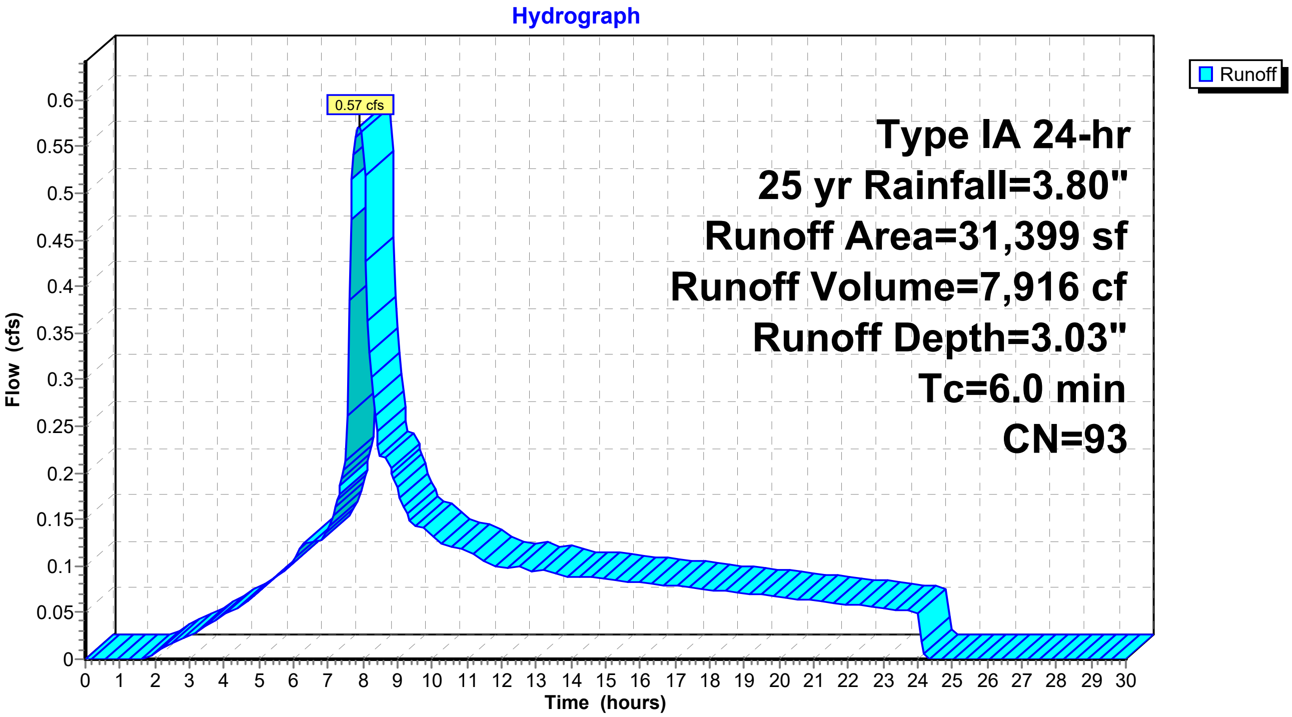
Runoff = 0.57 cfs @ 7.90 hrs, Volume= 7,916 cf, Depth= 3.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 yr Rainfall=3.80"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 14,383 | 86 | Landscaping |
| * | 7,331 | 98 | Road |
| * | 9,685 | 98 | Driveway |
| | 31,399 | 93 | Weighted Average |
| | 14,383 | | 45.81% Pervious Area |
| | 17,016 | | 54.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Subcatchment B2: ToSwale



## Summary for Reach R1: Swale

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 3.03" for 25 yr event
Inflow = 0.57 cfs @ 7.90 hrs, Volume= 7,916 cf
Outflow = 0.57 cfs @ 8.06 hrs, Volume= 7,916 cf, Atten= 1%, Lag= 9.8 min

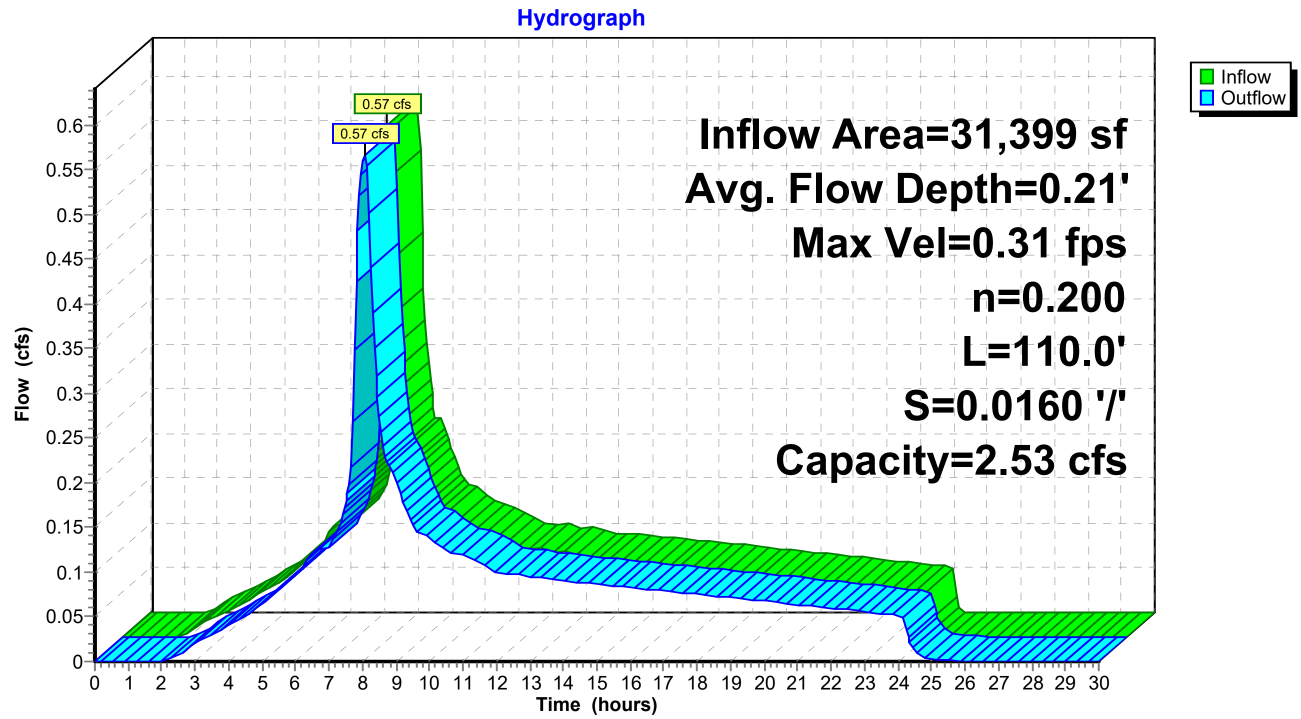
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.31 fps, Min. Travel Time= 5.8 min
Avg. Velocity = 0.13 fps, Avg. Travel Time= 14.4 min

Peak Storage= 198 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.21'
Bank-Full Depth= 0.50' Flow Area= 4.8 sf, Capacity= 2.53 cfs

8.00' x 0.50' deep channel, n= 0.200
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 110.0' Slope= 0.0160 '/'
Inlet Invert= 192.00', Outlet Invert= 190.24'

‡

### Reach R1: Swale



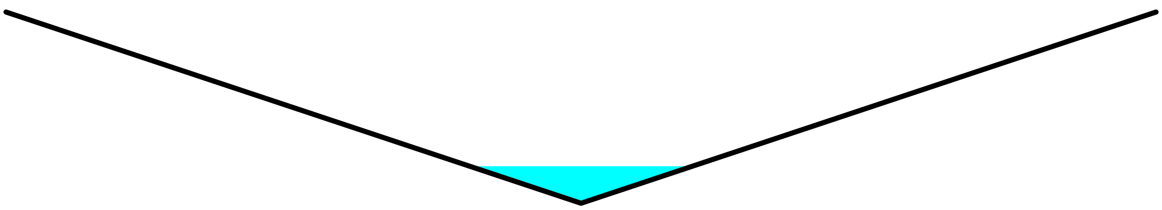
## Summary for Reach R2: Ditch (Point of Comparison)

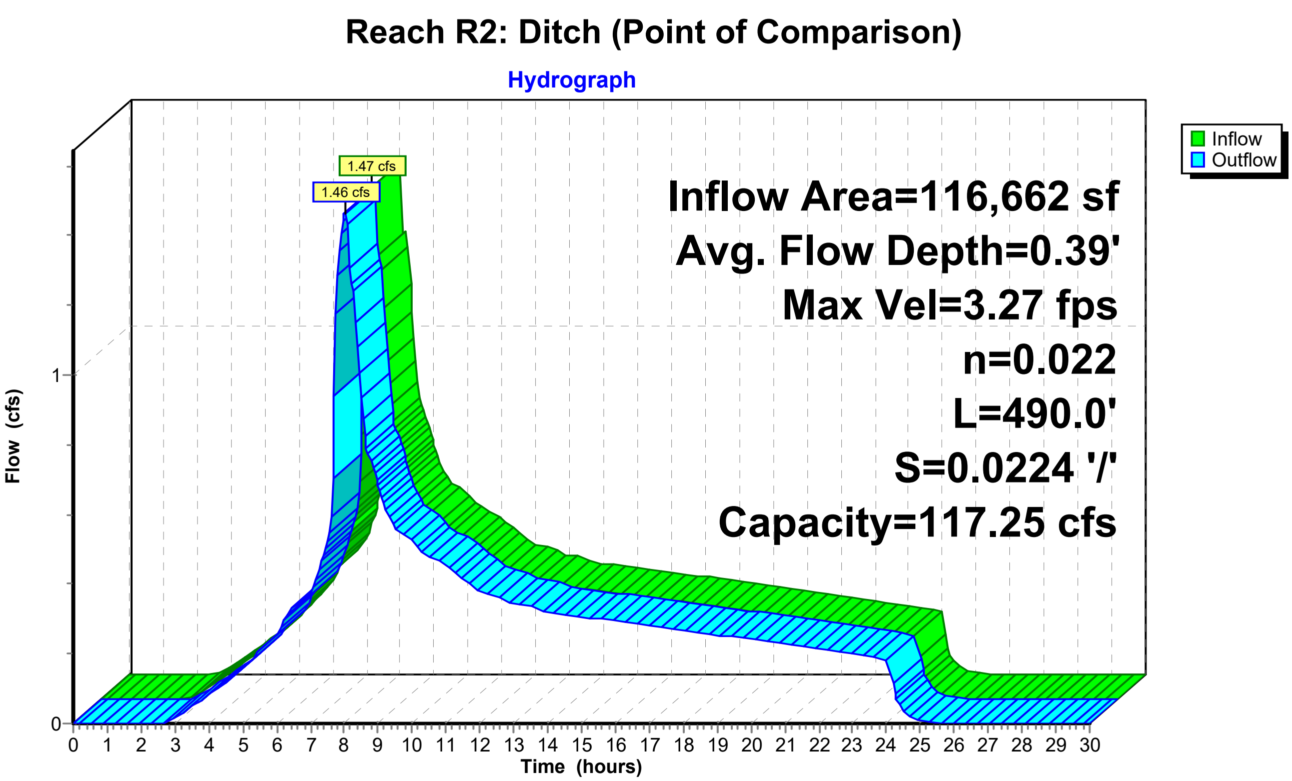
Inflow Area = 116,662 sf, 27.67% Impervious, Inflow Depth = 2.67" for 25 yr event
Inflow = 1.47 cfs @ 8.00 hrs, Volume= 25,991 cf
Outflow = 1.46 cfs @ 8.02 hrs, Volume= 25,991 cf, Atten= 0%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.27 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 1.82 fps, Avg. Travel Time= 4.5 min

Peak Storage= 220 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 117.25 cfs

0.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 490.0' Slope= 0.0224 '/'
Inlet Invert= 177.00', Outlet Invert= 166.00'





## Summary for Pond P1: Pond

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 3.03" for 25 yr event
Inflow = 0.57 cfs @ 8.06 hrs, Volume= 7,916 cf
Outflow = 0.51 cfs @ 8.21 hrs, Volume= 7,916 cf, Atten= 10%, Lag= 9.0 min
Primary = 0.51 cfs @ 8.21 hrs, Volume= 7,916 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 188.12' @ 8.21 hrs Surf.Area= 542 sf Storage= 724 cf

Plug-Flow detention time= 24.9 min calculated for 7,903 cf (100% of inflow)
Center-of-Mass det. time= 25.0 min ( 752.9 - 727.9 )

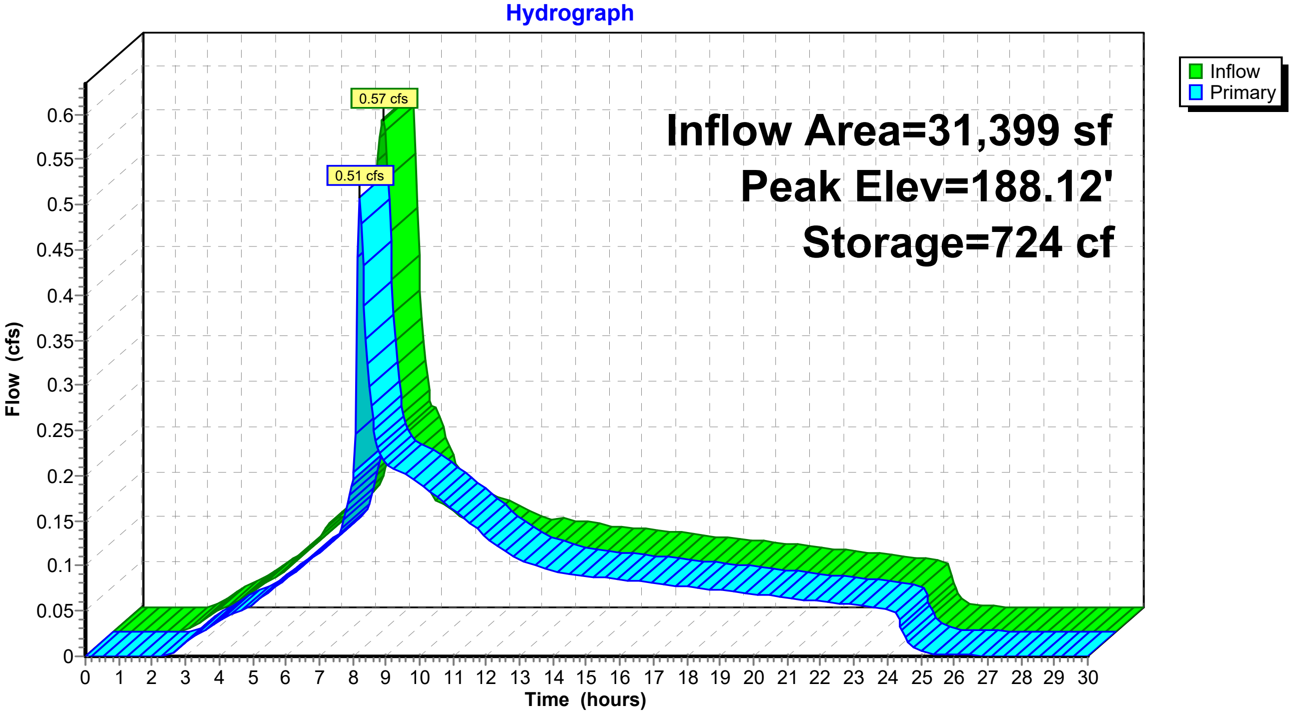
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 186.00' | 1,278 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71 |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 186.00 | 200 | 0 | 0 |
| 189.00 | 1,000 | 1,800 | 1,800 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 186.00' | **8.0" Round Culvert**<br>L= 70.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 186.00' / 184.60' S= 0.0200 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 186.00' | **2.4" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 188.00' | **2.3' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |

**Primary OutFlow** Max=0.50 cfs @ 8.21 hrs HW=188.11' (Free Discharge)
└─**1=Culvert** (Passes 0.50 cfs of 2.06 cfs potential flow)
 ├─**2=Orifice/Grate** (Orifice Controls 0.21 cfs @ 6.83 fps)
 └─**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.28 cfs @ 1.10 fps)

## Pond P1: Pond


Hydrograph
Inflow
Primary
0.57 cfs
0.51 cfs
Inflow Area=31,399 sf
Peak Elev=188.12'
Storage=724 cf
Flow (cfs)
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Time (hours)

## Summary for Pond P2: FlowSpreader w/Storage

Inflow Area = 85,263 sf, 17.90% Impervious, Inflow Depth = 2.54" for 25 yr event
Inflow = 1.28 cfs @ 7.93 hrs, Volume= 18,075 cf
Outflow = 1.29 cfs @ 7.91 hrs, Volume= 18,075 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.29 cfs @ 7.91 hrs, Volume= 18,075 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 183.03' @ 7.91 hrs Surf.Area= 85 sf Storage= 84 cf

Plug-Flow detention time= 1.1 min calculated for 18,044 cf (100% of inflow)
Center-of-Mass det. time= 1.1 min ( 750.9 - 749.8 )

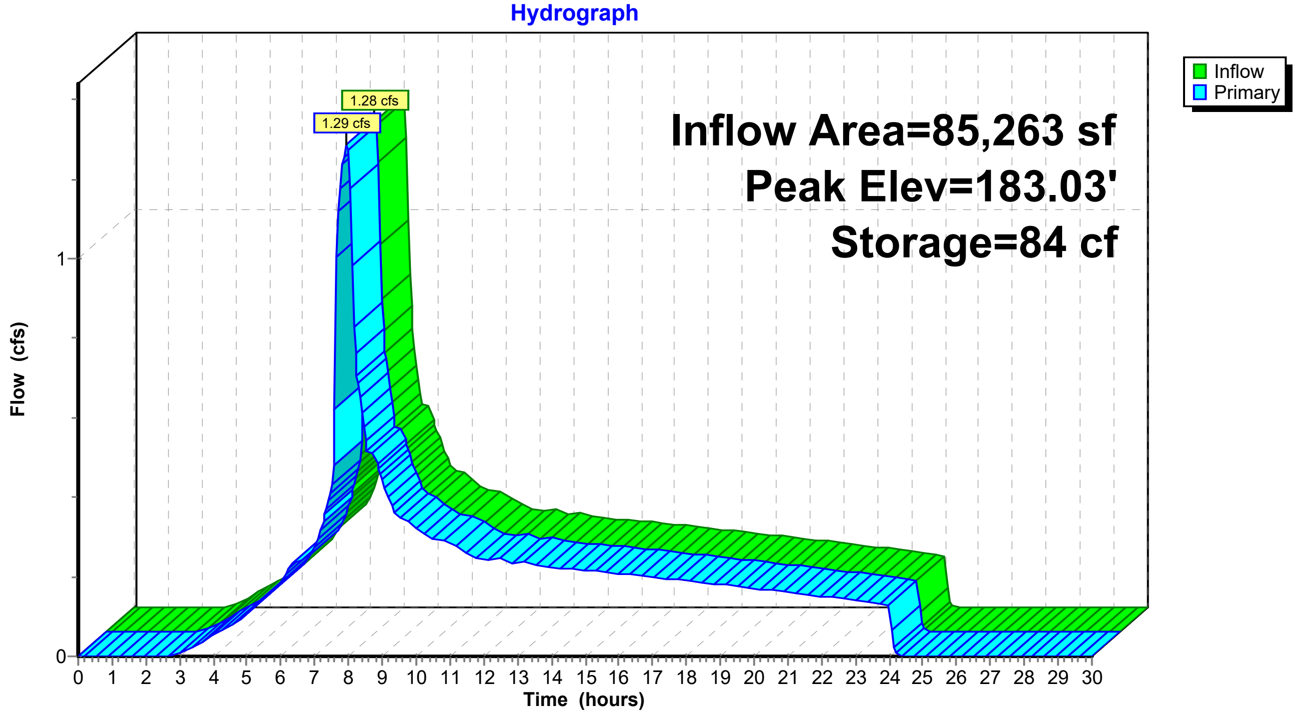
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 180.00' | 84 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71<br>256 cf Overall x 33.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 180.00 | 120 | 0 | 0 |
| 183.00 | 120 | 360 | 360 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 180.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 183.00' | **40.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=1.28 cfs @ 7.91 hrs HW=183.03' (Free Discharge)
—**1=Orifice/Grate** (Orifice Controls 0.71 cfs @ 8.15 fps)
—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.56 cfs @ 0.48 fps)

## Pond P2: FlowSpreader w/Storage



## Summary for Subcatchment A1: Pre Dev Basin 1

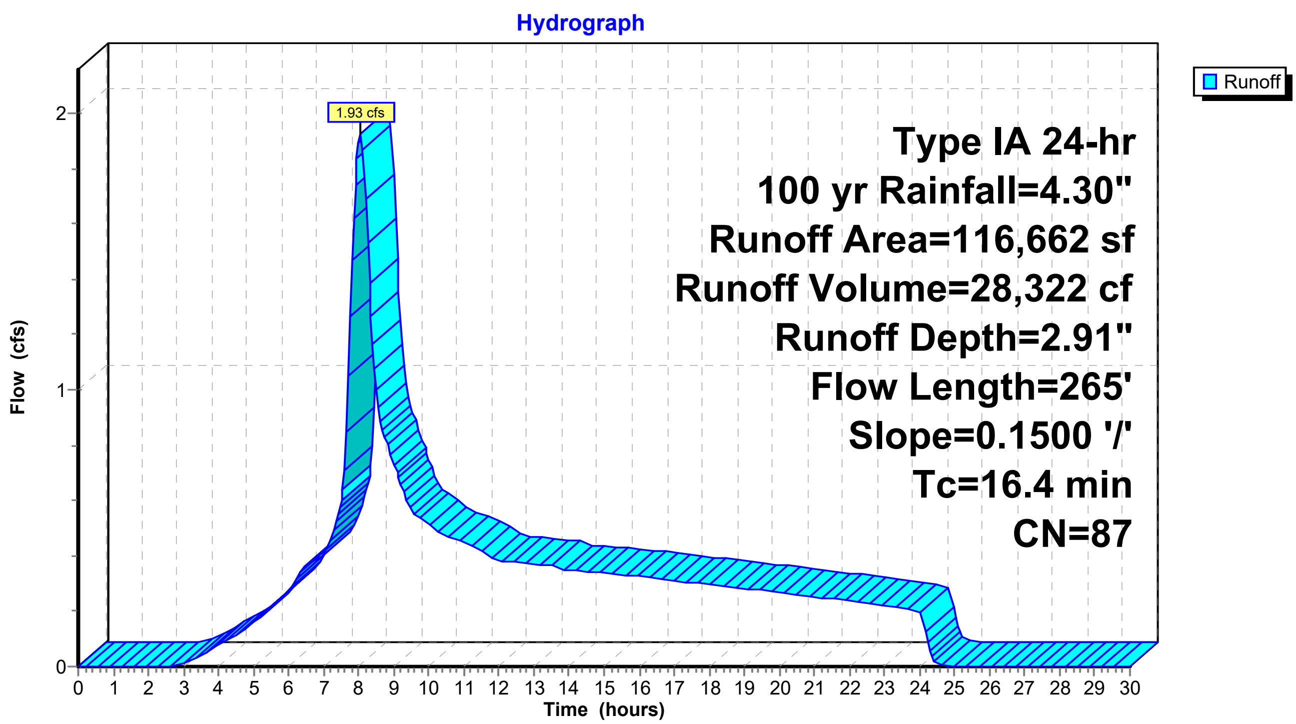
Runoff = 1.93 cfs @ 8.06 hrs, Volume= 28,322 cf, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 yr Rainfall=4.30"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,281 | 89 | Pasture/grassland/range, Poor, HSG D |
| * | 80,000 | 85 | Pasture/grassland/range, Poor, HSG C |
| * | 4,381 | 98 | Impervious |
| | 116,662 | 87 | Weighted Average |
| | 112,281 | | 96.24% Pervious Area |
| | 4,381 | | 3.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.4 | 265 | 0.1500 | 0.27 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 2.30" |

### Subcatchment A1: Pre Dev Basin 1



## Summary for Subcatchment B1: Park Area

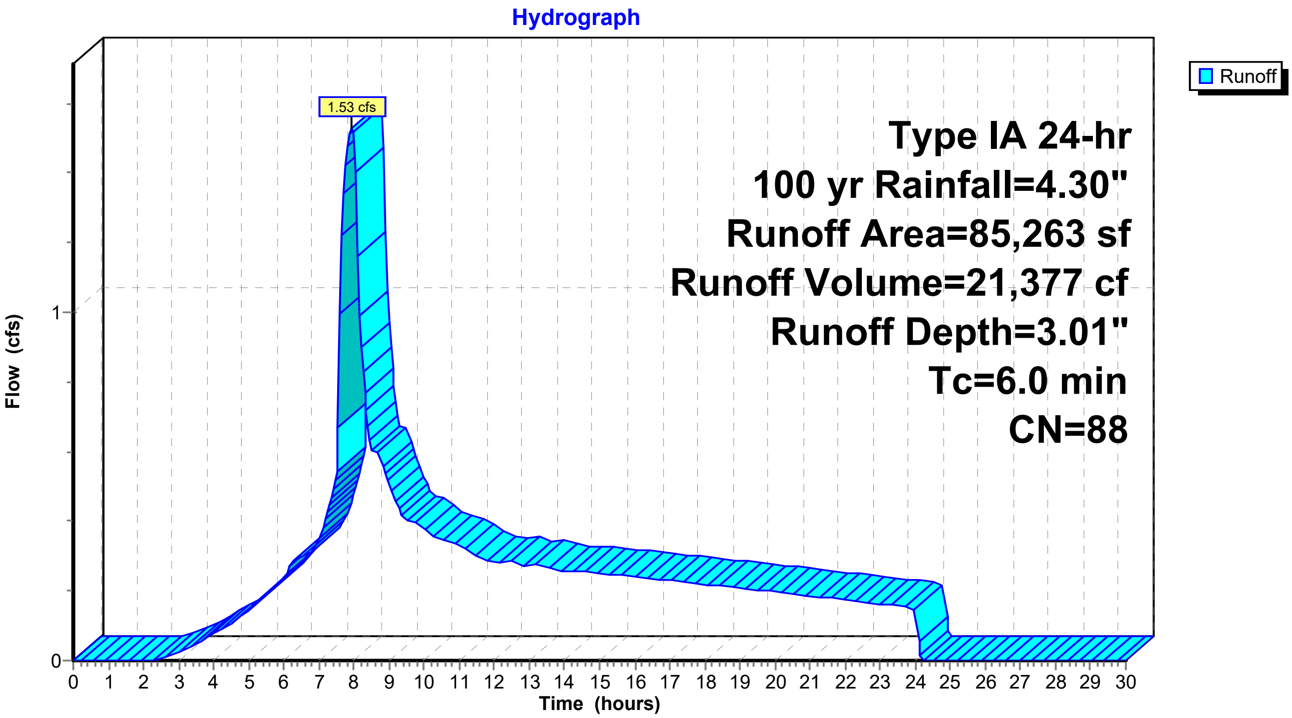
Runoff = 1.53 cfs @ 7.92 hrs, Volume= 21,377 cf, Depth= 3.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 yr Rainfall=4.30"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 70,000 | 86 | Landscaping |
| * | 15,263 | 98 | Sidewalk |
| | 85,263 | 88 | Weighted Average |
| | 70,000 | | 82.10% Pervious Area |
| | 15,263 | | 17.90% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Subcatchment B1: Park Area



## Summary for Subcatchment B2: ToSwale

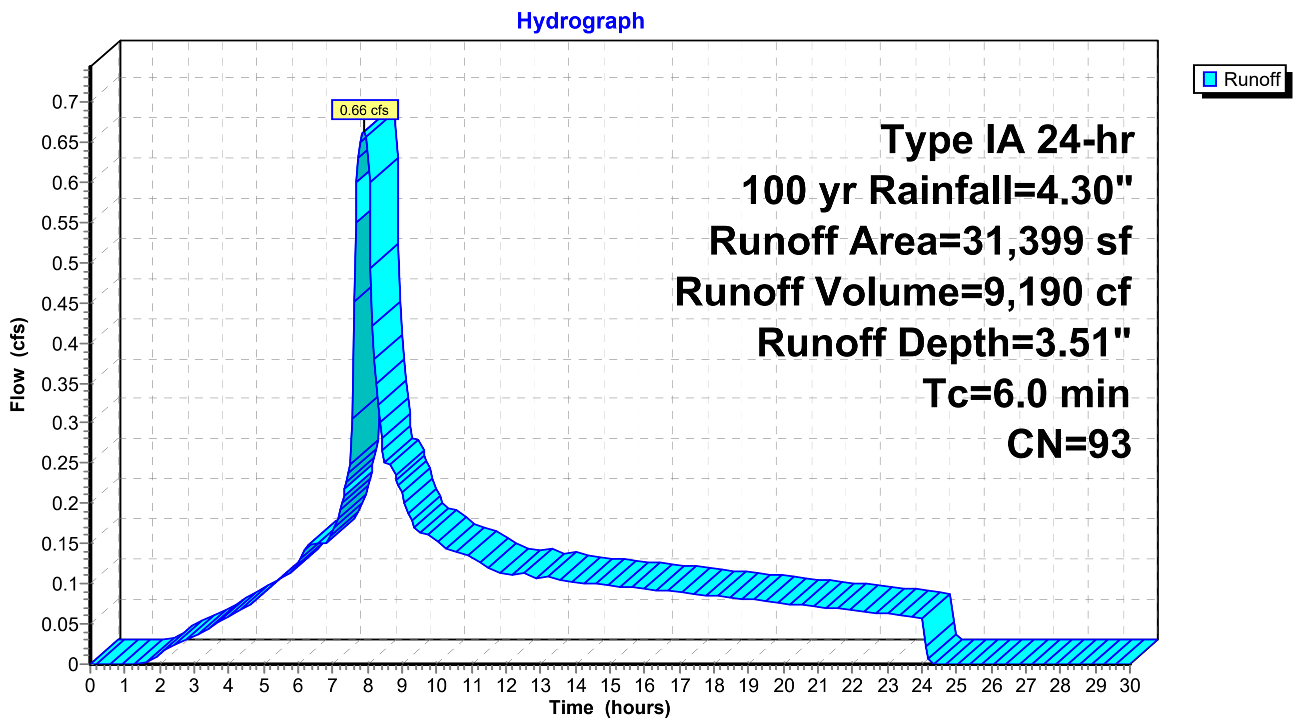
Runoff = 0.66 cfs @ 7.89 hrs, Volume= 9,190 cf, Depth= 3.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 yr Rainfall=4.30"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 14,383 | 86 | Landscaping |
| * | 7,331 | 98 | Road |
| * | 9,685 | 98 | Driveway |
| | 31,399 | 93 | Weighted Average |
| | 14,383 | | 45.81% Pervious Area |
| | 17,016 | | 54.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Subcatchment B2: ToSwale



