Perrinville Creek Stormwater Flow Reduction Predesign

Part 2 – 74th Avenue West Detention Facility
Predesign Report

#T31020

Prepared for:

City of Edmonds
Public Works
Department
Engineering Division

Prepared by:

TETRA TECH

October 2014

PRESENTED TO

City of Edmonds Public Works
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10/16/2014

Project Manager	Date

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ACKNOWLEDGEMENT

This project has been funded by the United States Environmental Protection Agency under Puget Sound Ecosystem Restoration and Protection Cooperative Agreement Grant PC-00J20101 with Washington State Department of Ecology (Ecology Grant Number G1400022). The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

EXECUTIVE SUMMARY

The City of Edmonds ("City") desires to improve the water quality and aquatic habitat in the lower reaches of Perrinville Creek, including at its mouth in Puget Sound. The 764-acre watershed, located both within the City of Edmonds and the City of Lynnwood, largely developed prior to modern stormwater quantity and quality controls.

The 30-inch-diameter Perrinville Creek culvert under Talbot Road near Puget Sound is a fish barrier, and the City has completed a preliminary design report for replacing it with a larger fish-friendly box culvert to permit access to upstream habitat. Replacing the culvert, however, could broaden sedimentation deposition and flooding risk in the lower reaches of Perrinville Creek, since the existing culvert restricts some high creek flows.

The primary goal of this project is to reduce high stormwater flows in Perrinville Creek. Flow reduction will provide multiple hydrologic and biological benefits to both the creek and Browns Bay in Puget Sound, allowing for the replacement of an anadromous fish barrier culvert and habitat improvements in the creek's lower reaches, reducing erosion and sedimentation that are impacting aquatic habitat and City infrastructure, and reducing the amount of pollutants in the aquatic environment. In addition, this project along with other projects recommended to retrofit the hydrology of the Perrinville Creek watershed, will reduce flood flows in the creek and corresponding risk to adjoining properties.

To achieve this goal the City is looking to implement priority stormwater retrofit projects which were selected based on a flow control reduction analysis performed by Tetra Tech and discussed in further detail in the report, *Perrinville Creek Stormwater Flow Reduction Retrofit Study, October 2014*. This report details the results of hydrologic modeling, geomorphic and geologic characterization of the creek, the development of target flow levels, and identification of locations and approaches for flow reduction methodologies. From this report, the City of Edmonds has selected two sites to advance to preliminary design. These sites were selected based on their cost-effectiveness in reducing scouring flows in the creek, employing their 2-year peak flow reduction as a comparative measure. The 74th Avenue West Detention Facility is one of two selected projects because it provides opportunity for reductions in frequent storm flows through storage and attenuation of peak flows while containing the footprint of improvements to city-owned property.

The subbasin area tributary to this retrofit project is contained within the Subbasin 17 area of the Perrinville Creek Subwatershed as defined in the retrofit study. This project is located along the western limits of the City of Lynnwood in the central upper reaches of the Perrinville Creek watershed. The project is located within the right of way area of 74th Avenue West, approximately 150 feet south of the intersection with 192nd Place SW. An existing 18" diameter storm sewer crosses 74th Avenue West after which the grade drops approximately 10 feet and the pipe daylights at an intermittently-flowing channel located behind the residential properties bordering the west side of 74th Avenue West.

This storm system collects 28 acres of residential area in catch basins and approximately 4,000 linear feet of 12"-18" diameter pipes flowing generally from east to west. Because of the large contributing drainage area and the drop in grade downstream, this location provides a good opportunity to detain peak flows. The retrofit project consists of a subsurface watertight 72" diameter pipe detention system with a footprint of approximately 150' x 15' and a storage volume of 8,450 cubic feet. This detention system is controlled by a downstream orifice riser structure, which is designed to convey the 100-year peak flow without upstream flooding. The total project cost is estimated to be $445,000 which includes the costs for completing the design, construction bid package, permitting; the construction cost with a 30% contingency; and construction phase inspection, management and engineering support.

The project is directed towards stormwater peak flow reduction, and does not intend to retrofit water quality from the drainage to current standards. Limited water quality treatment will be accomplished through sediment deposition that occurs within the detention facility. In addition, the project provides indirect water quality benefit by contributing to reduced channel scour in Perrinville Creek.

1.0 INTRODUCTION

Draining 764 acres in northern Edmonds and western Lynnwood, Perrinville Creek has the three conditions typical of Puget Sound coastal watersheds: a broad headwater plateau, urban land use, and runoff concentrated in storm drains. Below the confluence of four tributary drainages, the creek drops steeply through a ravine eroded into glacial and pre-glacial deposits. The creek emerges from the ravine and transitions to a lower-gradient channel, forming an alluvial fan. The creek drops 260 feet in elevation over about one mile before discharging to Browns Bay in Puget Sound. Approximately 90 percent of the watershed is residential land use; the remaining 10 percent is commercial.

The City is working to improve the aquatic habitat in the lower reaches of Perrinville Creek, including at its mouth in Puget Sound. The 30-inch-diameter Perrinville Creek culvert under Talbot Road is a fish barrier, and the City has completed a preliminary design report for replacing it with a fish-friendly box culvert to permit access to some upstream habitat. Replacing the culvert, however, could broaden sedimentation deposition and present flooding risk in the lower reaches of Perrinville Creek, since the existing culvert is restricting some high creek flows.

The primary goal of this project is to reduce flows in Perrinville Creek by attenuating peak flows of stormwater runoff. The flow reduction will provide multiple hydrologic and biological benefits to both the creek and Browns Bay in Puget Sound, such as allowing for the replacement of an anadromous fish barrier culvert, reducing erosion and sedimentation that are impacting aquatic habitat and City infrastructure, and reducing the amount of pollutants in the aquatic environment.

The *Perrinville Creek Stormwater Flow Reduction Study* (October 2014) identifies 12 recommended capital projects to reduce storm flows in the creek, and this project was been identified, in consultation with the City of Lynnwood, as a priority project to be advanced through preliminary design. The location of the project within the context of the watershed is shown in Figure 1. This project attenuates peak flows for a 28-acre tributary area in the upper reaches of the Perrinville Creek watershed through interception of the storm main by a 72-inch diameter subsurface pipe detention system.

