Olympic Vista PRD

Construction Drainage Report

Prepared for
Cornerstone Homes
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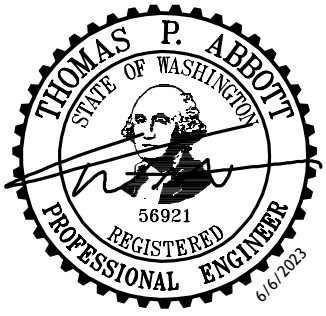
Tom Abbott, PE



June 2023

LDC Job No: C21-210

File Number: PA22-044, G23-0022

LDC, Inc. • Surveying • Engineering • Planning

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SECTION 1: PROJECT OVERVIEW

The Olympic Vista Project proposes the development of a 23-lot PRD. Project development includes construction of 23 individual lots with associated ROW, sidewalk, and utilities on a 5.39-acre site in Marysville, WA. The project site is located between Sunnyside Blvd and 59th Dr NE in Marysville, Washington. The project site is comprised of parcel #29050300102200. The site lies within the NE ¼ of Section 3, Township 29 N, Range 5 E within the City of Marysville. This project is vested under the 2019 Stormwater Management Manual for Western Washington (SWMMWW). See Vicinity Map in Appendix 1 for relative location.

Existing Site

The existing site is comprised of parcel #29050300102200, totaling 5.39 acres, and is currently occupied by two single-family residences, multiple storage sheds, and a barn. The subject property is currently zoned as R4.5. The site contains ground cover consisting primarily of lawn and scattered trees. The existing site is partially developed with one single-family residence, garage and shed.

A USGS soil survey classified native soils as "Tokul Gravelly Medial Loam" with slopes ranging from 0-15%. See the Soils Map in Appendix 3 for visual layout of soil type areas of the subject property. A geotechnical report was performed on the adjacent property to the south. The report, dated October 17th 2017 and prepared by Liu & Associates, Inc. is used as the basis of geotechnical review for this project. The existing site slopes are moderately sloping from east to west. Due to shallow glacial till soils present in the area, the Geotechnical Engineer does not recommend infiltration for LID BMPs to be used onsite. The project site does not contain any wetlands, steep slopes, or critical areas. A wetland is located directly to the west and downstream of the site.

The site is contained within a single threshold discharge area (TDA) that discharges into the Ebey Slough within a quarter mile of the site. See Predeveloped and Developed Hydrology Maps in Appendix 4 for a visual representation of the site basins.

Proposed Development

The Olympic Vista project will be developed with standalone single-family residences on 23 single-family lots, ROW, utilities, landscaping, and active open spaces. Project development will disturb 5.49 acres. Overall project impact will create 3.16 acres of new plus replaced impervious surfaces, with 1.02 acres being pollution generating impervious surfaces (PGIS).

All existing vegetation within the disturbed area will be cleared, and conflicting structures will be removed or demolished as part of the development. Access to the proposed site will be provided via a public road extension off 59th Dr NE with a new public road branching from it. See sheet RD-01 for more information regarding access.

Proposed Drainage System

This project is flow control exempt per the requirements of the 2019 Stormwater Management Manual for Western Washington (DOE Manual) because the site discharges to the Ebey Slough within less than ¼ mile. Per the 2019 DOE Manual, Appendix I-A: Flow Control Exempt Receiving Waters, "discharges to stream reaches heavily influenced by tides or backwater conditions can also be candidates for a Flow Control exemption."

Proposed pollution generating impervious surfaces (PGIS) will exceed the 5,000 SF threshold and thus basic water quality treatment will be provided via a water quality treatment vault that will treat stormwater runoff from roadways and driveways.

The site contains one TDA that outfalls to the Ebey Slough within less than ¼ mile. The disturbed area of the development is contained within the Onsite Basin. The Onsite Basin consists of developed roof, landscape, sidewalk, pavement and driveway. This project is not required to meet flow control requirements for the TDA. See Section 4.0 for additional discussion regarding proposed stormwater management and water quality treatment measures.

Erosion/Sedimentation Control
Erosion control measures that will be utilized during construction will include a combination of silt fence, storm drain inlet protection, interceptor swales, and sediment ponds. See Section 2.0 for discussion of how SWPPP Elements are addressed.

Minimum Requirements
Per the 2019 DOE, Minimum Requirements 1-9 apply to the proposed development.

Minimum Requirement #1: Preparation of Stormwater Site Plans
A report along with the construction plans, to be submitted at a later date, satisfies the minimum requirement.

Minimum Requirement #2: Construction Stormwater Pollution Prevention
See Section 2 of this Report for the SWPPP BMP Elements, and the SWPPP (submitted as a separate document at a later date) for a complete discussion of erosion control BMP's and their use specific to the site.

Minimum Requirement #3: Source of Pollution
Permanent source control BMPs are not applicable for the subject site since the associated activities for the new residence do not fall within the types of facilities listed within Volume IV of the DOE Manual (Residential developments are not required to implement source control BMP's). BMPs for erosion and sedimentation control are specified in the Preliminary Construction Plans.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls
Flow from the site will preserve its natural drainage pattern from east to the west. Runoff from the Onsite Basin discharges to a wetland just west of the site before entering the Ebey Slough.

Minimum Requirement #5: On-Site Stormwater Management
The project will exceed the 10,000 SF impervious surface threshold but is not required to provide flow control, as it is flow control exempt. Infiltration and dispersion BMPs are not feasible onsite due to soil conditions and spatial constraints. BMP T5.13 Post-Construction Soil Quality and Depth is feasible and will be applied to the site.

Minimum Requirement #6: Runoff Treatment
As the project will exceed the 5,000 SF threshold of new/replaced PGIS, the project is required to provide "basic" water quality treatment per the 2019 DOE manual. A Perkfilter water quality treatment vault will treat runoff from PGIS surfaces prior to discharge from the site to meet this requirement.

Minimum Requirement #7: Flow Control
The project is flow control exempt, as it is out falling to the Ebey Slough. Per the 2019 SWMMWW, "Discharges to stream reaches heavily influenced by tides or backwater conditions can also be candidates for a Flow Control exemption." One TDA exists on the site that will be discharged to the existing storm drain which outfalls to a wetland west of the site and then the Ebey Slough.

Minimum Requirement #8: Wetlands Protection

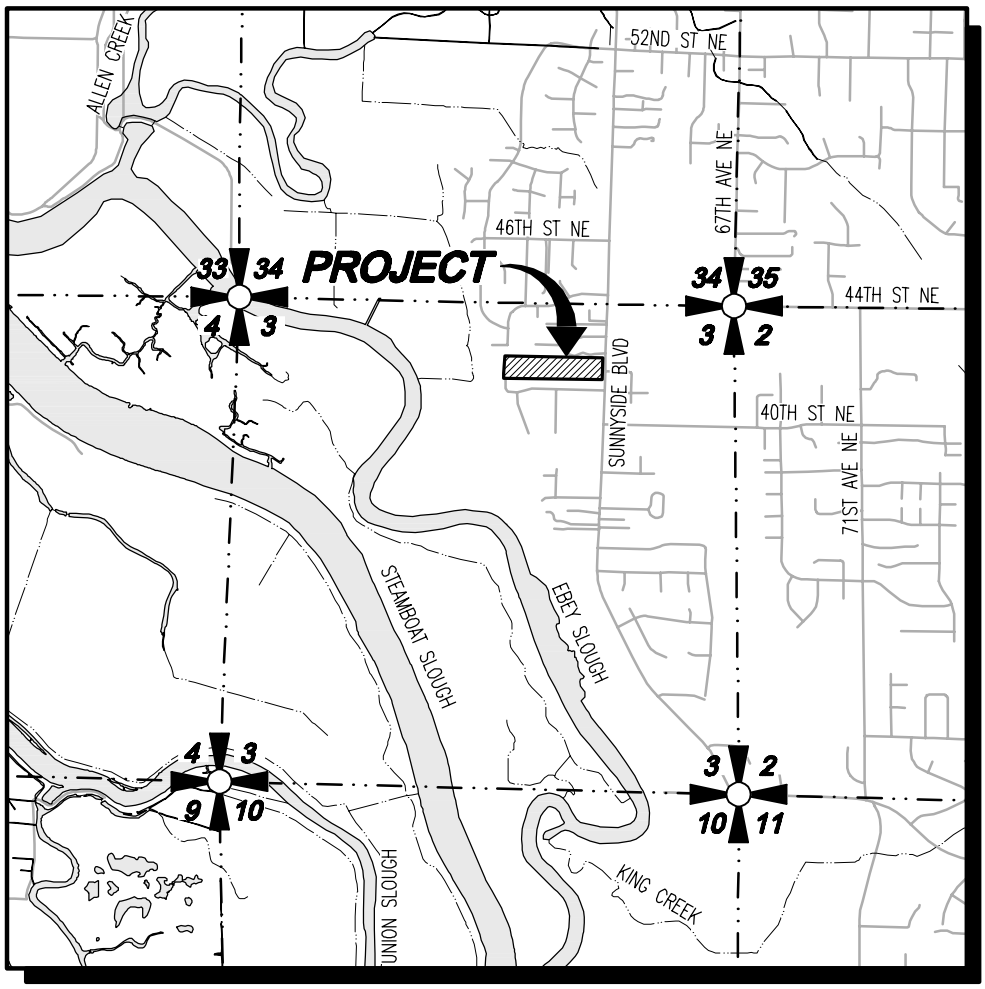
No wetlands have been identified onsite. A wetland exists west of the site that the site will discharge towards. Please see sheet RD-01 of the plan set for location information. Wetland areas will not be disturbed during site construction and will be protected with silt fencing and other BMPs throughout construction. Stormwater runoff will be treated per DOE requirements prior to discharge into the offsite wetland.

Minimum Requirement #9: Operation and Maintenance

See Operations and Maintenance in Section 6 of this report.

Appendix 1: Project Overview

1. Figure 1.0 – Vicinity Map
2. Figure 2.0 – Existing Conditions Map
3. Proposed Development Map



VICINITY MAP

SCALE: 1"=2000'

Drawing: P:\Civil\2021\C21-210 Olympic Vista\Drawings\Exhibits\C21210E-VM.dwg Plotted: Feb 17, 2022 - 12:01pm

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KEYSTONE LAND, LLC.

OLYMPIC VISTA PRD

VICINITY MAP

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

KEYSTONE LAND, LLC.

OLYMPIC VISTA
EXISTING CONDITIONS MAP

FIGURE: 2.0

NAD 1983 HARN
STATEPLANE WASHINGTON
NORTH FIPS 4601 FEET

REVISION:
JOB NUMBER: C21-210
DRAWING NAME: C21-210-2.0
DESIGNER: RFERGUSON
DRAWING BY: RFERGUSON
DATE: 10/11/2022
SCALE: AS SHOWN
JURISDICTION: MARYSVILLE

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SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
SNOHOMISH COUNTY GIS	PARCEL BOUNDARY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

NW 1/4 OF THE NE 1/4, SEC 3, TWN 29 N, RGE 5 E, W.M., CITY OF MARYSVILLE, SNOHOMISH COUNTY, WASHINGTON

NOTES

1. SEE SHEETS RD-03 THROUGH RD-05 FOR ROAD PROFILES.
2. SEE SHEET RD-06 FOR ROAD SECTIONS.
3. SEE SHEETS DT-01 TO DT-05 FOR NOTES AND DETAILS.
4. ALL EXISTING OVERHEAD UTILITIES TO BE UNDERGROUNDED.
5. APPLY TACK COAT TO FACE OF SAWCUT AND SEAL TOP OF JOINT PER STD PLAN 3-703-003.

DRIVEWAY CUT TABLE

LOT	STATION	WIDTH (FT)	SIDE	ROAD
1	20+77	20	RT	ROAD B
2	21+33	20	RT	ROAD B
3	21+89	20	RT	ROAD B
4	22+45	20	RT	ROAD B
5	23+01	20	RT	ROAD B
6	23+57	20	RT	ROAD B
7	24+13	20	RT	ROAD B
8	24+69	20	RT	ROAD B
9	25+25	20	RT	ROAD B
10	25+57	20	RT	ROAD B
11	26+94	20	LT	ROAD B
12	26+40	20	LT	ROAD B

LOT	STATION	WIDTH (FT)	SIDE	ROAD
13	26+23	20	LT	ROAD B
14	25+70	20	LT	ROAD B
15	25+14	20	LT	ROAD B
16	24+58	20	LT	ROAD B
17	24+02	20	LT	ROAD B
18	23+46	20	LT	ROAD B
19	22+90	20	LT	ROAD B
20	22+34	20	LT	ROAD B
21	21+78	20	LT	ROAD B
22	21+22	20	LT	ROAD B
23	20+66	20	LT	ROAD B

YARD DRAIN / CLEANOUT TABLE

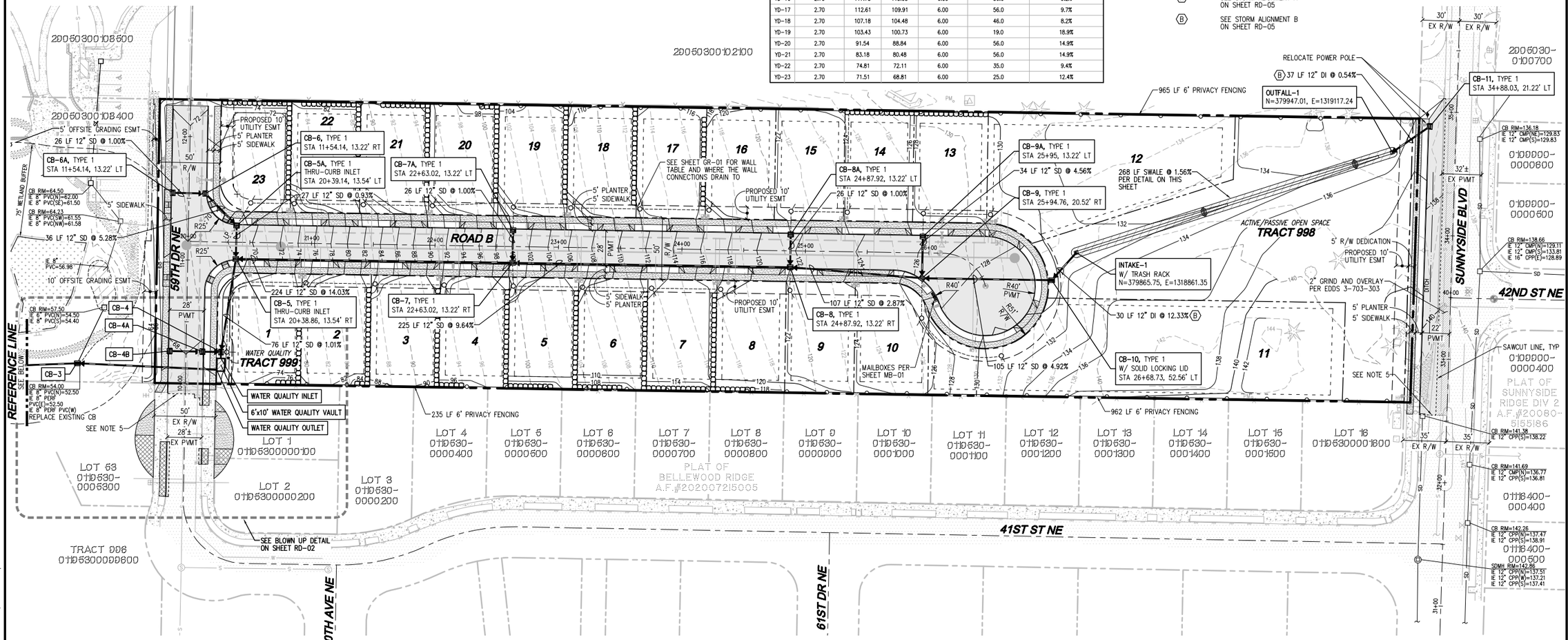
YD #	DEPTH (FT)	RIM (FT)	IE (FT)	PIPE SIZE (IN)	DOWNSTREAM (LF)	DOWNSTREAM SLOPE
YD-1	2.70	71.33	68.63	6.00	4.0	98.7%
YD-2	2.70	76.12	73.42	6.00	112.0	4.3%
YD-3	2.70	84.74	82.04	6.00	56.0	15.4%
YD-4	2.70	93.21	90.51	6.00	56.0	15.1%
YD-5	2.70	100.70	98.00	6.00	19.0	5.9%
YD-6	2.70	108.23	105.53	6.00	56.0	13.4%
YD-7	2.70	113.30	110.60	6.00	56.0	9.1%
YD-8	2.70	118.59	115.89	6.00	56.0	9.4%
YD-9	2.70	122.33	119.63	6.00	19.0	5.6%
YD-10	2.43	124.50	122.07	6.00	22.0	2.0%
YD-11	2.70	131.11	128.41	6.00	74.0	8.6%
YD-12	2.70	128.00	125.30	6.00	54.0	2.4%
YD-13	4.00	128.00	124.00	6.00	19.0	6.3%
YD-14	2.70	124.65	121.95	6.00	45.0	4.2%
YD-15	2.70	122.77	120.07	6.00	19.0	6.6%
YD-16	2.70	117.75	115.05	6.00	56.0	9.2%
YD-17	2.70	112.61	109.91	6.00	56.0	9.7%
YD-18	2.70	107.18	104.48	6.00	46.0	8.2%
YD-19	2.70	103.43	100.73	6.00	19.0	18.9%
YD-20	2.70	91.54	88.84	6.00	56.0	14.9%
YD-21	2.70	83.18	80.48	6.00	56.0	14.9%
YD-22	2.70	74.81	72.11	6.00	35.0	9.4%
YD-23	2.70	71.51	68.81	6.00	25.0	12.4%