## Summary for Reach R1: Swale

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 3.51" for 100 yr event
Inflow = 0.66 cfs @ 7.89 hrs, Volume= 9,190 cf
Outflow = 0.66 cfs @ 8.05 hrs, Volume= 9,190 cf, Atten= 1%, Lag= 9.2 min

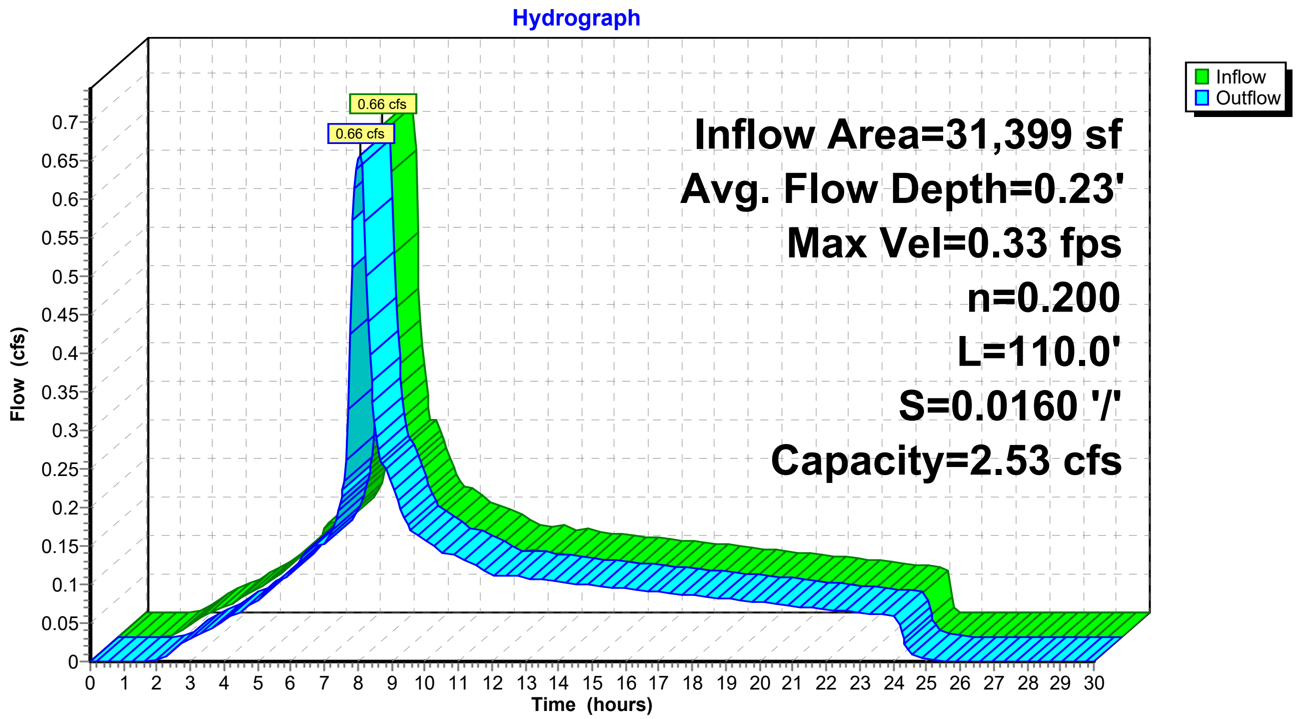
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.33 fps, Min. Travel Time= 5.5 min
Avg. Velocity = 0.13 fps, Avg. Travel Time= 13.6 min

Peak Storage= 218 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 0.50' Flow Area= 4.8 sf, Capacity= 2.53 cfs

8.00' x 0.50' deep channel, n= 0.200
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 110.0' Slope= 0.0160 '/'
Inlet Invert= 192.00', Outlet Invert= 190.24'

‡

### Reach R1: Swale



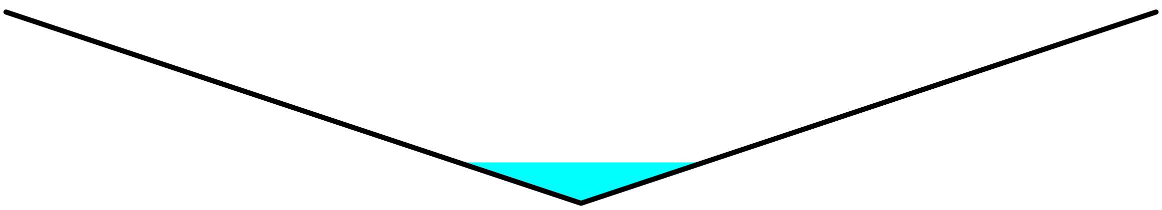
## Summary for Reach R2: Ditch (Point of Comparison)

Inflow Area = 116,662 sf, 27.67% Impervious, Inflow Depth = 3.14" for 100 yr event
Inflow = 2.18 cfs @ 8.05 hrs, Volume= 30,567 cf
Outflow = 1.90 cfs @ 8.11 hrs, Volume= 30,567 cf, Atten= 13%, Lag= 3.6 min

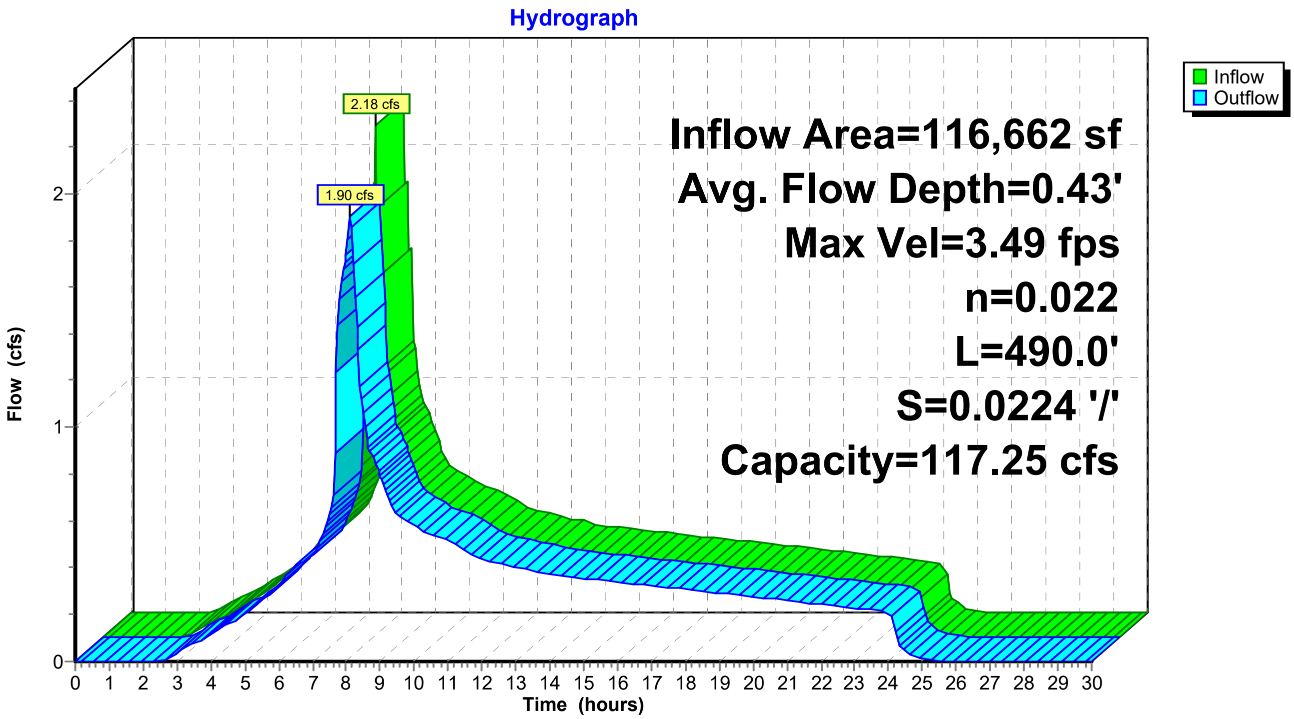
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.49 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.89 fps, Avg. Travel Time= 4.3 min

Peak Storage= 268 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 117.25 cfs

0.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 490.0' Slope= 0.0224 '/'
Inlet Invert= 177.00', Outlet Invert= 166.00'



**Reach R2: Ditch (Point of Comparison)**



## Summary for Pond P1: Pond

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 3.51" for 100 yr event
Inflow = 0.66 cfs @ 8.05 hrs, Volume= 9,190 cf
Outflow = 0.65 cfs @ 8.12 hrs, Volume= 9,190 cf, Atten= 1%, Lag= 4.7 min
Primary = 0.65 cfs @ 8.12 hrs, Volume= 9,190 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 188.15' @ 8.12 hrs Surf.Area= 549 sf Storage= 743 cf

Plug-Flow detention time= 25.9 min calculated for 9,190 cf (100% of inflow)
Center-of-Mass det. time= 25.9 min ( 746.3 - 720.4 )

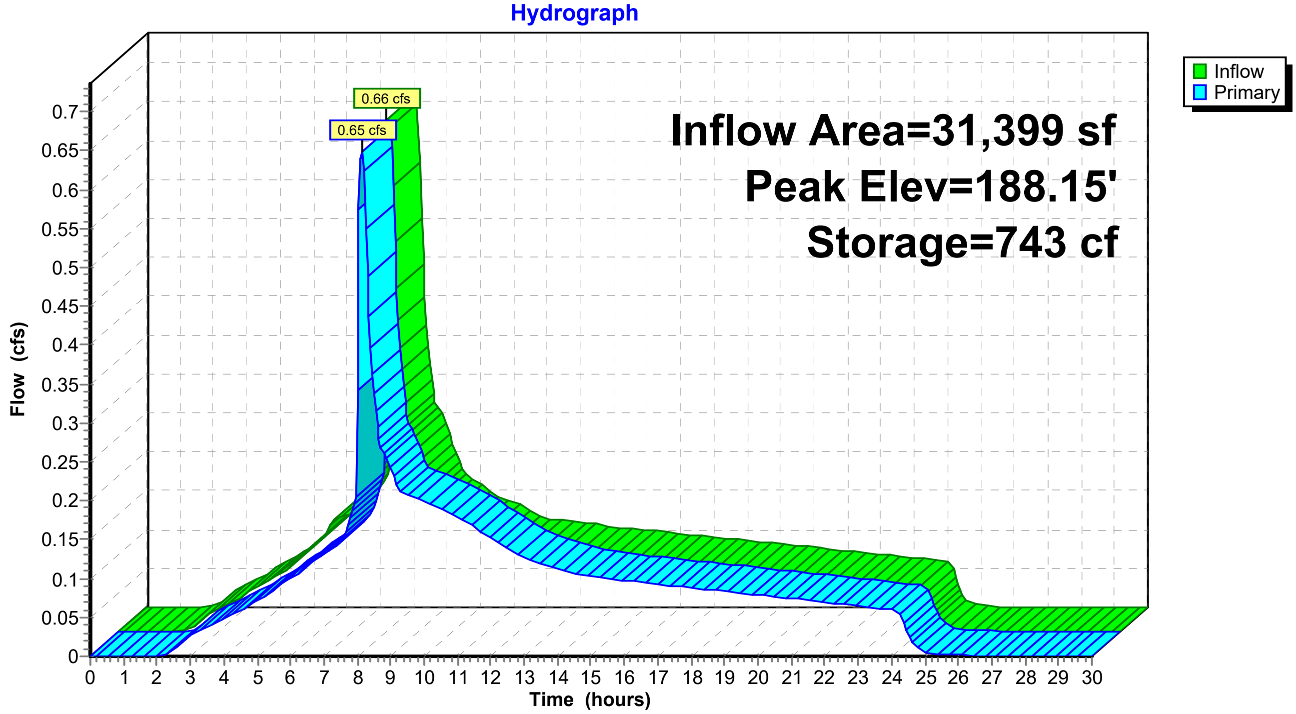
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 186.00' | 1,278 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71 |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 186.00 | 200 | 0 | 0 |
| 189.00 | 1,000 | 1,800 | 1,800 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 186.00' | **8.0" Round Culvert**<br>L= 70.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 186.00' / 184.60' S= 0.0200 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 186.00' | **2.4" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 188.00' | **2.3' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |

**Primary OutFlow** Max=0.64 cfs @ 8.12 hrs HW=188.15' (Free Discharge)
└─**1=Culvert** (Passes 0.64 cfs of 2.07 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.22 cfs @ 6.89 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.42 cfs @ 1.26 fps)

## Pond P1: Pond


Hydrograph
Inflow
Primary
0.66 cfs
0.65 cfs
Inflow Area=31,399 sf
Peak Elev=188.15'
Storage=743 cf
Flow (cfs)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Time (hours)

## Summary for Pond P2: FlowSpreader w/Storage

Inflow Area = 85,263 sf, 17.90% Impervious, Inflow Depth = 3.01" for 100 yr event
Inflow = 1.53 cfs @ 7.92 hrs, Volume= 21,377 cf
Outflow = 1.73 cfs @ 7.95 hrs, Volume= 21,377 cf, Atten= 0%, Lag= 1.7 min
Primary = 1.73 cfs @ 7.95 hrs, Volume= 21,377 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 183.04' @ 7.95 hrs Surf.Area= 85 sf Storage= 84 cf

Plug-Flow detention time= 1.1 min calculated for 21,341 cf (100% of inflow)
Center-of-Mass det. time= 1.1 min ( 741.9 - 740.8 )

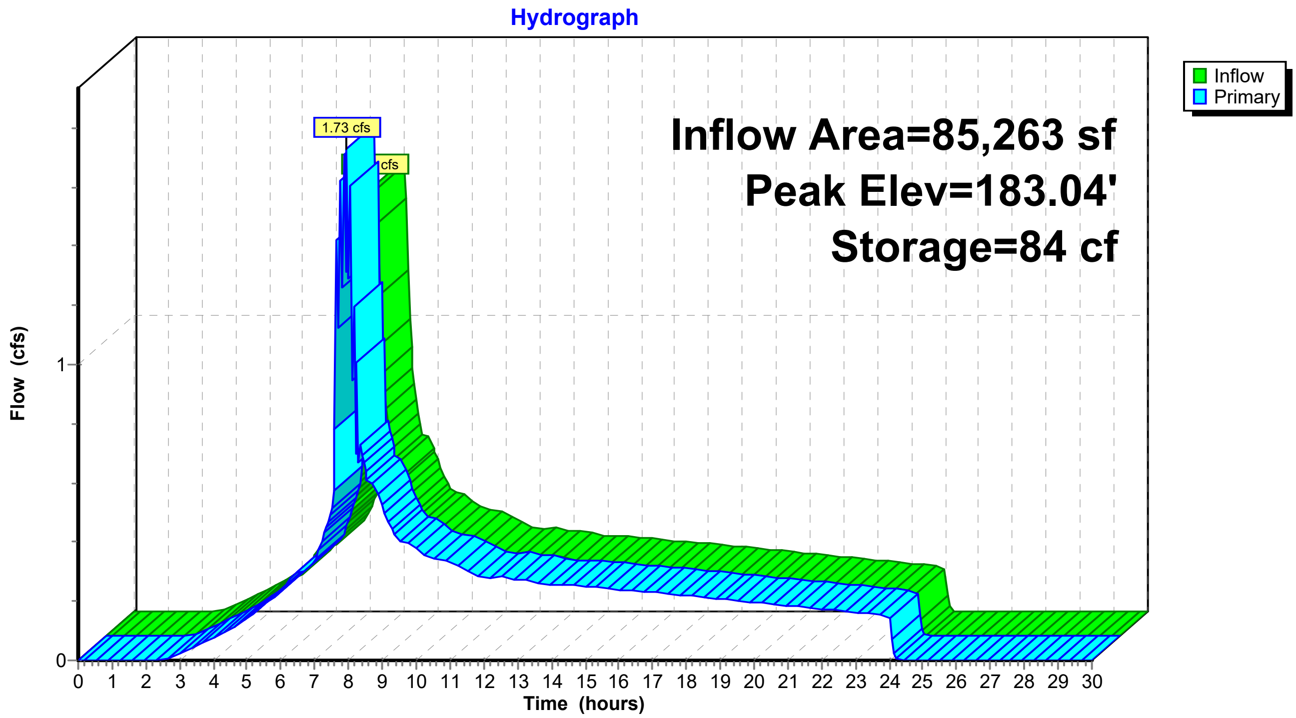
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 180.00' | 84 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71<br>256 cf Overall x 33.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 180.00 | 120 | 0 | 0 |
| 183.00 | 120 | 360 | 360 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 180.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 183.00' | **40.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=1.68 cfs @ 7.95 hrs HW=183.04' (Free Discharge)
├─**1=Orifice/Grate** (Orifice Controls 0.71 cfs @ 8.16 fps)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.97 cfs @ 0.58 fps)

## Pond P2: FlowSpreader w/Storage



## Summary for Subcatchment A1: Pre Dev Basin 1

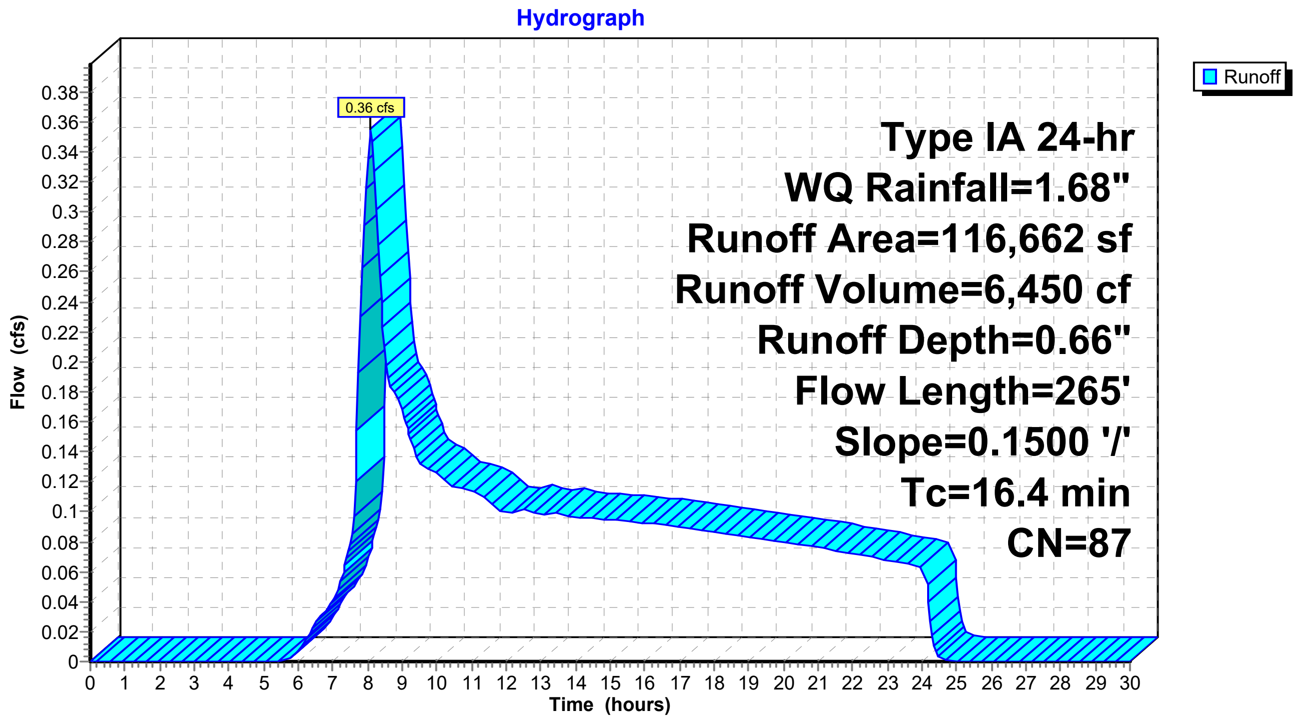
Runoff = 0.36 cfs @ 8.09 hrs, Volume= 6,450 cf, Depth= 0.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.68"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,281 | 89 | Pasture/grassland/range, Poor, HSG D |
| * | 80,000 | 85 | Pasture/grassland/range, Poor, HSG C |
| * | 4,381 | 98 | Impervious |
| | 116,662 | 87 | Weighted Average |
| | 112,281 | | 96.24% Pervious Area |
| | 4,381 | | 3.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.4 | 265 | 0.1500 | 0.27 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 2.30" |

## Subcatchment A1: Pre Dev Basin 1



## Summary for Subcatchment B1: Park Area

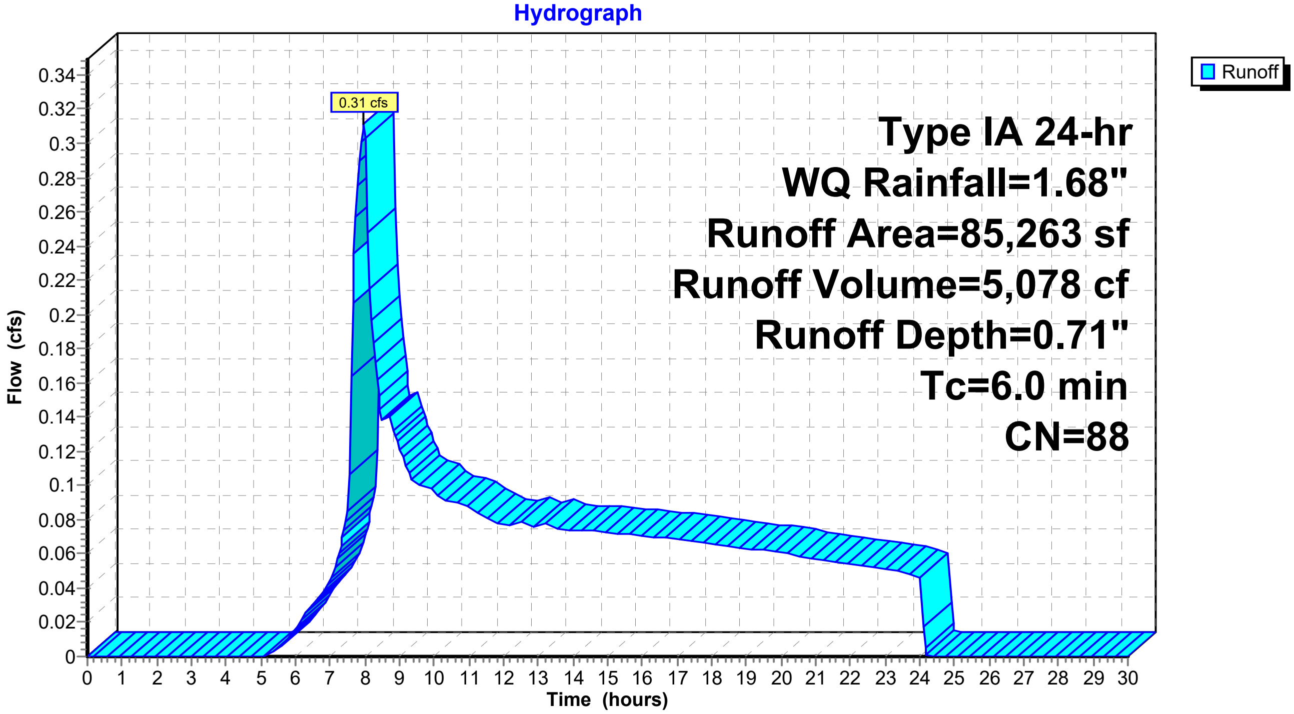
Runoff = 0.31 cfs @ 7.98 hrs, Volume= 5,078 cf, Depth= 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.68"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 70,000 | 86 | Landscaping |
| * | 15,263 | 98 | Sidewalk |
| | 85,263 | 88 | Weighted Average |
| | 70,000 | | 82.10% Pervious Area |
| | 15,263 | | 17.90% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

### Subcatchment B1: Park Area



## Summary for Subcatchment B2: ToSwale

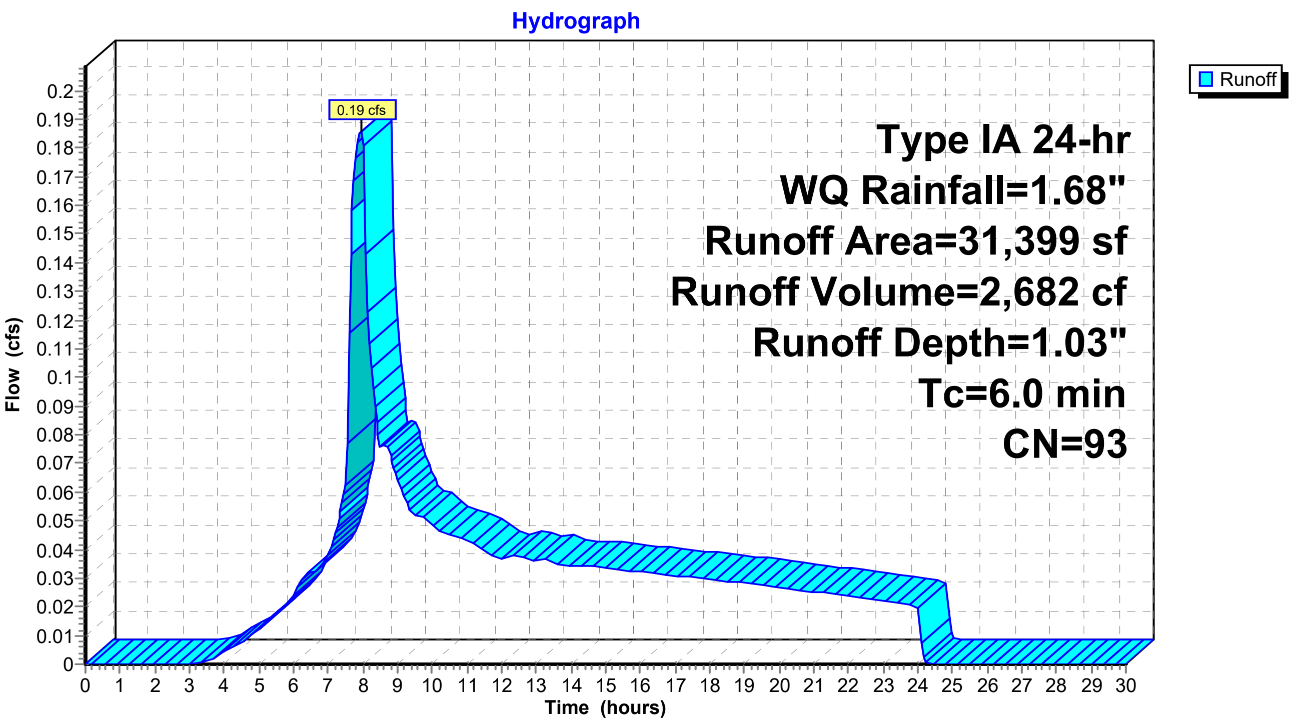
Runoff = 0.19 cfs @ 7.94 hrs, Volume= 2,682 cf, Depth= 1.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.68"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 14,383 | 86 | Landscaping |
| * | 7,331 | 98 | Road |
| * | 9,685 | 98 | Driveway |
| | 31,399 | 93 | Weighted Average |
| | 14,383 | | 45.81% Pervious Area |
| | 17,016 | | 54.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Subcatchment B2: ToSwale



## Summary for Reach R1: Swale

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth = 1.03" for WQ event
Inflow = 0.19 cfs @ 7.94 hrs, Volume= 2,682 cf
Outflow = 0.18 cfs @ 8.17 hrs, Volume= 2,682 cf, Atten= 3%, Lag= 13.3 min

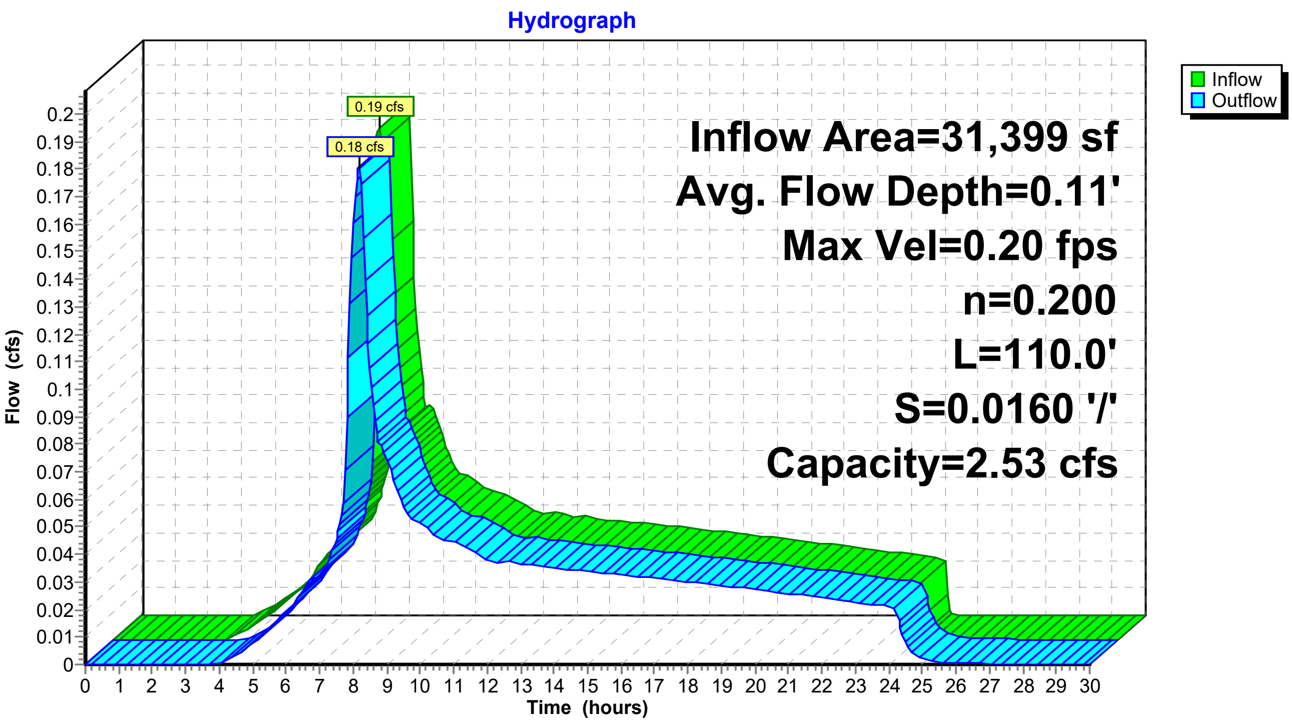
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.20 fps, Min. Travel Time= 9.0 min
Avg. Velocity = 0.09 fps, Avg. Travel Time= 21.0 min