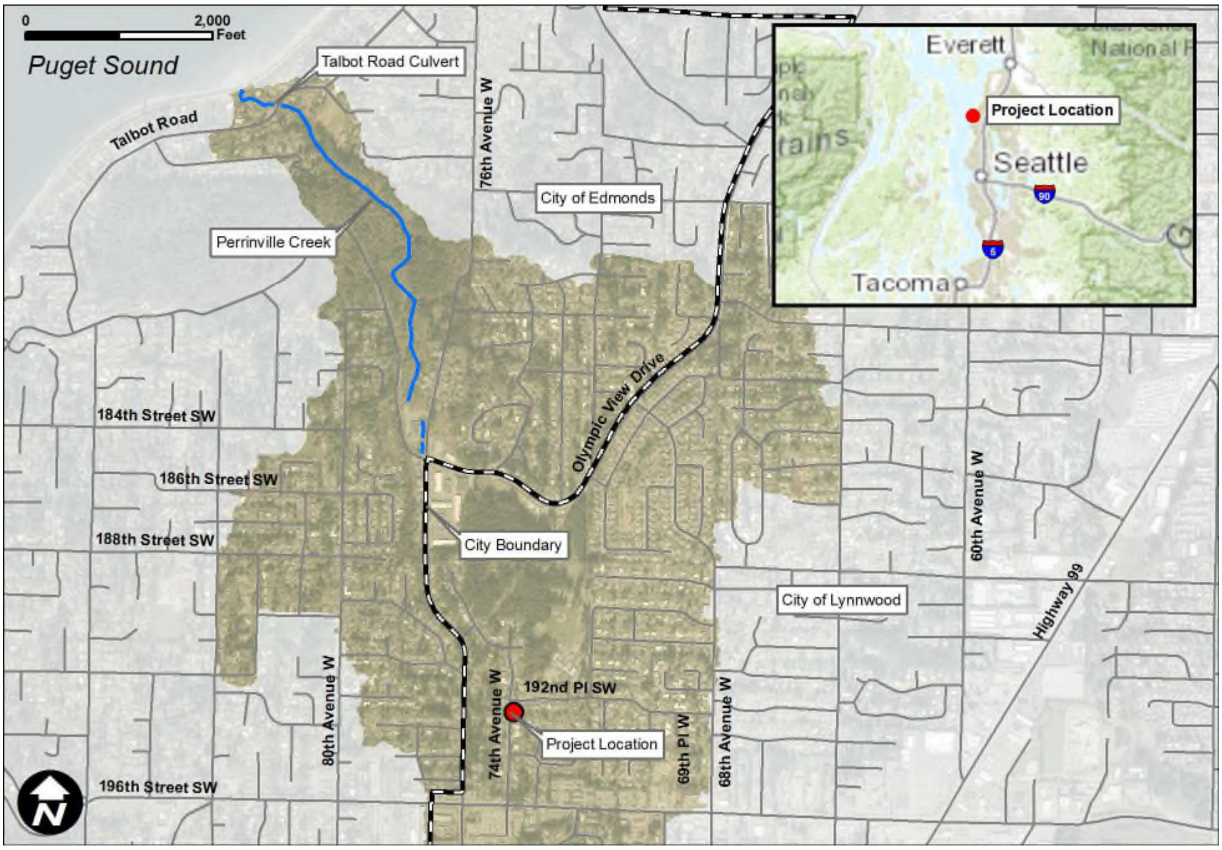


Figure 1. Project Location Map

1.1 TASKS PERFORMED TO COMPLETE THE PREDESIGN REPORT

The following tasks were performed to prepare the predesign report for the 74th Avenue West pipe detention retrofit project:

1. Collect data from existing sources.
2. Develop concept level solutions to maximize 2-year peak-flow reduction.
3. Conduct field survey and mapping of project area.
4. Analyze subwatershed hydrology and conveyance system hydraulics.
5. Evaluate peak-flow reductions.
6. Prepare preliminary design plans, cost estimate and predesign report.

1.2 PROJECT DESIGN TEAM

Tetra Tech, a national engineering consulting firm, has been retained by the City of Edmonds Public Works Department to design stormwater retrofits for the Perrinville Creek area. Associated Earth Sciences, Inc. is assisting Tetra Tech in soils/infiltration testing for select locations within the watershed area.

Jerry Schuster, PE is the Project Manager for the City of Edmonds. Jerry represents the City's interests as the project owner and grantee, coordinates communication between consultant and city staff, and acts as the liaison between the project team and the public.

Rick Schaefer, PE, is Tetra Tech's Project Manager to deliver both the study and the project predesigns. Rick is responsible for the day-to-day management of the project and provides technical direction to the team performing analyses and deliverables. Rick has a bachelor's degree in Civil Engineering from the University of Michigan, and Master Degree in Civil Engineering from North Carolina State University. Rick is registered as a Professional Engineer in the State of Washington (#19988) and State of California (#41430).

Greg Gaasland, P.E. provides QA/QC for the project. Greg has 30 years of experience designing storm drain systems. Greg has a Bachelor's and Master's degrees in Civil Engineering from the University of Washington and is registered as a Professional Engineer in the State of Washington (#26923).

Theo Prince, P.E., is the lead designer responsible for developing plans, specifications and cost estimates (PSE) for each design submittal. Theo has 14 years of design experience focusing on storm drain design for roadway projects. Recent design experience includes storm drain system design of a new 60" pile supported pipe associated with the Charleston Bus Annex in Staten Island, NY. Theo has Bachelor's degree from the University of Washington and is a registered Professional Engineer in the State of Washington (#41859).

Bryan Thomasy is the lead CAD technician responsible for production of the design drawings. Bryan is a certified professional and subject matter expert in AutoCAD Civil 3D 2013. Bryan has 24 years of experience that include stormwater and watershed drainage design.

Erik VanBuskirk is the lead for the mapping of the project area. Erik has 20 years of experience as a surveyor with a certificate in Basic Land Survey from the United States Marine Corps, via Palomar Community College. Erik is also registered as a Professional Land Surveyor in the State of Washington (#46325).

1.3 DATA COLLECTION

The following data were collected to support the 74th Avenue West Detention Facility predesign:

- GIS shapefiles of land cover, soils, water features and storm drain inventory.
- LiDAR mapping of the ground surface topography.
- Design guidance and standards from Ecology.
- Planimetric mapping of roads and utilities in the public right-of-way.
- Elevation of the ground surface, storm drain and sanitary sewer systems in the public right-of-way.
- Geomorphic characterization study of Perrinville Creek

1.4 DESCRIPTION OF THE PROBLEM

The City is working to improve the water quality and aquatic habitat in the lower reaches of Perrinville Creek, including at its mouth in Puget Sound. The 30-inch-diameter Perrinville Creek culvert under Talbot Road is a fish barrier, and the City has completed a preliminary design report for replacing it with a fish-friendly box culvert to permit access to some upstream habitat. Replacing the culvert, however, could affect sedimentation and flooding risk in the lower reaches of Perrinville Creek, since the existing culvert is restricting some high creek flows.

The primary goal of this project is to reduce flows in Perrinville Creek by attenuating peak flows of stormwater runoff. The flow reduction will provide multiple hydrologic and biological benefits to both the creek and Browns Bay in Puget Sound, such as allowing for the replacement of an anadromous fish barrier culvert, reducing erosion and sedimentation that are impacting aquatic habitat and City infrastructure, and reducing the amount of pollutants in the aquatic environment.

Although the City has been investigating many options of flow reduction for Perrinville Creek, this project is one opportunity that has been identified as a priority project which has been advanced to preliminary design.