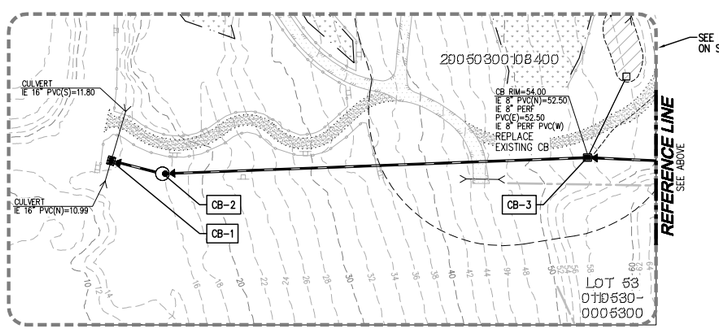
LEGEND

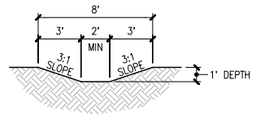
STORM PIPE
SEWER PIPE
WATER PIPE
DRAIN LINE
PRIVACY FENCE
ROCKERY RETAINING WALL
"NO-PARKING FIRE LANE" SIGN
STREET LIGHT
FULL DEPTH ASPHALT
CONCRETE
2" GRIND AND OVERLAY
ASPHALT/CONCRETE TO BE REMOVED
(A) SEE STORM ALIGNMENT A ON SHEET RD-05
(B) SEE STORM ALIGNMENT B ON SHEET RD-05

N

SCALE: 1" = 40'
40' 0 40' 80'







CONVEYANCE SWALE

SCALE: 1"=5'

NOTES:
1. INSTALL MINIMUM 6" QUARRY SPALL ARMORING AT INTAKE AND OUTFALL TO SWALE.
2. INSTALL PERMANENT CHECK DAMS EVERY 2' OF VERTICAL CHANGE OR 100' LINEAL FEET.

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

DISCLAIMER

TOPOGRAPHIC SURVEY INFORMATION CONTAINED ON THESE PLANS HAS BEEN PROVIDED BY PACIFIC COAST SURVEYS, INC. LOC, INC. (LAND DEVELOPMENT CONSULTANTS, INC.) ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

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811 or 1-800-424-5555
Utilities Underground Location Center

CITY FILE NO: PA22-044, G23-0022

CITY OF MARYSVILLE CONSTRUCTION DRAWING REVIEW ACKNOWLEDGEMENT

THIS PLAN SHEET HAS BEEN REVIEWED AND EVALUATED FOR GENERAL COMPLIANCE WITH THE APPLICABLE CITY OF MARYSVILLE CODES AND ORDINANCES. CONFORMANCE OF THIS DESIGN WITH ALL APPLICABLE LAWS AND REGULATIONS IS THE FULL AND COMPLETE RESPONSIBILITY OF THE LICENSED DESIGN ENGINEER, WHOSE STAMP AND SIGNATURE APPEAR ON THIS SHEET. ACKNOWLEDGMENT OF CONSTRUCTION DRAWING REVIEW DOES NOT IMPLY CITY APPROVAL FOR CONSTRUCTION ACTIVITIES THAT REQUIRED OTHER COUNTY, STATE OR FEDERAL PERMIT REVIEW AND APPROVAL. THE PROPERTY OWNER AND LICENSED DESIGN ENGINEER SHALL BE RESPONSIBLE FOR THE ACQUISITION AND COMPLIANCE OF ALL APPLICABLE PERMITS OR AUTHORIZATIONS WHICH MAY INCLUDE, BUT ARE NOT LIMITED TO, WSDRW HYDRAULIC PROJECT APPROVAL (HPS), WSDOE NOTICE OF INTENT (NOI), ANY CORPS OF ENGINEERS FILL PERMITS AND THE REQUIREMENTS OF THE ENDANGERED SPECIES ACT.

THIS DAY OF _____

BY: _____

KEN MCINTYRE, PE, DEVELOPMENT SERVICES MANAGER

APPROVAL FOR 18 MONTHS FROM DATE OF SIGNATURE.

NO.	DATE	DESCRIPTION	BY

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KEYSTONE LAND, LLC.

OLYMPIC VISTA PRD

ROAD AND STORM DRAINAGE PLAN

THOMAS P. ABBOTT
STATE OF WASHINGTON
56092
REGISTERED PROFESSIONAL ENGINEER

JOB NUMBER:	C21-210
DRAWING NAME:	C21210C-RD-PL
DESIGNER:	TPA
DRAFTING BY:	BJN
DATE:	4-24-23
SCALE:	1"=40'
JURISDICTION:	MARYSVILLE

RD-01

SHEET 9 OF 28

Drawing: P:\CIVIL\2021\21-210 olympic vista\Drawings\construction\C21210C-RD-PL.dwg Plotted: Jun 05, 2023 - 2:19pm

SECTION 2: TEMPORARY EROSION AND SEDIMENT CONTROL DESIGN

SWPPP Design Elements

A Stormwater Pollution Prevention Plan (SWPPP) will be provided prior to construction. The SWPPP report is modeled under the guidelines of Volume II, Section 3 of the 2019 Stormwater Management Manual for Western Washington. Construction SWPPP Elements #1 through #13 are addressed below.

Element #1 – Mark Clearing Limits

All clearing limits will be delineated with high visibility plastic fence and/or silt fence. See sheets ER-01 of the preliminary plans for locations and details.

Element #2 – Establish Construction Access

Stabilized construction accesses will be installed as shown on the preliminary plans. See sheets ER-01 and ER-02 of the construction plans for locations and details.

Element #3 – Control Flow Rates

Detention of construction period runoff will be provided by means of a sediment pond located in the western portion of the site. See sheets ER-01 of the preliminary plans for location and details for flow and sediment control BMP's.

Element #4 – Install Sediment Controls

Silt fence, catch basin protection, and the temporary sediment pond will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the preliminary plans for locations and details.

Element #5 – Stabilize Soils

Exposed soils will be stabilized as specified in the Grading and Erosion Control Notes with temporary and permanent seeding, mulching, and plastic covering. See sheet ER-02 of the preliminary plans for notes.

Element #6 – Protect Slopes

Slopes are minor on the subject site. Slopes shall be protected as specified under Element #5.

Element #7 – Protect Drain Inlets

Storm drain inlet protection will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the preliminary plans for locations and details.

Element #8 – Stabilize Channels and Outlets

Temporary channels shall be stabilized with check dams. See sheets ER-01 and ER-02 of the preliminary plans for locations and details.

Element #9 – Control Pollutants

Pollutants shall be controlled as specified in Volume IV of the 2019 DOE Manual—Source Control BMPs to address potential sources of pollution which may exacerbate possible soil/groundwater contamination identified onsite.

Element #10 – Control De-Watering

There will be no de-watering as a part of this project. See sheet ER-02 of the preliminary plans for notes.

Element #11 – Maintain BMPs

Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the preliminary plans for the Construction Sequence and notes.

Element #12: Manage the Project

The Grading and Erosion Control Notes specify seasonal work limitations. Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the preliminary plans for the Construction Sequence and notes.

Element #13: Protect on-site stormwater management BMPs

On-site stormwater management BMPs used for runoff from roofs and other hard surfaces are not feasible due to soil conditions and proposed project density.

SECTION 3: DOWNSTREAM ANALYSIS

Task 1. Study Area Definition and Maps

Snohomish County Bare Earth LiDAR, survey, and 2021 aerial photography were the best topographical references available for the area containing the site. The limits of the downstream analysis extend roughly 0.25 miles beyond the subject property's natural discharge location.

Task 2. Resource Review

All of the resources below have been reviewed for existing and potential issues near the project site:

Adopted Basin Plans

No Adopted Basin Plans were located that include the project site.

Drainage Basin

This site is located within the Allen-Creek Sub-Basin, which is in the Snohomish Basin. Discharge from the proposed development will outfall to the existing storm drain within Olympic View Park, just west of the site, which outfalls a wetland that connects directly to the Ebey Slough. The Ebey Slough is within 900 ft of the project site. See Figure 3.0 for flow paths and the delineation of the Onsite Basin.

Floodplain / Floodway (FEMA) maps

Per FEMA Floodplain map #53061C0717G the subject property is not within a floodplain.

Critical Areas Map

The Snohomish County PDS Map Portal does not show any critical areas on the site. The Marysville Critical Areas map shows a wetland buffer to the west of the site from the offsite downstream wetland.

Drainage Complaints

No relevant issues were identified near the proposed site.

Road Drainage Problems

No issues were identified near the proposed site.

Soil Survey

A USGS Soil Survey determined that the existing topography of the project site has westerly descending slopes ranging from 0-15%. Native soils are classified as "Tokul Gravelly Medial Loam".

Wetland Inventory Maps

No critical areas or buffers are located on the subject property. Wetlands located within Olympic View Park adjacent to the west of the site were mitigated as part of the City's development of the park, so buffers do not extend onto the subject property from those wetlands. Reference the critical areas report submitted with this report for additional information regarding the wetland areas onsite.

Migrating River Studies

Migrating River Studies are not considered applicable to the proposed development.

Section 303d List of Polluted Waters

Washington State Department of Ecology's Water Quality Assessment for Washington contains the following listings for water quality in the Ebey Slough:

- *Bacteria*

Water Quality Problems
The Ebey Slough has been listed as a category 5 water due to bacteria concerns. It is not anticipated that these concerns would be exacerbated by the proposed development due to the water quality treatment to be performed on the stormwater runoff prior to its discharge.

Stormwater Compliance Plans
Not applicable to the proposed project.

Task 3. Field Inspection/Downstream Analysis
On October 17th, 2022 a downstream analysis was performed at the site. The weather consisted of 66 degrees and partly sunny. The following observations were made at the site.

The subject property consists primarily of lawn and pasture (Image 1). The east edge of the site contains two single family residences as well as multiple sheds and a barn. Onsite flows travel east to west before leaving the west boundary of the site and sheet flowing towards the Olympic View Park. The downstream flow path then enters a French drain (Image 2) that is part of the existing storm drain within Olympic View Park. The downstream flow path continues west through Olympic View Park in an 8 inch storm pipe that outfalls to a vegetated swale within a Native Growth Protection Area (Image 3 and 4) and then outfalls to a wetland (Image 5). The wetland connects to the Ebey Slough (Image 6) which extends beyond the 1/4-mile boundary of analysis. The frontage along Sunnyside Blvd drains onto the site and follows the east to west onsite flow pattern of the rest of the site.

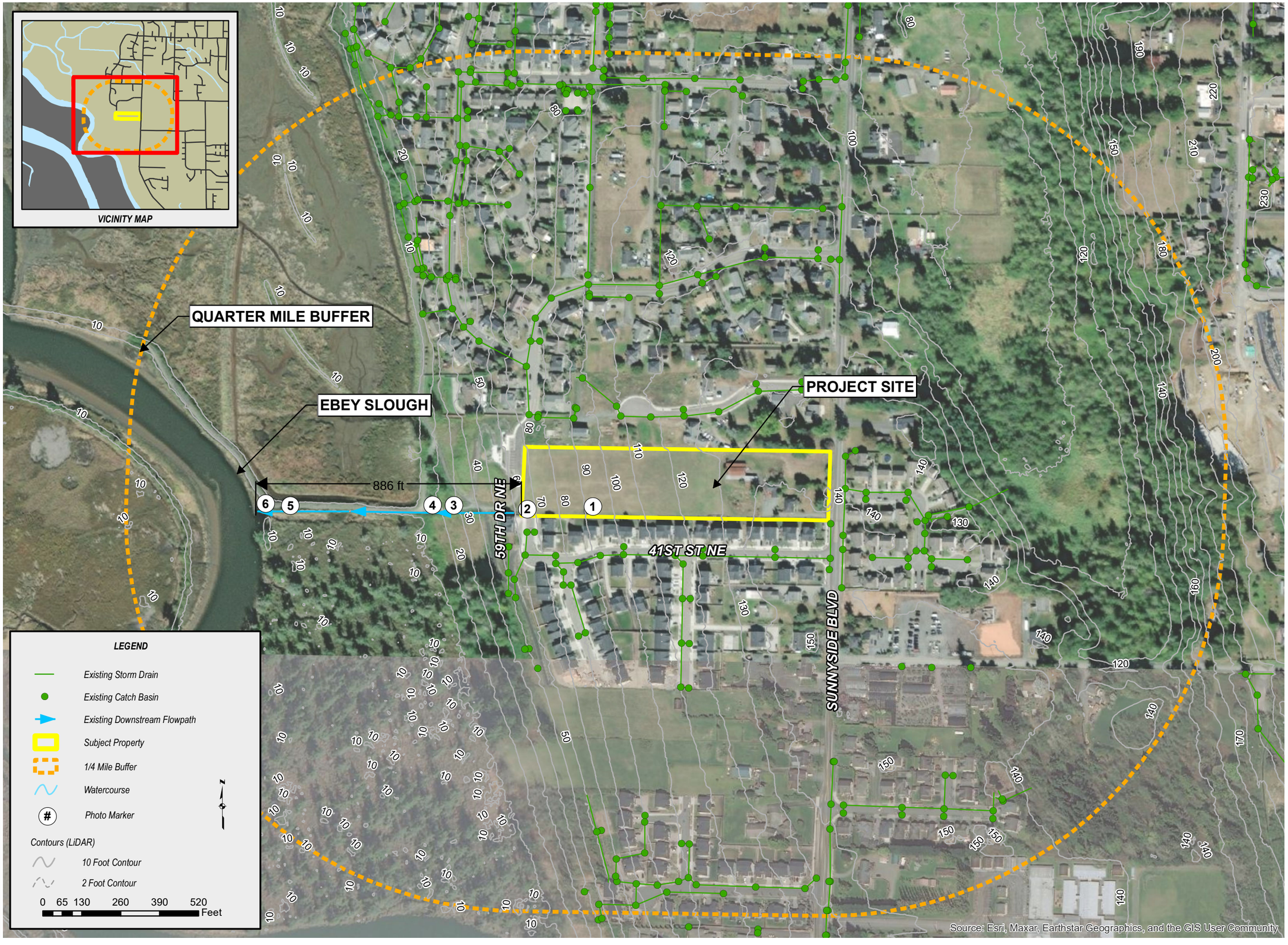
Improvements to the existing system within Olympic View Park will be required for the Olympic Vista project. Evaluation of the downstream flowpath shows that the existing system will require improvements. Upgrades to the conveyance system include a 12" drainage pipe that will outfall to the wetland just upstream of the Ebey Slough. For further analysis see Section 5.