Peak Storage= 97 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 0.50' Flow Area= 4.8 sf, Capacity= 2.53 cfs

8.00' x 0.50' deep channel, n= 0.200
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 110.0' Slope= 0.0160 '/'
Inlet Invert= 192.00', Outlet Invert= 190.24'

‡

### Reach R1: Swale



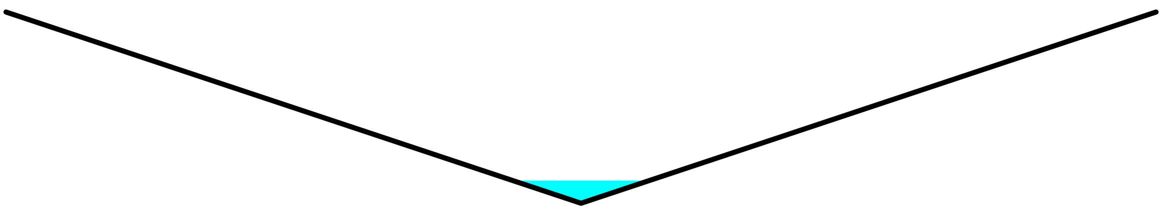
## Summary for Reach R2: Ditch (Point of Comparison)

Inflow Area = 116,662 sf, 27.67% Impervious, Inflow Depth > 0.80" for WQ event
Inflow = 0.40 cfs @ 8.03 hrs, Volume= 7,760 cf
Outflow = 0.39 cfs @ 8.11 hrs, Volume= 7,760 cf, Atten= 2%, Lag= 5.1 min

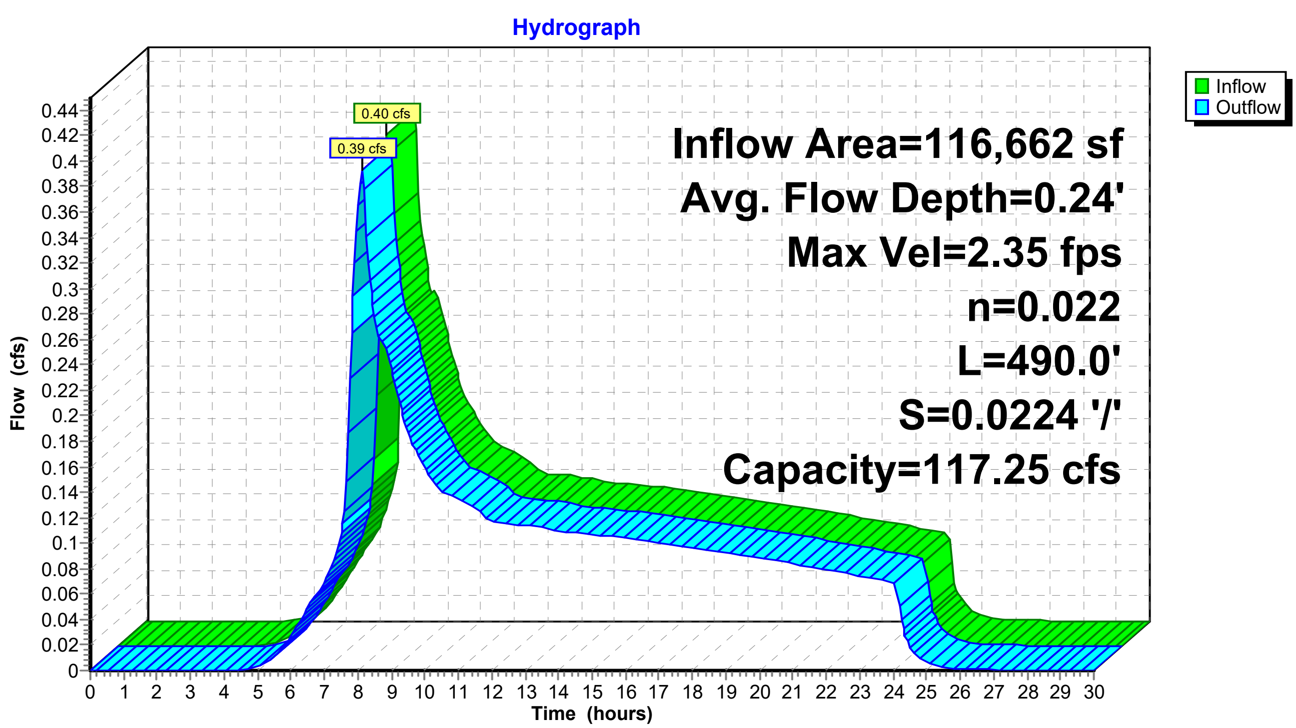
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.35 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 1.39 fps, Avg. Travel Time= 5.9 min

Peak Storage= 82 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 117.25 cfs

0.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 490.0' Slope= 0.0224 '/'
Inlet Invert= 177.00', Outlet Invert= 166.00'



### Reach R2: Ditch (Point of Comparison)



## Summary for Pond P1: Pond

Inflow Area = 31,399 sf, 54.19% Impervious, Inflow Depth > 1.02" for WQ event
Inflow = 0.18 cfs @ 8.17 hrs, Volume= 2,682 cf
Outflow = 0.12 cfs @ 8.43 hrs, Volume= 2,682 cf, Atten= 32%, Lag= 15.6 min
Primary = 0.12 cfs @ 8.43 hrs, Volume= 2,682 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 186.75' @ 8.43 hrs Surf.Area= 284 sf Storage= 159 cf

Plug-Flow detention time= 13.7 min calculated for 2,677 cf (100% of inflow)
Center-of-Mass det. time= 13.7 min ( 806.2 - 792.4 )

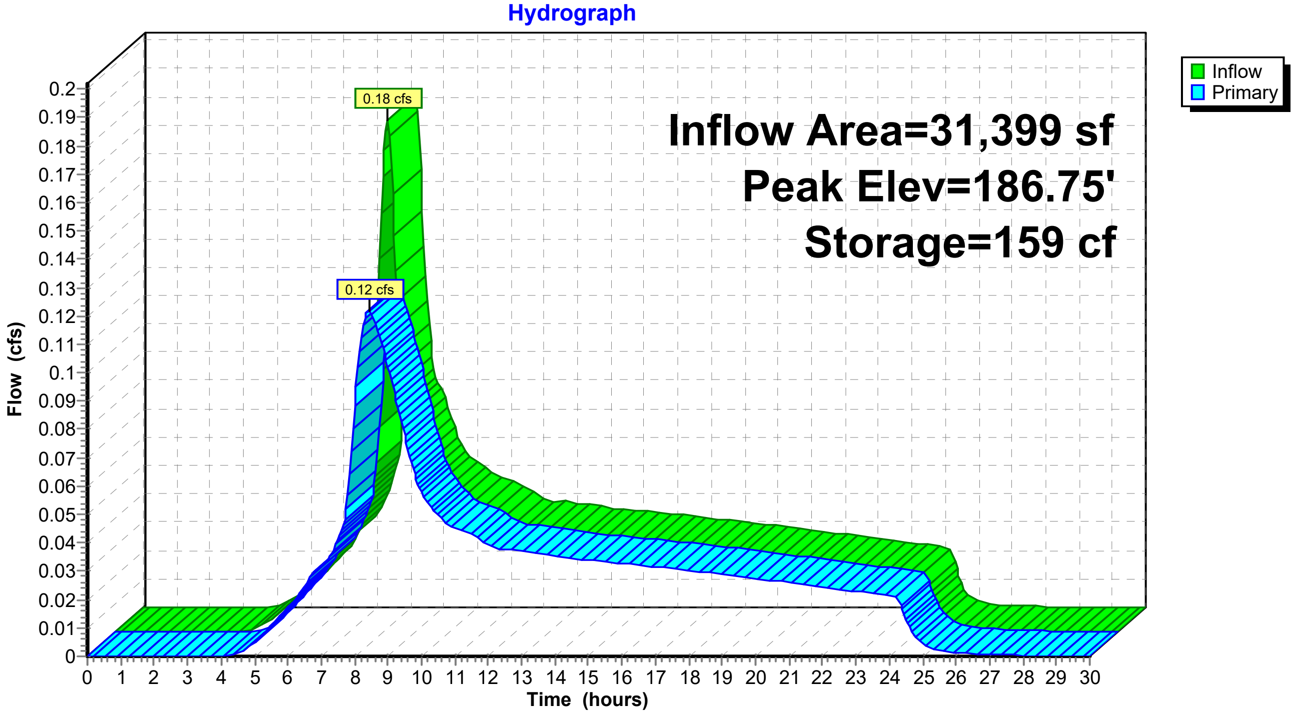
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 186.00' | 1,278 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71 |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 186.00 | 200 | 0 | 0 |
| 189.00 | 1,000 | 1,800 | 1,800 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 186.00' | **8.0" Round Culvert**<br>L= 70.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 186.00' / 184.60' S= 0.0200 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 186.00' | **2.4" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 188.00' | **2.3' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |

**Primary OutFlow** Max=0.12 cfs @ 8.43 hrs HW=186.75' (Free Discharge)
└─**1=Culvert** (Passes 0.12 cfs of 1.08 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.12 cfs @ 3.87 fps)
  └─**3=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond P1: Pond


Hydrograph
Inflow
Primary
0.18 cfs
0.12 cfs
Inflow Area=31,399 sf
Peak Elev=186.75'
Storage=159 cf
Flow (cfs)
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Time (hours)

## Summary for Pond P2: FlowSpreader w/Storage

Inflow Area = 85,263 sf, 17.90% Impervious, Inflow Depth = 0.71" for WQ event
Inflow = 0.31 cfs @ 7.98 hrs, Volume= 5,078 cf
Outflow = 0.31 cfs @ 8.00 hrs, Volume= 5,078 cf, Atten= 1%, Lag= 0.9 min
Primary = 0.31 cfs @ 8.00 hrs, Volume= 5,078 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 180.71' @ 8.00 hrs Surf.Area= 85 sf Storage= 20 cf

Plug-Flow detention time= 1.2 min calculated for 5,070 cf (100% of inflow)
Center-of-Mass det. time= 1.2 min ( 826.6 - 825.4 )

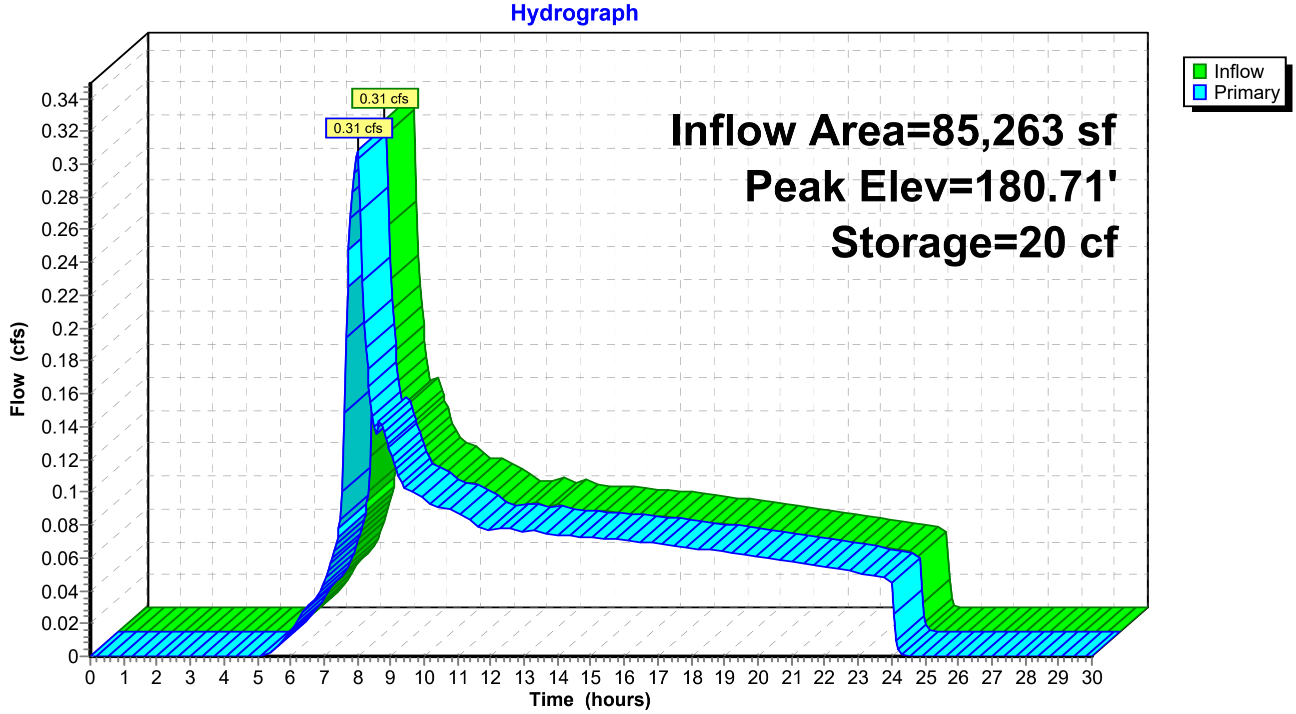
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 180.00' | 84 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.71<br>256 cf Overall x 33.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 180.00 | 120 | 0 | 0 |
| 183.00 | 120 | 360 | 360 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 180.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 183.00' | **40.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=0.31 cfs @ 8.00 hrs HW=180.71' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.31 cfs @ 3.54 fps)
└—**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond P2: FlowSpreader w/Storage



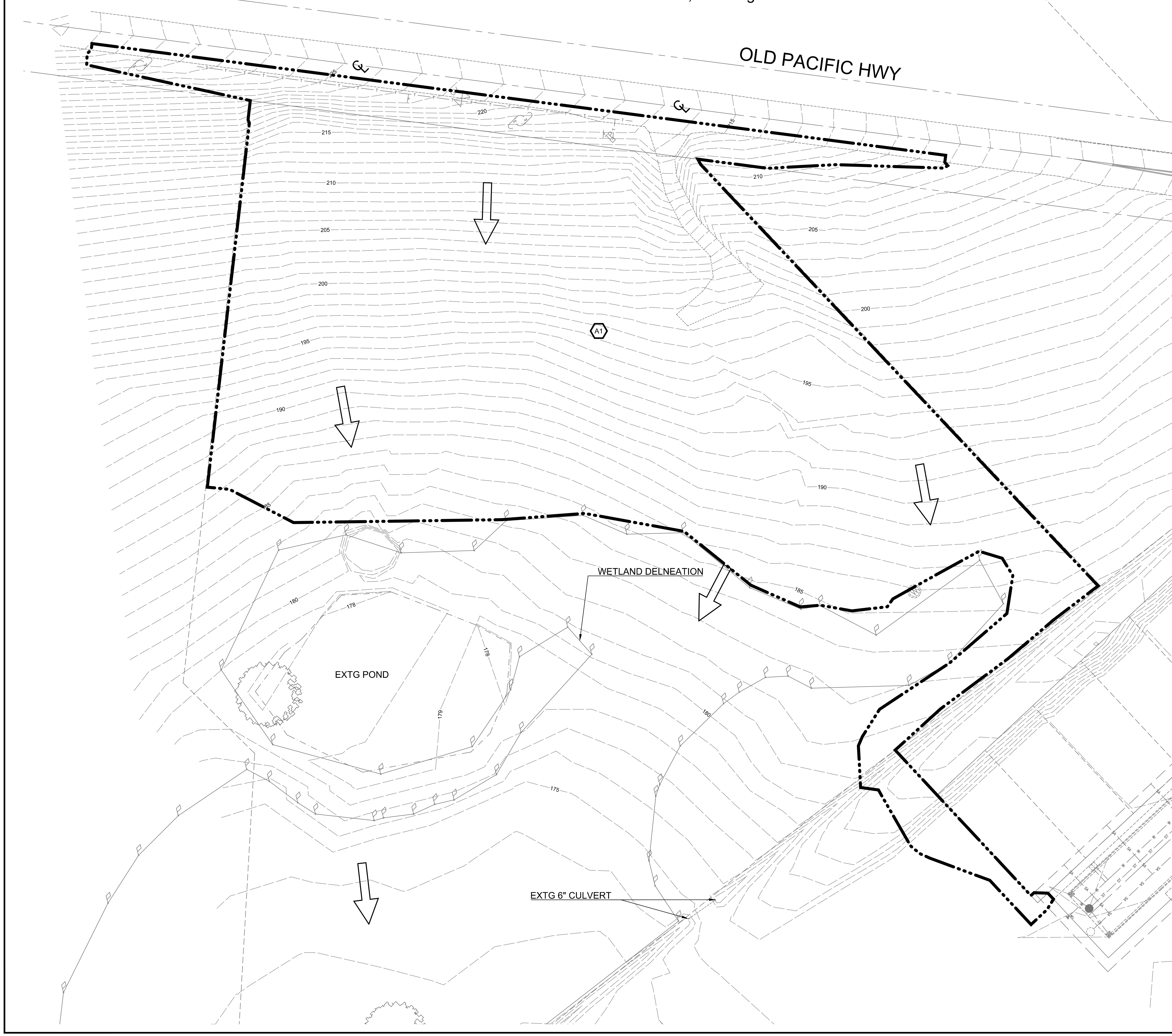
# APPENDIX C

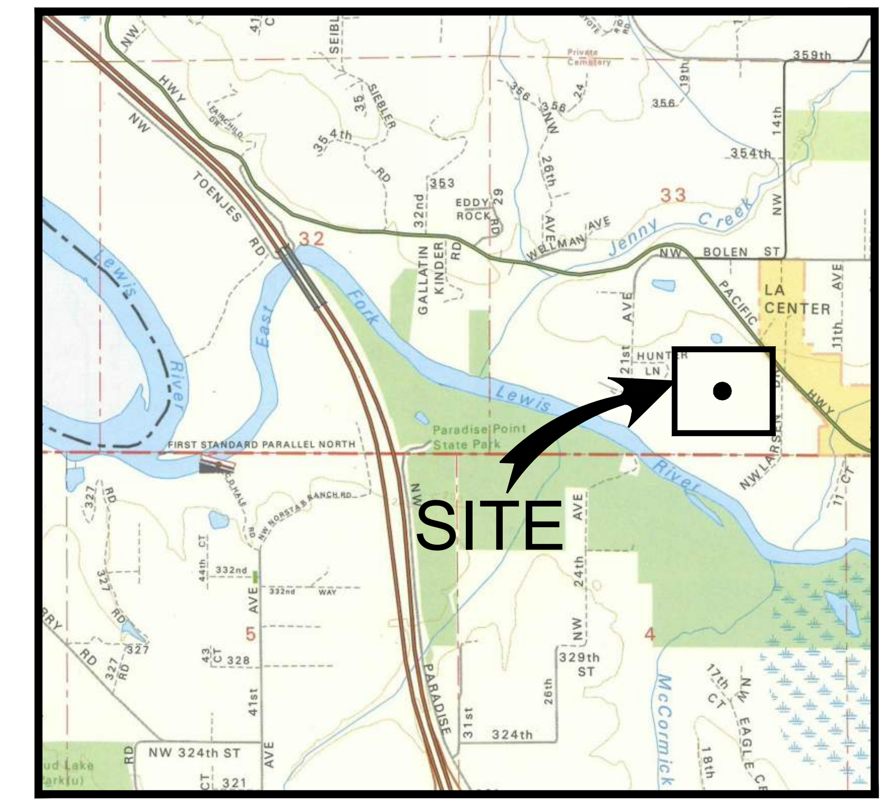
## Basin Maps

Pre-Developed
Post-Developed

# Riverside Neighborhood Park

Located in the SE ¼ of Section 33, T5N, R1E
La Center, Washington




VICINITY MAP
NOT TO SCALE

PROJECT NOTES

APPLICANT:
9317 LLC
Contact: Luke Sasse
9321 NE 72nd Ave. Bldg C #7
Vancouver, WA 98665
Office: (360) 449-0099
Email: luke@timberlandinc.com

OWNER:
ECM Riverside, LLC
Contact: Sid Constantinescu
340 Oswego Point Drive #208
Lake Oswego, OR 97034
PH: (425) 462-6372
Email: Sconstantinescu@paccrestrealty.com

CIVIL ENGINEER:
PLS Engineering
Contact: Travis Johnson, PE
604 W Evergreen Blvd
Vancouver, WA 98660
PH: (360) 944-6519
Email: PM@plsengineering.com

SITE ADDRESS:
Parcel # 986028-825
34512 NW Pacific Hwy
La Center, WA 98629

**EXISTING LOT SIZE:**
**Parcel # 986028-825: 225,943.66 SF (5.19 AC)**

**EXISTING SITE DRAINAGE:**
**The runoff currently drains South and SW to through a Wetland and to a Ditch. The low point of the site is the SW corner. From there it travels offsite to the SW where it eventually enters the East Fork Lewis River.**

A1 Point of Compliance 1: Pre-Development Basin Area
Basin A1 Areas:

| | |
|---|---|
| Disturbed Area: | 2.68 ac |
| Total Site Area: | 2.68 ac |

Drainage Basin Legend

| | |
|---|---|
| POC Line | — ··· — ··· — |
| Basin Line | — ··· — ··· — |
| Subcatchment Area ID | # |

Scale 1" = 30'
30 15 0 30

Know what's **below.**
**Call** before you dig.

PLS ENGINEERING

Pre-Development Basin Map For:
# Riverside Neighborhood Park
A Site Located in La Center, Washington

Engineering - Surveying - Planning | 604 W. Evergreen Blvd., Vancouver, WA 98660 | PH (360) 944-6519 | Fax (360) 944-6539

Revisions

| | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

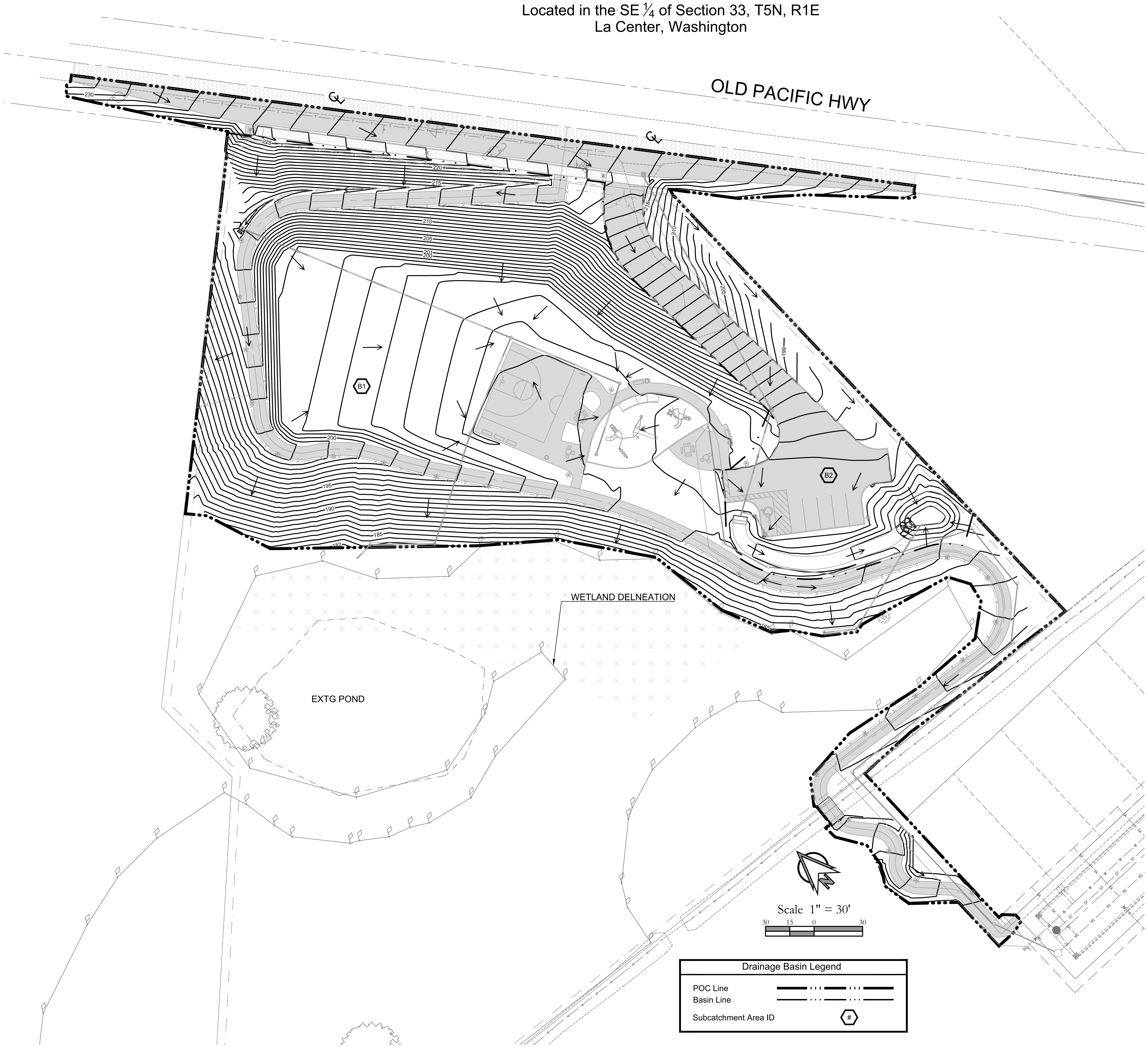
Project No. 2641

| | |
|---|---|
| SCALE: | H: 1" = 30' V: N/A |
| DESIGNED BY: | SWG |
| DRAFTED BY: | SWG |
| REVIEWED BY: | TGJ |

1
2

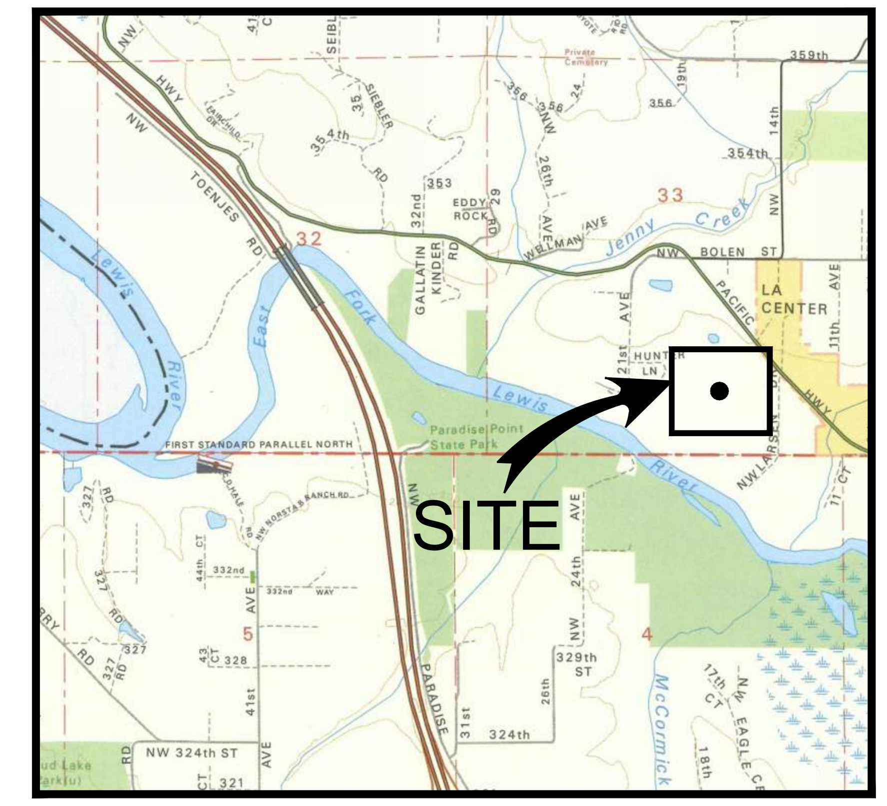
# Riverside Neighborhood Park

Located in the SE ¼ of Section 33, T5N, R1E
La Center, Washington




**Drainage Basin Legend**

| | |
|---|---|
| POC Line | |
| Basin Line | |
| Subcatchment Area ID | # |




VICINITY MAP
NOT TO SCALE

PROJECT NOTES

APPLICANT:
9317 LLC
Contact: Luke Sasse
9321 NE 72nd Ave. Bldg C #7
Vancouver, WA 98665
Office: (360) 449-0099
Email: luke@timberlandinc.com

OWNER:
ECM Riverside, LLC
Contact: Sid Constantinescu
340 Oswego Point Drive #208
Lake Oswego, OR 97034
PH: (425) 462-6372
Email: Sconstantinescu@paccrestrealty.com

CIVIL ENGINEER:
PLS Engineering
Contact: Travis Johnson, PE
604 W Evergreen Blvd
Vancouver, WA 98660
PH: (360) 944-6519
Email: PM@plsengineering.com

SITE ADDRESS:
Parcel # 986028-825
34512 NW Pacific Hwy
La Center, WA 98629

**EXISTING LOT SIZE:**
**Parcel # 986028-825: 225,943.66 SF (5.19 AC)**

**PROPOSED STORM DRAINAGE:**
**Basin 1 is comprised on non-pollution generating surfaces. It is collected in area drains and a ditch inlet, and routed to a flow spreader designed to detain the WQ event. Basin 2 collects the pollution generating surfaces and routes them to a biofiltration swale for treatment, and then a detention pond, where the runoff is released at rates that allow the total site to be equal to or slightly less than the existing site discharge.**

Point of Compliance 1: Pre-Development Basin Area

| | | |
|---|---|---|
| B1 | Basin 1 Areas: | |
| | Landscaped Area: | 70,000 SF |
| | Sidewalk Area: | 15,263 SF |
| | Total B1 Area: | 85,263 SF |
| B2 | Basin 2 Areas: | |
| | Landscaped Area: | 14,383 SF |
| | Road Area: | 7,331 SF |
| | Driveway Area: | 9,685 SF |
| | Total B2 Area: | 31,339 SF |
| | Total Point of Compliance Area: | 116,662 SF (2.68 AC) |

811 Know what's below. Call before you dig.

PLS ENGINEERING

Engineering - Surveying - Planning | 604 W. Evergreen Blvd., Vancouver, WA 98660 | PH (360) 944-6519 | Fax (360) 944-6539

Post-Development Basin Map For:
Riverside Neighborhood Park
A Site Located in La Center, Washington

Revisions

| | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

| | |
|---|---|
| Project No. 2641 | |
| SCALE: | H: 1" = 30' V: N/A |
| DESIGNED BY: | SWG |
| DRAFTED BY: | SWG |
| REVIEWED BY: | TGJ |

2

2

# APPENDIX D

Geotechnical Report

# Carlson Geotechnical

A Division of Carlson Testing, Inc.
Phone: (503) 601-8250
www.carlsontesting.com

| | |
|---|---|
| **Bend Office** | **(541) 330-9155** |
| **Eugene Office** | **(541) 345-0289** |
| **Salem Office** | **(503) 589-1252** |
| **Tigard Office** | **(503) 684-3460** |


**Engineering Geologic Report**
**Riverside Estates Subdivision**
**Ridgeline Park**
**34512 NW Pacific Highway**
**La Center, Washington**

**CGT Project Number G2005322**

Prepared for

Peter Ettro
Ettro Capital
340 Oswego Point Drive #208
Lake Oswego, Oregon 97034

July 22, 2020

**Carlson Geotechnical**
A Division of Carlson Testing, Inc.
Phone: (503) 601-8250
www.carlsontesting.com

| | |
|---|---|
| **Bend Office** | **(541) 330-9155** |
| **Eugene Office** | **(541) 345-0289** |
| **Salem Office** | **(503) 589-1252** |
| **Tigard Office** | **(503) 684-3460** |


July 22, 2020

Peter Ettro
Ettro Capital
340 Oswego Point Drive #208
Lake Oswego, Oregon 97034

**Engineering Geologic Report**
**Riverside Estates Subdivision**
**Ridgeline Park**
**34512 NW Pacific Highway**
**La Center, Washington**

CGT Project Number G2005322

Dear Mr. Ettro:

Carlson Geotechnical (CGT), a division of Carlson Testing, Inc. (CTI), is pleased to submit this engineering geologic report for the proposed Ridgeline Park project at the Riverside Estates Subdivision. The site is located at 34512 NW Pacific Highway in La Center, Washington. We performed our work in general accordance with CGT Proposal GP9004, dated July 8, 2020. Written authorization for our services was received on July 17, 2020.