2.0 PROJECT SUMMARY

2.1 EXISTING CONDITIONS

This project is located along the western limits of the City of Lynnwood in the central upper reaches of the Perrinville Creek watershed and the subbasin tributary to this retrofit project is contained within a portion of Subbasin 17 as identified in the *Perrinville Creek Stormwater Flow Reduction Retrofit Study, October 2014 (Study)*. The project is located within the right of way area of 74th Avenue West, approximately 150 feet south of the intersection with 192nd Place SW.

An existing 18-inch diameter storm sewer crosses 74th Avenue West after which the pipe grade drops approximately 10 feet prior to daylighting in a channel. This channel is located behind the residential properties bordering 74th Avenue West to the west and flows to the north. Drainage from contributing residential area flows west to Perrinville Creek from its limits at 68th Avenue West (see Figure 2).

The contributing headwaters consist primarily of relatively flat residential area also characterized as medium-density residential. The upper areas of the subbasin west of 68th Avenue West are relatively flat, and the gradient is notably steeper (about 3.5% on average) to the west of 69th Place West. Runoff is collected in roadside curb and gutters with catch basins and 12-inch pipe connections. Nearing the project location, an 18-inch concrete storm sewer conveys the drainage area through backyards of residential properties between a cul-de-sac at 73rd Place West and the crossing of 74th Avenue West.

This storm system collects 28 acres of residential areas in catch basins and approximately 4,000 linear feet of 12- to 18-inch diameter pipes. Because of the large contributing drainage area, position in the upper reaches of the watershed, and the drop in grade downstream, this location provides a good opportunity to intercept and attenuate peak flows.

2.2 DESCRIPTION OF SOILS

Surficial geology in the project area are Vashon till lodgments which are densely packed soils deposited and consolidated by glacial activity over 10,000 years ago. They have low permeability and a high potential for surface runoff. The subsurface exploration and infiltration assessment is summarized in the Subsurface Exploration, Infiltration Assessment, and Geotechnical Engineering Report (Associated Earth Sciences, Inc. 2014).

Because of the proximity of steep slopes on the west side of 74th Ave West, and the likelihood of soils with poor infiltration rates, this site was not selected as a good candidate for an infiltration facility.

2.3 PROPOSED PROJECT

The retrofit project consists of a subsurface watertight 72” diameter pipe detention system with a footprint of approximately 150’ x 15’ and an associated storage volume of 8,450 cubic feet. This detention system is controlled by a downstream orifice riser structure which is designed to: (1) control the 2-year discharge rate, and (2) convey the 100-year peak flow without flooding. The project area, at 74th Avenue West, has no known flooding problems. The proposed detention system intercepts runoff from an existing 18” diameter concrete storm pipe that flows through a depression in residential backyard area prior to crossing 74th Avenue West. This line will be tied into the pipe detention system which will be oriented north-south in the northbound lane and shoulder of 74th Ave W.

The following elements were considered when developing the proposed project:

- Target reduction of the 2-year return discharge
- To the maximum extent possible, provide conveyance for the 100-year peak flow event without flooding
- Consider a system that will minimally impact traffic during construction
- Ease of maintenance access to the facility
- Locate the retrofit on public property
- Avoid/resolve in-street utility conflicts

The proposed project addresses the goals of peak flow reduction in Perrinville Creek through flow attenuation in the pipe detention facility. The target of the 2-year control is derived from the basin-specific analysis described by the Perrinville Creek Stormwater Flow Reduction Study. Direct water quality benefits from this facility include limited sedimentation within the detention facility. More importantly, the peak flow reduction provided by this facility contributes to reducing peak flow magnitudes and durations which are eroding the Perrinville Creek channel and suspending sediments downstream.

3.0 SITE ASSESSMENT

The following engineering investigations were performed to support the development of the predesign report:

- Hydrologic analysis to estimate peak runoff rates for conveyance design
- Hydraulic analysis to size and evaluate performance of the proposed storm drain system
- Project mapping to define existing conditions and map known utilities
- Field reconnaissance to verify existing conditions

A project location map is located on Figure 1. The basemap of existing conditions can be found in the preliminary design drawings found in Attachment 1.

4.0 PRELIMINARY PROJECT DESIGN

Preliminary design drawings are found in Attachment 1.

5.0 ENVIRONMENTAL REVIEW DOCUMENTATION

Environmental review will be completed in later design phases per discussions with Ecology.

6.0 PRELIMINARY COST ESTIMATE AND COST TO COMPLETE

The total project construction cost is estimated to be $445,000, which includes a base construction cost estimate of $222,000 plus a design contingency of $67,000. Preliminary cost estimates are found in Attachment 2. The costs include the base construction cost estimate; an allowance for final design, preparation of the construction bid package, permitting, and construction phase engineering support; an allowance for construction contingencies; and a provision for City costs to administer construction. All estimates are in 2014 dollars.

Unit costs were generally derived from bid tabs from recently completed projects in the area and from Washington State Department of Transportation bid tabs for recent local projects. Adjustments for preliminary level cost assumptions were made using recent unit bid item costs. Unit prices used for the estimates are shown in Attachment 2.

The additional associated costs to complete the project are estimated to be $156,000. The cost breakdown is as follows:

- $56,000 for final engineering and preparation of bid package
- $56,000 for construction management
- $11,000 for preparation and coordination of permits and approvals
- $11,000 for City project management and administration
- $22,000 for management reserve

7.0 FACILITY MAINTENANCE NEEDS

Facility maintenance needs are summarized below. Because this project falls within the Western Washington Phase II Municipal Stormwater Permit area, maintenance requirements from the permit will also apply (S.5.C.5).

Pipelines and Catch Basins

1. Inspection annually or after a major storm event of catch basins for sediment accumulation. Structures will be cleaned if the depth of deposits is equal to or greater than one-third the depth from the basin to the invert of the lowest pipe into or out of the basin.
2. Annual inspection for any deterioration threatening the structural integrity of the facility.

Orifice Control Structure

1. Inspect once every six months, preferably after storm events and greater than 0.5 inches of rainfall in 24 hours.
2. Remove trash and debris in excess of 25% of the sump depth or 1 foot below orifice plate
3. Remove any debris blockage of orifices and overflow
4. Check structural integrity of all elements and water tightness of connections

Pipe Detention System

1. Inspect air-vents, remove any obstructions of openings.
2. Remove sediment and debris accumulation in excess of 10% of the diameter of the storage pipe for ½ the length of any one section or 15% accumulation at any one point in the storage area.
3. Seal any openings which allow material in or seepage out.
4. Tank sections bent more than 10% out of the design should be evaluated and/or repaired.
5. Repair any cracks or structural damage.

The pre-settling section of pipe will need to have sediment removed as it accumulates. This is fairly simple and can be performed with a vactor truck. Overall, the maintenance on this system should be within the range of typical stormwater facilities.