Task 4. Drainage System Description and Problem Descriptions
Based on the information available and all the resources available including visual inspection of the downstream flow path to the ¼-mile boundary, there is no evidence of existing or anticipated downstream drainage problems. All flows are adequately carried through natural channels.

Task 5. Mitigation of Existing or Potential Drainage Problems
No evidence of existing or potential problems with downstream drainage conveyance infrastructure was found. Mitigation is not required.

Appendix 3: Resource Review

1. Downstream Site Visit Images
2. Figure 3.0 - Downstream Analysis Map
3. USDA Soils Map & Description



SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
SNOHOMISH COUNTY GIS	PARCEL BOUNDARY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

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KEYSTONE LAND, LLC.

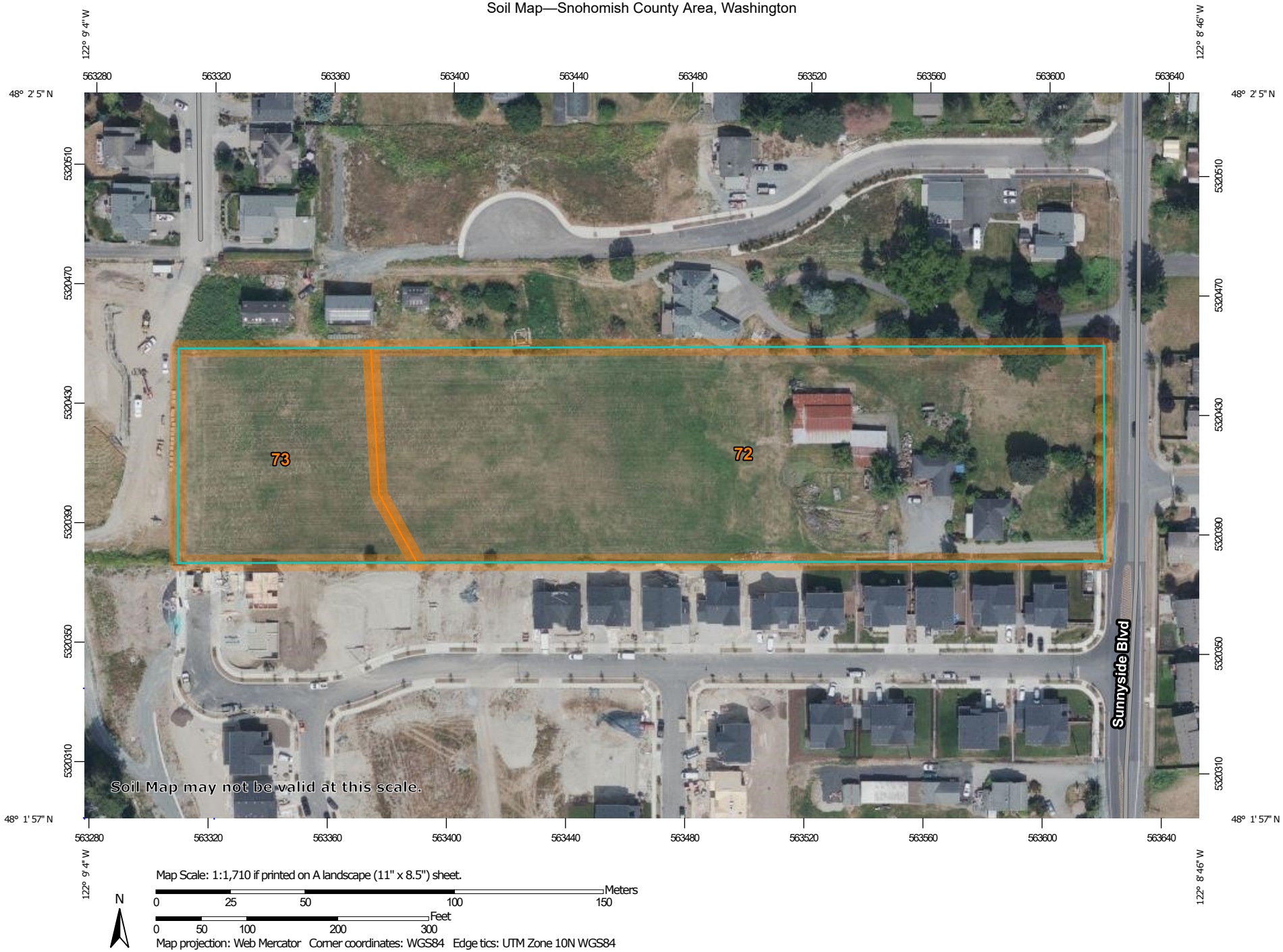
OLYMPIC VISTA
DOWNSTREAM ANALYSIS MAP

NAD 1983 HARN
STATEPLANE WASHINGTON
NORTH FIPS 4601 FEET

REVISION:
JOB NUMBER: C21-210
DRAWING NAME: C21-210-3.0
DESIGNER: RFERGUSON
DRAWING BY: RFERGUSON
DATE: 10/17/2022
SCALE: AS SHOWN
JURISDICTION: MARYSVILLE

FIGURE:
3.0

Downstream Analysis Map.mxd | MOD: 10/17/2022 | rferguson



Map Scale: 1:1,710 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

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 1:24,000.

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:
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: Snohomish County Area, Washington
Survey Area Data: Version 23, Aug 31, 2021

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

Date(s) aerial images were photographed: Aug 16, 2020—Aug 19, 2020

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
72	Tokul gravelly medial loam, 0 to 8 percent slopes	4.3	78.0%
73	Tokul gravelly medial loam, 8 to 15 percent slopes	1.2	22.0%
Totals for Area of Interest		**5.6**	**100.0%**

Snohomish County Area, Washington

72—Tokul gravelly medial loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t61k
Elevation: 160 to 1,150 feet
Mean annual precipitation: 45 to 70 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Tokul and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tokul

Setting

Landform: Hillslopes, till plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Volcanic ash mixed with loess over glacial till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oa - 1 to 2 inches: highly decomposed plant material
A - 2 to 6 inches: gravelly medial loam
Bs1 - 6 to 9 inches: gravelly medial loam
Bs2 - 9 to 17 inches: gravelly medial loam
Bs3 - 17 to 24 inches: gravelly medial loam
BC - 24 to 33 inches: gravelly medial fine sandy loam
2Bsm - 33 to 62 inches: cemented material

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 20 to 39 inches to densic material; 20 to 39 inches to cemented horizon
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Ecological site: F002XA005WA - Puget Lowlands Moist Forest
Forage suitability group: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XF303WA)
Other vegetative classification: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XF303WA)
Hydric soil rating: No

Minor Components

Pastik

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Barneston

Percent of map unit: 5 percent
Landform: Moraines, eskers, kames
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma

Percent of map unit: 3 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

Mckenna

Percent of map unit: 2 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 23, Aug 31, 2021

Snohomish County Area, Washington

73—Tokul gravelly medial loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t61l
Elevation: 160 to 1,150 feet
Mean annual precipitation: 45 to 70 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Tokul and similar soils: 70 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tokul

Setting

Landform: Till plains, hillslopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Volcanic ash mixed with loess over glacial till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oa - 1 to 2 inches: highly decomposed plant material
A - 2 to 6 inches: gravelly medial loam
Bs1 - 6 to 9 inches: gravelly medial loam
Bs2 - 9 to 17 inches: gravelly medial loam
Bs3 - 17 to 24 inches: gravelly medial loam
BC - 24 to 33 inches: gravelly medial fine sandy loam
2Bsm - 33 to 62 inches: cemented material

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 39 inches to densic material; 20 to 39 inches to cemented horizon
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F002XA005WA - Puget Lowlands Moist Forest
Forage suitability group: Limited Depth Soils (G002XF303WA)
Other vegetative classification: Limited Depth Soils (G002XF303WA)
Hydric soil rating: No

Minor Components

Vanzandt

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Pastik

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Barneston

Percent of map unit: 5 percent
Landform: Moraines, eskers, kames
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Base slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Rinker

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma

Percent of map unit: 3 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave

Hydric soil rating: Yes

Mckenna

Percent of map unit: 2 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 23, Aug 31, 2021

Downstream Analysis Photographs

Image 1: Looking west across the corner of the site towards the Olympic View Park and Ebey Slough.

Image 2: The French drain at the east edge of Olympic View Park collects sheet flow from the Olympic Vista project site.

Image 3: The 8" diameter storm drain crosses under the paved pathway and outlets to a vegetated swale within the NGPA.

Image 4: The swale continues west through the vegetation within the NGPA on the left side of the gravel path.

Image 5: Looking east towards the site, the flowpath outlets into a wetland on the right side of the trail.

Image 6: The flowpath and wetland connect to Ebey Slough.

SECTION 4: FLOW CONTROL AND WATER QUALITY TREATMENT DESIGN

4.1 Pre-Developed Hydrology/Land Cover

The pre-developed and developed conditions were modeled in WWHM for the purpose of peak flow determination for direct discharge and water quality treatment. Based on the site location, the WWHM used the Everett Gage and a Precipitation Scale factor of 1.0.

Onsite Basin:
The predeveloped condition was applied to the Onsite Basin. For visual representation of the listed basins, see Figure 4.0, "Predeveloped Hydrology Map". The values as modeled in WWHM are as follows:

Table 1: Predeveloped Conditions: Onsite Basin

Onsite Basin	
Ground Cover	Area (acre)
Forest, mod	5.49
Total	**5.49**

4.2 Developed Site Hydrology

In the developed condition, the project will develop 23 single-family lots and associated driveways and utilities. Frontage improvements, including pavement widening and construction of pedestrian facilities, will be constructed along 59th Dr NE and Sunnyside Boulevard.

In compliance with the 2019 DOE Manual, all runoff from onsite developed/disturbed surfaces will be collected, treated, and discharged directly to existing/historic flow paths, however this project is flow control exempt. Per the 2019 SWMMWW "discharges to stream reaches heavily influenced by tides or backwater conditions can also be candidates for a Flow Control exemption." The site is within 900 ft of the Ebey Slough and will outfall to a wetland connected to the slough, therefore it is flow control exempt.

Onsite Basin:
The developed Onsite Basin is 5.49 acres comprised of 23 single family lots, open spaces, and ROW. Consistent with Section 22.G "Planned Residential Developments" of the Marysville Municipal Code, the assumed maximum impervious coverage of 70% per lot was used, with the exception of Lots 11 and 12, which were assumed to have a maximum impervious coverage of 8,000 SF per lot. In the developed condition, the Onsite Basin has been modeled using WWHM with the following areas and ground cover designations:

Table 2: Developed Conditions: Onsite Basin

Onsite Basin	
Ground Cover	Area (acre)
Roof Tops, flat	1.87
Roads, flat	0.33
Roads, mod	0.46
Driveway, flat	0.27
Sidewalks, flat	0.16
Sidewalk, mod	0.10
Pasture, flat	2.30
Total	**5.49**

See table below for the flow rates by storm event at the downstream point of compliance.

Table 3: Predeveloped vs Developed Unmitigated Flow Rates

Storm Event	Predeveloped Rate (cfs)	Developed Unmitigated Rates (cfs)
2-Year	0.1223	1.4309
10-Year	0.2339	2.3158
50-Year	0.3457	3.2477
100-Year	0.3968	3.6925

4.3 Water Quality Treatment

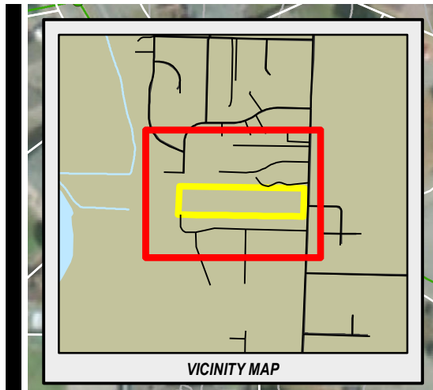
Perkfilter Vault
Water Quality Treatment for PGIS within the Onsite Basin is accomplished through a Perkfilter Vault located in the southwest corner of the site. A summary of design criteria is provided below:

Table 4: Perkfilter - Design Summary

Perkfilter Vault	
Tributary Area	*5.49 AC*
Tributary PGIS Area	*1.03 AC*
Water Quality Flow Rate (91% of runoff vol.)	0.4944 cfs
Number of Cartridges	13
Cartridge Height	18″
Internal Drop	2.33′
Peak Flow Rate	3.6925 cfs
Peak Flow Storm Event	100-Year

Appendix 4: Detention and Water Quality Design Analysis

1. Figure 4.0: Predeveloped Hydrology Map
2. Figure 5.0: Developed Hydrology Map
3. Perkfilter Detail
4. WWHM2012 Output



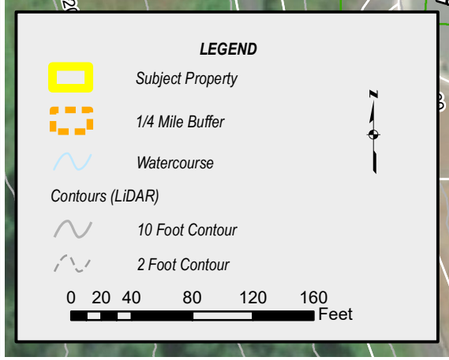
PREDEVELOPED BASIN AREAS	
BASIN AREAS	
FOREST	5.49 AC
TOTAL	5.49 AC

ONSITE BASIN

59TH DR NE

41ST ST NE

SUNNYSIDE BLVD



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
SNOHOMISH COUNTY GIS	PARCEL BOUNDARY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

LDC
Surveying
Engineering
Planning
Woodinville
20210 142nd Avenue NE
Woodinville, WA 98072
T 425.806.1869
Kent
1851 Central Pl S, #101
Kent, WA 98030
T 425.462.2893
www.LDCcorp.com

KEYSTONE LAND, LLC.