We appreciate the opportunity to work with you on this project. Please contact us at 503.601.8250 if you have any questions regarding this report.

Respectfully Submitted,
**CARLSON GEOTECHNICAL**

Melissa L. Lehman
Geotechnical Project Manager
mlehman@carlsontesting.com

Ryan T. Houser, LEG
Senior Engineering Geologist
rhouser@carlsontesting.com

Doc ID: G:\GEOTECH\PROJECTS\2020 Projects\G2005322 - Ridgeline Park - Geologic Hazard\G2005322 - GEO\008 - Deliverables\Report\Engineering Geologic Report.docx

## TABLE OF CONTENTS



## ATTACHMENTS

## 1.0 INTRODUCTION

Carlson Geotechnical (CGT), a division of Carlson Testing, Inc. (CTI), is pleased to submit this engineering geologic report for the proposed Ridgeline Park project at the Riverside Estates Subdivision. The site is located at 34512 NW Pacific Highway in La Center, Washington, as shown on the attached Site Location, Figure 1.

### 1.1 Project Information

CGT developed an understanding of the proposed project based on our correspondence with you and the following project documents provided to us:

- "Geotechnical Site Investigation, Goode Property, La Center, Washington," prepared by Columbia West Engineering, Inc., (CWE), dated January 31, 2008.
- "Site Plan for Ridgeline Park," prepared by PLS Engineering, not dated.

CGT was previously retained to prepare the following report:

- "Report of Site-Specific Pavement Design Services, Riverside Estates Subdivision, NW Pacific Highway & NW Larson Drive, La Center, Washington," CGT Project Number G1804931.A

In addition, CGT performed construction observations during the mass grading of the subdivision in 2018.

Based on our review of the site plan, we understand this portion of the project will include development of a new park at the north end of the residential subdivision. Ridgeline Park will include:

- Construction of an access road and parking area to serve the new park. We assume new pavements will be surfaced with asphalt concrete (AC).
- A new sports court.
- A new, 8-foot-wide, ADA-compliant path.
- The site plan indicates stormwater collected from new hardscaped areas will be disposed of in on-site biofiltration facilities and through the use of level spreaders. Design of infiltration facilities rests with others.
- The site plan indicates grading will include the placement of up to about 7 feet of structural fill in the area of the proposed roadway and ADA path to reach finished grades. New fill slopes will have finished gradients up to 2 horizontal to 1 vertical (2H:1V).

We understand that the site is located in a landslide hazard overlay zone, indicating it contains slopes in excess of 15 percent, and that the City of La Center requires an engineering geologic report be completed for the project prior to issuance of a building permit.

### 1.2 Scope of Services

The purpose of our work will be to identify geologic hazards that may affect the property. Our specific scope of services will include the following:

- Review available literature for geologic hazards in the vicinity of the site. Specific hazards to be addressed by this study include:
  - Erosion potential
  - Landslide potential / Slope stability
  - Seismic potential
  - Flood potential
  - Volcanic hazards potential
- Review readily available historical aerial photographs of the site.
- Review available topographic, geologic, and geologic hazard maps for the area.
- Perform a surface reconnaissance of the site.
- Explore subsurface conditions at the site by advancing three hand auger borings to depths of up to about 5½ feet below ground surface (bgs). Details of the subsurface investigation are presented in Appendix A.
- Provide **qualitative** conclusions regarding the potential impacts of geologic hazards on the proposed development, and vice versa.
- Provide a written report summarizing the results of our study in general accordance with Clark County Code Chapter 40.430.030(C)(5) and the 2006 Washington State Geologist Licensing Board Guidelines for Preparing Engineering Geology Reports in Washington.

## 2.0 GEOLOGY

### 2.1 Regional Geology

The project site is located within the eastern edge of the Portland-Vancouver Basin. Regional geologic maps indicate that the majority of the basin is underlain by Pleistocene Missoula Lake flood deposits. Approximately 18,000 to 15,000 years ago[1], large periodic glacial flooding occurred in the Portland-Vancouver Basin, depositing boulders, sands, and silts throughout the area.

### 2.2 Site Geology

The geologic map[2] for the area indicates that the site is primarily mapped as underlain by Pleistocene catastrophic flood deposits (Qfs) originating from glacial outburst floods of Lake Missoula (Figure 2) and Pleistocene and/or Pliocene conglomerate (QTc). The flood deposits (Qfs) are mapped along the southern portion of the site and were produced by the periodic failure of glacial ice dams that impounded Lake Missoula in present day Montana between 18,000 to 15,000 years ago[3]. Floodwaters raged through Idaho, eastern Washington, and through the Columbia River Gorge. Near Rainier, Oregon, the river channel was restricted, causing floodwaters to back up the Willamette Valley as far south as Eugene. Floodwaters throughout the quadrangle mantle low-relief surfaces below 300 feet in elevation with deposit thickness greater than 100 feet. The flood deposits are typically split into three different facies: the coarse-grained facies, the fine-grained facies, and the channel facies. The southern portion of the site is mapped as fine-grained Missoula flood deposits, which typically consist of silt, clay, and fine-grained sand. Beds are generally poorly defined and thin (less than 3 feet thick).

---

1 Allen, John Eliot, Burns, Marjorie, and Burns, Scott, 2009. Cataclysms on the Columbia, The Great Missoula Floods, Revised Second Edition: Ooligan Press, Portland State University.

2 Evarts, R.C, Philip Dinterman, and Jessica Block, 2004, Geologic Map of the Ridgefield Quadrangle, Clark and Cowlitz Counties, Washington, SIM-2844.

3 Allen, John Eliot, et al., 2009. Cataclysms on the Columbia, The Great Missoula Floods, Revised Second Edition: Ooligan Press, Portland State University.

The northern half of the site is mapped as underlain by Pleistocene and/or Pliocene conglomerate (QTc) that consist of semi-consolidated pebble, cobble, and gravel. This unit is well exposed in scattered outcrops that demonstrate the unit forms a continuous stratum of 65 to 130 feet in thickness beneath the cataclysmic flood deposits (Qfs) mapped throughout the area.

## 3.0 SEISMICITY

The site is located in a tectonically and seismically active area that may be affected by earthquakes generated by crustal and subduction zone sources.

### 3.1 Earthquake Sources

#### 3.1.1 Crustal Sources

Crustal earthquakes typically occur at depths ranging from 15 to 40 kilometers bgs[4]. According to the United States Geological Survey Quaternary fault and fold database[5], nearby seismic sources capable of producing damaging earthquakes in this region include Portland Hills fault and the Lacamas Lake fault (Figure 3). Distances from the site to the nearest mapped strands of these known active or potentially active faults are summarized in the following table.

**Table 1 Known Active or Potentially Active Crustal Faults in the Vicinity of the Site**

| USGS Fault No. | Fault Name | Distance and Direction from Site | USGS Fault Class[1] |
|---|---|---|---|
| 877 | Portland Hills fault | 20 km SW | A |
| 880 | Lacamas Lake fault | 25 km SE | A |

1 USGS Fault Classes from USGS Earthquake Hazards Program, 2008 National Seismic Hazard Maps
Class A: Fault with convincing evidence of Quaternary activity (ACTIVE)
Class B: Fault that requires further study in order to confidently define their potential as possible sources of earthquake-induced ground motion (POTENTIALLY ACTIVE)
Class C: Fault with insufficient evidence for Quaternary activity (LOW POTENTIAL FOR ACTIVITY)

##### *3.1.1.1 Portland Hills fault (USGS 877)*

The Portland Hills fault zone is a series of northwest-trending faults forming the northeastern margin of the Tualatin Mountains. The faults associated with this structural zone vertically displace the Columbia River Basalt Group by 1,130 feet, and appear to control thickness changes in late Pleistocene sediment[6]. Geomorphic lineaments suggestive of Pleistocene deformation have been identified within the fault zone, but none of the fault segments has been shown to cut Holocene deposits[7,8]. The fact that the faults do not cut Holocene sediments is most likely a result of the faulting being related to a time of intense uplift of the Oregon Coast Range during the Miocene, and little to no movement along the faults during the Holocene.

4 Geomatrix Consultants, 1995. Seismic Design Mapping, State of Oregon: unpublished report prepared for Oregon Department of Transportation, Personal Services Contract 11688, January 1995.
5 U.S. Geological Survey, 2020. Quaternary fault and fold database for the United States, *accessed July 2020*, from USGS web site: http://earthquakes.usgs.gov/regional/qfaults/.
6 Mabey, M.A., Madin, I.P., Youd, T.L., Jones, C.F., 1993, Earthquake hazard maps of the Portland quadrangle, Multnomah and Washington Counties, Oregon, and Clark County, Washington: Oregon Department of Geology and Mineral Industries Geological Map Series GMS-79, Plate 2, 1:24,000.
7 Conforth and Geomatrix Consultants, 1992. Seismic hazard evaluation, Bull Run dam sites near Sandy, Oregon: unpublished report to City of Portland Bureau of Water Works.
8 Balsillie, J.J. and Benson, G.T., 1971. Evidence for the Portland Hills fault: The Ore Bin, Oregon Dept. of Geology and Mineral Industries, v. 33, p. 109-118.

#### *3.1.1.2 Lacamas Lake fault (USGS 880)*

The Lacamas Lake fault is a northwest-trending structure located in the vicinity of Lacamas Lake, near Camas, Washington, at the northeastern margin of the Portland basin. This fault was originally identified by well-expressed lineaments defined by the relatively steep linear valley margins along both sides of Lacamas Lake[9]. Although recent activity on the Lacamas Lake fault is uncertain, the fault is considered active based on possible displacement of Troutdale sediments, prominent topographic lineaments associated with the fault, and possible associated seismicity. The fault is buried by Pleistocene Missoula flood deposits, suggesting a long recurrence interval.

### 3.1.2 Cascadia Subduction Zone Seismic Sources

The Cascadia Subduction Zone (CSZ) is a 1,100-kilometer-long zone of active tectonic convergence where oceanic crust of the Juan de Fuca Plate is subducting beneath the North American continental plate at a rate of about 3 to 4 centimeters per year[10]. The fault trace is located off of the coast of southern British Columbia, Washington, Oregon, and northern California; approximately 229 kilometers west of the site (see attached Figure 4).

Two primary sources of seismicity are associated with the CSZ: relatively shallow earthquakes that occur on the interface between the two plates (Subduction Zone earthquakes), and deep earthquakes that occur along faults within the subducting Juan de Fuca plate (intraplate earthquakes).

#### *3.1.2.1 Subduction Zone Earthquakes*

Large subduction zone (megathrust) earthquakes occur within the upper approximate 30 kilometers of the contact between the two plates[11]. As the Juan de Fuca Plate subducts beneath the North American Plate through this zone, the plates are locked together by friction[12]. Stress slowly builds as the plates converge until the frictional resistance is exceeded, and the plates rapidly slip past each other resulting in a “megathrust” earthquake. The United States Geologic Survey estimates megathrust earthquakes on the CSZ may have magnitudes up to M9.2.

Geologic evidence indicates a recurrence interval for major subduction zone earthquakes of 250 to 650 years, with the last major event occurring in 1700[13,14]. The eastern margin of the seismogenic portion of the Cascadia Subduction zone is located approximately 90 kilometers west of the site, as shown on Figure 4.

#### *3.1.2.2 Intraplate Earthquakes*

Below about 30 kilometers, the plate interface does not appear to be locked by friction, and the plates slowly slide past each other. The curvature of the subducted plate increases as the advancing edge moves east, creating extensional forces within the plate. Normal faulting occurs in response to these extensional forces.

---

9 Madin and Hemphill-Haley, 2001: The Portland Hills Fault at Rowe Middle School. Oregon Geology V63 p47.

10 DeMets, C., Gordon, R.G., Argus, D.F., Stein, S., 1990. Current plate motions: Geophysical Journal International, v. 101, p. 425-478.

11 Pacific Northwest Seismic Network, 2020. Pacific Northwest Earthquake Sources Overview, *accessed July 2020,* from PNSN web site, http://pnsn.org/outreach/earthquakesources/.

12 Pacific Northwest Seismic Network, 2020. Pacific Northwest Earthquake Sources Overview, *accessed July 2020,* from PNSN web site, http://pnsn.org/outreach/earthquakesources/.

13 Atwater, B.F., 1992. Geologic evidence for earthquakes during the past 2,000 years along the Copalis River, southern coastal Washington: Journal of Geophysical Research, v. 97, p. 1901-1919.

14 Peterson, C.D., Darienzo, M.E., Burns, S.F., and Burris, W.K., 1993. Field trip guide to Cascadia paleoseismic evidence along the northern California coast: evidence of subduction zone seismicity in the central Cascadia margin. Oregon Department of Geology and Mineral Industries, Oregon Geology, Vol. 55, p. 99-144.

This region of maximum curvature and faulting of the subducting plate is where large intraplate earthquakes are expected to occur, and is located at depths ranging from 30 to 60 kilometers[15,16,17]. Intraplate earthquakes within the Juan de Fuca plate generally have magnitudes less than M7.5[18].

The 2001 M6.8 Nisqually earthquake near Olympia, Washington, occurred within this seismogenic zone at a depth of 52 kilometers. The site is located within the intraplate seismogenic zone, as shown on Figure 4.

### 3.2 Historic Seismicity

The Pacific Northwest is a seismically active area. Epicenters for historic earthquakes[19] in western Washington from 1904 to 2020 are shown on Figure 5. The majority of these earthquakes are shallow (crustal) in nature, with a lesser amount of intraplate sources. No large-scale subduction-zone earthquakes occurred during this period.

## 4.0 LOCAL TOPOGRAPHY

Topography in the vicinity of the site is shown on the attached Figures 1 and 6. The site is located along a dissected high terrace above the East Fork Lewis River Valley located approximately 0.40 mile to the southwest. The terrace is bisected by NW Pacific Highway, which borders the site to the north-northeast. North of the highway the topography ascends to the northeast at a gradient of 9½ horizontal to 1 vertical (9½H:1V). To the south of the site, the terrain consists of a relatively level bench that steepens near the East Fork Lewis River to a gradient of about 4½H:1V.

## 5.0 HAZARDS

### 5.1 Flooding

The Federal Emergency Management Agency (FEMA) publishes the Flood Insurance Rate Maps (FIRM) for flood insurance purposes[20]. The mapping indicates that the site is not located within a regulatory flood hazard zone.

### 5.2 Landslides

Landsliding is a common hazard in the Pacific Northwest that can be initiated on marginally stable slopes by human disturbances such as grading and deforestation, and by natural processes including earthquake shaking, volcanism, heavy rainfalls, and rapid snow melt. Recent studies indicate that the most common causes for slope failures are intense rainfall and human alteration, including the placement of building loads on slopes, excavating or over-steepening slopes, and the infiltration or diversion of storm water runoff. For example, excavation into the base of marginally stable slopes may reduce forces resisting failure on those

---

15 Geomatrix Consultants, 1995. Seismic Design Mapping, State of Oregon: unpublished report prepared for Oregon Department of Transportation, Personal Services Contract 11688, January 1995.

16 Geomatrix Consultants, 1993. Seismic margin Earthquake For the Trojan Site: Final Unpublished Report For Portland General Electric Trojan Nuclear Plant, Rainier, Oregon, May 1993.

17 Kirby, Stephen H., Wang, Kelin, Dunlop, Susan, 2002, The Cascadia Subduction Zone and Related Subduction Systems—Seismic Structure, Intraslab Earthquakes and Processes, and Earthquake Hazards: U.S. Geological Survey Open-File Report 02-328, 182 pp.

18 Cascadia Region Earthquake Workshop, 2008. Cascadia Deep Earthquakes. Washington Division of Geology and Earth Resources, Open File Report 2008-1.

19 Niewendorp, Clark A., and Neuhaus, Mark E. , Map of Selected Earthquakes for Oregon,1841 through 2002 by Oregon Department of Geology and Mineral Industries, OFR O-03-02.

20 Federal Emergency Management Agency, 2020. FEMA Map Service Center, *accessed July 2020,* from FEMA web site: https://msc.fema.gov/portal.

slopes, thus causing movement. Adding fill and/or a structure to the top or mid portion of a slope increases the driving forces on a slope and may contribute to failure. Redirecting water onto or into slopes may exploit existing planes of weakness within those slopes, causing failure.

#### 5.2.1 Regional Mapping

The Clark Regional Emergency Services Agency (CRESA)[21] shows a small portion of the northeast portion of the site within a landslide hazard area (Figure 7). Another landslide hazard area is mapped northwest of the site alongside NW Pacific Highway. This map is based on topography, and indicates areas with slope gradients in excess of 15 percent.

Review of the Washington State Geologic Information Portal[22], indicates that no landslides are mapped on the site or in the immediate vicinity of the site. Two small landslide masses are located about 1½ miles and ¾ mile to the northwest and southeast, respectively. These landslide masses are located on slopes adjacent to the North Fork Lewis River.

We also reviewed Light Detection and Ranging (lidar) data and imagery available from the Washington State Department of Natural Resources Division of Geology and Earth Resources on the Washington Lidar Portal (WLP). WLP provides contours and bare earth imagery, which has been filtered to remove foliage and buildings. The lidar data portray the topography at a much greater level of detail than traditional mapping methods, and can reveal features that are otherwise difficult to ascertain. In areas where human activity has modified the topography extensively, such as through road-building and general grading, the resulting "background noise" can mask features that might otherwise be apparent. Based on our review of the lidar data, we did not observe any obvious signs of previous landslides at or in the immediate vicinity of the site. A portion of the lidar map showing the area of the site is presented as Figure 6.

### 5.3 Seismic Hazards

#### 5.3.1 Liquefaction

A wide variety of slope and ground failures can occur in response to intense seismic shaking during large magnitude earthquakes. These failures are often related to the phenomenon of liquefaction, the process by which water-saturated sediment changes from a solid to a liquid state. Since liquefied sediment may not support the overlying ground, or any structure built thereon, a variety of failures may occur, including lateral spreading, landslides, ground settlement and cracking, sand boils, oscillation lurching, etc. The conditions necessary for liquefaction to occur are: (1) the presence of poorly consolidated, generally cohesionless sediment; (2) saturation of the sediment by groundwater; and (3) an earthquake that produces intense seismic shaking (generally a moment magnitude greater than M5.0). In general, older, more consolidated sediment, and sediment above the water table will not liquefy[23]. Field performance data and laboratory tests

---

[21] Clark Regional Emergency Services Agency, *2020*, Hazard Maps, Clark County, Washington, *accessed July 2020*, from CRESA website: http://cresa911.org/emergency-management/mitigation/hazard-maps/

[22] Washington State Department of Natural Resources, 2020. Washington State Geologic Information Portal, *accessed July 2020,* from Washington State DNR website: https://geologyportal-qa.dnr.wa.gov/.

[23] Youd, T.L. and Hoose, S.N. 1978. Historic ground failures in Northern California triggered by earthquakes: U.S. Geological Survey Professional Paper 993, p.117.

indicate that liquefaction occurs predominantly in well-sorted, loose to medium dense sand or silty sand, but can also occur in lean clays and silts[24].

The liquefaction hazard mapping available via WPL[25] indicates the site has a very low susceptibility for liquefaction.

#### 5.3.2 Expected Ground Shaking

The CRESA[26] website includes a map indicating the expected earthquake shaking felt at a site for a magnitude 9.0 Cascadia Subduction Zone earthquake. The map indicates a "light potential damage, strong perceived shaking" level anticipated at the site during a design-level earthquake.

#### 5.3.3 Surface Rupture

##### *5.3.3.1 Faulting*

As discussed above, the site is situated in a region of the country characterized by extensive faulting and known for seismic activity. However, no known faults are mapped on or immediately adjacent to the site, the risk of surface rupture impacting the proposed development at the site due to faulting is considered very low.

##### *5.3.3.2 Lateral Spread*

Surface rupture due to lateral spread can occur on sites underlain by liquefiable soils that are located on or immediately adjacent to slopes steeper than about 3 degrees (20H:1V), and/or adjacent to a free face, such as a stream bank or the shore of an open body of water. During lateral spread, the materials overlying the liquefied soils are subject to lateral movement downslope or toward the free face. Recognizing the lack of liquefiable soils, we characterize the risk of lateral spread to be negligible.

## 6.0 SITE RECONNAISSANCE

Melissa Lehman, GIT, under supervision of CGT Senior Engineering Geologist Ryan Houser, LG, LEG, performed a reconnaissance of the site on July 16, 2020.

### 6.1 Surface Conditions

#### 6.1.1 On Site

The proposed site layout and site conditions during our reconnaissance are shown on the attached Site Plan (Figure 8) and Site Photographs (Figure 9). The existing topography shown on the Site Plan is consistent with that observed during the reconnaissance.

The approximate 5.19-acre irregular-shaped site was bordered by a rural residential property to the east, NW Pacific Highway to the northeast, the Riverside Estates subdivision to the south, and undeveloped land to the northwest. The site descended to the southwest below NW Pacific Highway at gradients up to about 3H:1V with an average gradient of about 6H:1V. A wetland area occupied the southern approximate half of the site. Total relief across the site was about 50 feet.

---

[24] Seed, R.B., et al. 2003. Recent Advances In Soil Liquefaction Engineering: A Unified And Consistent Framework. Earthquake Engineering Research Center College Of Engineering University Of California, Berkeley.

[25] Washington State Department of Natural Resources, 2020. Washington State Geologic Information Portal, *accessed July 2020,* from Washington State DNR website: https://geologyportal-qa.dnr.wa.gov/.

[26] Clark Regional Emergency Services Agency, 2020, Hazard Maps, Clark County, Washington, *accessed July 2020*, from CRESA website: https:// http://cresa911.org/emergency-management/mitigation/hazard-maps/

Development on the site consisted of a partially graveled driveway that provided access to the site from NW Pacific Highway. An approximate 10-foot tall, 100-foot long berm of undocumented fill paralleled south side of the gravel access road (see Figure 8). An agricultural pond/reservoir was located on the southwest corner of the site. The site was vegetated with tall grasses and sparse stands of coniferous and deciduous trees that were located around the pond.

No indicators of recent or ongoing slope instability were observed on the site during the reconnaissance.

#### 6.1.2 Area Conditions

The areas to the north and northeast of the site beyond NW Pacific Highway were densely wooded with overstory, and in terms of terrain, moderately ascended to the northeast. The area to the immediate south of the site was relatively flat and was undergoing active development (residential subdivision) at the time of the investigation. The area to the west of the site exhibited similar topography and consisted of an open grassy field.

### 6.2 Site Subsurface Conditions

#### 6.2.1 Subsurface Investigation & Laboratory Testing

Our subsurface investigation consisted of three hand auger borings (HA-1 through HA-3) completed on July 16, 2020. The approximate exploration locations are shown on the Site Plan, attached as Figure 8. In summary, the borings were advanced to depths ranging from about 5 to 5½ feet bgs. Details regarding the subsurface investigation, logs of the explorations, and results of laboratory testing are presented in Appendix A. Subsurface conditions encountered during our investigation are summarized below.

#### 6.2.2 Subsurface Materials

Logs of the explorations are presented in Appendix A. The following describes each of the subsurface materials encountered at the site.

*Organic Soil (OL)*
Organic soil was encountered at the surface of all three hand auger borings and extended to depths of ¼ to 1 foot bgs. This soil was generally dark brown, moist, exhibited low plasticity, and included abundant rootlets.

*Lean Clay (CL)*
Underlying the organic soil was native, lean clay that extended to the full depths explored in all three hand auger borings, approximately 5 to 5½ feet bgs. This soil was generally medium stiff to stiff, dark brown to brown, moist, and exhibited low plasticity.

The soils encountered during our subsurface investigation were consistent with the fine-grained catastrophic flood deposits described in Section 2.2 above, and are consistent to soils documented in the referenced reports.

#### 6.2.3 Groundwater

We did not encounter groundwater within the depths explored at the site on July 16, 2020. To determine approximate regional groundwater levels in the area, we researched well logs available on the Washington

Department of Ecology (WDE)[27] website for wells located within 1 mile of the site. Our review indicated that groundwater levels in the area generally ranged from about 30 to 65 feet bgs. It should be noted that groundwater levels vary with local topography. In addition, the groundwater levels reported on the WDE logs often reflect the purpose of the well, so water well logs may only report deeper, confined groundwater, while geotechnical or environmental borings will often report any groundwater encountered, including shallow, unconfined groundwater. Therefore, the levels reported on the WDE well logs referenced above are considered generally indicative of local water levels and may not reflect actual groundwater levels at the site. We anticipate that groundwater levels will fluctuate due to seasonal and annual variations in precipitation, changes in site utilization, or other factors. Additionally, the on-site, lean clay is conducive to formation of perched groundwater.

## 7.0 FINDINGS & RECOMMENDATIONS

The primary geologic hazards that may affect the site are potential for slope instability and seismic shaking. We anticipate that with proper construction control, the geology and topography of the site and the surrounding area will not adversely affect the proposed project, and the project will have no geologic impact on adjacent properties or the risk of slope instability. It is our opinion that, with the use of generally accepted construction techniques and by strictly following the recommendations contained in this report and in the building code, the site is geologically suitable for the proposed development.

### 7.1 Slope Considerations

Any construction within hillside areas inherently bears greater risk of slope instability. The on-site and off-site slopes may be susceptible to slope instability resulting from factors beyond the owner's control, such as off-site grading, erosion and other ground disturbance, a major earthquake, or heavy precipitation. The owners must recognize and accept the risk of potential slope instability from causes beyond their control or as yet unrecognized.

The Clark Regional Emergency Services Agency (CRESA)[28] shows a small portion of the northeast portion of the site within a landslide hazard area. Another landslide hazard area is mapped northwest of the site alongside NW Pacific Highway. We did not observe signs of previous or ongoing instability during our reconnaissance. As described in Section 1.1, the proposed development will include the placement of up to about 7 feet of structural fill in the area of the proposed roadway and ADA path to reach finished grades. New fill slopes will have finished gradients up to 2 horizontal to 1 vertical (2H:1V). We conclude the proposed development will have no significant impact on the potential for large-scale slope instability.

In no case should surface runoff or discharge from drains be directed onto the site slopes. The ground surface adjacent to the building should be sloped to drain away from the building and surface runoff should be collected and routed to a suitable discharge point. Surface water should not be directed into foundation drains. Surface and any subsurface drains should be connected to the nearest storm drain or other suitable discharge point.

---

[27] Washington State Department of Ecology, 2020. Well Log Records, *accessed July 2020*, from web site: https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/textsearch.aspx

[28] Clark Regional Emergency Services Agency, *2020*, Hazard Maps, Clark County, Washington, *accessed July 2020*, from CRESA website: https:// http://cresa911.org/emergency-management/mitigation/hazard-maps/

The established vegetation observed at the site should generally provide protection from excessive erosion and no remedial measures are warranted at this time. Any areas of exposed soils, should, at a minimum, be monitored for erosion and preferably be vegetated or otherwise protected from erosion.