8.0 DESIGN FLOWS AND SYSTEM HYDRAULICS

The design objective for this project is to reduce the magnitude of frequent storm discharges in order to reduce the magnitude and duration of scouring flows downstream in Perrinville Creek. The 2-year discharge was selected as the target for sizing of facilities in the Study. The predesign effort emphasized maximizing the amount of storage attainable within the available right-of-way without requiring extensive utility relocations.

Peak design flows for the analysis and sizing were estimated from the 2-year through the 100-year return period using the Western Washington Hydrology Model (WWHM). The WWHM model was selected as the appropriate tool to estimate peak stormwater runoff rates because it uses actual rainfall data, and is able to represent the varying land-use conditions and subcatchment areas in the subbasin. A 15-minute time-step is used for conveyance design to ensure that high-intensity, short-duration runoff flows that typically cause flooding in urbanized areas are considered in the sizing of conveyance facilities.

The WWHM model used regional runoff land use parameters and 15-minute rainfall from the Everett precipitation gage. Precipitation values were multiplied by a 0.80 regional adjustment factor provided by the WWHM model. Pan evaporation from Puyallup was adopted and multiplied by 0.76 as a pan factor regional adjustment.

Subbasins were delineated with respect to the conveyance network using LiDAR provided by the City of Edmonds. No reach routing was included in the subbasin model so peak flow rates represent the un-attenuated condition; this may produce conservative peak flow estimates.

TABLE 1 - WWHM LAND COVER PARAMETERS

Soil Type, Land Cover, Slope	Area (acres)
C, Lawn, Flat	16.6
Impervious Area, Flat	11.5
Total	**28.1**

Peak flows developed with the hydrologic analysis results were used to size the control structure for the detention facility. Orifice sizing targeted maximizing peak flow reduction of the 2-year event with the goal of reducing scouring flows in the creek.

A backwater analysis was performed to provide an estimate of the hydraulic grade line in the pipe system under pressure flow conditions. System hydraulics were analyzed assuming the lowest orifice opening on the control structure was blocked and the 100-year flood event of 13.1 cfs needed to pass through the riser overflow at elevation of 387.6 feet and the 18” diameter orifice at elevation 385.7 feet NAVD88. The analysis also assumed a Manning’s roughness coefficient of 0.012 representative of the existing concrete pipe.

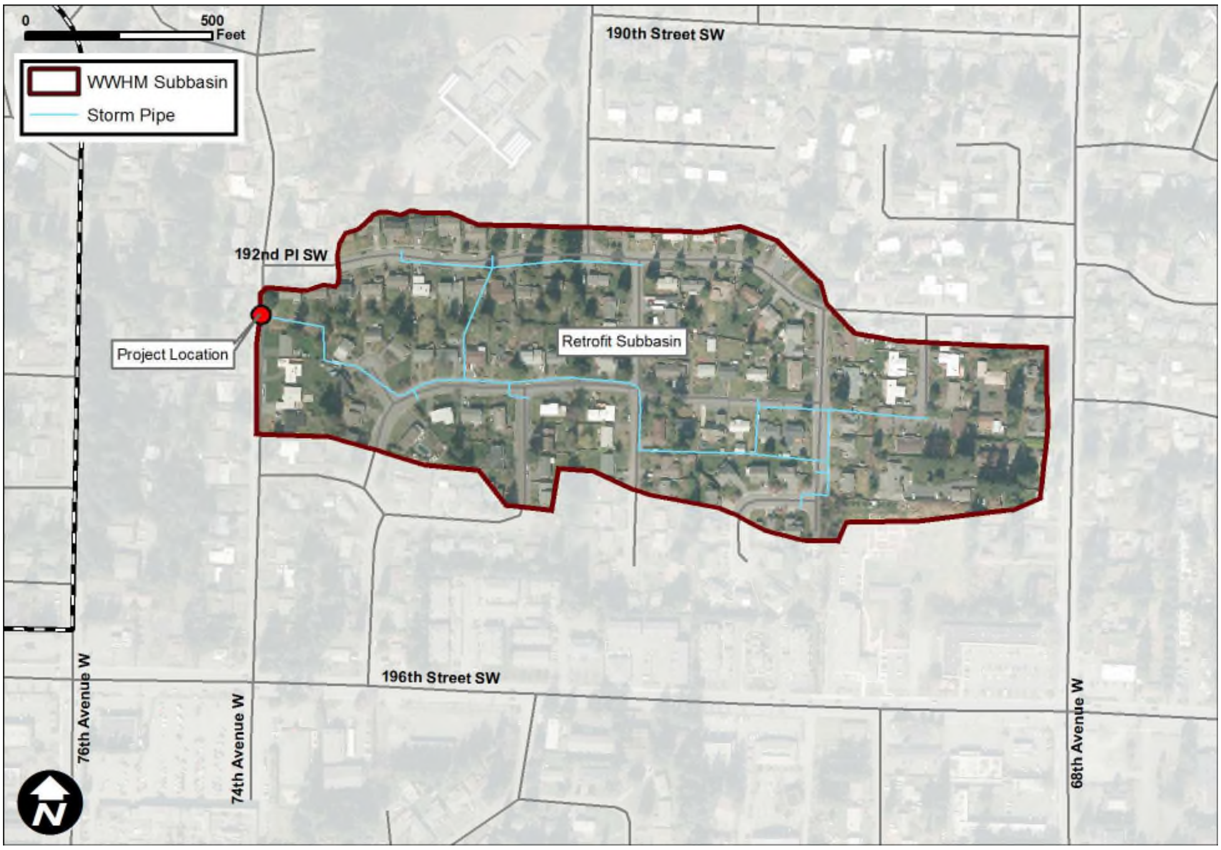


Figure 2. WWHM subbasin for the 74th Ave W Detention Facility

TABLE 2 - HYDROLOGIC MODEL RESULTS

EXISTING CONDITIONS		EXISTING CONDITION W/ PROPOSED FACILITY		HISTORIC FORESTED FLOW	
Return Period	Discharge (cfs)	Return Period	Discharge (cfs)	Return Period	Discharge (cfs)
2-Year	4.2	2-Year	2.8	2-Year	0.020
5-Year	5.9	5-Year	5.4	5-Year	0.023
10-Year	7.1	10-Year	6.5	10-Year	0.024
25-Year	9.9	25-Year	7.7	25-Year	0.025
50-Year	11.7	50-Year	8.9	50-Year	0.026
100-Year	13.1	100-Year	10.4	100-Year	0.027

The predicted performance and cost of the facility differs from that described in the Study. The Study concept assumed an 8-foot diameter tank would be used based upon the known topography and drainage system data derived from GIS. However, site survey identified an existing sanitary sewer which conflicts with lowering the discharge storm drain to accommodate the 8-foot diameter tank, thereby restricting the tank size to 6-foot diameter and reducing the available storage volume and increasing the facility footprint resulting in increased construction costs.