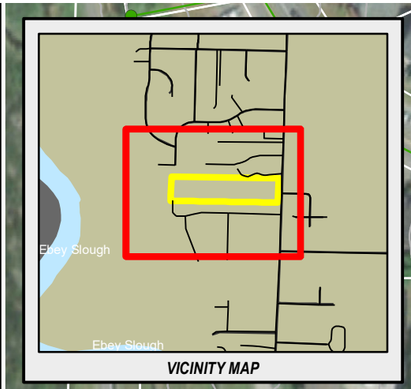
OLYMPIC VISTA
PREDEVELOPED HYDOLOGY MAP

NAD 1983 HARN
STATEPLANE WASHINGTON
NORTH FIPS 4601 FEET

REVISION:
JOB NUMBER: C21-210
DRAWING NAME: C21-210-4.0
DESIGNER: RFERGUSON
DRAWING BY: RFERGUSON
DATE: 6/6/2023
SCALE: AS SHOWN
JURISDICTION: MARYSVILLE

FIGURE:
4.0

Predeveloped Hydrology Map.mxd | MOD: 6/6/2023 | rferguson



VICINITY MAP

DEVELOPED BASIN AREAS	
PASTURE	2.01 AC
ROAD	0.60 AC
ROOF	2.00 AC
DRIVEWAY	0.38 AC
SIDEWALK	0.36 AC
TOTAL	5.35 AC

ONSITE BASIN

42ND ST NE

59TH DR NE

41ST ST NE

SUNNYSIDE BLVD

LEGEND

- Subject Property
- 1/4 Mile Buffer
- Watercourse

Contours (LiDAR)

- 10 Foot Contour
- 2 Foot Contour

0 25 50 100 150 200 Feet

N

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
SNOHOMISH COUNTY GIS	PARCEL BOUNDARY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

LDC
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Kent, WA 98030
T 425.462.2893

www.LDCcorp.com

KEYSTONE LAND, LLC.

OLYMPIC VISTA
DEVELOPED HYDOLOGY MAP

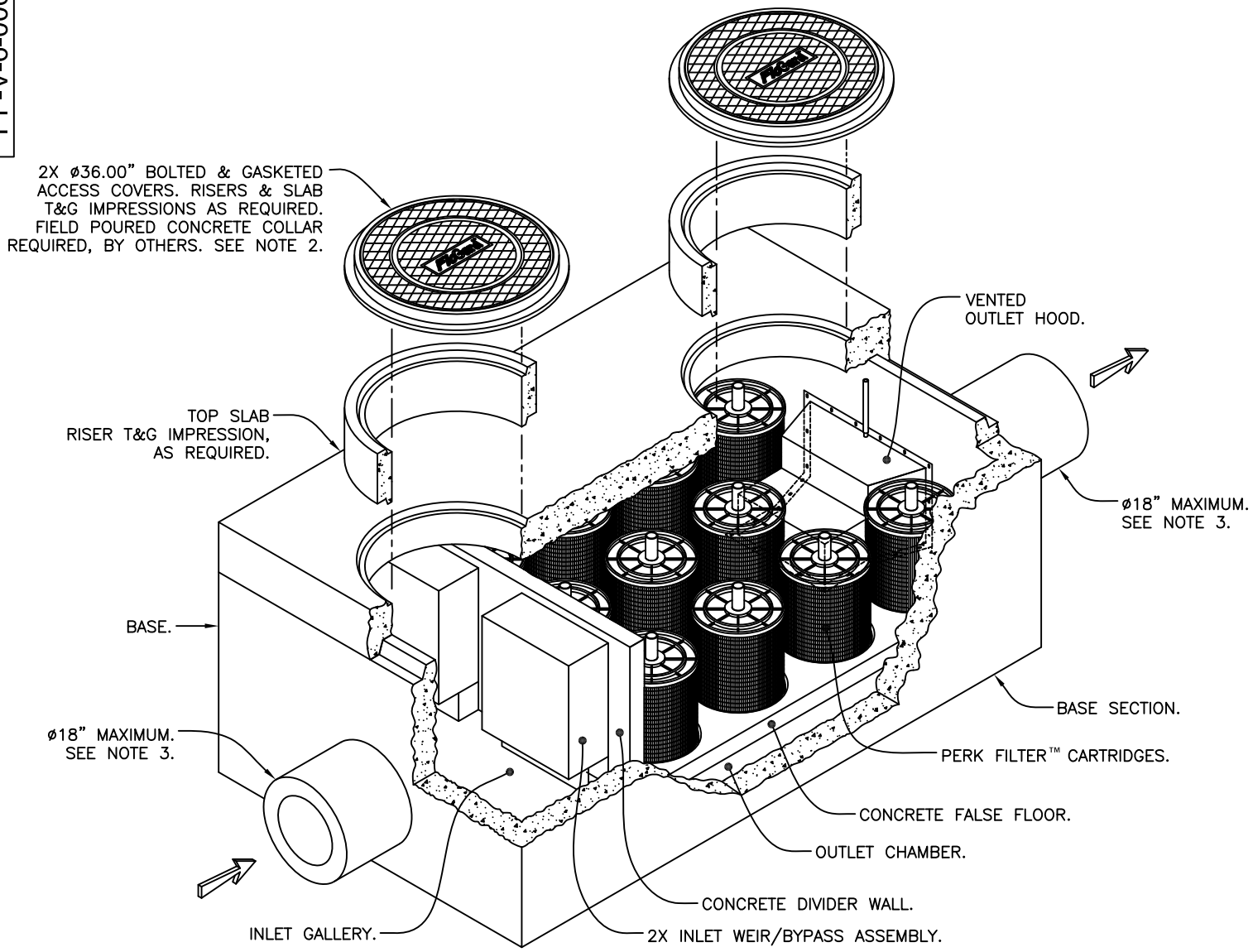
NAD 1983 HARN
STATEPLANE WASHINGTON
NORTH FIPS 4601 FEET

REVISION:
JOB NUMBER: C21-210
DRAWING NAME: C21-210-5.0
DESIGNER: RFERGUSON
DRAWING BY: RFERGUSON
DATE: 6/5/2023
SCALE: AS SHOWN
JURISDICTION: MARYSVILLE

FIGURE:
5.0

Developed Hydrology Map_Rev1.mxd | MOD: 6/5/2023 | rferguson

PF-V-6-0001



Notes:

1. Precast concrete structure shall be manufactured in accordance with ASTM Designation C857 and C858.
2. Filter system shall be supplied with traffic rated (H20) bolted & gasketed Ø36" circular access covers with risers as required. Shallow applications may require configurations with (H20) bolted & gasketed square/rectangular access hatches. Field poured concrete collars required, by others.
3. Inlet & outlet pipe(s) (Ø 18" maximum) may enter device on all three sides of the inlet & outlet chambers respectively.
4. Inlet chamber shall be supplied with a drain-down device designed to remove standing water between storm events.
5. For depths less than specified minimums contact Oldcastle® Stormwater Solutions for engineering assistance.

Media Filtration

PerkFilter™

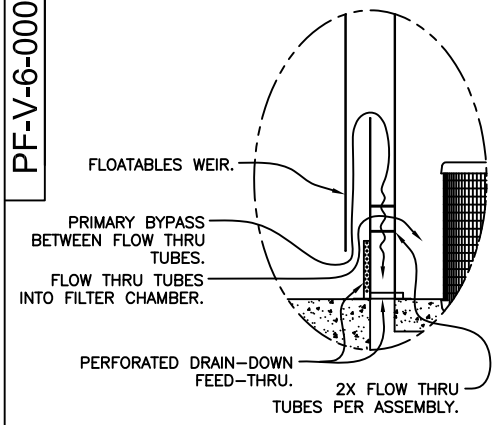
6' Wide Concrete Vault

Eight to Fourteen Cartridges / Stacks

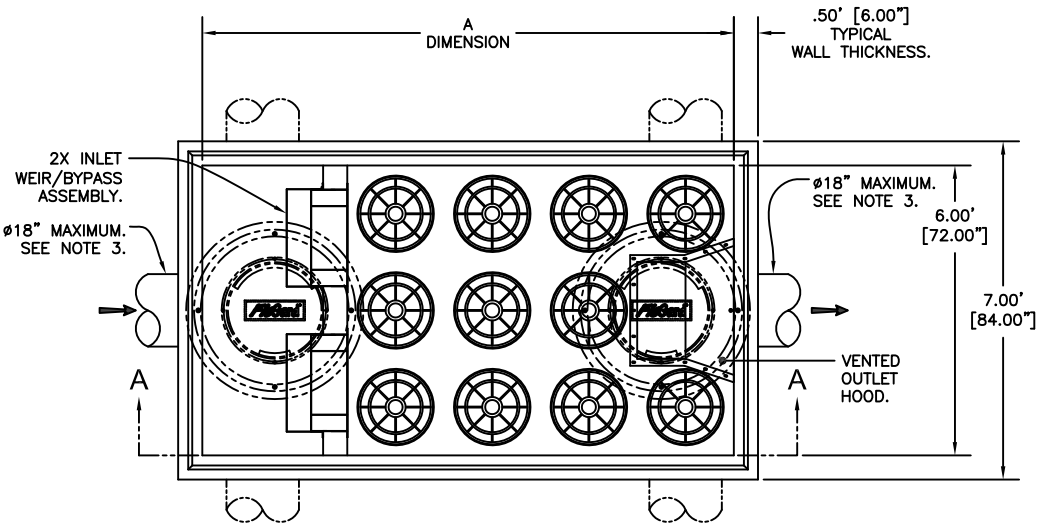
Oldcastle Infrastructure™
A CRH COMPANY

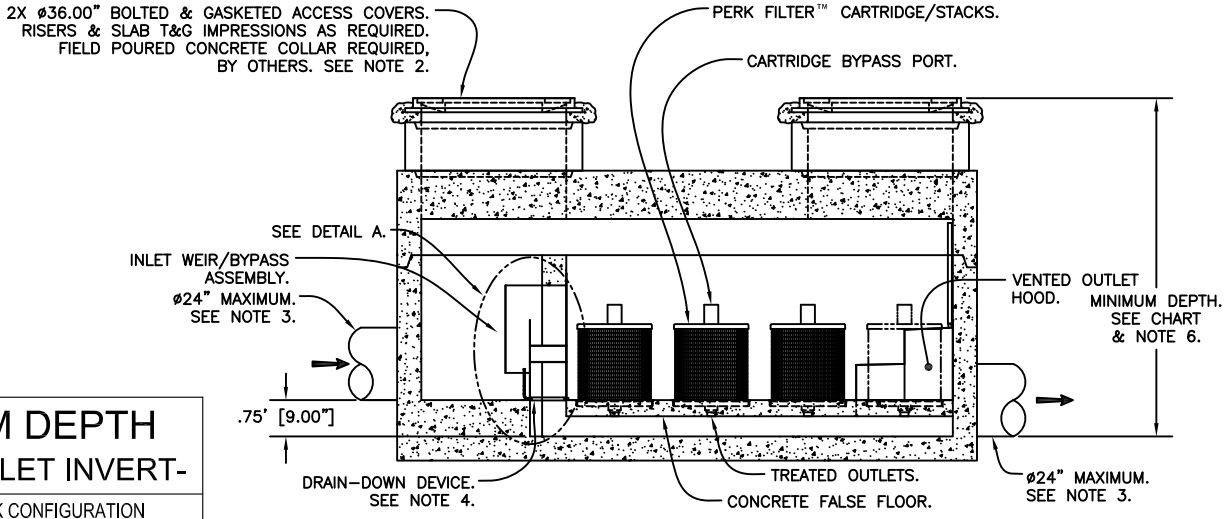
DRAWING NO.	REV	DATE	
PF-V-6-0001	G	CJS 6/16/20	SHEET 1 OF 2

PF-V-6-0001



DETAIL A
INLET WEIR/BYPASS ASSEMBLY & DRAIN–DOWN.
SCALE: NONE





SECTION A-A

MINIMUM DEPTH
-RIM TO OUTLET INVERT-

CARTRIDGE STACK CONFIGURATION			
12"	18"	12" + 12"	12" + 18"
4.25'	5.00'	5.92'	6.67'

6' VAULT
TREATMENT FLOW RATES, TOTAL FLOW CAPACITIES & MAXIMUM HEAD LOSS

CARTRIDGE STACK QUANTITY	A DIMENSION -LENGTH- (ID - FT)	CARTRIDGE STACK CONFIGURATION							
		12"		18"		12" + 12"		12" + 18"	
		TREATMENT FLOW RATE (GPM / CFS)	TOTAL FLOW CAPACITY (CFS)	TREATMENT FLOW RATE (GPM / CFS)	TOTAL FLOW CAPACITY (CFS)	TREATMENT FLOW RATE (GPM / CFS)	TOTAL FLOW CAPACITY (CFS)	TREATMENT FLOW RATE (GPM / CFS)	TOTAL FLOW CAPACITY (CFS)
8	8	96 / 0.21	5.8	144 / 0.32	8.7	192 / 0.43	9.9	240 / 0.53	13.2
9	12	108 / 0.24	5.8	162 / 0.36	8.7	216 / 0.48	10.0	270 / 0.60	13.3
10	12	120 / 0.27	5.9	180 / 0.40	8.8	240 / 0.53	10.0	300 / 0.67	13.4
11	12	132 / 0.29	5.9	198 / 0.44	8.8	264 / 0.59	10.1	330 / 0.74	13.4
12	12	144 / 0.32	5.9	216 / 0.48	8.8	288 / 0.64	10.1	360 / 0.80	13.4
13	12	156 / 0.35	5.9	234 / 0.52	8.8	312 / 0.70	10.1	390 / 0.87	13.4
14	12	168 / 0.37	5.9	252 / 0.56	8.8	336 / 0.75	10.1	420 / 0.94	13.4
MAXIMUM HEAD LOSS		1.7 FT		2.3 FT		2.9 FT		3.5 FT	

Media Filtration

PerkFilter™

6' Wide Concrete Vault

Eight to Fourteen Cartridges / Stacks

Oldcastle Infrastructure™
A CRH COMPANY

DRAWING NO.	REV	DATE	
PF-V-6-0001	G	CJS 6/16/20	SHEET 2 OF 2

WWHM2012
PROJECT REPORT

Project Name: Model 20220228
Site Name: Olympic Vista
Site Address:
City :
Report Date: 2/6/2023
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.00
Version Date: 2021/08/18
Version : 4.2.18

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Onsite Basin
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Mod	5.49
Pervious Total	5.49

Impervious Land Use	acre
Impervious Total	0
Basin Total	5.49

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Onsite Basin
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Pasture, Flat	2.3
Pervious Total	2.3

Impervious Land Use	acre
ROADS FLAT	0.33
ROADS MOD	0.46
ROOF TOPS FLAT	1.87
DRIVEWAYS FLAT	0.27
SIDEWALKS FLAT	0.16
SIDEWALKS MOD	0.1
Impervious Total	3.19
Basin Total	5.49

Element Flows To:
Surface Interflow Groundwater

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:5.49
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:2.3
Total Impervious Area:3.19

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.122308
5 year	0.187228
10 year	0.233899
25 year	0.296554
50 year	0.345693
100 year	0.396811

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	1.430889
5 year	1.941529
10 year	2.315766
25 year	2.831399
50 year	3.247681
100 year	3.69248

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.066	1.492
1950	0.130	1.694
1951	0.117	1.694
1952	0.089	1.330
1953	0.069	1.713
1954	0.349	2.375
1955	0.179	1.673
1956	0.156	0.753
1957	0.179	1.322
1958	0.126	3.215
1959	0.133	1.283
1960	0.112	1.303
1961	0.116	4.190
1962	0.102	1.601
1963	0.147	1.845
1964	0.104	0.998
1965	0.117	1.175
1966	0.064	1.180
1967	0.144	2.750
1968	0.168	1.464
1969	0.166	3.050
1970	0.092	1.135
1971	0.148	1.567
1972	0.115	2.008
1973	0.094	1.643
1974	0.205	1.973
1975	0.092	1.599
1976	0.088	1.116
1977	0.074	1.109
1978	0.093	0.853
1979	0.204	1.871
1980	0.107	1.190
1981	0.086	1.125
1982	0.111	1.147
1983	0.190	1.525
1984	0.116	1.365
1985	0.165	1.930
1986	0.390	1.958
1987	0.167	1.651
1988	0.093	1.351
1989	0.092	1.376
1990	0.122	1.070