### 7.2 Seismic Shaking

To minimize the risk that this hazard will adversely impact the proposed development should be designed and constructed in accordance with current building codes. The proposed development will have no impact on this hazard.

### 7.3 Other Hazards

Other geologic hazards identified in the Clark County Code Chapter 40.430.030(C)(5) and the 2006 Washington State Geologist Licensing Board Guidelines for Preparing Engineering Geology Reports in Washington include:

- Subsidence
- Erosion
- Fault Rupture
- Expansive Soils
- Volcanic Hazards

Based on our research, field reconnaissance, and previous experience in the area, none of these hazards are present at the site.

## 8.0 LIMITATIONS

The scope of this assignment did not include services related to geotechnical engineering for the proposed development such as bearing capacity evaluation, settlement estimates, recommendations regarding stripping and filling, or the use of footing/floor slab drains, etc. Additionally, quantitative soil or rock slope stability analyses was not performed. Our recommendations are not intended to indicate that all geologic hazards can be mitigated by proper engineering. They are provided in order to assist the project engineer in evaluating site conditions based on geologic research and preliminary, site specific, surface and shallow subsurface exploration. If you would like CGT to provide geotechnical recommendations or geotechnical construction observations during site construction, we can prepare a geotechnical report for the site for an additional fee.

We have prepared this report for use by the owner/developer and other members of the design and construction team for the proposed development. The opinions and recommendations contained within this report are not intended to be, nor should they be construed as, a warranty of subsurface conditions, but are forwarded to assist in the planning and design process.

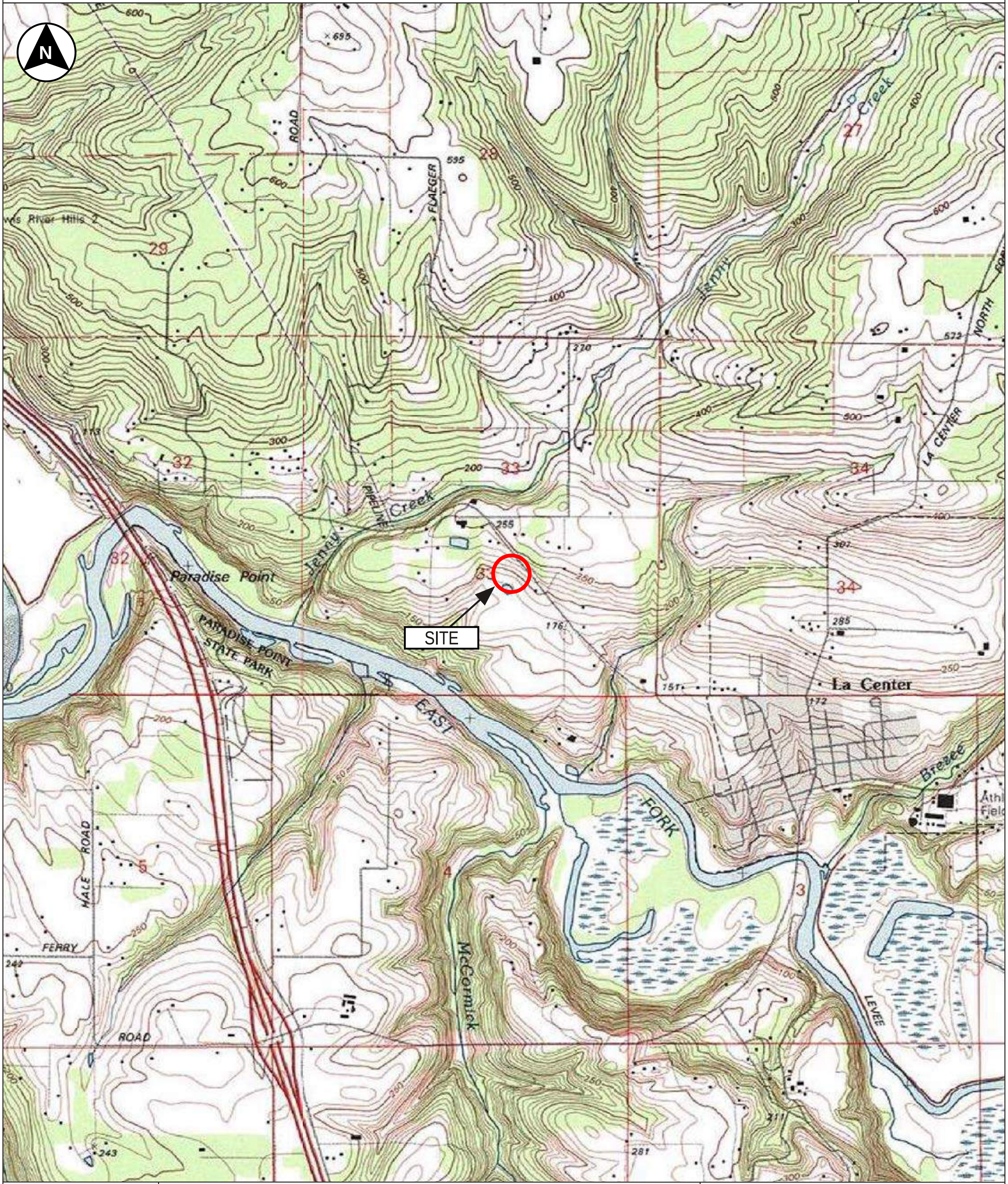
This site evaluation consisted of visual examinations of exposed soil conditions within shallow excavations and a review of readily available geologic resources judged pertinent to the evaluation. Accordingly, the limitations of the site evaluation must be recognized. An exploration of subsurface conditions at depth was not conducted for this evaluation. An investigation to explore subsurface conditions at depth using deeper soil borings or excavations could be conducted at additional cost to the owner to further define the risk of unforeseen, adverse geological issues on this site. However, based on our observations and the information available, the risk of unforeseen adverse geological issues on this site appear to be small and could, in our opinion, be assumed by the owner.

We have made observations based on our explorations that indicate the soil conditions at only those specific locations and only to the depths penetrated. These observations do not necessarily reflect soil types, strata thickness, or water level variations that may exist between or away from the explorations. If subsurface conditions vary from those encountered in our site exploration, CGT should be alerted to the change in conditions so that we may provide additional recommendations, if necessary. Observation by experienced geotechnical personnel should be considered an integral part of the construction process. The owner/developer is responsible for insuring that the project designers and contractors implement our recommendations.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood. This report is subject to review and should not be relied upon after a period of three years.

## *RIDGELINE PARK - LA CENTER, WASHINGTON*
## *Project Number G2005322*

| FIGURE 1 |
| --- |
| Site Location |




CARLSON CGT GEOTECHNICAL 503-601-8250

Drafted by: MMS

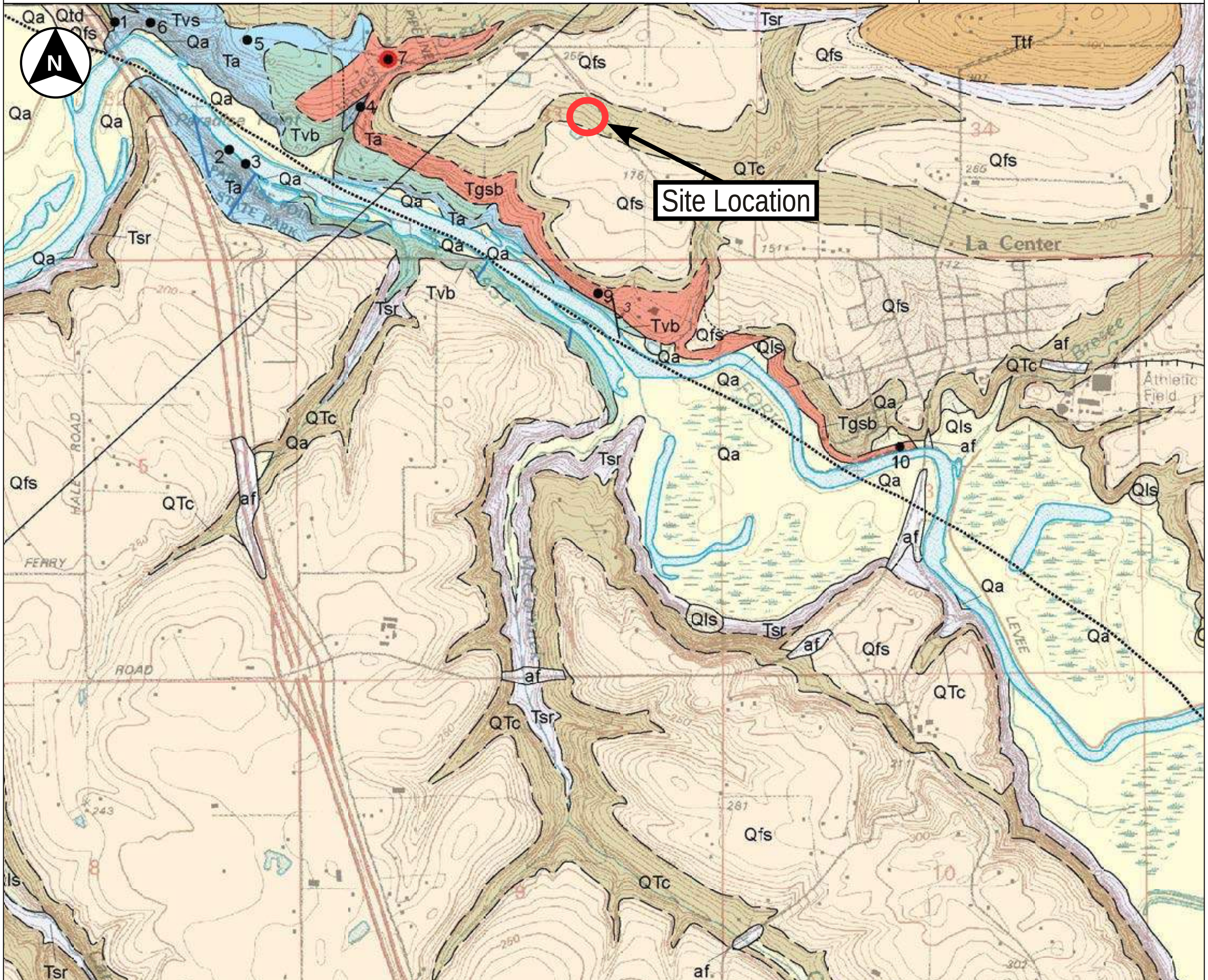
Map created with TOPO!™, © 2006 National Geographic Holdings
USGS 7.5 Minute Topographic Map Series, Ridgefield, Washington Quadrangle, 1990.
Township 5 North, Range 1 East, Section 33 Willamette Meridian

Latitude: 45.870877° North
Longitude: 122.688732° West

1 Inch = 2,000 feet

0 2000 4000

| *RIDGELINE PARK - LA CENTER, WASHINGTON* | **FIGURE 2** |
|---|---|
| ***Project Number G2005322*** | **Geologic Map** |




**Surficial Deposits**

- af — Artificial fill
- Qa — Alluvium deposits
- Qoa — Older alluvium deposits
- Qls — Landslide deposits
- Ql — Lake deposits
- Qfs — Cataclysmic-flood deposits
- Qtd — Terrace deposits

**Basin-Fill Deposits**

- QTc — Conglomerate
- Ttf — Troutdale formation
- Tsr — Sandy River Mudstone

**Columbia River Basalt Group**

- Tgsb — Member of Sentinel Bluffs

**Bedrock**

- Ta — Andesite
- Tvb — Volcanic breccia

**Contact**—Dashed where approximately located; short-dashed where inferred; dotted where concealed

**Fault**—Dashed where inferred; dotted where concealed

**Anticline**—Dashed where inferred; dotted where concealed

**Strike and dip of beds**
- 10 Inclined
- Horizontal

**Terrace scarp**

33 **Sample locality for chemical analysis**—See table 1

**Glacial erratic**

**Oil well**

7 **Sample locality for paleomagnetic measurement**

CARLSON CGT GEOTECHNICAL 503-601-8250

Map adapted from Evarts, R.C., 2004, Geologic Map of the Ridgefield Quadrangle, Clark and Cowlitz Counties, Washington: U.S. Geological Survey, Scientific Investigation Map SIM-2844

Township 5 North, Range 1 East, Section 33 Willamette Meridian

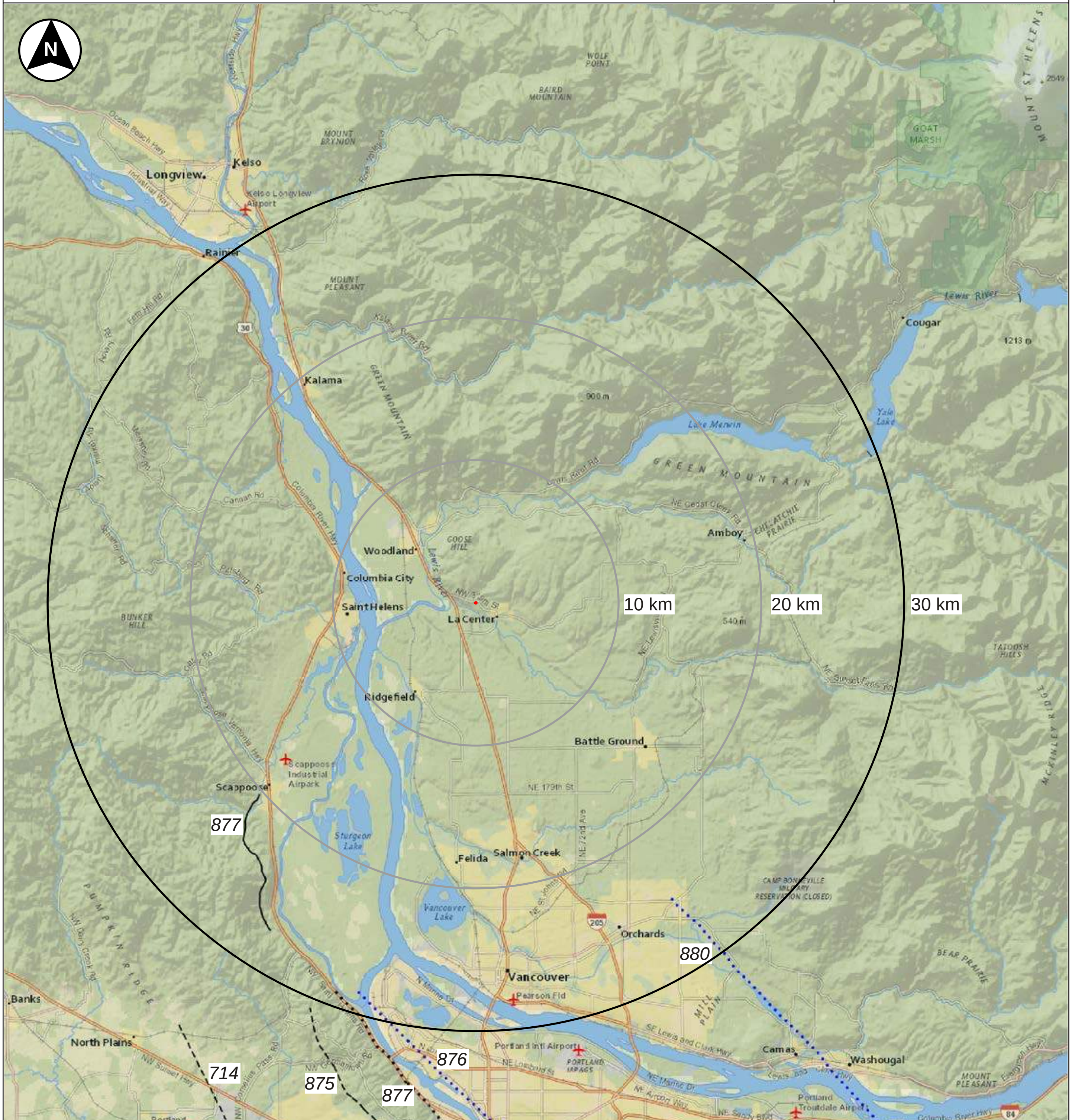
Latitude: 45.870877° North
Longitude: 122.688732° West

1 Inch = 2,000 feet

0 2000 4000

**RIDGELINE PARK - LA CENTER, WASHINGTON**
**Project Number G2005322**

**FIGURE 3**
**USGS Quaternary Faults**




LEGEND

- Historic (< 150 years)
- Latest Quaternary (< 15,000 years)
- Late Quaternary (< 130,000 years)
- Middle and late Quaternary (< 750,000 years)
- Undifferentiated Quaternary (< 1.6 million years)
- Unspecified Age
- Class B (age varies)

- Well constrained location (solid line)
- Moderately constrained location (dashed line)
- Inferred location (dotted line)

716 USGS Fault Number

CARLSON CGT GEOTECHNICAL 503-601-8250

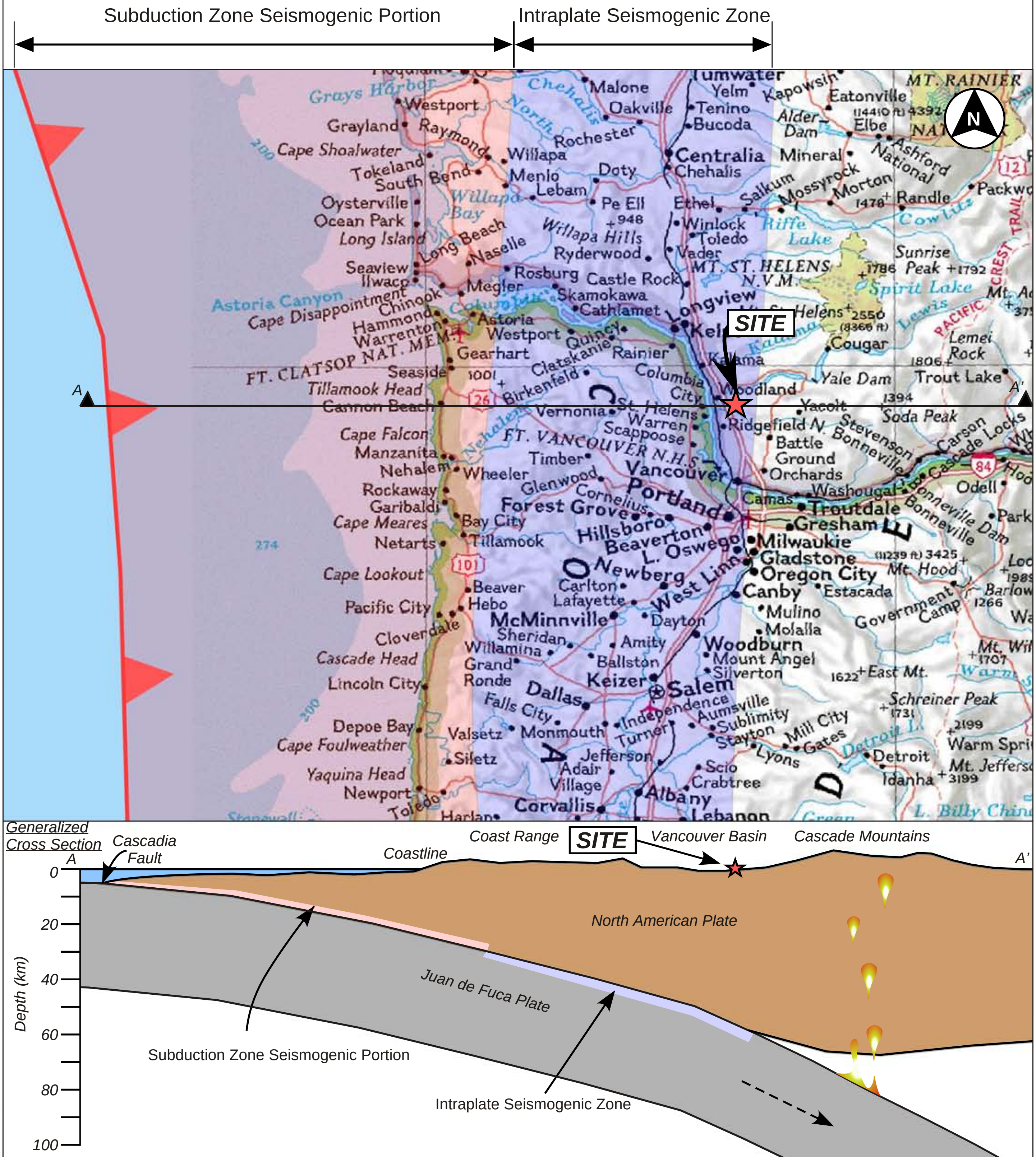
NOTES: Data from USGS Quaternary Fault and Fold Database, accessed July 2020, at website: https://earthquake.usgs.gov/cfusion/qfault/.

1 Inch = 10 Kilometers
0 10 20

**RIDGELINE PARK - LA CENTER, WASHINGTON**
**Project Number G2005322**

**FIGURE 4**

**Cascadia Subduction Zone**




CARLSON CGT GEOTECHNICAL 503-601-8250

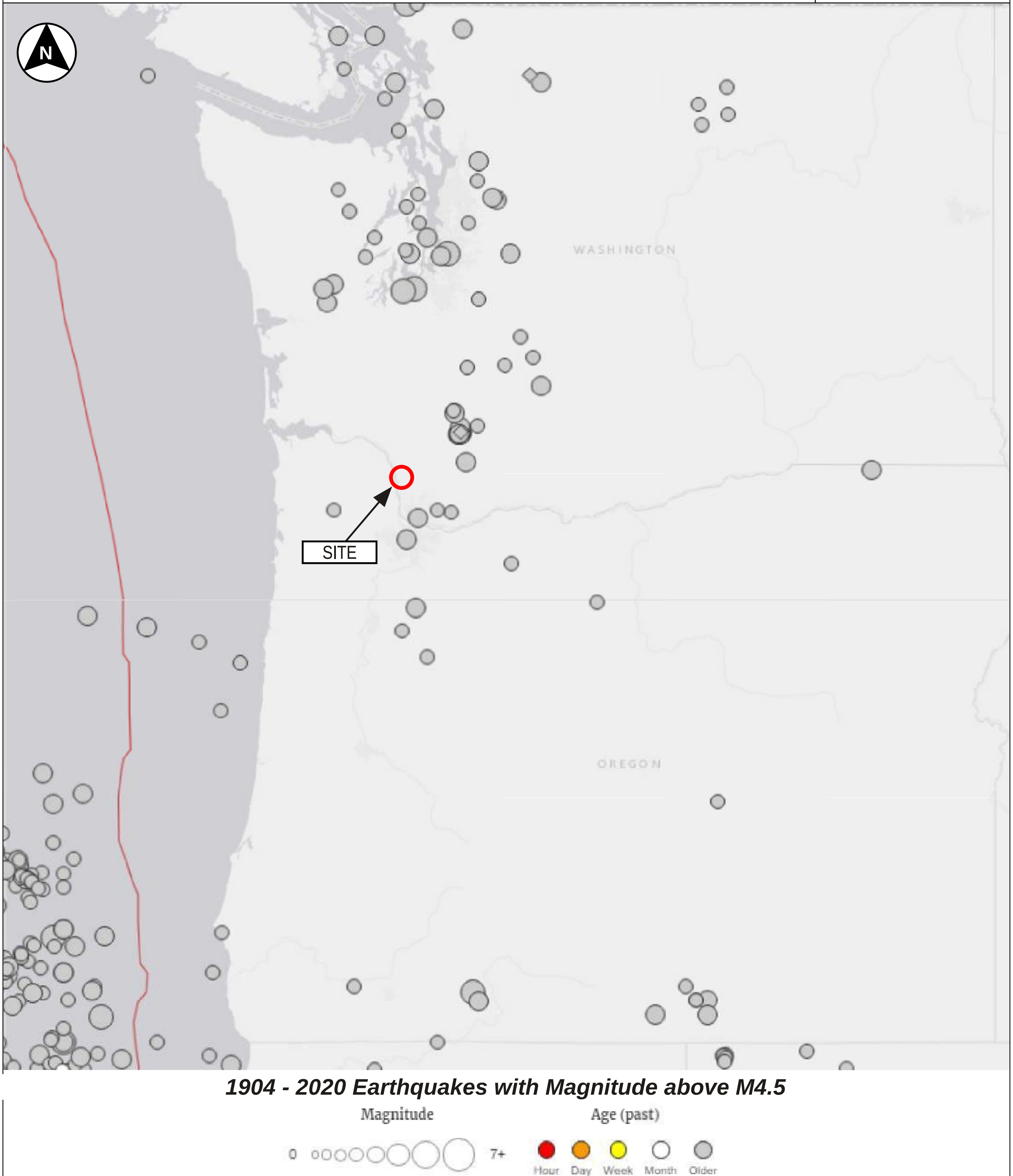
McCrory, Blair, Oppenheimer, and Walter, 2004. Depth to the Juan de Fuca slab beneath the Cascadia subduction margin - A 3-D model for storing earthquakes: U.S. Geological Survey Data Series 91.

Scale 1 Inch = 50 kilometers

0 50 100

*RIDGELINE PARK - LA CENTER, WASHINGTON*
*Project Number G2005322*

**FIGURE 5**
**Vicinity Earthquakes**




CARLSON
CGT
GEOTECHNICAL
503-601-8250

Map created from USGS Earthquake Catalog at https://earthquake.usgs.gov/earthquakes/.

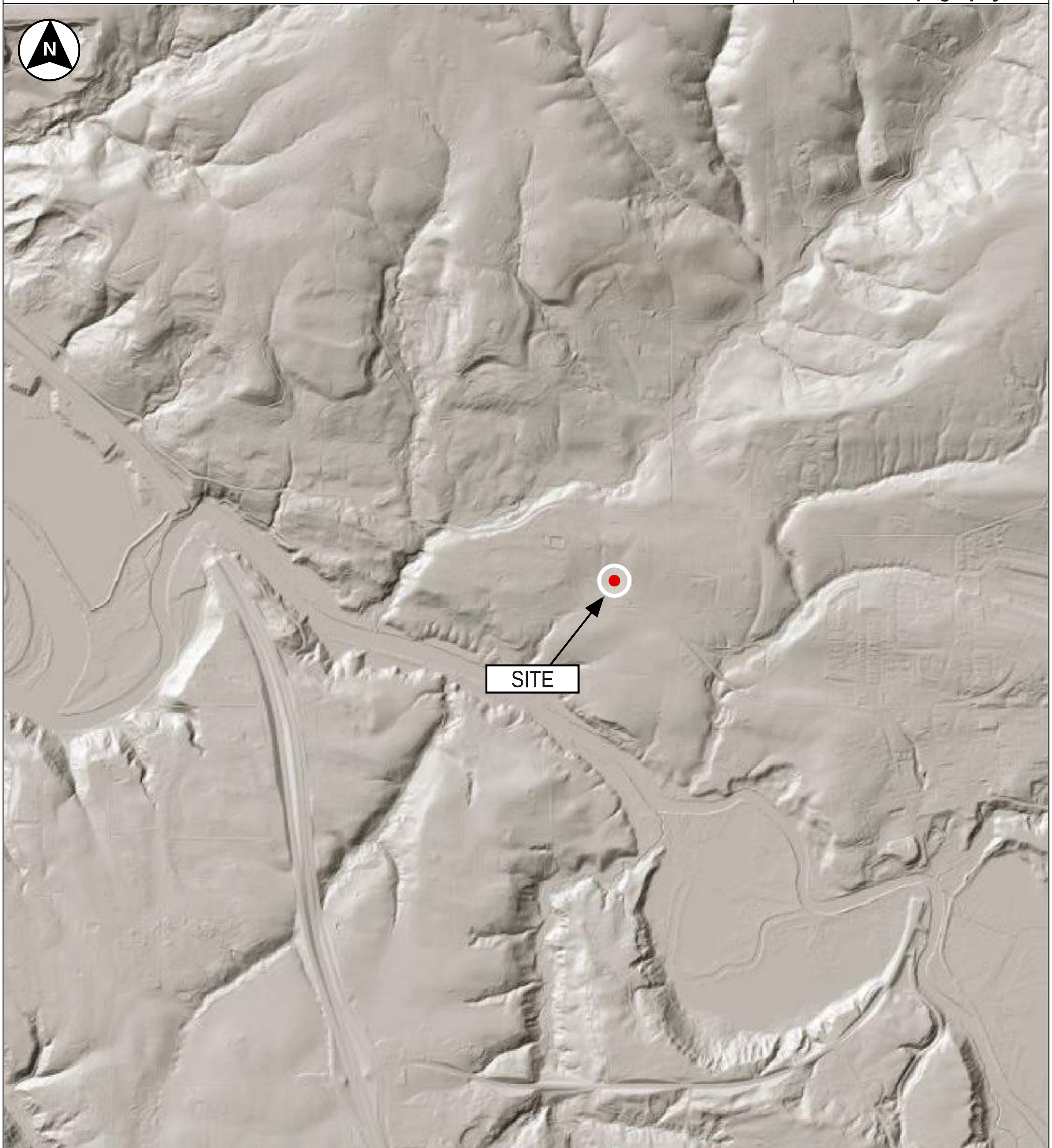
Latitude: 45.870877° North
Longitude: 122.688732° West

1 Inch = 100 kilometers
0 100 200

*RIDGELINE PARK - LA CENTER, WASHINGTON*
*Project Number G2005322*

**FIGURE 6**

**Local Topography**




CARLSON CGT GEOTECHNICAL 503-601-8250

NOTES: Bare Earth Lidar Hillshade mapping obtained from Washington State Department of Natural Resources, 2020. Washington State Geologic Information Portal, accessed July 2020, from Washington State DNR website: https://geologyportal-qa.dnr.wa.gov/

Latitude: 45.870877° North
Longitude: 122.688732° West

1 Inch = 2,000 Feet

0 2,000 4,000

| *RIDGELINE PARK - LA CENTER, WASHINGTON*<br>*Project Number G2005322* | **FIGURE 7**<br>**Geologic Hazard Overlay** |
|---|---|