9.0 WATER QUALITY BENEFITS

This detention retrofit, will reduce erosion of the Perrinville Creek channel by attenuating peak flows of stormwater runoff, thereby reducing the magnitude and duration of discharge exceeding the scour threshold. Additionally, the detention system will provide limited sediment deposition within the tanks which will be periodically removed when maintained.

This project is one step forward in achieving the desired goals for improvement to the aquatic habitat in the lower reaches of Perrinville Creek, including at its mouth in Puget Sound. The reduction of peak flows resulting from this retrofit, along with the other recommended projects, will contribute to reducing the magnitude and duration of erosive flows that degrade the Perrinville Creek channel through the mile-long ravine. The flow reduction to be achieved by implementing the two priority projects will mitigate the risk of flooding and sedimentation that may result from the replacement 30-inch-diameter Perrinville Creek culvert under Talbot Road with a fish-passable culvert.

10.0 CONSTRUCTION SCENARIO

A potential construction sequencing scenario is outlined below. Actual sequencing will be determined by the contractor at the time of construction.

Potential Construction Sequence:

1. Establish clearing limits
2. Install erosion control
3. Maintain erosion control
4. Implement and maintain traffic control
5. Sawcut and remove pavement
6. Provide temporary flow bypass
7. Remove existing pipe
8. Relocate utilities (if needed)
9. Install new pipe detention facility
10. Restore pavement
11. Install plantings and seeding
12. Remove erosion control

10.1 CONSTRUCTION SCHEDULE

The project construction schedule has not been established but would occur during the summer and early fall time period.

10.2 CONSTRUCTION EQUIPMENT

Construction equipment used to construct this project has not been specified, but the contractor will most likely use excavators, end loaders, and dump trucks normally associated with utility projects of this type. Light trucks, bobcats, and other utility vehicles will also be used.

10.3 PERMIT REQUIREMENTS

The following permits are anticipated for this project:

- City of Lynnwood, Storm Drainage Permit Application
- City of Lynnwood, Road Improvement Permit Application
- City of Lynnwood, Water Main/Service Permit Application
- SEPA checklist

11.0 REFERENCES

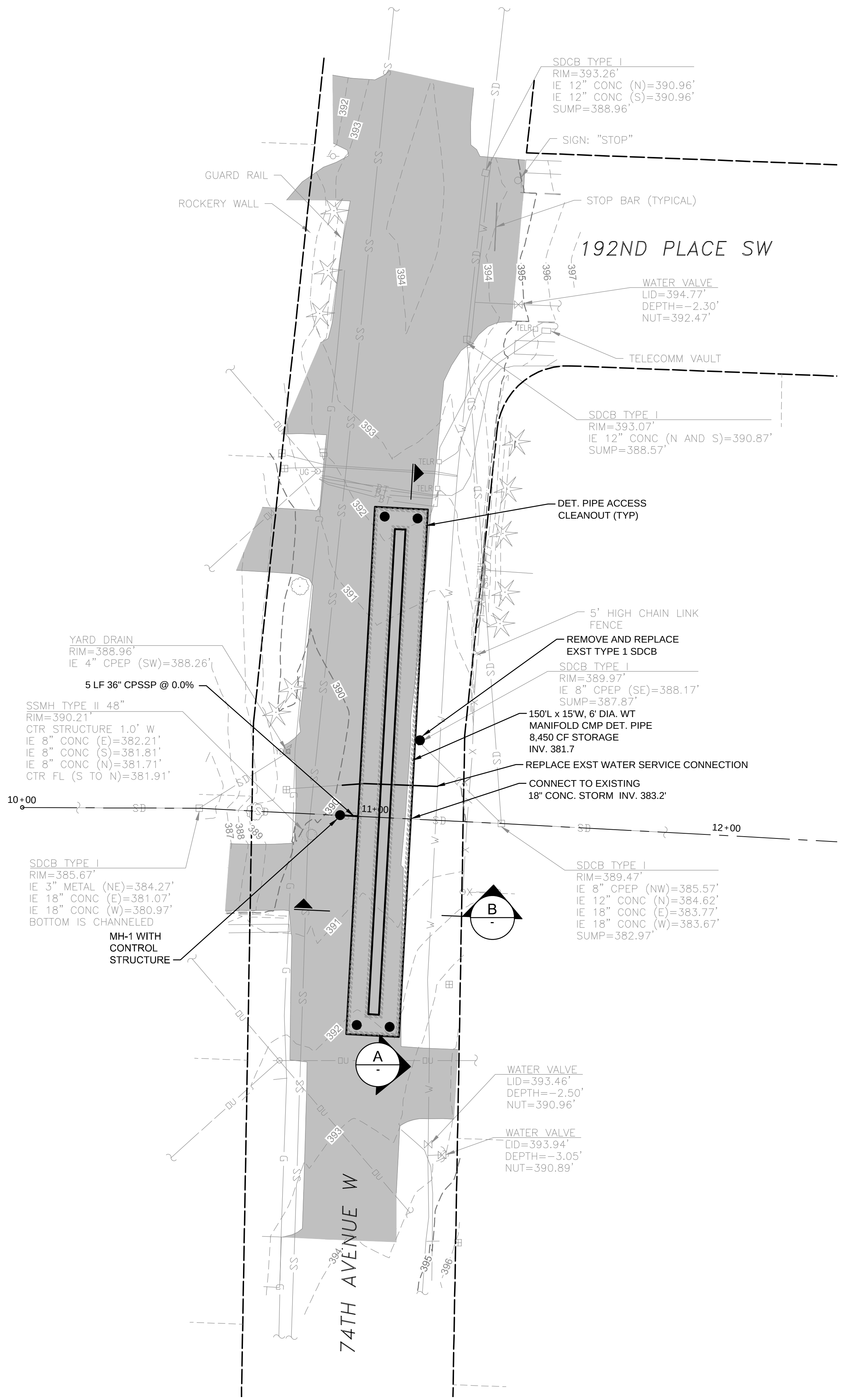
Tetra Tech. 2014. *Perrinville Creek Stormwater Flow Reduction Retrofit Study* (October 2014). Prepared for City of Edmonds Public Works.