1991	0.130	1.318
1992	0.099	1.345
1993	0.064	1.041
1994	0.060	1.134
1995	0.124	1.006
1996	0.231	1.568
1997	0.440	1.765
1998	0.078	1.795
1999	0.113	0.843
2000	0.067	2.896
2001	0.020	0.985
2002	0.119	0.945
2003	0.086	1.281
2004	0.136	2.488
2005	0.100	1.148
2006	0.296	1.565
2007	0.233	1.525
2008	0.315	1.147
2009	0.099	1.171

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.4396	4.1902
2	0.3905	3.2152
3	0.3488	3.0498
4	0.3148	2.8960
5	0.2960	2.7502
6	0.2327	2.4879
7	0.2313	2.3749
8	0.2049	2.0077
9	0.2037	1.9729
10	0.1903	1.9582
11	0.1793	1.9297
12	0.1785	1.8707
13	0.1680	1.8455
14	0.1673	1.7953
15	0.1656	1.7653
16	0.1645	1.7128
17	0.1559	1.6938
18	0.1485	1.6937
19	0.1471	1.6730
20	0.1435	1.6512
21	0.1361	1.6427
22	0.1331	1.6006
23	0.1301	1.5987
24	0.1295	1.5675
25	0.1262	1.5672
26	0.1240	1.5650
27	0.1218	1.5249
28	0.1189	1.5245
29	0.1173	1.4923
30	0.1169	1.4641
31	0.1164	1.3761

32	0.1156	1.3647
33	0.1146	1.3513
34	0.1131	1.3446
35	0.1119	1.3302
36	0.1113	1.3216
37	0.1068	1.3185
38	0.1038	1.3025
39	0.1015	1.2832
40	0.1001	1.2814
41	0.0989	1.1899
42	0.0987	1.1804
43	0.0938	1.1746
44	0.0928	1.1714
45	0.0926	1.1480
46	0.0924	1.1469
47	0.0918	1.1466
48	0.0917	1.1349
49	0.0895	1.1338
50	0.0885	1.1250
51	0.0865	1.1157
52	0.0864	1.1088
53	0.0783	1.0700
54	0.0739	1.0414
55	0.0689	1.0060
56	0.0674	0.9978
57	0.0665	0.9845
58	0.0644	0.9450
59	0.0636	0.8532
60	0.0602	0.8426
61	0.0205	0.7528

Stream Protection Duration
POC #1
The Facility FAILED

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0612	20672	122280	591	Fail
0.0640	18358	117703	641	Fail
0.0669	16294	113339	695	Fail
0.0698	14427	109233	757	Fail
0.0727	12872	105254	817	Fail
0.0755	11477	101511	884	Fail
0.0784	10243	97982	956	Fail
0.0813	9133	94752	1037	Fail
0.0841	8183	91758	1121	Fail
0.0870	7270	88956	1223	Fail
0.0899	6494	86347	1329	Fail
0.0928	5831	83759	1436	Fail
0.0956	5251	81363	1549	Fail
0.0985	4753	79074	1663	Fail
0.1014	4312	76893	1783	Fail
0.1043	3867	74839	1935	Fail

0.1071	3461	72765	2102	Fail
0.1100	3069	70797	2306	Fail
0.1129	2725	69107	2536	Fail
0.1158	2451	67268	2744	Fail
0.1186	2212	65471	2959	Fail
0.1215	2008	63824	3178	Fail
0.1244	1849	62263	3367	Fail
0.1273	1710	60701	3549	Fail
0.1301	1571	59161	3765	Fail
0.1330	1456	57686	3961	Fail
0.1359	1367	56210	4111	Fail
0.1388	1291	54798	4244	Fail
0.1416	1212	53472	4411	Fail
0.1445	1143	52210	4567	Fail
0.1474	1075	51012	4745	Fail
0.1503	999	49836	4988	Fail
0.1531	934	48681	5212	Fail
0.1560	893	47419	5310	Fail
0.1589	849	46285	5451	Fail
0.1617	809	45109	5575	Fail
0.1646	761	44040	5787	Fail
0.1675	722	42970	5951	Fail
0.1704	689	42008	6096	Fail
0.1732	664	41002	6175	Fail
0.1761	641	40018	6243	Fail
0.1790	623	39120	6279	Fail
0.1819	604	38115	6310	Fail
0.1847	586	37238	6354	Fail
0.1876	570	36361	6379	Fail
0.1905	554	35484	6405	Fail
0.1934	540	34671	6420	Fail
0.1962	523	33858	6473	Fail
0.1991	506	33067	6534	Fail
0.2020	484	32361	6686	Fail
0.2049	465	31548	6784	Fail
0.2077	448	30821	6879	Fail
0.2106	439	30137	6864	Fail
0.2135	424	29452	6946	Fail
0.2164	412	28747	6977	Fail
0.2192	403	28105	6973	Fail
0.2221	390	27399	7025	Fail
0.2250	376	26800	7127	Fail
0.2279	365	26201	7178	Fail
0.2307	357	25602	7171	Fail
0.2336	343	25025	7295	Fail
0.2365	335	24469	7304	Fail
0.2394	322	23913	7426	Fail
0.2422	311	23399	7523	Fail
0.2451	304	22907	7535	Fail
0.2480	300	22373	7457	Fail
0.2508	293	21859	7460	Fail
0.2537	285	21333	7485	Fail
0.2566	277	20858	7529	Fail
0.2595	268	20390	7608	Fail
0.2623	259	19958	7705	Fail

0.2652	251	19562	7793	Fail
0.2681	244	19149	7847	Fail
0.2710	235	18758	7982	Fail
0.2738	228	18352	8049	Fail
0.2767	213	17947	8425	Fail
0.2796	205	17567	8569	Fail
0.2825	198	17171	8672	Fail
0.2853	191	16758	8773	Fail
0.2882	185	16405	8867	Fail
0.2911	177	16048	9066	Fail
0.2940	168	15678	9332	Fail
0.2968	163	15349	9416	Fail
0.2997	154	15023	9755	Fail
0.3026	148	14745	9962	Fail
0.3055	141	14448	10246	Fail
0.3083	132	14136	10709	Fail
0.3112	126	13821	10969	Fail
0.3141	119	13548	11384	Fail
0.3170	115	13233	11506	Fail
0.3198	110	12940	11763	Fail
0.3227	108	12654	11716	Fail
0.3256	104	12378	11901	Fail
0.3284	101	12102	11982	Fail
0.3313	98	11849	12090	Fail
0.3342	92	11599	12607	Fail
0.3371	87	11377	13077	Fail
0.3399	76	11139	14656	Fail
0.3428	70	10908	15582	Fail
0.3457	68	10671	15692	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.3612 **acre-feet**
On-line facility target flow: 0.4944 **cfs.**
Adjusted for 15 min: 0.4944 **cfs.**
Off-line facility target flow: 0.2799 **cfs.**
Adjusted for 15 min: 0.2799 **cfs.**

LID Report

LID Technique	Used for Water Quality	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft.)	Cumulative Volume Infiltration Credit	Percent Treatment?	Comment
Total Volume Infiltrated		0.00	0.00	0.00			
0.00	0.00	0%	No Treat. Credit				
Compliance with LID Standard 8							

Duration Analysis Result = Failed

Perlnd and Implnd Changes

No changes have been made.

SECTION 5: CONVEYANCE DESIGN

The stormwater conveyance system is comprised of a network of open/closed grate catch basins, buried pipe, and a Perkfilter water quality vault, and the discharge to an existing drainage connection to Ebey Slough. Catch basins have been located such that each section of storm drainage pipe may adequately convey associated tributary area flows. All storm pipe located within the proposed private road was sized at the minimum diameter in accordance with the conveyance analysis.

Conveyance analysis for the drainage system was completed using AutoCAD Storm and Sanitary Analysis (SSA). The conveyance system was designed for the 100-year, 24-hour storm event, using the Santa Barbara Unit Hydrograph Method. The 100-year cumulative storm for Snohomish County, Washington, with a total rainfall amount of 3.20, using a SCS Type IA 24-hr storm distribution was applied to each subbasin. The Uniform Flow Method (Manning's Equation) was utilized to ensure that during the 100-year, 24-hour storm event, no catch basin structures would be overtopping. See Appendix 5 for full SSA output data as well as a visual representation of contributing conveyance basins.

The following catch basin summary table demonstrates that no catch basin structures overtop for the detention tributary drainage lines in the 100-year design storm event:

Storm Drain Conveyance Analysis				
CB #	**Rim**	**HGL**	**Distance to Overtopping (ft)**	**Pipe Dia (in)**
CB-10	126.39	121.30	5.09	**12**
CB-10A	125.88	122.80	3.08	**12**
CB-11	136.58	133.33	3.25	**12**
CB-2	14.74	13.03	1.71	**12**
CB-3	34.21	28.12	6.09	**12**
CB-4	54.71	54.22	0.49	**12**
CB-5	69.19	64.93	4.26	**12**
CB-5A	67.79	64.93	2.86	**12**
CB-5B	67.79	64.93	2.86	**12**
CB-6	69.15	65.71	3.44	**12**
CB-6A	69.24	65.71	3.53	**12**
CB-7	70.56	67.23	3.33	**12**
CB-7A	70.56	67.46	3.10	**12**
CB-8	99.84	96.91	2.93	**12**
CB-8A	99.84	97.14	2.70	**12**
CB-9	121.52	118.38	3.14	**12**
CB-9A	121.52	118.82	2.70	**12**
EX CB-1	136.18	129.83	6.35	**12**
ExCB2	57.50	54.72	2.78	**12**
WQ-Vault	69.12	61.47	7.65	**12**

Outfall Discharge System

A conveyance capacity calculation was performed using Manning's Equation on the pipe downstream of the discharge pipe can accommodate the 100-year unmitigated storm event. A summary evaluation of pipe capacity, offered below, demonstrates compliance in a condition where the full 100-year peak flow is conveyed through the discharge line. The calculations associated with this evaluation can be found in Appendix 5.
CB-2 to CB-1:

DISCHARGE PIPE CAPACITY EVALUATION	
100-Year Peak Flow Rate:	3.99 cfs (WWHM2012 - 701 Series)
Pipe Diameter:	12"
Minimum Slope:	2.00%
Pipe Flow Depth:	100%
Pipe Flow Capacity:	5.97 cfs
Evaluation:	System Adequate

Appendix 5: Conveyance Design Analysis

1. AutoCAD Storm and Sanitary Analysis Output
2. Conveyance Basin Map
3. Mannings Analysis: CB-2 to CB-1

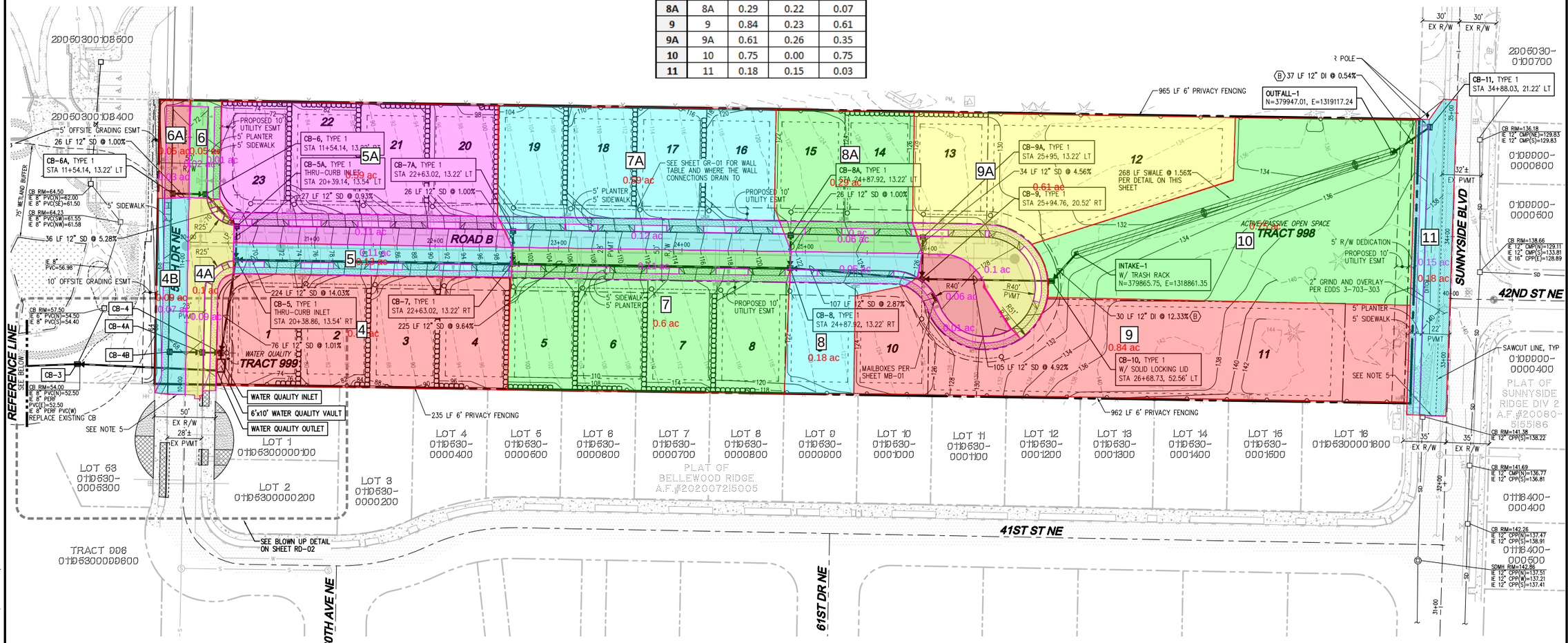
NW 1/4 OF THE NE 1/4, SEC 3, TWN 29 N, RGE 5 E, W.M., CITY OF MARYSVILLE, SNOHOMISH COUNTY, WASHINGTON

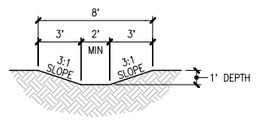
NOTES

1. SEE SHEETS RD-03 THROUGH RD-05 FOR ROAD PROFILES.
2. SEE SHEET RD-06 FOR ROAD SECTIONS.
3. SEE SHEETS DT-01 TO DT-05 FOR NOTES AND DETAILS.
4. ALL EXISTING OVERHEAD UTILITIES TO BE UNDERGROUNDED.
5. APPLY TACK COAT TO FACE OF SAWCUT AND SEAL TOP OF JOINT PER STD PLAN 3-703-003.

Basin	Basin (CB)	Total Area	Total Imp	Pervious
4	4	0.59	0.43	0.16
4A	4A	0.1	0.09	0.01
4B	4B	0.09	0.07	0.02
5	5	0.13	0.11	0.02
5A	5A	0.59	0.43	0.16
6	6	0.05	0.03	0.02
6A	6A	0.05	0.03	0.02
7	7	0.6	0.43	0.17
7A	7A	0.59	0.44	0.15
8	8	0.18	0.13	0.05
8A	8A	0.29	0.22	0.07
9	9	0.84	0.23	0.61
9A	9A	0.61	0.26	0.35
10	10	0.75	0.00	0.75
11	11	0.18	0.15	0.03

SCALE: 1" = 40'





CONVEYANCE SWALE

SCALE: 1"=5'

NOTES:
1. INSTALL MINIMUM 6" QUARRY SPALL ARMORING AT INTAKE AND OUTFALL TO SWALE.
2. INSTALL PERMANENT CHECK DAMS EVERY 2' OF VERTICAL CHANGE OR 100' LINEAL FEET.