LEGEND

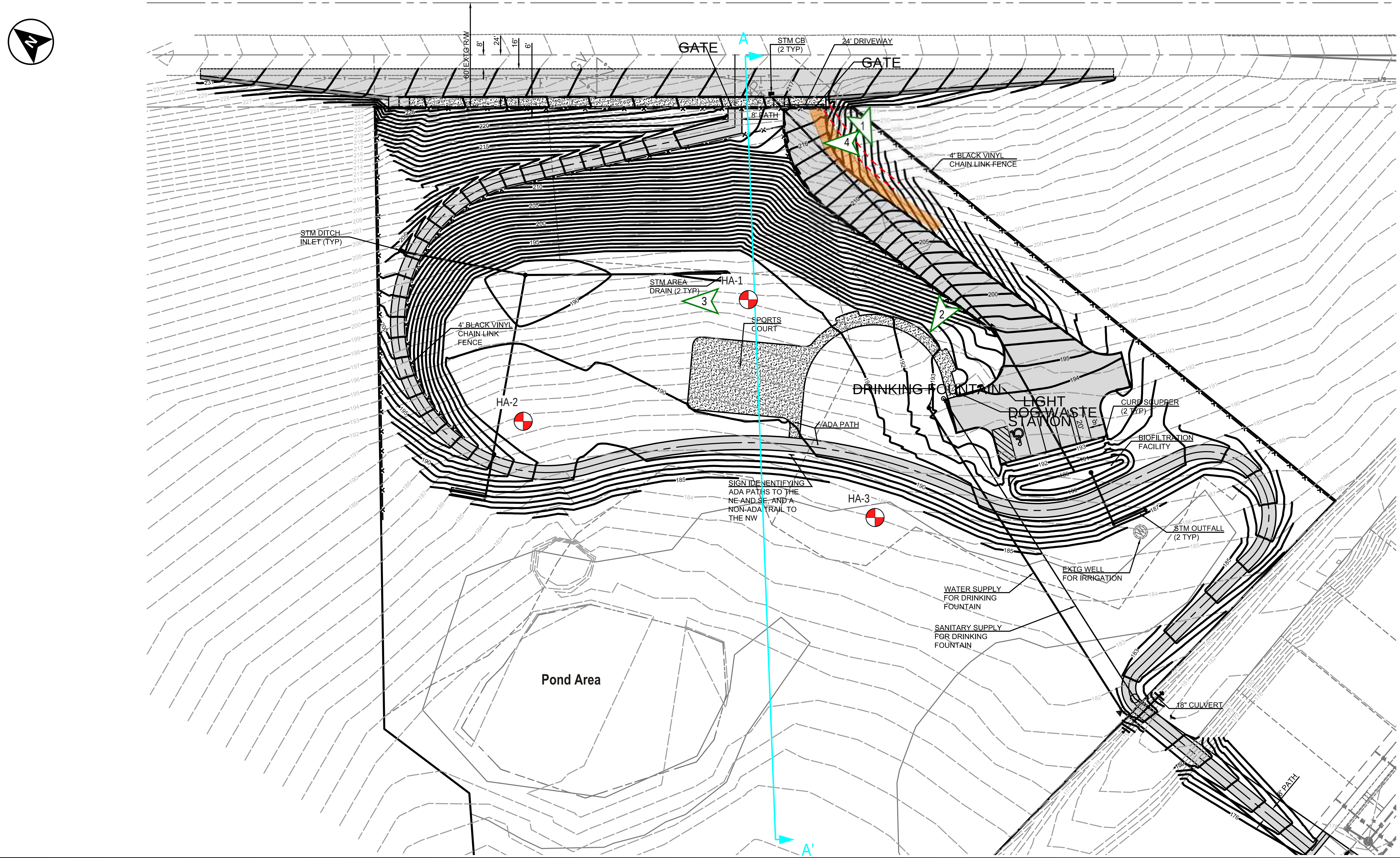
Landslide Hazard Areas

| CARLSON CGT GEOTECHNICAL 503-601-8250 | Map adapted from Clark County Landslide Areas from the Clark Regional Emergency Services Agency (CRESA), accessed July 2020, http://cresa911.org/emergency-management/mitigation/hazard-maps/ | Latitude: 45.870877° North<br>Longitude: 122.688732° West<br>1 Inch = 500 feet<br>0 500 1000 |
|---|---|---|

**RIDGELINE PARK - LA CENTER, WASHINGTON**
**Project Number G2005233**

**FIGURE 8**

**Site Plan**




CARLSON CGT GEOTECHNICAL 503-601-8250

Drafted by: MMS

LEGEND

HA-1 Hand auger boring

A A' Location of cross section shown on Figure 10

Approximate location of berm

Orientation of site photographs shown on Figure 9

Existing Gravel Path

1 Inch = 60 Feet

0 60 120

NOTES: Drawing based on Sheet 1, "Site Plan", produced by PLS Engineering, undated, and modified by CGT. All locations are approximate.

Photograph 1

Photograph 2

Photograph 3

Photograph 4



*See Figure 8 for approximate photograph locations and directions. Photographs were taken at the time of our fieldwork.*

Carlson Geotechnical
A Division of Carlson Testing, Inc.
www.carlsontesting.com

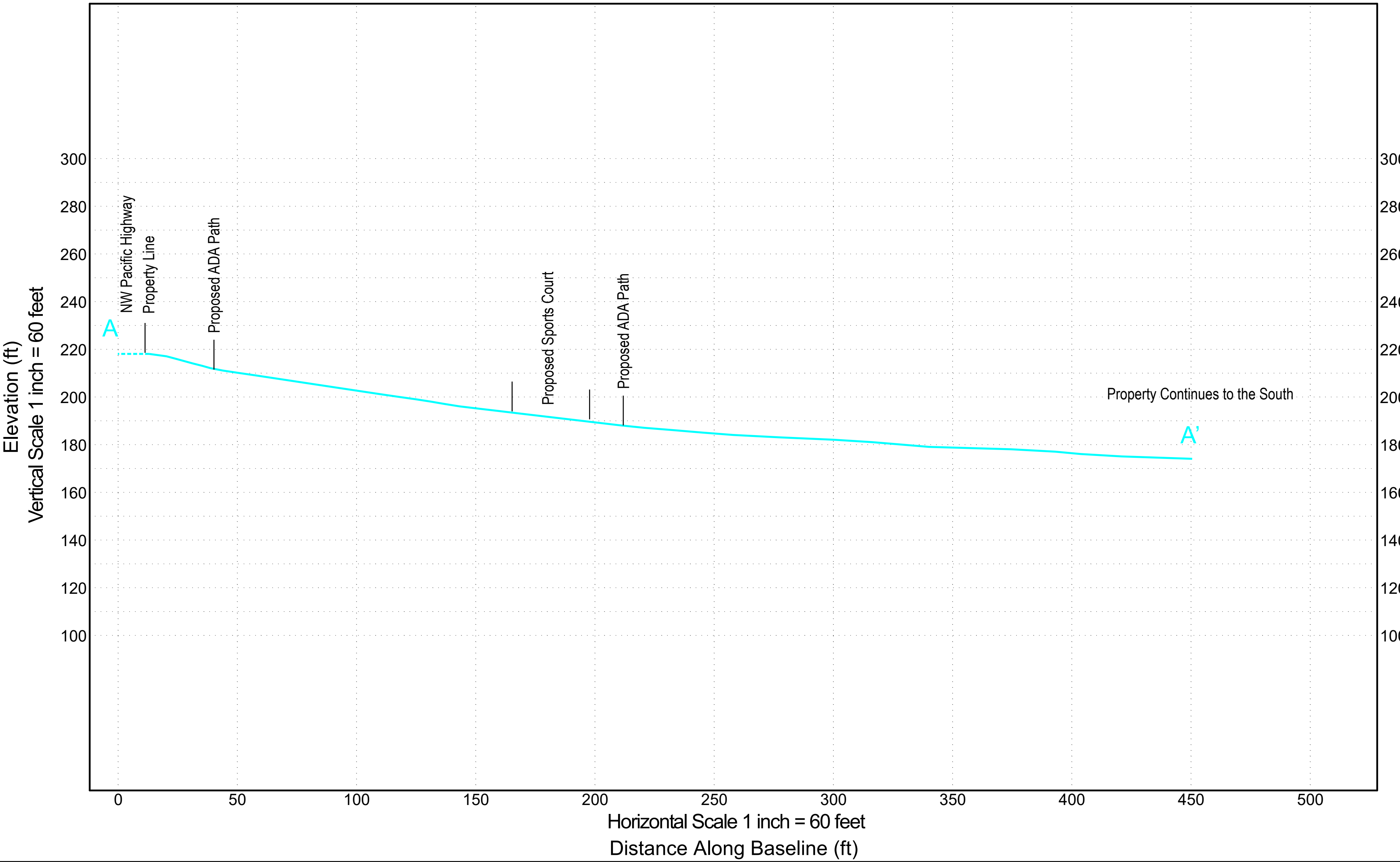
# FIGURE 10 - Topographic Profile A-A'

**CLIENT** Peter Ettro - Ettro Capital

**PROJECT NUMBER** G2005233

**PROJECT NAME** Ridgeline Park

**PROJECT LOCATION** 34512 NW Pacific Highway, La Center, Washington



# Carlson Geotechnical

A Division of Carlson Testing, Inc.
Phone: (503) 601-8250
www.carlsontesting.com

**Bend Office** **(541) 330-9155**
**Eugene Office** **(541) 345-0289**
**Salem Office** **(503) 589-1252**
**Tigard Office** **(503) 684-3460**

## Appendix A: Subsurface Investigation

**Ridgeline Park**
**34512 NW Pacific Highway**
**La Center, Washington**

**CGT Project Number G2005233**

July 22, 2020

*Prepared For:*

Peter Ettro
Ettro Capital
340 Oswego Point Drive #208
Lake Oswego, Oregon 97034

*Prepared by*
**Carlson Geotechnical**

## A.1.0 SUBSURFACE INVESTIGATION

Our field investigation consisted of three hand auger borings completed in July 2020. The boring locations are shown on the Site Plan, attached to the main report as Figure 2. The boring locations shown therein were recorded in the office using desktop GIS software and located in the field using handheld a GPS device, and are approximate (+/- 30 feet horizontally). Surface elevations indicated on the logs were estimated based on the topographic contours shown on the referenced Site Plan and are approximate. The attached figures detail the exploration methods (Figure A1), soil classification criteria (Figure A2), and present detailed logs of the explorations (Figures A3 through A5), as discussed below.

### A.1.1 Hand Auger Borings

CGT advanced three hand auger borings (HA-1 through HA-3) at the site on July 16, 2020, to depths of up to about 5½ feet bgs using equipment provided and operated by CGT. The hand auger borings were loosely backfilled with the excavated materials upon completion.

### A.1.2 Material Classification & Sampling

Representative grab samples of the soils encountered were obtained at select intervals within the hand auger borings. A qualified member of CGT's geological staff collected the samples and logged the soils in general accordance with the Visual-Manual Procedure (ASTM D2488). An explanation of this classification system is attached as Figure A2. The grab samples were stored in sealable plastic bags and transported to our soils laboratory for further examination. Our geotechnical staff visually examined all samples in order to refine the initial field classifications.

### A.1.3 Subsurface Conditions

Subsurface conditions are summarized in Section 6.2 of the main report. Detailed logs of the explorations are presented on the attached exploration logs, Figures A3 through A5.

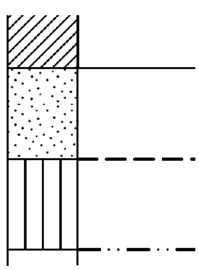
| RIDGELINE PARK -LA CENTER, WASHINGTON<br>Project Number G2005233 | FIGURE A1<br>Exploration Key |
|---|---|

| | |
|---|---|
| PL —●— LL<br>MC | Atterberg limits (plasticity) test results (ASTM D4318): PL = Plastic Limit, LL = Liquid Limit, and MC= Moisture Content (ASTM D2216) |
| ☐ FINES CONTENT (%) | Percentage passing the U.S. Standard No. 200 Sieve (ASTM D1140) |

## SAMPLING

| | |
|---|---|
| GRAB | Grab sample |
| BULK | Bulk sample |
| SPT | **Standard Penetration Test** (SPT) consists of driving a 2-inch, outside-diameter, split-spoon sampler into the undisturbed formation with repeated blows of a 140-pound, hammer falling a vertical distance of 30 inches (ASTM D1586). The number of blows (N-value) required to drive the sampler the last 12 inches of an 18-inch sample interval is used to characterize the soil consistency or relative density. The drill rig was equipped with an cat-head or automatic hammer to conduct the SPTs. The observed N-values, hammer efficiency, and $N_{60}$ are noted on the boring logs. |
| MC | **Modified California** sampling consists of 3-inch, outside-diameter, split-spoon sampler (ASTM G3550) driven similarly to the SPT sampling method described above. A sampler diameter correction factor of 0.44 is applied to calculate the equivalent SPT $N_{60}$ value per Lacroix and Horn, 1973. |
| CORE | **Rock Coring** interval |
| SH | **Shelby Tube** is a 3-inch, inner-diameter, thin-walled, steel tube push sampler (ASTM D1587) used to collect relatively undisturbed samples of fine-grained soils. |
| WDCP | **Wildcat Dynamic Cone Penetrometer** (WDCP) test consists of driving 1.1-inch diameter, steel rods with a 1.4-inch diameter, cone tip into the ground using a 35-pound drop hammer with a 15-inch free-fall height. The number of blows required to drive the steel rods is recorded for each 10 centimeters (3.94 inches) of penetration. The blow count for each interval is then converted to the corresponding SPT $N_{60}$ values. |
| DCP | **Dynamic Cone Penetrometer** (DCP) test consists of driving a 20-millimeter diameter, hardened steel cone on 16-millimeter diameter steel rods into the ground using a 10-kilogram drop hammer with a 460-millimeter free-fall height. The depth of penetration in millimeters is recorded for each drop of the hammer. |
| POCKET PEN. (tsf) | **Pocket Penetrometer** test is a hand-held instrument that provides an approximation of the unconfined compressive strength in tons per square foot (tsf) of cohesive, fine-grained soils. |

## CONTACTS



Observed (measured) contact between soil or rock units.

Inferred (approximate) contact between soil or rock units.

Transitional (gradational) contact between soil or rock units.

## ADDITIONAL NOTATIONS

| | |
|---|---|
| *Italics* | Notes drilling action or digging effort |
| { Braces } | Interpretation of material origin/geologic formation (e.g. { Base Rock } or { Columbia River Basalt }) |

CARLSON CGT GEOTECHNICAL 503-601-8250

*All measurements are approximate.*

## *RIDGELINE PARK - LA CENTER, WASHINGTON*
## *Project Number G2005233*

**FIGURE A2**
**Soil Classification**

### Classification of Terms and Content

NAME: Group Name and Symbol
Relative Density or Consistency
Color
Moisture Content
Plasticity
Other Constituents
Other: Grain Shape, Approximate Gradation
Organics, Cement, Structure, Odor, etc.
Geologic Name or Formation

### Grain Size

| Grain Size | | U.S. Standard Sieve |
|---|---|---|
| Fines | | <#200 (0.075 mm) |
| Sand | Fine | #200 - #40 (0.425 mm) |
| | Medium | #40 - #10 (2 mm) |
| | Coarse | #10 - #4 (4.75 mm) |
| Gravel | Fine | #4 - 0.75 inch |
| | Coarse | 0.75 inch - 3 inches |
| Cobbles | | 3 to 12 inches |
| Boulders | | > 12 inches |

### Coarse-Grained (Granular) Soils

**Relative Density**

| SPT $N_{60}$-Value | Density |
|---|---|
| 0 - 4 | Very Loose |
| 4 - 10 | Loose |
| 10 - 30 | Medium Dense |
| 30 - 50 | Dense |
| >50 | Very Dense |

**Minor Constituents**

| Percent by Volume | Descriptor | Example |
|---|---|---|
| 0 - 5% | "Trace" as part of soil description | "trace silt" |
| 5 - 15% | "With" as part of group name | "**POORLY GRADED SAND WITH SILT**" |
| 15 - 49% | Modifier to group name | "**SILTY SAND**" |

### Fine-Grained (Cohesive) Soils

| SPT $N_{60}$-Value | Torvane tsf Shear Strength | Pocket Pen tsf Unconfined | Consistency | Manual Penetration Test |
|---|---|---|---|---|
| <2 | <0.13 | <0.25 | Very Soft | Thumb penetrates more than 1 inch |
| 2 - 4 | 0.13 - 0.25 | 0.25 - 0.50 | Soft | Thumb penetrates about 1 inch |
| 4 - 8 | 0.25 - 0.50 | 0.50 - 1.00 | Medium Stiff | Thumb penetrates about ¼ inch |
| 8 - 15 | 0.50 - 1.00 | 1.00 - 2.00 | Stiff | Thumb penetrates less than ¼ inch |
| 15 - 30 | 1.00 - 2.00 | 2.00 - 4.00 | Very Stiff | Readily indented by thumbnail |
| >30 | >2.00 | >4.00 | Hard | Difficult to indent by thumbnail |

**Minor Constituents**

| Percent by Volume | Descriptor | Example |
|---|---|---|
| 0 - 5% | "Trace" as part of soil description | "trace fine-grained sand" |
| 5 - 15% | "Some" as part of soil description | "some fine-grained sand" |
| 15 - 30% | "With" as part of group name | "**SILT WITH SAND**" |
| 30 - 49% | Modifier to group name | "**SANDY SILT**" |

### Moisture Content

Dry: Absence of moisture, dusty, dry to the touch

Moist: Leaves moisture on hand

Wet: Visible free water, likely from below water table

| | Plasticity | Dry Strength | Dilatancy | Toughness |
|---|---|---|---|---|
| **ML** | Non to Low | Non to Low | Slow to Rapid | Low, can't roll |
| **CL** | Low to Medium | Medium to High | None to Slow | Medium |
| **MH** | Medium to High | Low to Medium | None to Slow | Low to Medium |
| **CH** | Medium to High | High to Very High | None | High |

### Structure

Stratified: Alternating layers of material or color >6 mm thick

Laminated: Alternating layers < 6 mm thick

Fissured: Breaks along definite fracture planes

Slickensided: Striated, polished, or glossy fracture planes

Blocky: Cohesive soil that can be broken down into small angular lumps which resist further breakdown

Lenses: Has small pockets of different soils, note thickness

Homogeneous: Same color and appearance throughout

### Visual-Manual Classification

| Major Divisions | | | Group Symbols | Typical Names |
|---|---|---|---|---|
| Coarse Grained Soils: More than 50% retained on No. 200 sieve | Gravels: 50% or more *retained* on the No. 4 sieve | Clean Gravels | GW | Well-graded gravels and gravel/sand mixtures, little or no fines |
| | | | GP | Poorly-graded gravels and gravel/sand mixtures, little or no fines |
| | | Gravels with Fines | GM | Silty gravels, gravel/sand/silt mixtures |
| | | | GC | Clayey gravels, gravel/sand/clay mixtures |
| | Sands: More than 50% *passing* the No. 4 sieve | Clean Sands | SW | Well-graded sands and gravelly sands, little or no fines |
| | | | SP | Poorly-graded sands and gravelly sands, little or no fines |
| | | Sands with Fines | SM | Silty sands, sand/silt mixtures |
| | | | SC | Clayey sands, sand/clay mixtures |
| Fine-Grained Soils: 50% or more Passes No. 200 Sieve | Silt and Clays Low Plasticity Fines | | ML | Inorganic silts, rock flour, clayey silts |
| | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays |
| | | | OL | Organic soil of low plasticity |
| | Silt and Clays High Plasticity Fines | | MH | Inorganic silts, clayey silts |
| | | | CH | Inorganic clays of high plasticity, fat clays |
| | | | OH | Organic soil of medium to high plasticity |
| Highly Organic Soils | | | PT | Peat, muck, and other highly organic soils |

CARLSON CGT GEOTECHNICAL 503-601-8250


References:

*ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

*ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*

*Terzaghi, K., and Peck, R.B., 1948, Soil Mechanics in Engineering Practice, John Wiley & Sons.*

Carlson Geotechnical
A Division of Carlson Testing, Inc.
www.carlsontesting.com

# FIGURE A3

## Boring HA-1



**CLIENT** Peter Ettro - Ettro Capital
**PROJECT NAME** Ridgeline Park
**PROJECT NUMBER** G2005233
**PROJECT LOCATION** 34512 NW Pacific Highway, La Center, Washington

**DATE STARTED** 7/16/20
**GROUND ELEVATION** 200 ft
**ELEVATION DATUM** Topographic Contours - Site Plan
**WEATHER** cloudy, ~65 degrees
**SURFACE** grass
**LOGGED BY** MLL
**REVIEWED BY** RTH
**DRILLING CONTRACTOR** CGT
**SEEPAGE** ---
**EQUIPMENT** 3-inch diameter hand auger
**GROUNDWATER DURING DRILLING** ---
**DRILLING METHOD** Manual Hand Auger
**GROUNDWATER AFTER DRILLING** ---

| ELEVATION (ft) | GRAPHIC LOG | GROUP SYMBOL | MATERIAL DESCRIPTION | GROUNDWATER | DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | WDCP $N_{60}$ VALUE | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | ▲ WDCP $N_{60}$ VALUE ▲ / PL — MC — LL / ☐ FINES CONTENT (%) ☐ 0 20 40 60 80 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | **ORGANIC SOIL:** Dark brown, moist, low plasticity, abundant rootlets. | | 0 | | | | | | |
| | | CL | **LEAN CLAY:** *Stiff*, light brown, moist, low plasticity, trace rootlets. | | | | | | | | |
| 198 | | | | | 2 | GRAB 1 | | | | | |
| | | | Brown, trace fine-grained sand below 3 feet bgs. | | | | | | | | |
| 196 | | | | | 4 | | | | | | |
| 194 | | | | | | | | | | | |
| 192 | | | | | | | | | | | |
| 190 | | | | | | | | | | | |

- Hand auger boring terminated at 5½ feet bgs.
- No groundwater or caving encountered.
- Boring loosely backfilled with excavated material upon completion.

Carlson Geotechnical
A Division of Carlson Testing, Inc.
www.carlsontesting.com

# FIGURE A4

## Boring HA-2



**CLIENT** Peter Ettro - Ettro Capital
**PROJECT NAME** Ridgeline Park
**PROJECT NUMBER** G2005233
**PROJECT LOCATION** 34512 NW Pacific Highway, La Center, Washington
**DATE STARTED** 7/16/20
**GROUND ELEVATION** 190 ft
**ELEVATION DATUM** Topographic Contours - Site Plan
**WEATHER** cloudy, ~65 degrees
**SURFACE** grass
**LOGGED BY** MLL
**REVIEWED BY** RTH
**DRILLING CONTRACTOR** CGT
**SEEPAGE** ---
**EQUIPMENT** 3-inch diameter hand auger
**GROUNDWATER DURING DRILLING** ---
**DRILLING METHOD** Manual Hand Auger
**GROUNDWATER AFTER DRILLING** ---

| ELEVATION (ft) | GRAPHIC LOG | GROUP SYMBOL | MATERIAL DESCRIPTION | GROUNDWATER | DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | WDCP $N_{60}$ VALUE | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | ▲ WDCP $N_{60}$ VALUE ▲ / PL — MC — LL / ☐ FINES CONTENT (%) ☐ (0 20 40 60 80 100) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | **ORGANIC SOIL:** Dark brown, moist, low plasticiy, abundant rootlets. | | 0 | | | | | | |
| | | CL | **LEAN CLAY:** *Stiff*, brown, moist, low plasticity, trace rootlets. | | | | | | | | |
| 188 | | | | | 2 | | | | | | |
| 186 | | | | | 4 | | | | | | |

• Hand auger boring terminated at 5 feet bgs.
• No groundwater or caving encountered.
• Boring loosely backfilled with excavated material upon completion.

184

182

180

CGT EXPLORATION WITH WDCP LOGS.GPJ 7/21/20 DRAFTED BY: MLL

Carlson Geotechnical
A Division of Carlson Testing, Inc.
www.carlsontesting.com

# FIGURE A5

## Boring HA-3



**CLIENT** Peter Ettro - Ettro Capital
**PROJECT NAME** Ridgeline Park
**PROJECT NUMBER** G2005233
**PROJECT LOCATION** 34512 NW Pacific Highway, La Center, Washington
**DATE STARTED** 7/16/20
**GROUND ELEVATION** 184 ft
**ELEVATION DATUM** Topographic Contours - Site Plan
**WEATHER** cloudy, ~65 degrees
**SURFACE** grass
**LOGGED BY** MLL
**REVIEWED BY** RTH
**DRILLING CONTRACTOR** CGT
**SEEPAGE** ---
**EQUIPMENT** 3-inch diameter hand auger
**GROUNDWATER DURING DRILLING** ---
**DRILLING METHOD** Manual Hand Auger
**GROUNDWATER AFTER DRILLING** ---

| ELEVATION (ft) | GRAPHIC LOG | GROUP SYMBOL | MATERIAL DESCRIPTION | GROUNDWATER | DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | WDCP $N_{60}$ VALUE | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | ▲ WDCP $N_{60}$ VALUE ▲ / PL MC LL / ☐ FINES CONTENT (%) ☐ 0 20 40 60 80 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | **ORGANIC SOIL:** Dark brown, moist, low plasiticy, abundant rootlets. | | 0 | | | | | | |
| 182 | | CL | **LEAN CLAY:** *Medium stiff*, dark brown to brown, moist, low plasticity, trace rootlets. | | 2 | | | | | | |
| 180 | | | *Stiff*, brown below 2 feet bgs. | | 4 | GRAB 1 | | | | | |

- Hand auger boring terminated at 5 feet bgs.
- No groundwater or caving encountered.
- Boring loosely backfilled with excavated material upon completion.

178

176

174

# APPENDIX E

Operations and Maintenance Manual

# Clark County Stormwater Manual 2015

Book 4
Stormwater Facility
Operations and Maintenance

November 24, 2015

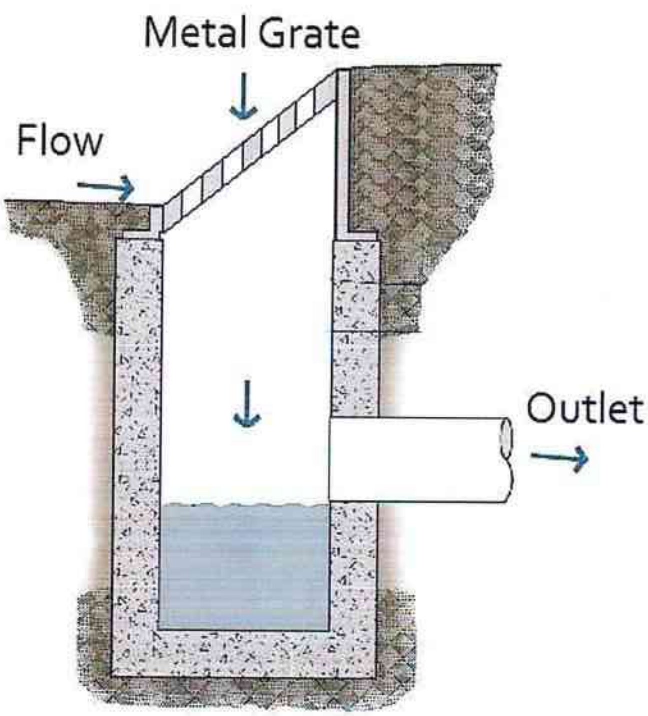
## Field Inlet

A field inlet is a concrete structure fitted with a slotted grate to collect stormwater runoff and route it through underground pipes.

Field inlets typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some field inlets are fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

Facility objects that are typically associated with a field inlet include:

- access road or easement
- control structure/flow restrictor
- biofiltration wale
- detention pond
- infiltration trench




### Key Operations and Maintenance Considerations

- The most common tool for cleaning field inlets is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.

- A field inlet may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a field inlet, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

| Field Inlet | | | |
|---|---|---|---|
| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
| | | | Note: table spans multiple pages. |
| General | Trash and Debris | Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the field inlet by more than 10%. | No trash or debris located immediately in front of field inlet or on grate opening. |
| | | Trash or debris (in the field inlet) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. | No trash or debris in the field inlet. |
| | | Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. | Inlet and outlet pipes free of trash or debris. |
| | | Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane). | No dead animals or vegetation present within the field inlet. |
| | Sediment | Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe. | No sediment in the field inlet. |
| | Structure Damage to Frame and/or Top Slab | Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). | Top slab is free of holes and cracks. |
| | | Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached. | Frame is sitting flush on the riser rings or top slab and firmly attached. |
| | Fractures or Cracks in Basin Walls/ Bottom | Maintenance person judges that structure is unsound. | Basin replaced or repaired to design standards. |
| | | Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering field inlet through cracks. | Pipe is regrouted and secure at basin wall. |

| Field Inlet | | | |
|---|---|---|---|
| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
| | | | Note: table spans multiple pages. |
| | Settlement/ Misalignment | If failure of basin has created a safety, function, or design problem. | Basin replaced or repaired to design standards. |
| | Vegetation Inhibiting System | Vegetation growing across and blocking more than 10% of the basin opening. | No vegetation blocking opening to basin. |
| | | Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart. | No vegetation or root growth present. |
| | Contaminants and Pollution | Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present.<br><br>• Identify and remove source, AND<br>• Report to Clark County Clean Water Program. | No contaminants or pollutants present. |
| Metal Grates | Grate Not in Place | Cover is missing or only partially in place. Any open field inlet requires maintenance. | Field inlet cover is closed. |
| | Grate Opening Unsafe | Grate with opening wider than 3 inches. | Grate opening meets design standards. |
| | Trash and Debris | Trash and debris that is blocking more than 20% of grate surface inletting capacity. | Grate free of trash and debris. |
| | Damaged or Missing | Grate missing or broken member(s) of the grate. | Grate is in place and meets design standards. |

## Catch Basin

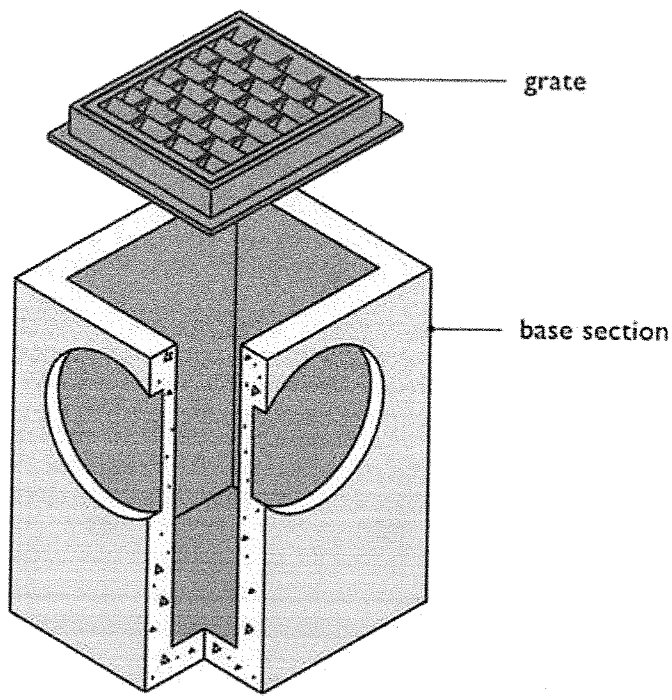
A catch basin is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two types.