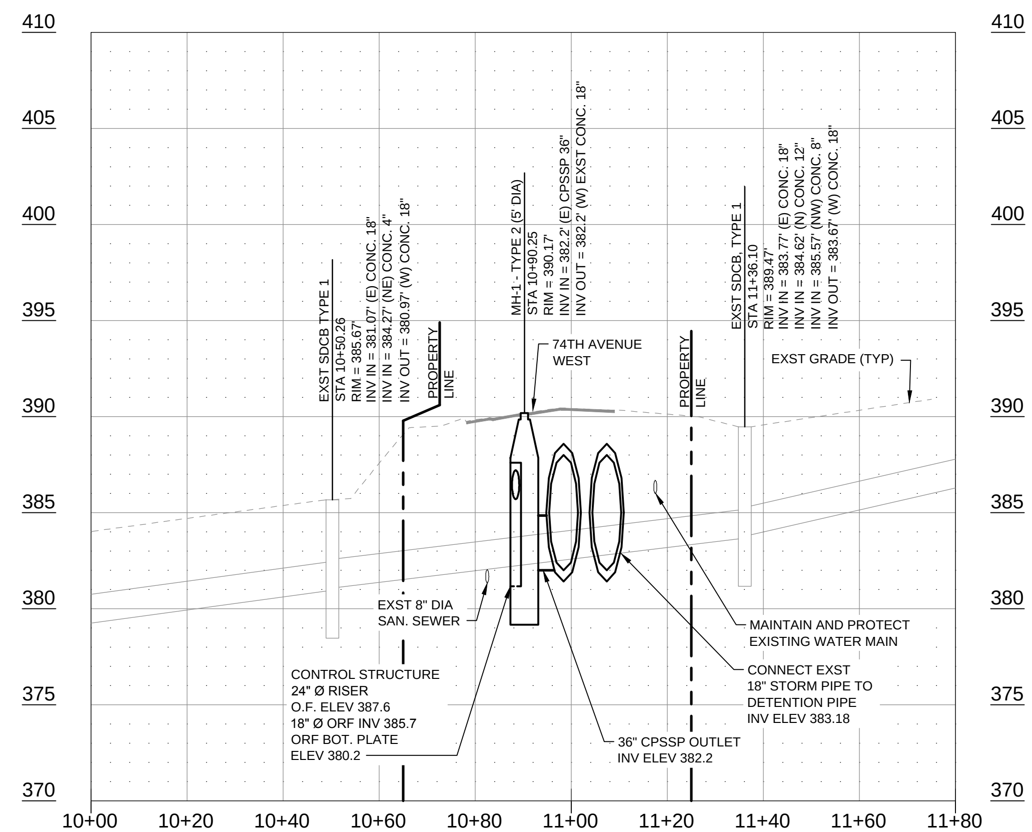
Associated Earth Sciences, Inc., 2014 *Subsurface Exploration, Infiltration Assessment, and Geotechnical Engineering Report* July, 2014. Prepared for Tetra Tech.

Washington State Department of Ecology, 2005. Stormwater Management Manual for Western Washington.

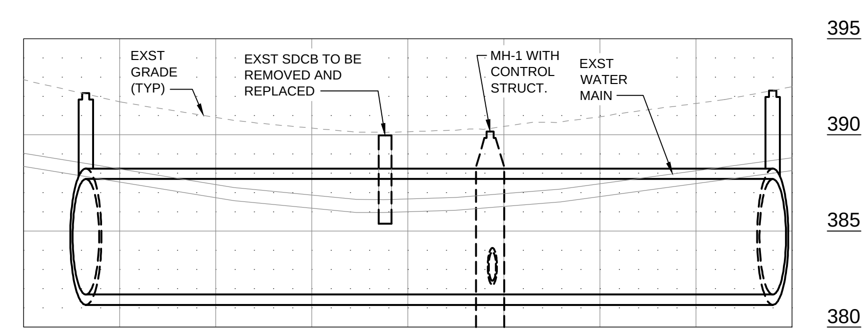
ATTACHMENT 1

PRELIMINARY DESIGN DRAWINGS

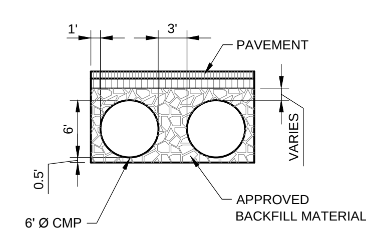




PROFILE EXIST-STRM-ALGN - VERT SCALE 1" = 5 '



A DETENTION PIPE SECTION
H:1"=20' V:1"=5'



B SECTION
NTS

SCALE: 1" = 20'

MARK	DATE	DESCRIPTION	BY

TETRA TECH
www.tetratech.com

SITE LAYOUT
74TH AVE W
STORMWATER DETENTION

Project No.:	T31020
Designed By:	TP
Drawn By:	BT/TP
Checked By:	GG

C-001

Bar Measures 1 inch

2/3/2015 10:36:28 AM - P:\T31020 EDMONDS PERRINVILLE CREEK\8 CAD\SHEETFILES\74TH - PH02\C-001 SITE LAYOUT.DWG - WOLOVEKE, GREG

ATTACHMENT 2

PRELIMINARY COST ESTIMATE

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
74TH AVE W DET PIPE, SITE 26-1					
1	MOBILIZATION (10%)	1	LS	$ 18,227	$ 18,227
2	CONTRACTOR PROVIDED SURVEY (3%)	1	LS	$ 5,468	$ 5,468
3	TESC (5%)	1	LS	$ 9,114	$ 9,114
4	TRAFFIC CONTROL (4%)	1	LS	$ 7,291	$ 7,291
5	SAWCUTTING	210	LF	$ 2	$ 420
6	STRUCTURAL EXCAVATION CLASS B INCL. HAUL	1700	CY	$ 15	$ 25,500
7	SHORING	1200	SF	$ 2	$ 2,400
8	SCHEDULE A STORM SEWER PIPE 36 IN. DIAM.	5	LF	$ 30	$ 150
9	72" DIA DETENTION PIPE	300	LF	$ 250	$ 75,000
10	GRAVEL BACKFILL	1400	CY	$ 40	$ 56,000
11	CATCH BASIN TYPE 1	1	EA	$ 1,300	$ 1,300
12	CATCH BASIN TYPE 2 (60" DIAMETER)	1	EA	$ 4,500	$ 4,500
13	WATER SERVICE CONNECTION	1	EA	$ 1,000	$ 1,000
14	FLOW RESTRICTOR	1	EA	$ 3,000	$ 3,000
15	CONNECTION TO DRAINAGE STRUCTURE	2	EA	$ 1,000	$ 2,000
16	PAVEMENT RESTORATION	1	LS	$ 10,000	$ 10,000
17	LANDSCAPING	1	LS	$ 1,000	$ 1,000
	CONSTRUCTION COST SUBTOTAL				$ 222,369
	DESIGN CONTINGENCY	30%			$ 66,711
	PERMITTING	5%			$ 11,118
	DESIGN FEES	25%			$ 55,592
	CITY PM / ADMIN	5%			$ 11,118
	CONSTRUCTION MANAGEMENT	25%			$ 55,592
	MANAGEMENT RESERVE	10%			$ 22,237
	PROJECT COST TOTAL				$ 445,000

* ALL COST ESTIMATES IN 2014 DOLLARS

ATTACHMENT 3

WWHM OUTPUT

WWHM2012
PROJECT REPORT

Project Name: 74th Ave W Max Length Det Pipe
Site Name: 26-1 74th Ave W Det
Site Address:
City : Lynnwood, WA
Report Date: 10/17/2014
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/01/16

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : 26-1
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	16.56

Pervious Total 16.56

Impervious Land Use	Acres
ROADS FLAT	11.51

Impervious Total 11.51

Basin Total 28.07

Element Flows To:
Surface Interflow Groundwater

MITIGATED LAND USE

Name : 26-1
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	16.56

Pervious Total 16.56

Impervious Land Use	Acres
ROADS FLAT	11.51

Impervious Total 11.51

Basin Total 28.07

Element Flows To:

Surface	Interflow	Groundwater
Tank 1	Tank 1	

Name : Tank 1
Tank Name: Tank 1

Dimensions
Depth: 6 ft.
Tank Type : Circular
Diameter : 6 ft.
Length : 300 ft.
Discharge Structure
Riser Height: 5.4 ft.
Riser Diameter: 24 in.
Orifice 1 Diameter: 8 in. Elevation: 0.5 ft.
Orifice 2 Diameter: 18 in. Elevation: 3.5 ft.