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

DISCLAIMER

TOPOGRAPHIC SURVEY INFORMATION CONTAINED ON THESE PLANS HAS BEEN PROVIDED BY PACIFIC COAST SURVEYS, INC. LDC, INC. (LAND DEVELOPMENT CONSULTANTS, INC.) ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

Call 2 Business Days Before You Dig
811 or 1-800-424-5555
Utilities Underground Location Center

CITY FILE NO: PA22-044, G23-0022

CITY OF MARYSVILLE CONSTRUCTION DRAWING REVIEW ACKNOWLEDGEMENT

THIS PLAN SHEET HAS BEEN REVIEWED AND EVALUATED FOR GENERAL COMPLIANCE WITH THE APPLICABLE CITY OF MARYSVILLE CODES AND ORDINANCES. CONFORMANCE OF THIS DESIGN WITH ALL APPLICABLE LAWS AND REGULATIONS IS THE FULL AND COMPLETE RESPONSIBILITY OF THE LICENSED DESIGN ENGINEER, WHOSE STAMP AND SIGNATURE APPEAR ON THIS SHEET. ACKNOWLEDGMENT OF CONSTRUCTION DRAWING REVIEW DOES NOT IMPLY CITY APPROVAL FOR CONSTRUCTION ACTIVITIES THAT REQUIRED OTHER COUNTY, STATE OR FEDERAL PERMIT REVIEW AND APPROVAL. THE PROPERTY OWNER AND LICENSED DESIGN ENGINEER SHALL BE RESPONSIBLE FOR THE ACQUISITION AND COMPLIANCE OF ALL APPLICABLE PERMITS OR AUTHORIZATIONS WHICH MAY INCLUDE, BUT ARE NOT LIMITED TO, WSDRW HYDRAULIC PROJECT APPROVAL (HPS), WSDOE NOTICE OF INTENT (NOI), ANY CORPS OF ENGINEERS FILL PERMITS AND THE REQUIREMENTS OF THE ENDANGERED SPECIES ACT.

THIS DAY OF _____

BY: _____

KEN MCINTYRE, PE, DEVELOPMENT SERVICES MANAGER

APPROVAL FOR 18 MONTHS FROM DATE OF SIGNATURE.

REVISIONS

NO.	DATE	DESCRIPTION	BY

LDC | Surveying Engineering Planning
Kent: 20210 142nd Avenue NE, Woodinville, WA 98072 T 425.806.1869
Olympia: 606 Woodland Square Loop SE, Lacey, WA 98503 F 425.482.2893
www.LDCcorp.com

KEYSTONE LAND, LLC.

OLYMPIC VISTA PRD

CONVEYANCE BASIN MAP

THOMAS P. ABBOTT, STATE OF WASHINGTON, 56092, REGISTERED PROFESSIONAL ENGINEER

JOB NUMBER:	C21-210
DRAWING NAME:	C21210C-RD-PL
DESIGNER:	TPA
DRAFTING BY:	BJN
DATE:	4-24-23
SCALE:	1"=40'
JURISDICTION:	MARYSVILLE

Drawing: P:\CIVIL\2021\21-210 olympic vista\Drawings\construction\C21210C-RD-PL.dwg Plotted: Jun 05, 2023 - 2:19pm

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.3.412 (Build 0)

****
Project Description
****
File Name ..... 20230605 Model.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date APR-17-2023 00:00:00
Ending Date APR-18-2023 00:00:00
Report Time Step 00:00:10

****
Element Count
****
Number of rain gages 1
Number of subbasins 15
Number of nodes 22
Number of links 21

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	TS-01	CUMULATIVE	6.00

****
Subbasin Summary
****

Subbasin ID	Total Area acres	Imperv. Area %	Raingage
4	0.59	74.00	Rain Gage-01
5	0.13	85.00	Rain Gage-01
6	0.05	60.00	Rain Gage-01
7	0.60	72.00	Rain Gage-01
8	0.18	73.00	Rain Gage-01
9	0.85	27.00	Rain Gage-01
10	0.75	0.00	Rain Gage-01
11	0.18	83.00	Rain Gage-01
4A	0.10	90.00	Rain Gage-01
4B	0.09	78.00	Rain Gage-01
5A	0.59	74.00	Rain Gage-01
6A	0.05	60.00	Rain Gage-01
7A	0.59	75.00	Rain Gage-01
8A	0.29	77.00	Rain Gage-01
9A	1.37	19.00	Rain Gage-01

****

Node Summary

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
CB-10	JUNCTION	126.30	129.67	0.00	
CB-11	JUNCTION	134.38	136.58	0.00	
CB-2	JUNCTION	9.00	15.74	0.00	
CB-3	JUNCTION	53.38	54.71	0.00	
CB-4	JUNCTION	64.18	69.19	0.00	
CB-4A	JUNCTION	64.33	67.79	0.00	
CB4B	JUNCTION	64.59	67.79	0.00	
CB-5	JUNCTION	64.95	69.15	0.00	
CB-5A	JUNCTION	65.20	69.24	0.00	
CB-6	JUNCTION	67.10	70.56	0.00	
CB-6A	JUNCTION	67.36	70.56	0.00	
CB-7	JUNCTION	96.38	99.84	0.00	
CB-7A	JUNCTION	96.64	99.84	0.00	
CB-8	JUNCTION	118.06	121.52	0.00	
CB-8A	JUNCTION	118.32	121.52	0.00	
CB-9	JUNCTION	121.13	126.39	0.00	
CB-9A	JUNCTION	122.68	125.88	0.00	
ExCB2	JUNCTION	54.50	57.50	0.00	Yes
INTAKE1	JUNCTION	130.00	132.00	0.00	
OUTFALL1	JUNCTION	134.18	136.18	0.00	
WQ-Vault	JUNCTION	60.63	69.12	0.00	
CB1	OUTFALL	11.52	12.52	0.00	

Link Summary

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
Link-02	CB-9	CB-8	CONDUIT	107.0	2.8692	0.0150
Link-03	CB-4	WQ-Vault	CONDUIT	5.0	1.0000	0.0150
Link-04	CB-9A	CB-9	CONDUIT	34.0	4.5588	0.0150
Link-05	CB-4A	CB-4	CONDUIT	15.0	1.0000	0.0150
Link-08	CB-10	CB-9	CONDUIT	105.0	4.9238	0.0150
Link-09	CB-11	OUTFALL1	CONDUIT	37.0	0.5405	0.0150
Link-10	OUTFALL1	INTAKE1	CHANNEL	268.0	1.5597	0.0320
Link-11	INTAKE1	CB-10	CONDUIT	30.0	12.3333	0.0150
Link-12	CB-2	CB1	CONDUIT	30.0	2.0000	0.0150
Pipe - (19)	CB-5A	CB-5	CONDUIT	26.0	0.9615	0.0120
Pipe - (20)	CB-6A	CB-6	CONDUIT	26.0	1.0000	0.0120
Pipe - (21)	CB-6	CB-5A	CONDUIT	37.0	5.1351	0.0120
Pipe - (22)	CB-8A	CB-8	CONDUIT	26.0	1.0000	0.0120
Pipe - (24)	CB-7A	CB-7	CONDUIT	26.0	1.0000	0.0120
Pipe - (25)	CB-8	CB-7	CONDUIT	225.0	9.6356	0.0120
Pipe - (26)	CB-7	CB-5	CONDUIT	224.0	14.0312	0.0120
Pipe - (29)	CB-5	CB-4	CONDUIT	77.0	1.0000	0.0120
Pipe - (31)	WQ-Vault	CB-3	CONDUIT	113.0	6.4159	0.0120
Pipe - (32)	CB4B	CB-4A	CONDUIT	26.0	1.0000	0.0120
Pipe - (89)	CB-3	CB-2	CONDUIT	238.0	18.6471	0.0120
Pipe - (98)	ExCB2	CB-3	CONDUIT	50.0	1.5800	0.0120

Cross Section Summary

Link ID	Shape	Depth/ Diameter	Width	No. of Barrels	Cross Sectional Area	Full Flow Design Flow	Hydraulic Radius

		ft	ft		ft²	ft
Capacity cfs						
Link-02	CIRCULAR	1.00	1.00	1	0.79	0.25
5.23						
Link-03	CIRCULAR	1.00	1.00	1	0.79	0.25
3.09						
Link-04	CIRCULAR	1.00	1.00	1	0.79	0.25
6.59						
Link-05	CIRCULAR	1.00	1.00	1	0.79	0.25
3.09						
Link-08	CIRCULAR	1.00	1.00	1	0.79	0.25
6.85						
Link-09	CIRCULAR	1.00	1.00	1	0.79	0.25
2.27						
Link-10	TRAPEZOIDAL	1.00	8.00	1	5.00	0.60
20.64						
Link-11	CIRCULAR	1.00	1.00	1	0.79	0.25
10.84						
Link-12	CIRCULAR	1.00	1.00	1	0.79	0.25
4.37						
Pipe - (19)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.78						
Pipe - (20)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.86						
Pipe - (21)	CIRCULAR	1.00	1.00	1	0.79	0.25
8.75						
Pipe - (22)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.86						
Pipe - (24)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.86						
Pipe - (25)	CIRCULAR	1.00	1.00	1	0.79	0.25
11.98						
Pipe - (26)	CIRCULAR	1.00	1.00	1	0.79	0.25
14.46						
Pipe - (29)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.86						
Pipe - (31)	CIRCULAR	1.00	1.00	1	0.79	0.25
9.78						
Pipe - (32)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.86						
Pipe - (89)	CIRCULAR	1.00	1.00	1	0.79	0.25
16.67						
Pipe - (98)	CIRCULAR	0.67	0.67	1	0.35	0.17
1.65						

**********	Volume	Depth
Runoff Quantity Continuity	acre-ft	inches
**********	---------	-------
Total Precipitation	1.706	3.194
Surface Runoff	1.059	1.983
Continuity Error (%)	0.000	

**********	Volume	Volume
Flow Routing Continuity	acre-ft	Mgallons
**********	---------	---------
External Inflow	0.357	0.116
External Outflow	1.407	0.458
Initial Stored Volume	0.002	0.001
Final Stored Volume	0.006	0.002
Continuity Error (%)	0.004	

****
Composite Curve Number Computations Report
****

Subbasin 4

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.59		92.28

Subbasin 5

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.13		94.70

Subbasin 6

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.05		89.20

Subbasin 7

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.60		91.84

Subbasin 8

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.18		92.06

Subbasin 9

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.85		81.94

Subbasin 10

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.75		76.00

Subbasin 11

Soil/Surface Description	Area (acres)	Soil Group	CN

Composite Area & Weighted CN	0.18		94.26

Subbasin 4A

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.10		95.80

Subbasin 4B

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.09		93.16

Subbasin 5A

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.59		92.28

Subbasin 6A

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.05		89.20

Subbasin 7A

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.59		92.50

Subbasin 8A

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.29		92.94

Subbasin 9A

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	1.37		80.18

****
Runoff Coefficient Computations Report
****

Subbasin 4

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.59	-	0.72
Composite Area & Weighted Runoff Coeff.	0.59		0.72

Subbasin 5

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.13	-	0.72
Composite Area & Weighted Runoff Coeff.	0.13		0.72

Subbasin 6

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.05	-	0.72
Composite Area & Weighted Runoff Coeff.	0.05		0.72

Subbasin 7

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.60	-	0.72
Composite Area & Weighted Runoff Coeff.	0.60		0.72

Subbasin 8

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.18	-	0.72
Composite Area & Weighted Runoff Coeff.	0.18		0.72

Subbasin 9

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.85	-	0.72
Composite Area & Weighted Runoff Coeff.	0.85		0.72

Subbasin 10

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.75	-	0.72
Composite Area & Weighted Runoff Coeff.	0.75		0.72

Subbasin 11

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.18	-	0.72
Composite Area & Weighted Runoff Coeff.	0.18		0.72

Subbasin 4A

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.10	-	0.72
Composite Area & Weighted Runoff Coeff.	0.10		0.72

Subbasin 4B

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.09	-	0.72
Composite Area & Weighted Runoff Coeff.	0.09		0.72

Subbasin 5A

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.59	-	0.72
Composite Area & Weighted Runoff Coeff.	0.59		0.72

Subbasin 6A

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.05	-	0.72
Composite Area & Weighted Runoff Coeff.	0.05		0.72

Subbasin 7A

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.59	-	0.72
Composite Area & Weighted Runoff Coeff.	0.59		0.72

Subbasin 8A

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.29	-	0.72
Composite Area & Weighted Runoff Coeff.	0.29		0.72

Subbasin 9A

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.37	-	0.72
Composite Area & Weighted Runoff Coeff.	1.37		0.72

****
SCS TR-55 Time of Concentration Computations Report
****

Sheet Flow Equation

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where:

Tc = Time of Concentration (hrs)
n = Manning's Roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hrs)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hrs)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's Roughness

Subbasin 4

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	90.00	0.00	0.00
Slope (%):	2.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	1.55	

1.55

Velocity (ft/sec):	0.05	0.00	
0.00			
Computed Flow Time (minutes):	28.36	0.00	
0.00			

==========

Total TOC (minutes): 28.36

==========

Subbasin 5

User-Defined TOC override (minutes): 5.00

Subbasin 6

User-Defined TOC override (minutes): 5.00

Subbasin 7

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	90.00	0.00	0.00
Slope (%):	2.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	1.55	1.55
Velocity (ft/sec):	0.05	0.00	0.00
Computed Flow Time (minutes):	28.36	0.00	0.00

==========

Total TOC (minutes): 28.36

==========

Subbasin 8

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	90.00	0.00	0.00
Slope (%):	2.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	1.55	1.55

Velocity (ft/sec):	0.05	0.00	0.00
Computed Flow Time (minutes):	28.36	0.00	0.00
Total TOC (minutes):	28.36		

Subbasin 9

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	380.00	0.00	0.00
Slope (%):	2.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	1.55	1.55
Velocity (ft/sec):	0.07	0.00	0.00
Computed Flow Time (minutes):	89.77	0.00	0.00
Total TOC (minutes):	89.77		

Subbasin 10

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	265.00	0.00	0.00
Slope (%):	1.60	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	0.00	0.00
Velocity (ft/sec):	0.06	0.00	0.00
Computed Flow Time (minutes):	73.57	0.00	0.00
Total TOC (minutes):	73.57		

Subbasin 11

==========

Total TOC (minutes): 0.00

==========

Subbasin 4A

User-Defined TOC override (minutes): 5.00

Subbasin 4B

User-Defined TOC override (minutes): 5.00

Subbasin 5A

User-Defined TOC override (minutes): 5.00

Subbasin 6A

User-Defined TOC override (minutes): 5.00

Subbasin 7A

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	90.00	0.00	0.00
Slope (%):	2.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	1.55	1.55
Velocity (ft/sec):	0.05	0.00	0.00
Computed Flow Time (minutes):	28.36	0.00	0.00

==========

Total TOC (minutes): 28.36

==========

Subbasin 8A

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	90.00	0.00	0.00
Slope (%):	2.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	1.55	1.55
Velocity (ft/sec):	0.05	0.00	0.00
Computed Flow Time (minutes):	28.36	0.00	0.00
Total TOC (minutes):	28.36		

Subbasin 9A

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.40	0.00	0.00
Flow Length (ft):	210.00	0.00	0.00
Slope (%):	2.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.55	1.55	1.55
Velocity (ft/sec):	0.06	0.00	0.00
Computed Flow Time (minutes):	55.86	0.00	0.00
Total TOC (minutes):	55.86		