A Type 1 catch basin is a rectangular box with approximate dimensions of 3'x2'x5'. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the gate to the bottom of the pipe is less than 5 feet.

A Type 2 catch basin, also commonly referred to as a storm manhole, is listed separately under "Manhole" in this book.

Catch basins typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or debris.

Catch basins are frequently associated with all stormwater facilities.




**Type I**

## Key Operations and Maintenance Considerations

- The most common tool for cleaning catch basins is an industrial vacuum truck with a tank and vacuum hose (e.g. Vactor® truck) to remove sediment and debris from the sump.
- A catch basin may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

**Catch Basin**

| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
|---|---|---|---|
| | | | Note: table spans multiple pages. |
| General | Trash and Debris | Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. | No trash or debris located immediately in front of catch basin or on grate opening. |
| | | Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. | No trash or debris in the catch basin. |
| | | Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. | Inlet and outlet pipes free of trash or debris. |
| | | Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane). | No dead animals or vegetation present within the catch basin. |
| | Sediment | Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe. | No sediment in the catch basin. |
| | Structure Damage to Frame and/or Top Slab | Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch.<br><br>(Intent is to make sure no material is running into basin.) | Top slab is free of holes and cracks. |
| | | Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached. | Frame is sitting flush on the riser rings or top slab and firmly attached. |
| | Fractures or Cracks in | Maintenance person judges that structure is unsound. | Basin replaced or repaired to design standards. |

## Key Operations and Maintenance Considerations

- The most common tool for cleaning manholes is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.
- A manhole may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a manhole, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

| Manhole | | | |
|---|---|---|---|
| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
| | | | Note: table spans multiple pages. |
| General | Trash and Debris | Trash or debris which is located immediately in front of the opening or is blocking inletting capacity of the basin by more than 10%. | No trash or debris located immediately in front of manhole or on grate opening. |
| | | Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. | No trash or debris in the basin. |
| | | Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. | Inlet and outlet pipes free of trash or debris. |
| | | Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane). | No dead animals or vegetation present within the catch basin. |
| | Sediment | Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe. | No sediment in the basin. |
| | Structure Damage to Frame and/or Top Slab | Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch.<br><br>(Intent is to make sure no material is running into manhole.) | Top slab is free of holes and cracks. |
| | | Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached. | Frame is sitting flush on the riser rings or top slab and firmly attached. |
| | Fractures or Cracks in Basin Walls/ Bottom | Maintenance person judges that structure is unsound. | Basin replaced or repaired to design standards. |
| | | Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering manhole through cracks. | Pipe is regrouted and secure at basin wall. |

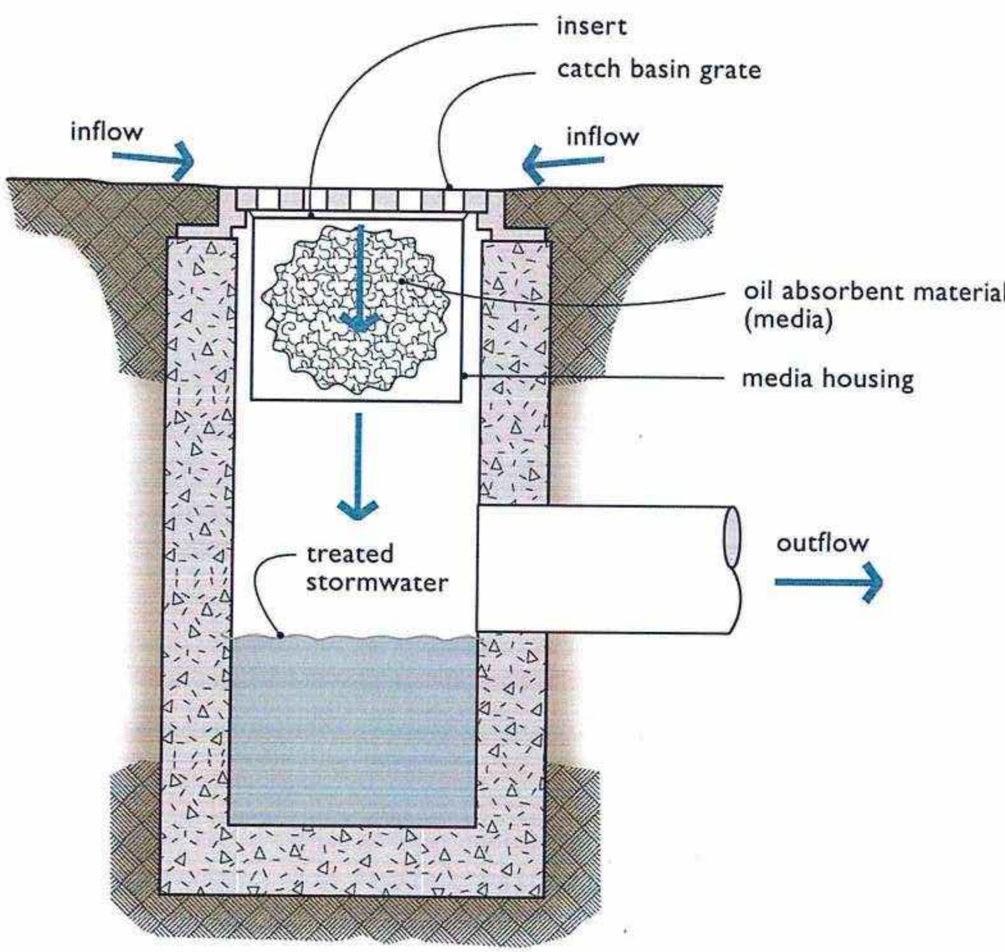
| | | | |
|---|---|---|---|
| | Settlement/ Misalignment | If failure of manhole has created a safety, function, or design problem. | Manhole replaced or repaired to design standards. |
| | Vegetation Inhibiting System | Vegetation growing across and blocking more than 10% of the opening. | No vegetation blocking opening to manhole. |
| | | Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart. | No vegetation or root growth present. |
| | Contaminants and Pollution | Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present.<br><br>• Identify and remove source, AND<br>• Report to Clark County Clean Water Program. | No contaminants or pollutants present. |
| Manhole Cover | Cover Not in Place | Cover is missing or only partially in place. Any open manhole is a safety hazard and requires immediate maintenance. | Manhole cover is closed. |
| | Locking Mechanism Not Working | Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread. | Mechanism opens with proper tools. |
| | Cover Difficult to Remove | One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance). | Cover can be removed by one maintenance person. |
| Ladder | Ladder Rungs Unsafe | Ladder is unsafe due to missing rungs, not securely attached to manhole wall, misalignment, rust, cracks, or sharp edges. | Ladder meets design standards and allows maintenance person safe access. |
| Metal Grates (If Applicable) | Grate Opening Unsafe | Grate with opening wider than 7/8 inch. | Grate opening meets design standards. |
| | Trash and Debris | Trash and debris that is blocking more than 20% of grate surface inletting capacity. | Grate free of trash and debris. |
| | Damaged or Missing | Grate missing or broken member(s) of the grate. | Grate is in place and meets design standards. |

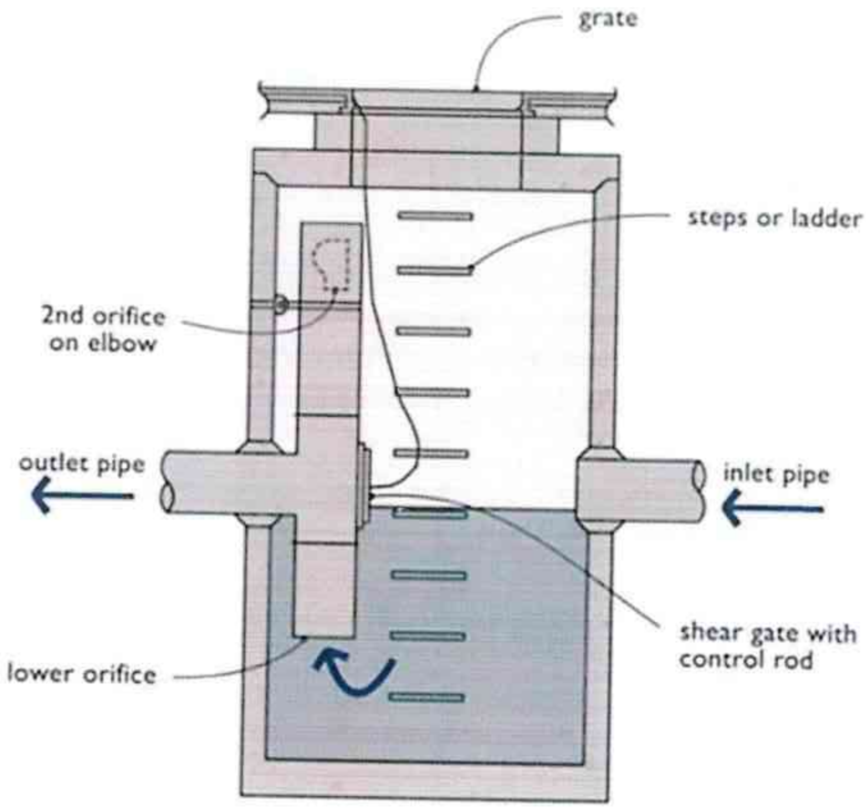
## Catch Basin Insert

Catch basin inserts are used to trap sediment and oil entering catch basins. Most involve some type of filter media and oil-absorbent pads. Filters avoid flooding by overflowing when they become clogged or when there are high storm flows.

Catch basin inserts typically consist of the following components:

- A structure (screened box, brackets, etc.) which contains a pollutant removal medium
- A means of suspending the structure in a catch basin
- A filter medium such as sand, carbon, fabric, etc.
- A primary inlet and outlet for the stormwater
- A secondary outlet for bypassing flows that exceed design flow






SECTION PROFILE

## Key Operations and Maintenance Considerations

- Conduct regular inspections of control structures to detect the need for non-routine cleanout, especially if construction or land-disturbing activities occur in the contributing drainage area.
- The most common tool for cleaning control structures/flow restrictors is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.
- A control structure is an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a control structure, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

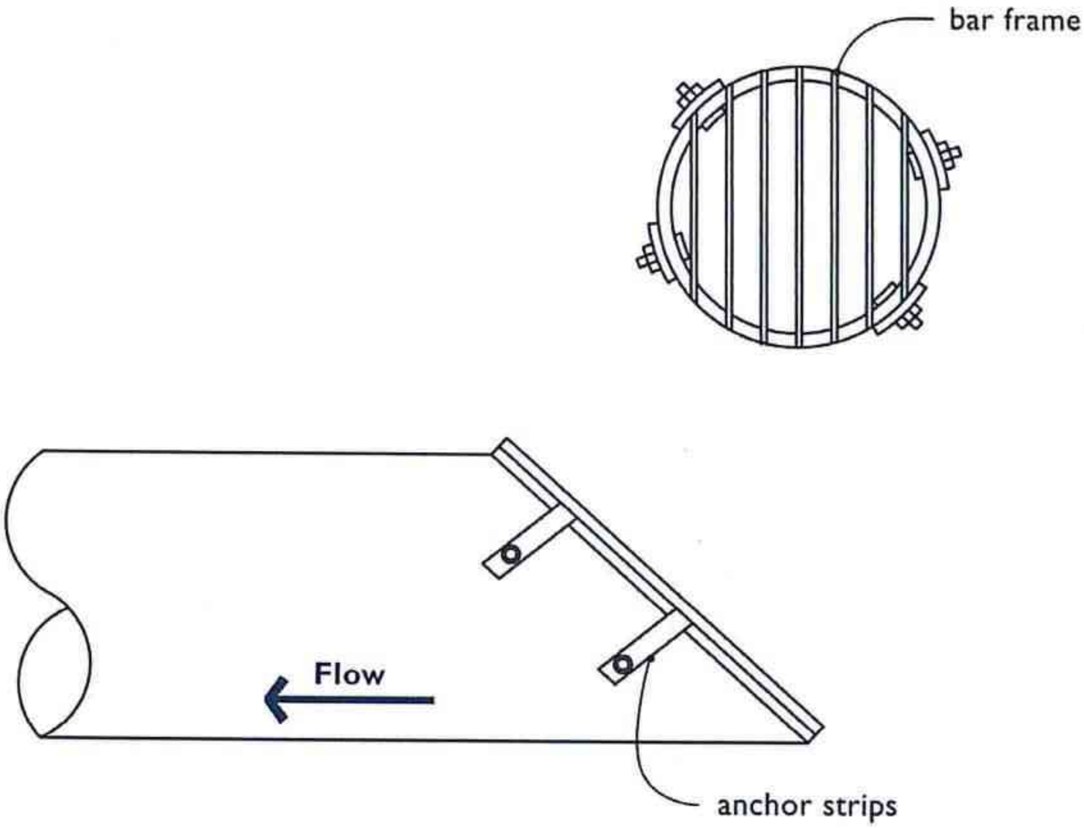
## Control Structure/Flow Restrictor

| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
|---|---|---|---|
| General | Trash and Debris (Includes Sediment) | Material exceeds 25% of sump depth or 1 foot below orifice plate. | Control structure orifice is not blocked. All trash and debris has been removed. |
| | Structural Damage | Structure is not securely attached to manhole wall. | Structure securely attached to wall and outlet pipe. |
| | | Structure is not in upright position (allow up to 10% from plumb). | Structure in correct position. |
| | | Connections to outlet pipe are not watertight and show signs of rust. | Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. |
| | | Any holes--other than designed holes--in the structure. | Structure has no holes other than designed holes. |
| Cleanout Gate | Damaged or Missing | Cleanout gate is not watertight or is missing. | Gate is watertight and works as designed. |
| | | Gate cannot be moved up and down by one maintenance person. | Gate moves up and down easily and is watertight. |
| | | Chain/rod leading to gate is missing or damaged. | Chain is in place and works as designed. |
| | | Gate is rusted over 50% of its surface area. | Gate is repaired or replaced to meet design standards. |
| Orifice Plate | Damaged or Missing | Control device is not working properly due to missing, out of place, or bent orifice plate. | Plate is in place and works as designed. |
| | Obstructions | Any trash, debris, sediment, or vegetation blocking the plate. | Plate is free of all obstructions and works as designed. |
| Overflow Pipe | Obstructions | Any trash or debris blocking (or having the potential of blocking) the overflow pipe. | Pipe is free of all obstructions and works as designed. |
| Manhole | Cover Not in Place | Cover is missing or only partially in place. Any open manhole requires maintenance. | Manhole is closed. |
| | Locking Mechanism Not Working | Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids). | Mechanism opens with proper tools. |
| | Cover Difficult to Remove | One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance. | Cover can be removed and reinstalled by one maintenance person. |
| | Ladder Rungs Unsafe | Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks. | Ladder meets design specifications. Allows maintenance person safe access. |
| Catch Basins | **See "Catch Basins"** | | |

## Debris Barrier & Access Barrier (e.g. Trash Rack)

A debris barrier is a bar grate over the open end of a culvert or stormwater conveyance pipe. The intent of a debris barrier is to prevent large materials from entering a closed pipe system. Debris barriers are typically located on the outlet pipe from a detention pond to the control structure. If a debris barrier is not located on an outlet pipe of 18-inch diameter or greater, one should be installed to prevent plugging of the control structure and possible flooding.

An access barrier is installed on a pipe end that is large enough to allow entry. Their function is to prevent debris and unauthorized access into the storm conveyance pipe. Only qualified personnel should attempt to maintain or remove debris from the barrier when water is flowing through the conveyance pipe.



## Key Operations and Maintenance Considerations

- The most common tool for cleaning debris and access barriers are hand tools such as a rake to remove collected debris.

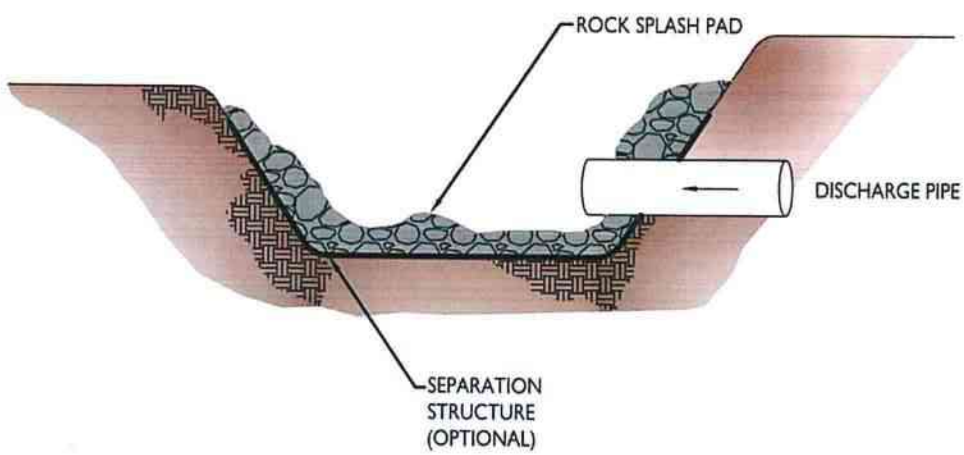
| Debris Barrier | | | |
|---|---|---|---|
| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
| General | Trash and Debris | Trash or debris that is plugging more than 20% of the openings in the barrier. | Barrier cleared to design flow capacity. |
| | Damaged/ Missing Bars | Bars are bent out of shape more than 3 inches. | Bars in place with no bends more than 3/4 inch. |
| | | Bars are missing or entire barrier missing. | Bars in place according to design specifications. |
| | | Bars are loose and rust is causing 50% deterioration to any part of barrier. | Barrier replaced or repaired to design specifications. |
| | Missing or Damaged Debris Barrier | Debris barrier missing or not attached to inlet/ outlet pipe. | Barrier is in place and firmly attached to pipe. |

## Energy Dissipater / Outfall Protection

An energy dissipater is installed on or near the inlet or outlet to a closed pipe system to prevent erosion at these locations. There are a variety of designs, including wire gabion baskets, rock splash pads, trenches, and specially designed pools or manholes. The rock splash pad is typically constructed of 4- to 12-inch diameter rocks a minimum of 12 inches thick and is often lined with filter fabric. The rock pad should extend above the top of the pipe a minimum of 1 foot.

Facility features that are typically associated with energy dissipaters include:

- detention ponds
- infiltration basin
- wetponds
- treatment wetlands




### Key Operations and Maintenance Considerations

- The most common tools for maintenance are hand tools such as rakes to redistribute rocks as necessary.
- Periodic removal of sediment or debris may be necessary.

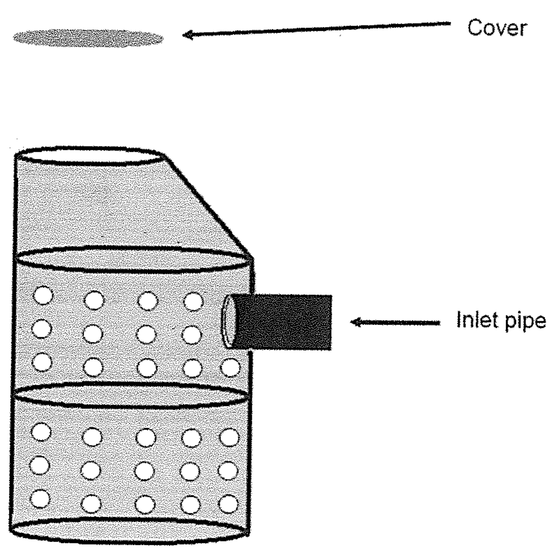
## Drywell

A drywell is a perforated, open-bottomed manhole used to infiltrate stormwater into the ground. Drywells temporarily store stormwater runoff during rain events. Drywells do not discharge to a downstream conveyance system or nearby surface water. Instead, drywells rely on the ability of the site's soils to infiltrate the stormwater into the ground.

While not the intended use, drywells trap sediment and some of the oily pollutants in runoff. They are more likely to fill with oily sediment in areas that lack swales or other treatment facilities. Fine soil sediment can clog drywells and lead to localized street flooding. Also, pollutants discharged into drywells can migrate into groundwater. Drywells were often installed in closed topographic depressions, areas with well-drained soils, or areas having inadequate storm sewers. Because drywells can be easily clogged and tend to concentrate pollutants in one place; pollution and sediment control practices should be used to protect them.

Facility objects that are typically associated with a drywell include:

- access road or easement
- fence, gate, and water quality sign
- infiltration trench
- catch basin
- field inlet
- bioswale
- media cartridge filter



**Drywell with Accumulated Trash**

## Key Operations and Maintenance Considerations

- The most common tool for cleaning drywells is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the facility.
- If water remains in a drywell after extended dry periods, that suggests the drywell is in direct contact with groundwater and must be retrofitted to meet state water quality standards and the requirements of the state Underground Injection Control rules. Contact Clark County Environmental Services or the Washington Department of Ecology for more information.

| Drywell | | | |
|---|---|---|---|
| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
| General | Does Not Dissipate Stormwater | Does not dissipate stormwater. | Replace or repair. |
| | Opening Clogged | Openings are clogged, reducing capacity. | Openings have been cleared (e.g. by water-jetting);<br>or<br>Convert existing, clogged drywell to a sediment trap and install a new drywell or drainage trench. To convert to a sediment trap, required are grouting holes, covering the base with concrete, and adding piping. |
| | Standing Water | Standing water indicates the drywell is into the water table. | Rebuild drywell to prevent stormwater from going directly into groundwater. |
| | Trash and Debris | Trash, debris, or floatables that may exit through pipes. | No trash or debris in drywell. |
| | | Trash or debris in any inlet or outlet pipe. | Inlet and outlet pipes free of trash or debris. |
| | Sediment | Sediment in drywell exceeds 60 percent of the depth below the inlet pipe. | No sediment in drywell. |
| | Structure Damage | Maintenance person judges that structure is unsound. | Drywell replaced or repaired to design standards. |
| | Contaminants and Pollution | Any evidence of oil, gasoline, contaminants or other pollutants.<br><br>• Identify and remove source, AND<br>• Report to Clark County Clean Water Program Illicit Discharge and Detection Elimination Program. | No contaminants or pollutants present. |
| Drywell Manhole | Cover Not in Place | Cover is missing or only partially in place. Any open catch basin requires maintenance. | Catch basin cover is closed |
| | Cover Difficult to Remove | One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance). | Cover can be removed by one maintenance person. |
| Metal Grates (If Applicable) | Grate opening Unsafe | Grate with opening wider than 7/8 inch. | Grate opening meets design standards. |
| | Trash and Debris | Trash and debris that is blocking more than 20% of grate surface inletting capacity. | Grate free of trash and debris. |
| | Damaged or Missing | Grate missing or broken member(s) of the grate. | Grate is in place and meets design standards. |

## Access Road and Easement

Many stormwater facilities have access roads to bring in heavy equipment for facility maintenance. These roads should be maintained for inspection access and ease of equipment access.

All facilities should allow access for the inspection process.

The easement area should be adequately landscaped. Landscaping is an essential component of stormwater management. Bare soil areas may generate higher levels of stormwater runoff and increase erosion and sedimentation in stormwater facilities. The following checklist gives some general guidance for management.

| Access Road/Easement | | | |
|---|---|---|---|
| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
| General | Erosion | Soils are bare or eroded. | Erosion repaired and soils have been protected (through seeding/matting/etc). |
| | Road Surface | Condition of road surface may lead to erosion of the facility or limit access. | Road repaired. |
| | Erosion of Ground Surface | Noticeable rills are seen in landscaped areas. | Eroded areas are filled, contoured, and seeded. Affected areas regraded as necessary. Steps have been taken to eliminate source of erosion (dispersing flows, energy dissipation, etc.). |
| | Trash & Debris / Litter | Litter accumulation exceeds 1 cubic foot per 1,000 square feet. | No trash or debris present. |
| | Poisonous Plants and Noxious weeds | Any poisonous plants or nuisance vegetation which may constitute a hazard to maintenance personnel or the public.<br><br>Any evidence of noxious weeds as defined by State or local regulations.<br><br>(Coordinate with Clark County Environmental Services, Vegetation Management program.) | Eradication of Class A weeds as required by State law. Control of Class B weeds designated by Clark County Weed Board. Control of other listed weeds as directed by local policy.<br><br>Apply requirements of adopted IMP plan for use of herbicides. |
| | Tree Growth and Hazard Trees | Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vacuuming, or equipment movements). If trees are not interfering with access or maintenance, do not remove.<br><br>If dead, diseased, or dying trees are identified.<br><br>(Use a certified Arborist to determine health of tree or removal requirements.) | Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).<br><br>Remove hazard trees. |
| | | Trees or shrubs that have been blown down or knocked over. | Vegetation has been replanted if feasible, or replaced. |
| | Weeds (Nonpoisonous) | Weeds growing in more than 20% of the landscaped area (trees and shrubs only). | Weeds present in less than 5% of the landscaped area. |
| | Insects | When insects such as wasps and hornets interfere with maintenance activities. | Insects destroyed or removed from site.<br><br>Apply insecticides in compliance with adopted Clark County Maintenance and Operations policies. |

## Fence, Gate, and/or Water Quality Sign

Stormwater facilities such as detention ponds or treatment wetlands often have fences to protect them from damage and keep children away from ponds or hazardous areas. Some facilities are required to have informational signs telling the public that the site is a stormwater facility.

| Fence, Gate and/or Water Quality Sign | | | |
|---|---|---|---|
| Drainage System Feature | Potential Defect | Conditions When Maintenance Is Needed | Minimum Performance Standard |
| General | Gate or Fence Allows Unauthorized Entry | Openings in fence, missing gate, openings beneath fence allowing unauthorized access. | Gate and/or fence repaired to prevent unauthorized access. |
| | Locking Mechanism | Mechanism cannot be opened by one maintenance person with proper tools. | Lock repaired/replaced. |
| | | No lock on gate allows unauthorized entry. | Lock replaced. |
| | Damaged Parts | Posts out of plumb more than six inches. | Post plumb to within 1-1/2 inches of plumb. |
| | | Top rails of plumb more than six inches. | Top rails free of bends greater than 1 inch. |
| | Erosion | Erosion has resulted in an opening under a fence that allows entry by people or pets. | Soil replaced under fence so that no opening exceeds 4 inches in height. |
| | Water Quality Sign | Water quality sign is leaning more than 8 inches off vertical. | Sign reset to plumb. |
| | | Water quality sign is missing or 20% of the surface is unreadable. | Sign replaced. |

# APPENDIX F

SWPPP

# Stormwater Pollution Prevention Plan

**For**
Riverside Neighborhood Park

**Prepared For**
Southwest Regional Office
300 Desmond Drive
Lacey, WA 98503
(360) 407-6300

| Owner | Developer | Operator/Contractor |
| --- | --- | --- |
| ECM Riverside, LLC | 9317 LLC | To Be Determined |
| 340 Oswego Pointe Drive, Suite 208 | 9321 NE 72nd Ave. Bldg C #7 | |
| Lake Oswego, OR 97034 | Vancouver, WA 98665 | |

**Project Site Location**
34512 NW Pacific Highway
La Center, WA 98629

**Certified Erosion and Sediment Control Lead**
To be Determined

**SWPPP Prepared By**
PLS Engineering
Consulting Engineers and Planners
604 W. Evergreen Blvd
Vancouver, WA 98660
PH: (360) 944-6519
PM@plsengineering.com

**SWPPP Preparation Date**
October 23, 2020

**Approximate Project Construction Dates**
November 2020
November 2023

# Contents

**Appendix A Site plans**

- Vicinity map (with all discharge points)
- Site plan with TESC measures

**Appendix B Construction BMPs**

- Possibly reference in BMPs, but likely it will be a consolidated list so that the applicant can photocopy from the list from the SWMMWW.

**Appendix C Alternative Construction BMP list**

- List of BMPs not selected, but can be referenced if needed in each of the 12 elements

**Appendix D General Permit**

**Appendix E Site Log and Inspection Forms**

**Appendix F Engineering Calculations**

# 1.0 Introduction

This Stormwater Pollution Prevention Plan (SWPPP) has been prepared for the Riverside Neighborhood Park Site Plan project in La Center, Washington. The Riverside Neighborhood Park is a 5.19-acre site located on the southwest side of Old Pacific Highway directly west of Larson Road in La Center, WA. The site address is 34512 NW Pacific Highway and is located in the SE ¼ of Section 33, T5N, R1E, Willamette Meridian. It is identified as Parcel Number 986028825 per the Clark County Assessor's records. The site currently consists of vacant fields, wetlands, and a stock watering pond. In addition, the site was previously used for residential purposes with an existing home having been removed sometime around 2014. A drainage ditch traverses along the south line of the parcel.

The site's existing topography is generally rolling with some steep areas near NW Pacific Hwy. It slopes down from the highway towards the drainage ditch, with the SW corner of the site as a low point. There is a high point near the south property line that separates the site into two drainage basins. The proposed development will maintain these drainage patterns by routing water to two separate facilities. Riverside Neighborhood Park will include picnic tables, play equipment, a basketball court, pedestrian paths, open space, and a drinking fountain. Infrastructure improvements to support the park will include lighting, a water lateral for the drinking fountain, paved driveway and parking area.