Element Flows To:
Outlet 1 Outlet 2

Tank Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.000	0.000	0.000	0.000
0.0667	0.008	0.000	0.000	0.000
0.1333	0.012	0.001	0.000	0.000
0.2000	0.014	0.002	0.000	0.000
0.2667	0.017	0.003	0.000	0.000
0.3333	0.018	0.004	0.000	0.000
0.4000	0.020	0.005	0.000	0.000
0.4667	0.022	0.007	0.000	0.000
0.5333	0.023	0.008	0.306	0.000
0.6000	0.024	0.010	0.531	0.000
0.6667	0.026	0.011	0.686	0.000
0.7333	0.027	0.013	0.811	0.000
0.8000	0.028	0.015	0.920	0.000

0.8667	0.029	0.017	1.017	0.000
0.9333	0.030	0.019	1.106	0.000
1.0000	0.030	0.021	1.188	0.000
1.0667	0.031	0.023	1.265	0.000
1.1333	0.032	0.025	1.337	0.000
1.2000	0.033	0.027	1.406	0.000
1.2667	0.033	0.030	1.471	0.000
1.3333	0.034	0.032	1.534	0.000
1.4000	0.035	0.034	1.594	0.000
1.4667	0.035	0.036	1.652	0.000
1.5333	0.036	0.039	1.708	0.000
1.6000	0.036	0.041	1.762	0.000
1.6667	0.037	0.044	1.815	0.000
1.7333	0.037	0.046	1.866	0.000
1.8000	0.037	0.049	1.916	0.000
1.8667	0.038	0.051	1.965	0.000
1.9333	0.038	0.054	2.012	0.000
2.0000	0.039	0.056	2.058	0.000
2.0667	0.039	0.059	2.103	0.000
2.1333	0.039	0.062	2.148	0.000
2.2000	0.039	0.064	2.191	0.000
2.2667	0.040	0.067	2.234	0.000
2.3333	0.040	0.070	2.275	0.000
2.4000	0.040	0.072	2.316	0.000
2.4667	0.040	0.075	2.357	0.000
2.5333	0.040	0.078	2.396	0.000
2.6000	0.041	0.080	2.435	0.000
2.6667	0.041	0.083	2.474	0.000
2.7333	0.041	0.086	2.512	0.000
2.8000	0.041	0.089	2.549	0.000
2.8667	0.041	0.091	2.585	0.000
2.9333	0.041	0.094	2.622	0.000
3.0000	0.041	0.097	2.657	0.000
3.0667	0.041	0.100	2.692	0.000
3.1333	0.041	0.102	2.727	0.000
3.2000	0.041	0.105	2.762	0.000
3.2667	0.041	0.108	2.795	0.000
3.3333	0.041	0.111	2.829	0.000
3.4000	0.041	0.113	2.862	0.000
3.4667	0.040	0.116	2.895	0.000
3.5333	0.040	0.119	4.481	0.000
3.6000	0.040	0.122	5.650	0.000
3.6667	0.040	0.124	6.465	0.000
3.7333	0.040	0.127	7.133	0.000
3.8000	0.039	0.130	7.714	0.000
3.8667	0.039	0.132	8.236	0.000
3.9333	0.039	0.135	8.716	0.000
4.0000	0.039	0.137	9.161	0.000
4.0667	0.038	0.140	9.580	0.000
4.1333	0.038	0.143	9.976	0.000
4.2000	0.037	0.145	10.35	0.000
4.2667	0.037	0.148	10.71	0.000
4.3333	0.037	0.150	11.05	0.000
4.4000	0.036	0.153	11.39	0.000
4.4667	0.036	0.155	11.71	0.000
4.5333	0.035	0.157	12.02	0.000
4.6000	0.035	0.160	12.32	0.000

4.6667	0.034	0.162	12.62	0.000
4.7333	0.033	0.164	12.90	0.000
4.8000	0.033	0.167	13.18	0.000
4.8667	0.032	0.169	13.46	0.000
4.9333	0.031	0.171	13.72	0.000
5.0000	0.030	0.173	13.98	0.000
5.0667	0.030	0.175	14.24	0.000
5.1333	0.029	0.177	14.49	0.000
5.2000	0.028	0.179	14.73	0.000
5.2667	0.027	0.181	14.98	0.000
5.3333	0.026	0.182	15.21	0.000
5.4000	0.024	0.184	15.45	0.000
5.4667	0.023	0.186	16.01	0.000
5.5333	0.022	0.187	16.85	0.000
5.6000	0.020	0.189	17.87	0.000
5.6667	0.018	0.190	19.02	0.000
5.7333	0.017	0.191	20.31	0.000
5.8000	0.014	0.192	21.70	0.000
5.8667	0.012	0.193	23.19	0.000
5.9333	0.008	0.194	24.77	0.000
6.0000	0.000	0.194	26.44	0.000
6.0667	0.000	0.000	28.20	0.000

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:16.56
Total Impervious Area:11.51

Mitigated Landuse Totals for POC #1
Total Pervious Area:16.56
Total Impervious Area:11.51

Flow Frequency Return Periods for Predeveloped. POC #1
Flood Frequency Method: Gringorten

Return Period	Flow(cfs)
2 year	4.1668
5 year	5.9091
10 year	7.0528
25 year	9.8932
50 year	11.7279
100 year	13.1103

Flow Frequency Return Periods for Mitigated. POC #1
Flood Frequency Method: Gringorten