****

Subbasin Runoff Summary

****

Subbasin ID	Total Precip in	Total Runoff in	Peak Runoff cfs	Weighted Curve Number	Time of Concentration days	hh:mm:ss
4	3.19	2.47	0.26	92.280	0	00:28:21
5	3.19	2.69	0.09	94.700	0	00:05:00
6	3.19	2.23	0.03	89.200	0	00:05:00
7	3.19	2.43	0.26	91.840	0	00:28:21
8	3.19	2.45	0.08	92.060	0	00:28:21
9	3.19	1.56	0.13	81.940	0	01:29:46
10	3.19	1.09	0.08	76.000	0	01:13:34
11	3.19	2.65	0.12	94.260	0	00:05:00
4A	3.19	2.78	0.07	95.800	0	00:05:00
4B	3.19	2.56	0.06	93.160	0	00:05:00
5A	3.19	2.49	0.36	92.280	0	00:05:00
6A	3.19	2.23	0.03	89.200	0	00:05:00

7A	3.19	2.48	0.27	92.500	0	00:28:21
8A	3.19	2.52	0.13	92.940	0	00:28:21
9A	3.19	1.45	0.23	80.180	0	00:55:51

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
CB-10	0.07	0.11	126.41	0	08:03	0	0	0:00:00
CB-11	0.08	0.17	134.55	0	07:54	0	0	0:00:00
CB-2	3.43	3.74	12.74	0	08:03	0	0	0:00:00
CB-3	0.41	0.90	54.28	0	08:03	0	0	0:00:00
CB-4	0.37	0.81	64.99	0	08:02	0	0	0:00:00
CB-4A	0.23	0.66	64.99	0	08:02	0	0	0:00:00
CB4B	0.08	0.40	64.99	0	08:02	0	0	0:00:00
CB-5	0.37	0.83	65.78	0	08:02	0	0	0:00:00
CB-5A	0.20	0.58	65.78	0	08:02	0	0	0:00:00
CB-6	0.04	0.13	67.23	0	08:00	0	0	0:00:00
CB-6A	0.04	0.10	67.46	0	08:00	0	0	0:00:00
CB-7	0.28	0.61	96.99	0	08:09	0	0	0:00:00
CB-7A	0.16	0.50	97.14	0	00:00	0	0	0:00:00
CB-8	0.24	0.40	118.46	0	08:07	0	0	0:00:00
CB-8A	0.11	0.50	118.82	0	00:00	0	0	0:00:00
CB-9	0.14	0.21	121.34	0	08:07	0	0	0:00:00
CB-9A	0.08	0.13	122.81	0	08:18	0	0	0:00:00
ExCB2	0.22	0.22	54.72	0	00:13	0	0	0:00:00
INTAKE1	0.03	0.07	130.07	0	08:00	0	0	0:00:00
OUTFALL1	0.02	0.06	134.24	0	07:57	0	0	0:00:00
WQ-Vault	0.39	0.92	61.55	0	08:03	0	0	0:00:00
CB1	0.28	0.51	12.03	0	08:03	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
CB-10	JUNCTION	0.08	0.18	0	08:02	0.00		
CB-11	JUNCTION	0.12	0.12	0	07:54	0.00		
CB-2	JUNCTION	0.00	2.24	0	08:03	0.00		
CB-3	JUNCTION	0.00	2.26	0	08:03	0.00		
CB-4	JUNCTION	0.26	2.06	0	08:02	0.00		
CB-4A	JUNCTION	0.07	0.13	0	07:52	0.00		
CB4B	JUNCTION	0.06	0.06	0	07:54	0.00		
CB-5	JUNCTION	0.09	1.69	0	08:01	0.00		
CB-5A	JUNCTION	0.36	0.41	0	07:54	0.00		
CB-6	JUNCTION	0.03	0.05	0	08:00	0.00		
CB-6A	JUNCTION	0.03	0.03	0	08:00	0.00		
CB-7	JUNCTION	0.26	1.26	0	08:06	0.00		
CB-7A	JUNCTION	0.27	0.27	0	08:06	0.00		
CB-8	JUNCTION	0.08	0.74	0	08:06	0.00		
CB-8A	JUNCTION	0.13	0.13	0	08:06	0.00		
CB-9	JUNCTION	0.13	0.52	0	08:06	0.00		
CB-9A	JUNCTION	0.23	0.23	0	08:18	0.00		

ExCB2	JUNCTION	0.18	0.18	0	00:00	0.00
INTAKE1	JUNCTION	0.00	0.12	0	07:57	0.00
OUTFALL1	JUNCTION	0.00	0.12	0	07:54	0.00
WQ-Vault	JUNCTION	0.00	2.06	0	08:02	0.00
CB1	OUTFALL	0.00	2.24	0	08:03	0.00

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
CB1	99.63	0.80	2.24
System	99.63	0.80	2.24

****
Link Flow Summary
****

Link ID	Element Type	Total Reported Time	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Ratio of Maximum Depth	Surcharged minutes
Link-02	CONDUIT	0	08:07	2.62	1.00	0.52	5.23	0.10	0.30	0
Calculated										
Link-03	CONDUIT	0	08:02	3.49	1.00	2.06	3.09	0.67	0.71	0
Calculated										
Link-04	CONDUIT	0	08:18	2.65	1.00	0.23	6.59	0.04	0.17	0
Calculated										
Link-05	CONDUIT	0	07:34	0.81	1.00	0.14	3.09	0.05	0.74	0
Calculated										
Link-08	CONDUIT	0	08:03	2.17	1.00	0.18	6.85	0.03	0.16	0
Calculated										
Link-09	CONDUIT	0	07:54	2.31	1.00	0.12	2.27	0.05	0.12	0
Calculated										
Link-10	CHANNEL	0	07:57	0.79	1.00	0.12	20.64	0.01	0.07	0
Calculated										
Link-11	CONDUIT	0	08:00	3.31	1.00	0.12	10.84	0.01	0.09	0
Calculated										
Link-12	CONDUIT	0	08:03	4.94	1.00	2.24	4.37	0.51	0.56	0
Calculated										
Pipe - (19)	CONDUIT	0	00:00	3.84	1.00	0.60	3.78	0.16	0.71	0
Calculated										
Pipe - (20)	CONDUIT	0	08:00	0.63	1.00	0.03	3.86	0.01	0.12	0
Calculated										
Pipe - (21)	CONDUIT	0	08:00	0.38	1.00	0.05	8.75	0.01	0.36	0
Calculated										
Pipe - (22)	CONDUIT	0	00:00	4.12	1.00	0.36	3.86	0.09	0.32	0
Calculated										
Pipe - (24)	CONDUIT	0	00:00	1.75	1.00	0.52	3.86	0.13	0.50	0
Calculated										

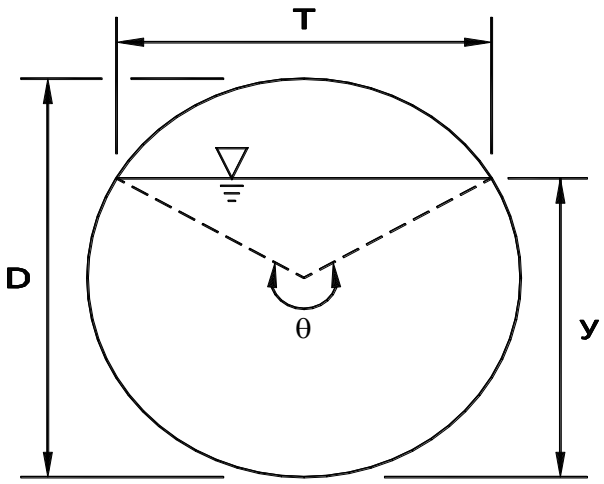
```
  Pipe - (25)          CONDUIT      0  08:07      2.05    1.00        0.74       11.98      0.06
0.50           0  Calculated
  Pipe - (26)          CONDUIT      0  08:09      4.68    1.00        1.25       14.46      0.09
0.71           0  Calculated
  Pipe - (29)          CONDUIT      0  08:02      3.16    1.00        1.69        3.86      0.44
0.82           0  Calculated
  Pipe - (31)          CONDUIT      0  08:03      2.94    1.00        2.08        9.78      0.21
0.91           0  Calculated
  Pipe - (32)          CONDUIT      0  08:04      0.50    1.00        0.06        3.86      0.02
0.53           0  Calculated
  Pipe - (89)          CONDUIT      0  08:03      3.23    1.00        2.24       16.67      0.13
0.95           0  Calculated
  Pipe - (98)          CONDUIT      0  00:13      2.27    1.00        0.18        1.65      0.11
0.59           0  Calculated


  ********************************
  Highest Flow Instability Indexes
  ********************************
  Link Pipe - (25) (20)
  Link Pipe - (26) (9)
  Link Pipe - (29) (6)
  Link Pipe - (31) (4)
  Link Pipe - (89) (3)

  WARNING 107 : Initial water surface elevation defined for Junction INTAKE1 is below junction
invert elevation.
                Assumed initial water surface elevation equal to invert elevation.
  WARNING 108 : Surcharge elevation defined for Junction INTAKE1 is below junction maximum
elevation. Assumed surcharge elevation equal to maximum elevation.
  WARNING 108 : Surcharge elevation defined for Junction OUTFALL1 is below junction maximum
elevation. Assumed surcharge elevation equal to maximum elevation.
  WARNING 107 : Initial water surface elevation defined for Junction WQ-Vault is below junction
invert elevation.
                Assumed initial water surface elevation equal to invert elevation.
  WARNING 108 : Surcharge elevation defined for Junction WQ-Vault is below junction maximum
elevation. Assumed surcharge elevation equal to maximum elevation.

  Analysis began on:  Tue Jun  6 09:02:44 2023
  Analysis ended on:  Tue Jun  6 09:02:49 2023
  Total elapsed time: 00:00:05
```

Open Channel Flow Calculator For Circular Pipes	**Land Development Consultants, Inc.**	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name: Frontier Heights
Description: Downstream Conveyance

Project No.: C22-239
Date: 6/6/2023
Calc. By: RKF

Pipe Diameter (D) =	12	in
Pipe Slope (S) =	2.00	%
Flow Depth (y) =	1.00	ft
Flowrate (Q) =	**5.97**	**cfs**
Mannings Coeff. (n) =	0.011	
Theta Angle (θ) =	6.28	rad
Wetted Area (A) =	0.79	ft^2
Wet. Perimeter (P) =	3.14	ft
Hydraulic Radius (R) =	0.25	ft
Top Width (T) =	0.00	ft
Flow Velocity =	7.60	fps



Formulas:

Theta Angle (θ): If y ≥ r : $\theta = 2\pi - 2a\cos(\frac{y-r}{r})$ where: r = Pipe Radius

If y ≤ r : $\theta = 2a\cos(\frac{r-y}{r})$ where: r = Pipe Radius

Wetted Area (A): $A = \frac{1}{8}(\theta - \sin\theta)d^2$

Wetted Perimeter (P): $P = \frac{1}{2}\theta d$

Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = \sin\left(\theta/2\right)d$

SECTION 6: OPERATIONS AND MAINTENANCE MANUAL

The proposed storm drainage system consists of buried pipes, catch basins, and a Perkfilter vault. These facilities will require periodic maintenance and inspection. Inspection and maintenance procedures are contained on the following pages.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Structure	Sediment	Sediment exceeds 60% of the depth from the bottom of the catch basin to the invert of the lowest pipe into or out of the catch basin or is within 6 inches of the invert of the lowest pipe into or out of the catch basin.	Sump of catch basin contains no sediment.
	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the catch basin by more than 10%.	No Trash or debris blocking or potentially blocking entrance to catch basin.
		Trash or debris in the catch basin that exceeds $^1/_3$ the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		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 catch basin.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that catch basin is unsound.	Catch basin is sealed and is structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than $^1/_4$ inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Catch basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the catch basin at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Metal Grates (Catch Basins)	Unsafe grate opening	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.	Grate free of trash and debris. footnote to guidelines for disposal
	Damaged or missing	Grate missing or broken member(s) of the grate. **Any open structure requires urgent maintenance**.	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open structure requires urgent maintenance**.	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

NO. 6 – CONVEYANCE PIPES AND DITCHES

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & debris accumulation	Accumulated sediment or debris that exceeds 20% of the diameter of the pipe.	Water flows freely through pipes.
	Vegetation/roots	Vegetation/roots that reduce free movement of water through pipes.	Water flows freely through pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damage to protective coating or corrosion	Protective coating is damaged; rust or corrosion is weakening the structural integrity of any part of pipe.	Pipe repaired or replaced.
	Damaged	Any dent that decreases the cross section area of pipe by more than 20% or is determined to have weakened structural integrity of the pipe.	Pipe repaired or replaced.
Ditches	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment accumulation	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion damage to slopes	Any erosion observed on a ditch slope.	Slopes are not eroding.
	Rock lining out of place or missing (If Applicable)	One layer or less of rock exists above native soil area 5 square feet or more, any exposed native soil.	Replace rocks to design standards.

Oldcastle Infrastructure™
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PERKFILTER™

Inspection and Maintenance Guide

Water

PerkFilter™ Media Filtration System

Description

The PerkFilter is a stormwater treatment device used to remove pollutants from urban runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters. The PerkFilter is a media-filled cartridge filtration device designed to capture and retain sediment, gross solids, metals, nutrients, hydrocarbons, and trash and debris. As with any stormwater treatment system, the PerkFilter requires periodic maintenance to sustain optimum system performance.

Function

The PerkFilter is a water quality treatment system consisting of three chambers: an inlet chamber, a filter cartridge treatment chamber, and an outlet chamber (Figure 1). Stormwater runoff enters the inlet chamber through an inlet pipe, curb opening, or grated inlet. Gross solids are settled out, and floating trash and debris are trapped in the inlet chamber. Pretreated flow is then directed to the treatment chamber through an opening in the baffle wall between the inlet chamber and treatment chamber. The treatment chamber contains media-filled filter cartridges (Figure 2) that use physical and chemical processes to remove pollutants. During a storm event, runoff pools in the treatment chamber before passing radially through the cylindrical cartridges from the outside surface, through the media for treatment, and into the center of the cartridge. At the center of the cartridge is a center tube assembly designed to distribute the hydraulic load evenly across the surface of the filter cartridge and control the treatment flow rate. The center tube assembly discharges treated flow through the false floor and into the outlet chamber. A draindown feature built into each cartridge allows the treatment chamber to dewater between storm events.

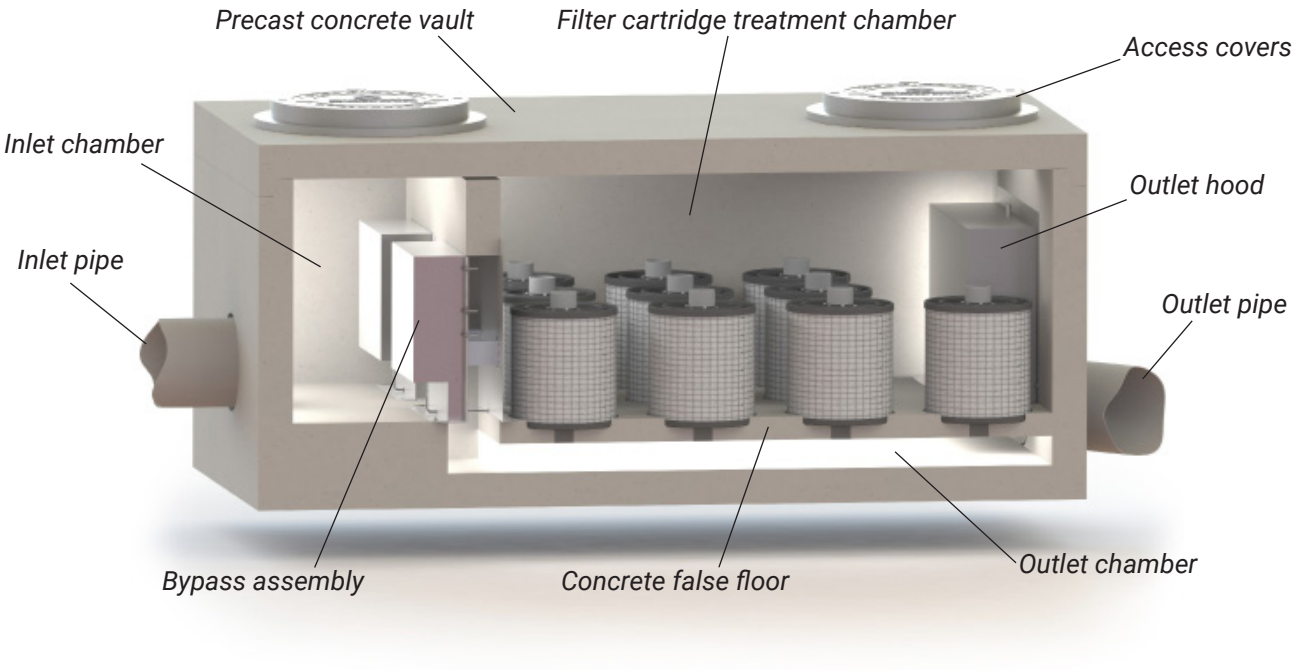

Figure 1. Schematic of the PerkFilter system.