The purpose of this SWPPP is to describe the proposed construction activities and all temporary and permanent erosion and sediment control (TESC) measures, pollution prevention measures, inspection/monitoring activities, and recordkeeping that will be implemented during the proposed construction project. The objectives of the SWPPP are to:

1. Implement Best Management Practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity.

2. Prevent violations of surface water quality, ground water quality, or sediment management standards.

3. Prevent, during the construction phase, adverse water quality impacts including impacts on beneficial uses of the receiving water by controlling peak flow rates and volumes of stormwater runoff at the Permittee's outfalls and downstream of the outfalls.

This SWPPP was prepared using the Ecology SWPPP Template downloaded from the Ecology website. This SWPPP was prepared based on the requirements set forth in the Construction Stormwater General Permit and the *Stormwater Management Manual for Western Washington* (SWMMWW). The report is divided into seven main sections with several appendices that include stormwater related reference materials. The topics presented in the each of the main sections are:

- Section 1 – INTRODUCTION. This section provides a summary description of the project, and the organization of the SWPPP document.

- Section 2 – SITE DESCRIPTION. This section provides a detailed description of the existing site conditions, proposed construction activities, and calculated stormwater flow rates for existing conditions and post–construction conditions.

- Section 3 – CONSTRUCTION BMPs. This section provides a detailed description of the BMPs to be implemented based on the 12 required elements of the SWPPP (SWMMEW 2004).

- Section 4 – CONSTRUCTION PHASING AND BMP IMPLEMENTATION. This section provides a description of the timing of the BMP implementation in relation to the project schedule.

- Section 5 – POLLUTION PREVENTION TEAM. This section identifies the appropriate contact names (emergency and non-emergency), monitoring personnel, and the onsite temporary erosion and sedimentation control inspector

- Section 6 – INSPECTION AND MONITORING. This section provides a description of the inspection and monitoring requirements such as the parameters of concern to be monitored, sample locations, sample frequencies, and sampling methods for all stormwater discharge locations from the site.

- Section 7 – RECORDKEEPING. This section describes the requirements for documentation of the BMP implementation, site inspections, monitoring results, and changes to the implementation of certain BMPs due to site factors experienced during construction.

Supporting documentation and standard forms are provided in the following Appendices:

Appendix A – Site plans
Appendix B – Construction BMPs
Appendix C – Alternative Construction BMP list
Appendix D – General Permit
Appendix E – Site Log and Inspection Forms
Appendix F – Engineering Calculations

# 2.0 Site Description

## 2.1 Existing Conditions

The Riverside Neighborhood Park is a 5.19-acre site located on the southwest side of Old Pacific Highway directly west of Larson Road in La Center, WA. The site address is 34512 NW Pacific Highway and is located in the SE ¼ of Section 33, T5N, R1E, Willamette Meridian. It is identified as Parcel Number 986028825 per the Clark County Assessor's records. The site currently consists of vacant fields, wetlands, and a stock watering pond. In addition, the site was previously used for residential purposes with an existing home having been removed sometime around 2014. A drainage ditch traverses along the south line of the parcel.

## 2.2 Proposed Construction Activities

Current proposed development associated with this SWPPP includes the construction of a park along with the associated infrastructure. The site's existing topography is generally rolling with some steep areas near NW Pacific Hwy. It slopes down from the highway towards the drainage ditch, with the SW corner of the site as a low point. There is a high point near the south property line that separates the site into two drainage basins. The proposed development will maintain these drainage patterns by routing water to two separate facilities.

Riverside Neighborhood Park will include picnic tables, play equipment, a basketball court, pedestrian paths, open space, and a drinking fountain. Infrastructure improvements to support the park will include lighting, a water lateral for the drinking fountain, paved driveway and parking area.

# 3.0 Construction Stormwater BMPs

## 3.1 The 12 BMP Elements

### 3.1.1 Element #1 – Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction will be clearly marked before land-disturbing activities begin. Trees that are to be preserved, as well as all sensitive areas and their buffers, shall be clearly delineated, both in the field and on the plans. In general, natural vegetation and native topsoil shall be retained in an undisturbed state to the maximum extent possible. The BMPs relevant to marking the clearing limits that will be applied for this project include:

- Preserving Native Vegetation (BMP C101)
- Silt Fence (BMP C233)

Alternate BMPs for marking clearing limits are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

### 3.1.2 Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. The specific BMPs related to establishing construction access that will be used on this project include:

- Stabilized Construction Entrance (BMP C105)

Alternate construction access BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

### 3.1.3 Element #3 – Control Flow Rates

In order to protect the properties and waterways downstream of the project site, stormwater discharges from the site will be controlled. The specific BMPs for flow control that shall be used on this project include:

- The stormwater detention facility which will initially function as a Temporary Sediment Pond (BMP C241).

Alternate flow control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, the project must comply with Minimum Requirement 7 (Ecology 2005).

In general, discharge rates of stormwater from the site will be controlled where increases in impervious area or soil compaction during construction could lead to downstream erosion, or where necessary to meet local agency stormwater discharge requirements (e.g. discharge to combined sewer systems).

### 3.1.4 Element #4 – Install Sediment Controls

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site or prior to being discharged to an infiltration facility. The specific BMPs to be used for controlling sediment on this project include:

- Silt Fence (BMP C233)
- Storm Drain Inlet Protection (BMP C220)
- Detention facility to initially function as sediment control facility

Alternate sediment control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

In addition, sediment will be removed from paved areas in and adjacent to construction work areas manually or using mechanical sweepers, as needed, to minimize tracking of sediments on vehicle tires away from the site and to minimize washoff of sediments from adjacent streets in runoff.

Whenever possible, sediment laden water shall be discharged into onsite, relatively level, vegetated areas (BMP C240 paragraph 5, page 4-102).

In some cases, sediment discharge in concentrated runoff can be controlled using permanent stormwater BMPs (e.g., infiltration swales, ponds, trenches). Sediment loads can limit the effectiveness of some permanent stormwater BMPs, such as those used for infiltration or biofiltration; however, those BMPs designed to remove solids by settling (wet ponds or detention ponds) can be used during the construction phase. When permanent stormwater BMPs will be used to control sediment discharge during construction, the structure will be protected from excessive sedimentation with adequate erosion and sediment control BMPs. Any accumulated sediment shall be removed after construction is complete and the permanent stormwater BMP will be restabilized with vegetation per applicable design requirements once the remainder of the site has been stabilized.

The following BMPs will be implemented as end-of-pipe sediment controls as required to meet permitted turbidity limits in the site discharge(s). Prior to the implementation of these technologies, sediment sources and erosion control and soil stabilization BMP efforts will be maximized to reduce the need for end-of-pipe sedimentation controls.

- Temporary Sediment Pond (BMP C241)
- Construction Stormwater Filtration (BMP C251)
- Construction Stormwater Chemical Treatment (BMP C 250) (implemented only with prior written approval from Ecology).

### 3.1.5 Element #5 – Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

- Temporary and Permanent Seeding (BMP C120)
- Mulching (BMP C121)
- Nets and Blankets (BMP C122)
- Plastic Covering (BMP C123)
- Topsoiling (BMP C125)
- Surface Roughening (BMP C130)
- Dust Control (BMP C140)
- Early application of gravel base on areas to be paved

Alternate soil stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, no soils shall remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

In general, cut and fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

### 3.1.6 Element #6 – Protect Slopes

All cut and fill slopes will be designed, constructed, and protected in a manner than minimizes erosion. The following specific BMPs will be used to protect slopes for this project:

- Temporary and Permanent Seeding (BMP C120)

Alternate slope protection BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

### 3.1.7 Element #7 – Protect Drain Inlets

All storm drain inlets and culverts made operable during construction or inlets near the site that could potentially receive surface runoff from the construction site shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets and culverts that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

Drop Inlet Protection

- Block and Gravel Drop Inlet Protection
- Gravel and Wire Drop Inlet Protection
- Catch Basin Filter If the BMP options listed above are deemed ineffective or

inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D), or if no BMPs are listed above but deemed necessary during construction, the Certified Erosion and Sediment Control Lead shall implement one or more of the alternative BMP inlet protection options listed in Appendix C.

#### 3.1.8 Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. The specific BMPs for channel and outlet stabilization that shall be used on this project include:

- Outlet Protection (BMP C209)

Alternate channel and outlet stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, all temporary on-site conveyance channels shall be designed, constructed, and stabilized to prevent erosion from the expected peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour recurrence interval storm for the developed condition. Alternatively, the 10-year, 1-hour peak flow rate indicated by an approved continuous runoff simulation model, increased by a factor of 1.6, shall be used. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches shall be provided at the outlets of all conveyance systems.

#### 3.1.9 Element #9 – Control Pollutants

All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the site will be kept clean, well organized, and free of debris. If required, BMPs to be implemented to control specific sources of pollutants are discussed below.

Vehicles, construction equipment, and/or petroleum product storage/dispensing:

- All vehicles, equipment, and petroleum product storage/dispensing areas will be inspected regularly to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- On-site fueling tanks and petroleum product storage containers shall include secondary containment.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- In order to perform emergency repairs on site, temporary plastic will be placed beneath and, if raining, over the vehicle.
- Contaminated surfaces shall be cleaned immediately following any discharge or spill incident.

Chemical storage:

- Any chemicals stored in the construction areas will conform to the appropriate source control BMPs listed in Volume IV of the Ecology stormwater manual. In Western WA, all chemicals shall have cover, containment, and protection provided on site, per BMPC153 for Material Delivery, Storage and Containment in SWMMWW 2005
- Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations for application procedures and rates shall be followed.

Excavation and tunneling spoils dewatering waste:

- Dewatering BMPs and BMPs specific to the excavation and tunneling (including handling of contaminated soils) are discussed under Element 10.

Demolition:

- Dust released from demolished sidewalks, buildings, or structures will be controlled using Dust Control measures (BMP C140).
- Storm drain inlets vulnerable to stormwater discharge carrying dust, soil, or debris will be protected using Storm Drain Inlet Protection (BMP C220 as described above for Element 7).
- Process water and slurry resulting from sawcutting and surfacing operations will be prevented from entering the waters of the State by implementing Sawcutting and Surfacing Pollution Prevention measures (BMP C152).

Concrete and grout:

- Process water and slurry resulting from concrete work will be prevented from entering the waters of the State by implementing Concrete Handling measures (BMP C151).

Sanitary wastewater:

- Portable sanitation facilities will be firmly secured, regularly maintained, and emptied when necessary.
- Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system or to the sanitary sewer as part of Wheel Wash implementation (BMP C106).

Solid Waste:

- Solid waste will be stored in secure, clearly marked containers.

Other:

- Other BMPs will be administered as necessary to address any additional pollutant sources on site.

The facility does not require a Spill Prevention, Control, and Countermeasure (SPCC) Plan under the Federal regulations of the Clean Water Act (CWA).

### 3.1.10 Element #10 – Control Dewatering

No dewatering is anticipated as part of this construction project. If it is necessary, appropriate BMP's will be implemented to ensure that dewatering water meets state water quality requirements before being discharged from the site.

### 3.1.11 Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMPs specifications (attached). Visual monitoring of the BMPs will be conducted at least once every calendar week and within 24 hours of any stormwater or non-stormwater discharge from the site. If the site becomes inactive, and is temporarily stabilized, the inspection frequency will be reduced to once every month.

All temporary erosion and sediment control BMPs shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation shall be permanently stabilized.

### 3.1.12 Element #12 – Manage the Project

Erosion and sediment control BMPs for this project have been designed based on the following principles:

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.
- Thoroughly monitor site and maintain all ESC measures.
- Schedule major earthwork during the dry season.

In addition, project management will incorporate the key components listed below:

As this project site is located west of the Cascade Mountain Crest, the project will be managed according to the following key project components:

Phasing of Construction

- The construction project is being phased to the extent practicable in order to prevent soil erosion, and, to the maximum extent possible, the transport of sediment from the site during construction.
- Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C 162).

Seasonal Work Limitations

- From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:
  - Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters; and
  - Limitations on activities and the extent of disturbed areas; and
  - Proposed erosion and sediment control measures.
- Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance.
- The following activities are exempt from the seasonal clearing and grading limitations:
  - Routine maintenance and necessary repair of erosion and sediment control BMPs;
  - Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
  - Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Coordination with Utilities and Other Jurisdictions

- Care has been taken to coordinate with utilities, other construction projects, and the local jurisdiction in preparing this SWPPP and scheduling the construction work.

Inspection and Monitoring

- All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:
  - Assess the site conditions and construction activities that could impact the quality of stormwater, and
  - Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.
- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP

- This SWPPP shall be retained on-site or within reasonable access to the site.
- The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
- The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

### 3.1.13 Element #13 – Protect Low Impact Development BMPs

- Protect all bioretention and rain garden BMP’s from sedimentation through installation and maintenance of erosion control BMP’s on portions of the site that drain into them. Restore the BMP’s to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden bioretention/ rain garden soils, and replacing the removed soils with soils meeting the design specification.
- Prevent compacting bioretention and rain garden BMP’s by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction by construction equipment.
- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff into permeable pavements or base materials.
- Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures from Book 4 of the manufacturer’s procedures.
- Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils

## 3.2 Site Specific BMPs

Site specific BMPs are shown on the TESC Plan Sheets and Details in Appendix A. These site-specific plan sheets will be updated annually.

## 3.3 Additional Advanced BMPs

- The following BMPs are advanced and are only recommended if construction activities are complex enough to warrant them; or if the site has the potential for significant impacts to water quality. The following BMPs are directed at “end-of-pipe” treatment for sedimentation issues related to turbid runoff from construction sites. Effective BMPs are most often the simple BMPs and focus on the minimization of erosion before sedimentation is an issue. The following BMPs will most likely be implemented only after other BMP options are exhausted, or if the construction activity is large and off-site sedimentation or turbid runoff occurs or is inevitable.

- For BMP 250, written pre-approval, through Ecology is required (see SWMMWW 2005):
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration.

# 4.0 Construction Phasing and BMP Implementation

The BMP implementation schedule will be driven by the construction schedule. The following provides a sequential list of the proposed construction schedule milestones and the corresponding BMP implementation schedule. The list contains key milestones such as wet season construction.

The BMP implementation schedule listed below is keyed to proposed phases of the construction project and reflects differences in BMP installations and inspections that relate to wet season construction. The project site is located west of the Cascade Mountain Crest. As such, the dry season is considered to be from May 1 to September 30 and the wet season is considered to be from October 1 to April 30.

- Estimate of Construction start date: Unknown
- Estimate of Construction finish date (Phase 1): Unknown
- Mobilize equipment on site: Unknown
- Mobilize and store all ESC and soil stabilization products: Unknown
- Install ESC measures: Unknown
- Install stabilized construction entrance: Unknown
- Begin clearing and grubbing: Unknown
- Demolish existing structures: Unknown
- Begin site grading Unknown
- Site grading ends Unknown
- Excavate and install new utilities and services: Unknown
- Excavation for building foundations Unknown
- Begin building construction: Unknown
- Complete utility construction Unknown
- Begin implementing soil stabilization and sediment control BMPs throughout the site in preparation for wet season: Unknown
- Wet Season starts: Unknown
- Site inspections and monitoring conducted weekly and for applicable rain events as detailed in Section 6 of this SWPPP: Unknown
- Implement Element #12 BMPs and manage site to minimize soil disturbance during the wet season: Unknown
- Complete road paving Unknown
- Building construction complete: Unknown
- Dry Season starts: Unknown

# 5.0 Pollution Prevention Team

## 5.1 Roles and Responsibilities

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead (CESCL) – primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Resident Engineer – For projects with engineered structures only (sediment ponds/traps, sand filters, etc.): site representative for the owner that is the project's supervising engineer responsible for inspections and issuing instructions and drawings to the contractor's site supervisor or representative
- Emergency Ecology Contact – individual to be contacted at Ecology in case of emergency.
- Emergency Owner Contact – individual that is the site owner or representative of the site owner to be contacted in the case of an emergency.
- Non-Emergency Ecology Contact – individual that is the site owner or representative of the site owner than can be contacted if required.
- Monitoring Personnel – personnel responsible for conducting water quality monitoring; for most sites this person is also the Certified Erosion and Sediment Control Lead.

## 5.2 Team Members

Names and contact information for those identified as members of the pollution prevention team are provided in the following table.

| Title | Name(s) | Phone Number |
|---|---|---|
| Certified Erosion and Sediment Control Lead (CESCL) | Unknown | |
| Resident Engineer | Travis Johnson | (360) 944-6519 |
| Emergency Ecology Contact | Unknown | |
| Emergency Owner Contact | N/A Contact the engineer | (360) 944-6519 |
| Non-Emergency Ecology Contact | Unknown | |
| Monitoring Personnel | Unknown | |

# 6.0 Site Inspections and Monitoring

Monitoring includes visual inspection, monitoring for water quality parameters of concern, and documentation of the inspection and monitoring findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book. This SWPPP may function as the site log book if desired, or the forms may be separated and included in a separate site log book. However, if separated, the site log book but must be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

## 6.1 Site Inspection

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. The inspector will be a Certified Erosion and Sediment Control Lead (CESCL) per BMP C160. The name and contact information for the CESCL is provided in Section 5 of this SWPPP.

Site inspection will occur in all areas disturbed by construction activities and at all stormwater discharge points. Stormwater will be examined for the presence of suspended sediment, turbidity, discoloration, and oily sheen. The site inspector will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs to improve the quality of stormwater discharges. All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible.

### 6.1.1 Site Inspection Frequency

Site inspections will be conducted at least once a week and within 24 hours following any discharge from the site. For sites with temporary stabilization measures, the site inspection frequency can be reduced to once every month.

### 6.1.2 Site Inspection Documentation

The site inspector will record each site inspection using the site log inspection forms provided in Appendix E. The site inspection log forms may be separated from this SWPPP document, but will be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

## 6.2 Stormwater Quality Monitoring

The construction site is more than one acre in size and is therefore not subject to the general water quality monitoring requirements set forth in the 2005 Construction Stormwater General Permit (Appendix D).

The following text describes the monitoring for the proposed development.

### 6.2.1 Turbidity Sampling

Monitoring requirements for the proposed project will include turbidity sampling to monitor site discharges for water quality compliance with the 2005 Construction Stormwater General Permit(Appendix D), provided that site discharges occur. It should be noted that the site is designed such that all site runoff will be infiltrated so it is likely that discharges will be rare or may not occur at all. Sampling will be conducted at all discharge points at least once per calendar week.

Turbidity monitoring will follow the analytical methodologies described in Section S4 of the 2005 Construction Stormwater General Permit (Appendix D). The key benchmark values that require action are 25 NTU for turbidity (equivalent to 32 cm transparency) and 250 NTU for turbidity (equivalent to 6 cm transparency). If the 25 NTU benchmark for turbidity (equivalent to 32 cm transparency) is exceeded, the following steps will be conducted:

1. Ensure all BMPs specified in this SWPPP are installed and functioning as intended.
2. Assess whether additional BMPs should be implemented, and document revisions to the SWPPP as necessary.
3. Sample discharge location daily until the analysis results are less than 25 NTU (turbidity) or greater than 32 cm (transparency).

If the turbidity is greater than 25 NTU (or transparency is less than 32 cm) but less than 250 NTU (transparency greater than 6 cm) for more than 3 days, additional treatment BMPs will be implemented within 24 hours of the third consecutive sample that exceeded the benchmark value. Additional treatment BMPs to be considered will include, but are not limited to, off-site treatment, infiltration, filtration and chemical treatment.

If the 250 NTU benchmark for turbidity (or less than 6 cm transparency) is exceeded at any time, the following steps will be conducted:

1. Notify Ecology by phone within 24 hours of analysis (see Section 5.0 of this SWPPP for contact information).
2. Continue daily sampling until the turbidity is less than 25 NTU (or transparency is greater than 32 cm).
3. Initiate additional treatment BMPs such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours of the first 250 NTU exceedance.
4. Implement additional treatment BMPs as soon as possible, but within 7 days of the first 250 NTU exceedance.

5. Describe inspection results and remedial actions taken in the site log book and in monthly discharge monitoring reports as described in Section 7.0 of this SWPPP.

# 7.0 Reporting and Recordkeeping

## 7.1 Recordkeeping

### 7.1.1 Site Log Book

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book.

### 7.1.2 Records Retention

Records of all monitoring information (site log book, inspection reports/checklists, etc.), this Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements will be retained during the life of the construction project and for a minimum of three years following the termination of permit coverage in accordance with permit condition S5.C.

### 7.1.3 Access to Plans and Records

The SWPPP, General Permit, Notice of Authorization letter, and Site Log Book will be retained on site or within reasonable access to the site and will be made immediately available upon request to Ecology or the local jurisdiction. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of a written request for the SWPPP from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with permit condition S5.G.

### 7.1.4 Updating the SWPPP

In accordance with Conditions S3, S4.B, and S9.B.3 of the General Permit, this SWPPP will be modified if the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site or there has been a change in design, construction, operation, or maintenance at the site that has a significant effect on the discharge, or potential for discharge, of pollutants to the waters of the State. The SWPPP will be modified within seven days of determination based on inspection(s) that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

## 7.2 Reporting

### 7.2.1 Discharge Monitoring Reports

Discharge Monitoring Reports (DMRs) will be submitted to Ecology monthly. If there was no discharge during a given monitoring period, the Permittee shall submit the form as required, with the words "No discharge" entered in the place of monitoring results. The DMR due date is 15 days following the end of each month.

Water quality sampling results will be submitted to Ecology monthly on Discharge Monitoring Report (DMR) forms in accordance with permit condition S5.B. If there was no discharge during a given monitoring period, the form will be submitted with the words "no discharge" entered in place of the monitoring results. If a benchmark was exceeded, a brief summary of inspection results and remedial actions taken will be included. If sampling could not be performed during a monitoring period, a DMR will be submitted with an explanation of why sampling could not be performed.

### 7.2.2 Notification of Noncompliance

If any of the terms and conditions of the permit are not met, and it causes a threat to human health or the environment, the following steps will be taken in accordance with permit section S5.F:

1. Ecology will be immediately notified of the failure to comply.
2. Immediate action will be taken to control the noncompliance issue and to correct the problem. If applicable, sampling and analysis of any noncompliance will be repeated immediately and the results submitted to Ecology within five (5) days of becoming aware of the violation.
3. A detailed written report describing the noncompliance will be submitted to Ecology within five (5) days, unless requested earlier by Ecology.

Any time turbidity sampling indicates turbidity is 250 nephelometric turbidity units (NTU) or greater or water transparency is 6 centimeters or less, the Ecology regional office will be notified by phone within 24 hours of analysis as required by permit condition S5.A (see Section 5.0 of this SWPPP for contact information).

In accordance with permit condition S2.A, a complete application form will be submitted to Ecology and the appropriate local jurisdiction (if applicable) to be covered by the General Permit.

# Appendix A – Site Plans

# Appendix B – Construction BMPs

Stabilized Construction Entrance (BMP C105)

Temporary Sediment Pond (BMP C241)

Silt Fence (BMP C233)

Storm Drain Inlet Protection (BMP C220)

Bioretention Facility

Temporary and Permanent Seeding (BMP C120)

Mulching (BMP C121)

Nets and Blankets (BMP C122)

Plastic Covering (BMP C123)

Topsoiling (BMP C125)

Dust Control (BMP C140)

Early application of gravel base on areas to be paved

Temporary and Permanent Seeding (BMP C120)

Outlet Protection (BMP C209)

# Appendix C – Alternative BMPs

The following includes a list of possible alternative BMPs for each of the 12 elements not described in the main SWPPP text. This list can be referenced in the event a BMP for a specific element is not functioning as designed and an alternative BMP needs to be implemented.

**Element #1 - Mark Clearing Limits**
High Visibility Plastic or Metal Fence (BMP C103)
Stake and Wire Fence (BMP C104)
**Element #2 - Establish Construction Access**
Wheel Wash (BMP C106)
Water Bars (BMP C203)
**Element #3 - Control Flow Rates**
Wattles (BMP C235)

**Element #4 - Install Sediment Controls**
Straw Bale Barrier (BMP C230)
Gravel Filter Berm (BMP C232)
Straw Wattles (BMP C235)
Portable Water Storage Tanks (Baker Tanks)
Construction Stormwater Chemical Treatment (BMP C250)
Construction Stormwater Filtration (BMP C251)

**Element #5 - Stabilize Soils**
Polyacrylamide (BMP C126)

**Element #6 - Protect Slopes**
Straw Wattles (BMP C235)
Surface Roughening (BMP C240)

**Element #8 - Stabilize Channels and Outlets**
Level Spreader (BMP C206)
Check Dams (BMP C207)

**Element #9 – Control Pollutants**
Concrete Handling (BMP C151)
Construction Stormwater Chemical Treatment (BMP C250)
Construction Stormwater Filtration (BMP C251)

**Element #10 - Control Dewatering**
Vegetated Filtration (BMP C236)
Additional Advanced BMPs to Control Dewatering:

# Appendix D – General Permit

# Appendix E – Site Inspection Forms (and Site Log)

The results of each inspection shall be summarized in an inspection report or checklist that is entered into or attached to the site log book. It is suggested that the inspection report or checklist be included in this appendix to keep monitoring and inspection information in one document, but this is optional. However, it is mandatory that this SWPPP and the site inspection forms be kept onsite at all times during construction, and that inspections be performed and documented as outlined below.

At a minimum, each inspection report or checklist shall include:

a. Inspection date/times

b. Weather information: general conditions during inspection, approximate amount of precipitation since the last inspection, and approximate amount of precipitation within the last 24 hours.

c. A summary or list of all BMPs that have been implemented, including observations of all erosion/sediment control structures or practices.

d. The following shall be noted:

   i. locations of BMPs inspected,

   ii. locations of BMPs that need maintenance,

   iii. the reason maintenance is needed,

   iv. locations of BMPs that failed to operate as designed or intended, and

   v. locations where additional or different BMPs are needed, and the reason(s) why

e. A description of stormwater discharged from the site. The presence of suspended sediment, turbid water, discoloration, and/or oil sheen shall be noted, as applicable.

f. A description of any water quality monitoring performed during inspection, and the results of that monitoring.

g. General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.

h. A statement that, in the judgment of the person conducting the site inspection, the site is either in compliance or out of compliance with the terms and conditions of the SWPPP and the NPDES permit. If the site inspection indicates that the site is out of compliance, the inspection report shall include a summary of the remedial actions required to bring the site back into compliance, as well as a schedule of implementation.

i. Name, title, and signature of person conducting the site inspection; and the following statement: "I certify under penalty of law that this report is true, accurate, and complete, to the best of my knowledge and belief".

When the site inspection indicates that the site is not in compliance with any terms and conditions of the NPDES permit, the Permittee shall take immediate action(s) to: stop, contain, and clean up the unauthorized discharges, or otherwise stop the noncompliance; correct the problem(s); implement appropriate Best Management Practices (BMPs), and/or conduct maintenance of existing BMPs; and achieve compliance with all applicable standards and permit conditions. In addition, if the noncompliance causes a threat to human health or the environment, the Permittee shall comply with the Noncompliance Notification requirements in Special Condition S5.F of the permit.

# Site Inspection Form

| **General Information** | | | |
|---|---|---|---|
| **Project Name:** | | | |
| **Inspector Name:** | | **Title:**<br>**CESCL # :** | |
| **Date:** | | **Time:** | |
| **Inspection Type:** | □ After a rain event<br>□ Weekly<br>□ Turbidity/transparency benchmark exceedance<br>□ Other | | |
| **Weather** | | | |
| **Precipitation** | Since last inspection | In last 24 hours | |
| **Description of General Site Conditions:** | | | |

## Inspection of BMPs

***Element 1: Mark Clearing Limits***

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

***Element 2: Establish Construction Access***

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

***Element 3: Control Flow Rates***

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

***Element 4: Install Sediment Controls***

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

***Element 5: Stabilize Soils***

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

***Element 6: Protect Slopes***

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected Y | Inspected N | Functioning Y | Functioning N | Functioning NIP | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |

***Element 7: Protect Drain Inlets***

BMP:

| Location | Inspected | | Functioning | | | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected | | Functioning | | | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected | | Functioning | | | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

***Element 8: Stabilize Channels and Outlets***

BMP:

| Location | Inspected | | Functioning | | | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected | | Functioning | | | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected | | Functioning | | | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

BMP:

| Location | Inspected | | Functioning | | | Problem/Corrective Action |
|---|---|---|---|---|---|---|
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| ***Element 9: Control Pollutants*** | | | | | | |
|---|---|---|---|---|---|---|
| BMP: | | | | | | |
| Location | Inspected | | Functioning | | | Problem/Corrective Action |
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| BMP: | | | | | | |
| Location | Inspected | | Functioning | | | Problem/Corrective Action |
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| ***Element 10: Control Dewatering*** | | | | | | |
|---|---|---|---|---|---|---|
| BMP: | | | | | | |
| Location | Inspected | | Functioning | | | Problem/Corrective Action |
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| BMP: | | | | | | |
| Location | Inspected | | Functioning | | | Problem/Corrective Action |
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| BMP: | | | | | | |
| Location | Inspected | | Functioning | | | Problem/Corrective Action |
| | Y | N | Y | N | NIP | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| **Water Quality Monitoring** | | |
|---|---|---|
| Was any water quality monitoring conducted? | □ Yes | □ No |
| If water quality monitoring was conducted, record results here: | | |
| | | |
| If water quality monitoring indicated turbidity 250 NTU or greater; or transparency 6 cm or less, was Ecology notified by phone within 24 hrs? | □ Yes | □ No |
| If Ecology was notified, indicate the date, time, contact name and phone number below: | | |
| Date: | | |
| Time: | | |
| Contact Name: | | |
| Phone #: | | |
| **General Comments and Notes** | | |
| Include BMP repairs, maintenance, or installations made as a result of the inspection. | | |
| Were Photos Taken? | □ Yes | □ No |
| If photos taken, describe photos below: | | |
| | | |

# Appendix F – Engineering Calculations