Return Period	Flow(cfs)
2 year	2.8063
5 year	5.3830

10 year	6.4883
25 year	7.7293
50 year	8.9234
100 year	10.3704

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

Year	Predeveloped	Mitigated
1949	4.198	2.434
1950	5.539	5.340
1951	3.940	2.706
1952	3.648	2.636
1953	4.766	2.827
1954	8.087	5.475
1955	5.405	5.126
1956	2.252	1.919
1957	4.630	3.106
1958	9.804	6.849
1959	3.579	2.493
1960	3.562	2.464
1961	15.621	13.212
1962	4.167	2.603
1963	6.495	6.599
1964	3.038	2.210
1965	2.644	1.922
1966	2.708	2.030
1967	7.708	7.697
1968	4.480	3.617
1969	11.016	8.139
1970	3.131	2.225
1971	4.906	3.632
1972	6.384	6.499
1973	4.907	3.139
1974	5.760	3.860
1975	4.944	2.821
1976	3.252	2.543
1977	2.979	2.045
1978	2.540	1.945
1979	6.565	6.320
1980	2.879	1.989
1981	3.122	2.218
1982	3.105	2.379
1983	4.518	2.886
1984	3.551	2.556
1985	5.480	3.912
1986	6.230	5.631
1987	4.790	3.226
1988	3.459	2.398
1989	4.356	2.806
1990	2.660	1.964
1991	3.471	2.274
1992	3.843	2.321
1993	2.811	2.185
1994	2.554	1.822
1995	2.863	2.343
1996	4.274	2.820

1997	6.611	6.481
1998	5.201	5.089
1999	2.564	2.058
2000	7.022	5.556
2001	2.773	2.313
2002	2.587	1.886
2003	3.501	2.449
2004	7.098	6.112
2005	3.266	2.836
2006	5.238	3.606
2007	4.744	3.822
2008	3.639	3.639
2009	3.531	2.530

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

Rank	Predeveloped	Mitigated
1	15.6210	13.2122
2	11.0156	8.1387
3	9.8041	7.6969
4	8.0871	6.8493
5	7.7084	6.5991
6	7.0979	6.4991
7	7.0218	6.4808
8	6.6109	6.3198
9	6.5646	6.1122
10	6.4948	5.6307
11	6.3844	5.5563
12	6.2302	5.4753
13	5.7595	5.3400
14	5.5392	5.1262
15	5.4801	5.0890
16	5.4049	3.9119
17	5.2380	3.8604
18	5.2014	3.8215
19	4.9444	3.6387
20	4.9069	3.6321
21	4.9065	3.6174
22	4.7898	3.6056
23	4.7661	3.2264
24	4.7440	3.1390
25	4.6300	3.1059
26	4.5183	2.8860
27	4.4798	2.8363
28	4.3557	2.8269
29	4.2741	2.8211
30	4.1983	2.8204
31	4.1668	2.8063
32	3.9402	2.7056
33	3.8435	2.6360
34	3.6481	2.6029
35	3.6392	2.5563
36	3.5787	2.5428
37	3.5615	2.5295
38	3.5508	2.4927
39	3.5306	2.4636

40	3.5007	2.4491
41	3.4712	2.4336
42	3.4593	2.3977
43	3.2656	2.3793
44	3.2524	2.3429
45	3.1308	2.3208
46	3.1217	2.3130
47	3.1049	2.2744
48	3.0380	2.2249
49	2.9792	2.2179
50	2.8787	2.2104
51	2.8632	2.1848
52	2.8113	2.0580
53	2.7729	2.0452
54	2.7083	2.0299
55	2.6601	1.9888
56	2.6445	1.9643
57	2.5870	1.9453
58	2.5639	1.9216
59	2.5535	1.9194
60	2.5404	1.8862
61	2.2516	1.8220

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
2.0505	1263	967	76	Pass
2.1410	1092	802	73	Pass
2.2314	957	675	70	Pass
2.3218	832	548	65	Pass
2.4122	736	449	61	Pass
2.5026	641	366	57	Pass
2.5930	557	303	54	Pass
2.6834	484	233	48	Pass
2.7738	417	184	44	Pass
2.8643	369	129	34	Pass
2.9547	325	115	35	Pass
3.0451	282	111	39	Pass
3.1355	249	105	42	Pass
3.2259	225	98	43	Pass
3.3163	201	87	43	Pass
3.4067	176	83	47	Pass
3.4972	155	78	50	Pass
3.5876	140	71	50	Pass
3.6780	128	62	48	Pass
3.7684	121	60	49	Pass
3.8588	109	55	50	Pass
3.9492	96	52	54	Pass
4.0396	94	52	55	Pass
4.1300	88	51	57	Pass
4.2205	85	48	56	Pass
4.3109	80	46	57	Pass

4.4013	75	45	60	Pass
4.4917	73	43	58	Pass
4.5821	65	39	60	Pass
4.6725	61	36	59	Pass
4.7629	57	35	61	Pass
4.8534	53	32	60	Pass
4.9438	47	31	65	Pass
5.0342	44	30	68	Pass
5.1246	41	29	70	Pass
5.2150	38	25	65	Pass
5.3054	37	25	67	Pass
5.3958	36	23	63	Pass
5.4862	32	22	68	Pass
5.5767	28	19	67	Pass
5.6671	28	17	60	Pass
5.7575	27	15	55	Pass
5.8479	22	15	68	Pass
5.9383	21	15	71	Pass
6.0287	21	13	61	Pass
6.1191	20	11	55	Pass
6.2096	17	11	64	Pass
6.3000	16	11	68	Pass
6.3904	13	9	69	Pass
6.4808	13	9	69	Pass
6.5712	10	7	70	Pass
6.6616	8	6	75	Pass
6.7520	8	6	75	Pass
6.8424	8	6	75	Pass
6.9329	8	5	62	Pass
7.0233	7	5	71	Pass
7.1137	6	5	83	Pass
7.2041	6	5	83	Pass
7.2945	6	5	83	Pass
7.3849	6	5	83	Pass
7.4753	6	5	83	Pass
7.5658	6	5	83	Pass
7.6562	6	5	83	Pass
7.7466	5	4	80	Pass
7.8370	5	4	80	Pass
7.9274	5	3	60	Pass
8.0178	5	3	60	Pass
8.1082	4	3	75	Pass
8.1986	4	2	50	Pass
8.2891	4	2	50	Pass
8.3795	4	2	50	Pass
8.4699	4	2	50	Pass
8.5603	4	2	50	Pass
8.6507	4	2	50	Pass
8.7411	4	2	50	Pass
8.8315	4	2	50	Pass
8.9220	4	2	50	Pass
9.0124	4	2	50	Pass
9.1028	4	2	50	Pass
9.1932	4	2	50	Pass
9.2836	4	2	50	Pass
9.3740	4	2	50	Pass
9.4644	4	2	50	Pass

9.5548	4	2	50	Pass
9.6453	4	2	50	Pass
9.7357	4	2	50	Pass
9.8261	3	2	66	Pass
9.9165	3	2	66	Pass
10.0069	3	1	33	Pass
10.0973	3	1	33	Pass
10.1877	3	1	33	Pass
10.2781	3	1	33	Pass
10.3686	3	1	33	Pass
10.4590	3	1	33	Pass
10.5494	3	1	33	Pass
10.6398	3	1	33	Pass
10.7302	3	1	33	Pass
10.8206	3	1	33	Pass
10.9110	3	1	33	Pass
11.0015	2	1	50	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 acre-feet
On-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.
Off-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Perlnd and Implnd Changes

No changes have been made.