All PerkFilter systems include a high-flow bypass assembly to divert flow exceeding the treatment capacity of the filter cartridges around the treatment chamber. The bypass assembly routes peak flow from the inlet chamber directly to the outlet chamber, bypassing the treatment chamber to prevent sediment and other captured pollutants from being scoured and re-entrained by high flow. Treated flow and bypass flow merge in the outlet chamber for discharge by a single outlet pipe.

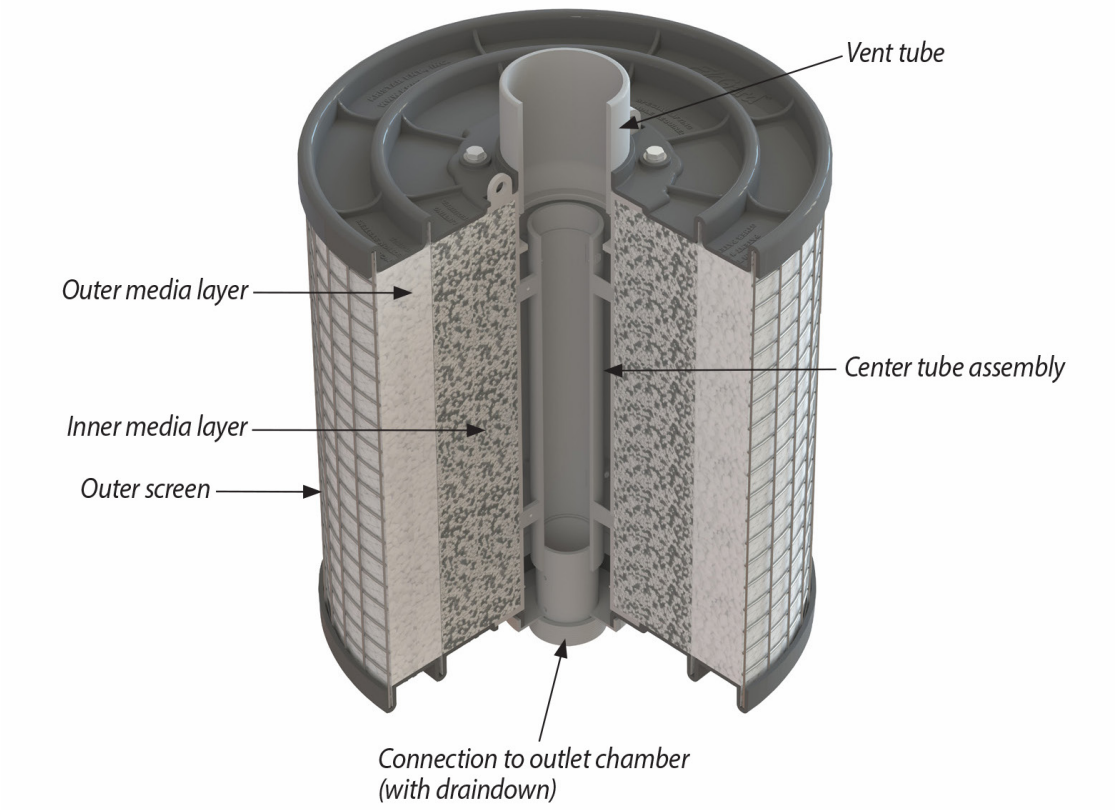

Figure 2. Schematic of PerkFilter cartridge.

Configuration

The PerkFilter structure may consist of a vault, manhole, or catch basin configuration. Catch basin units may be fabricated from concrete or steel. Internal components including the PerkFilter cartridges are manufactured from durable plastic and stainless steel components and hardware. All cartridges are 18 inches in diameter and are available in two heights: 12-inch and 18-inch. Cartridges may be used alone or may be stacked (Figure 3) to provide 24-inch and 30-inch combinations. The capacity of each cartridge or cartridge combination is dictated by the allowable operating rate of the media and the outer surface area of the cartridge. Thus, taller cartridges have greater treatment capacity than shorter cartridges, but they also require more hydraulic drop across the system. Cartridges may be filled with various media depending on the target pollutants and desired treatment rate, among other factors.

Access to an installed PerkFilter system is typically provided by ductile iron castings or hatch covers. The location and number of access appurtenances is dependent on the size and configuration of the system.

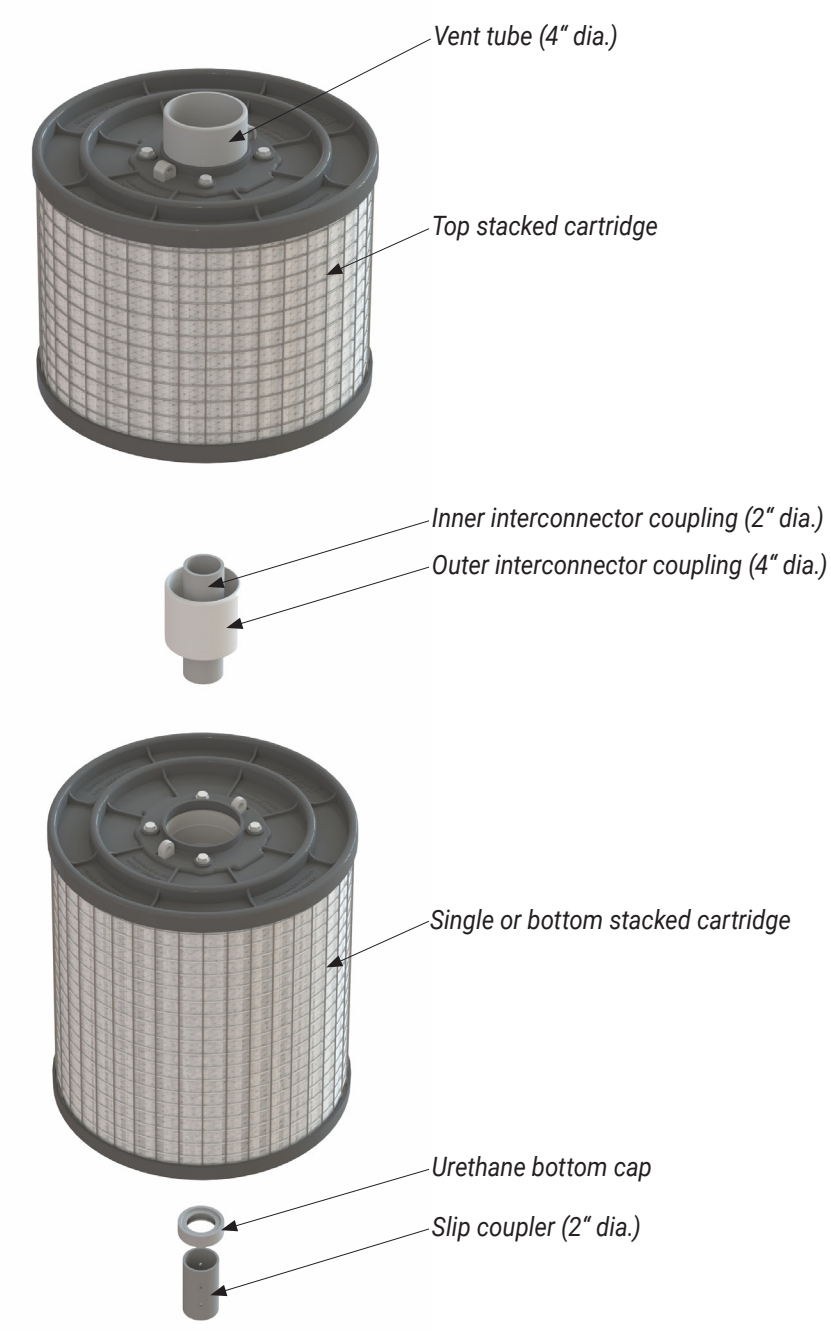

Figure 3. Schematic of stacked cartridges and connector components.

Maintenance Overview

State and local regulations require all stormwater management systems to be inspected on a periodic basis and maintained as necessary to ensure performance and protect downstream receiving waters. Maintenance prevents excessive pollutant buildup that can limit system performance by reducing the operating capacity and increasing the potential for scouring of pollutants during periods of high flow.

Inspection and Maintenance Frequency

The PerkFilter should be inspected on a periodic basis, typically twice per year, and maintained as required. Initially, inspections of a new system should be conducted more frequently to help establish an appropriate site-specific inspection frequency. The maintenance frequency will be driven by the amount of runoff and pollutant loading encountered by a given system. In most cases, the optimum maintenance interval will be one to three years. Inspection and maintenance activities should be performed only during dry weather periods.

Inspection Equipment

The following equipment is helpful when conducting PerkFilter inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net (optional)

Inspection Procedures

PerkFilter inspections are visual and may be conducted from the ground surface without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided at the end of this document) to determine whether maintenance is required:

- Inspect the internal components and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Infrastructure at (800) 579-8819 to determine appropriate corrective action.
- Note whether the inlet pipe is blocked or obstructed. The outlet pipe is covered by a removable outlet hood and cannot be observed without entering the unit.
- Observe, quantify and record the accumulation of floating trash and debris in the inlet chamber. The significance of accumulated floating trash and debris is a matter of judgment. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to accumulation of floating oils or settled sediment is not yet warranted.

- Observe, quantify and record the accumulation of oils in the inlet chamber. The significance of accumulated floating oils is a matter of judgment. However, if there is evidence of an oil or fuel spill, immediate maintenance by appropriate certified personnel is warranted.
- Observe, quantify and record the average accumulation of sediment in the inlet chamber and treatment chamber. A calibrated dipstick, tape measure, or sludge sampler may be used to determine the amount of accumulated sediment in each chamber. The depth of sediment may be determined by calculating the difference between the measurement from the rim of the PerkFilter to the top of the accumulated sediment, and the measurement from the rim of the PerkFilter to the bottom of the PerkFilter structure. Finding the top of the accumulated sediment below standing water takes some practice and a light touch, but increased resistance as the measuring device is lowered toward the bottom of the unit indicates the top of the accumulated sediment.
- Finally, observe, quantify and record the amount of standing water in the treatment chamber around the cartridges. If standing water is present, do not include the depth of sediment that may have settled out below the standing water in the measurement.

Maintenance Triggers

Maintenance should be scheduled if any of the following conditions are identified during the inspection:

- Internal components are broken or missing.
- Inlet piping is obstructed.
- The accumulation of floating trash and debris that cannot be retrieved with a net and/or oil in the inlet chamber is significant.
- There is more than 6” of accumulated sediment in the inlet chamber.
- There is more than 4” of accumulated sediment in the treatment chamber.
- There is more than 4” of standing water in the treatment chamber more than 24 hours after end of rain event.
- A hazardous material release (e.g. automotive fluids) is observed or reported.
- The system has not been maintained for 3 years (wet climates) to 5 years (dry climates).

Maintenance Equipment

The following equipment is helpful when conducting PerkFilter maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Confined space entry equipment, if needed
- Flashlight
- Tape measure
- 9/16” socket and wrench to remove hold-down struts and filter cartridge tops
- Replacement filter cartridges
- Vacuum truck with water supply and water jet

Contact Oldcastle Infrastructure at (800) 579-8819 for replacement filter cartridges. A lead time of four weeks is recommended.

Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. Confined space entry is necessary to maintain vault and manhole PerkFilter configurations. Only personnel that are OSHA Confined Space Entry trained and certified may enter underground structures. Confined space entry is not required for catch basin PerkFilter configurations. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove floating trash, debris and oils from the water surface in the inlet chamber using the extension nozzle on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the inlet chamber and evacuate all accumulated sediment from the inlet chamber. Some jetting may be required to fully remove sediment. The inlet chamber does not need to be refilled with water after maintenance is complete. The system will fill with water when the next storm event occurs.
- Remove the hold-down strut from each row of filter cartridges and then remove the top of each cartridge (the top is held on by four 9/16" bolts) and use the vacuum truck to evacuate the spent media. When empty, the spent cartridges may be easily lifted off their slip couplers and removed from the vault. The couplers may be left inserted into couplings cast into the false floor to prevent sediment and debris from being washed into the outlet chamber during washdown.
- Once all the spent cartridges have been removed from the structure, the vacuum truck may be used to evacuate all accumulated sediment from the treatment chamber. Some jetting may be required to fully remove sediment. Take care not to wash sediment and debris through the openings in the false floor and into the outlet chamber. All material removed from the PerkFilter during maintenance including the spent media must be disposed of in accordance with local, state, and/or federal regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.
- Place a fresh cartridge in each cartridge position using the existing slip couplers and urethane bottom caps. If the vault is equipped with stacked cartridges, the existing outer and inner interconnector couplers must be used between the stacked cartridges to provide hydraulic connection. Transfer the existing vent tubes from the spent cartridges to the fresh cartridges. Finally, refit the struts to hold the fresh cartridges in place.
- Securely replace access covers, as appropriate.
- Make arrangements to return the empty spent cartridges to Oldcastle Infrastructure.

PerkFilter
Inspection and Maintenance Log

Location_____

Structure Configuration and Size:

Inspection Date_____

☐ Vault _____feet x _____feet
☐ Manhole _____feet diameter
☐ Catch Basin _____feet x _____feet

Number and Height of Cartridge Stacks:

Count____each ☐12" ☐ 18" ☐ 24" ☐ 30"

Media Type:

☐ ZPC ☐ Perlite ☐ Other_____

Condition of Internal Components ☐ Good ☐ Damaged ☐ Missing	Notes:
Inlet or Outlet Blockage or Obstruction ☐ Yes ☐ No	Notes:
Floating Trash and Debris ☐ Significant ☐ Not Significant	Notes:
Floating Oils ☐ Significant ☐ Not Significant ☐ Spill	Notes:
Sediment Depth in Inlet Chamber ☐ Inches of Sediment:_____	Notes:
Sediment Depth in Treatment Chamber ☐ Inches of Sediment:_____	Notes:
Standing Water in Treatment Chamber ☐ Inches of Standing Water:_____	Notes:

Maintenance Required

☐ **Yes - Schedule Maintenance** ☐ **No - Inspect Again in _____ Months**

PERKFILTER™

OUR MARKETS

BUILDING STRUCTURES

COMMUNICATIONS

WATER

ENERGY

TRANSPORTATION

SECTION 7: SPECIAL REPORTS AND STUDIES

The following studies were conducted in preparation of this Report:

- Geotechnical Investigation, Lui and Associates, October 11, 2017