



Agenda
Planning Commission Meeting
Wednesday, March 25, 2015
City Hall Council Chamber | 505 Swift Boulevard

Commission Members: Chair Madsen, Vice-Chair Boring and Commissioners Berkowitz, Clark, Palmer, Wallner and Wise

Liaisons: Council Liaison Lemley
Staff Liaison Planning and Development Services Manager Simon

PUBLIC OPEN HOUSE - 5:30PM - 7:00PM
Stormwater Retrofit Program

Regular Meeting - 7:00 p.m.

Welcome and Roll Call

Approval of Agenda: (Approved by Motion)

Approval of Minutes: (Approved by Motion)

Public Comments:

Public Hearing Explanation:

Unfinished Business - Public Hearing:

New Business – Public Hearing:

1. Stormwater Retrofit Program
2. Consideration of Zoning for Proposed Whitfield Annexation
3. Consideration of Amendments to RMC Section 23.42.300 Concerning Swimming Pools on Residential Lots

Communications:

Adjournment

The next Planning Commission Workshop is Wednesday, April 8, 2015

The next Planning Commission Meeting is Wednesday, April 22, 2015

This Meeting is broadcast live on CityView Channel 192 and online at CI.RICHLAND.WA.US/CITYVIEW

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PLANNING COMMISSION AGENDA ITEM COVERSHEET

Meeting Date: 03/25/2015

Agenda Category: New Business – Public Hearing

Prepared By: Pete Rogalsky, Public Works Director

Subject:

Stormwater Treatment Retrofit Program

Request:

Key 5 - Natural Resources Management

Recommended Motion:

Staff recommends that all of the selected projects be implemented, but does not have a recommendation on prioritization of the projects or on the preferred design alternatives. Staff is seeking Planning Commission recommendation on these two items: 1) prioritization of the projects; and 2) selection of design alternatives.

Summary:

The City's Public Works Department operates a Stormwater Utility, whose primary functions are property damage risk mitigation from flooding and stormwater pollution mitigation. Stormwater pollution mitigation is a relatively recent function that was imposed on the City by federal and state regulations. The City's Stormwater Utility implements programs to maintain compliance with the federal and state regulations, as expressed in a National Pollution Discharge Elimination System (NPDES) permit.

Most of Richland's stormwater conveyance system constructed before the 1990's discharges untreated stormwater to our rivers and Amon Wasteway. The aim of the pollution mitigation programs is to reduce pollution reaching those waterways. An important strategy is to retrofit water quality treatment features into the existing conveyance system. Public Works has completed several studies, resulting in selection of priority retrofit water treatment projects. Several projects have alternative strategies and features that can be implemented. Grant funds are in place to complete a number of projects.

City staff have designed a public outreach program to solicit input on the proposed projects and the identified alternatives. The purpose of the Planning Commission meeting is to solicit public and Planning Commission input on the proposed projects and ultimately to obtain a Planning Commission recommendation to City Council regarding the priority of the projects and selection of design alternatives. The meeting will be structured with an open house educational period from 5:30 to 7:00 p.m., after which the regular Planning Commission meeting will include a public comment period and deliberations by the Commission on the proposed projects.

Attachments:

1. Stormwater Analysis - Rating form
2. Richardson Road Outfall Report
3. Sprout Road Outfall Report
4. Ferry Road Outfall Report
5. Saint Street Outfall Report
6. Park Street Outfall Report
7. Swift / Columbia Park Trail Outfall Report
8. Army Corps Review Letter



STORMWATER RETROFIT OUTFALL PROJECTS

Alternatives & Cost Benefit Analysis

OUTFALL NAME	TREATMENT SYSTEM	CNST COST	RANK 5=Best 1=Worst	O & M COST (annual)	RANK 5=Best 1=Worst	TREATMENT Effectiveness	RANK 5=Best 1=Worst	IMPLEMENTATION DELAYS (i.e. Corp of Eng property)	RANK 5=Best 1=Worst	CHANGE TO EXISTING FEATURES (i.e. Leslie Grove Park drain fields)	RANK 5=Best 1=Worst	Construction IMPACTS	RANK 5=Best 1=Worst	Rank	COMMENTS
RICHARDSON RD OUTFALL	Pond Infiltration	\$136,100	5	Low	5	High	5	Port Easement (\$0)	5	Pond	2	---	5		
SPROUT STREET OUTFALL	Drywell System	\$76,200	3	Mod *	3	Med	4	---	5	Underground	5	Traffic Delays	2		
FERRY STREET OUTFALL															
Ferry St Outfall Alt 1	Pond Infiltration	\$91,400	5	Low	5	High	5	CORP (+\$50k + 6 Mo.)	1	Pond	2	---	5		
Ferry St Outfall Alt 2	Drywell System (4)	\$146,500	3	Mod *	3	Med	4	---	5	Underground	5	Traffic Delays	2		
SAINT STREET OUTFALL															
Saint Street Outfall Alt 1	Pond Infiltration (WTP)	\$212,000	5	Low	5	High	5	---	5	Pond	2	---	5		
Saint St. Outfall Alt 2	Trench Gallery (Soccer Field)	\$462,000	2	Mod *	3	Med	4	CORP (+\$75k + 6 Mo.)	1	Underground	5	Park Closed	2		
Saint St. Outfall Alt 3	Trench Gallery (WTP)	\$478,000	2	Mod *	3	Med	4	---	5	Underground	5	---	5		
Saint St Outfall Alt 4	Drywell System (51)	\$2,315,000	1	Mod *	3	Med	4	---	5	Underground	5	Traffic Delays	2		
Saint St Outfall Alt 5	Linear Bioretention (122)	\$2,801,000	1	High	1	High	5	---	5	Reduced street width	2	Traffic Delays	2		
Saint St Outfall Alt 6	Infiltration Trenches (32)	\$1,326,000	1	High	1	Med	4	---	5	Underground	5	Traffic Delays	2		
Saint St Outfall Alt 7	Contech Storm Filters	\$786,000	2	High**	1	Low	3	CORP (+\$50k + 6 Mo.)	1	Underground	5	---	5		
Saint St Outfall Alt 8	Curb Bump Outs (378)	\$4,492,000	1	High	1	Med	4	---	5	Reduced street width	2	Traffic Delays	2		
Saint St Outfall Alt 9	Snyder Pond + Contech Filters	\$1,116,000	2	High**	1	Med	4	CORP (+\$50k + 6 Mo.)	1	Pond + Underground	2	Traffic Delays	2		
PARK STREET OUTFALL															
Park St Outfall Alt 1	Dispersion Infiltration	\$75,300	5	Low	5	High	5	CORP (+\$50k + 6 Mo.)	1	Saturated in Rain Events	3	Park Closed	2		
Park St Outfall Alt 2	Pond Infiltration	\$113,200	3	Low	5	High	5	CORP (+\$50k + 6 Mo.)	1	Pond	2	Traffic Delays	2		
Park St Outfall Alt 3	Drywell System	\$158,500	2	Mod *	3	Med	4	---	5	Underground	5	Traffic Delays	2		
SWIFT Blvd LID System	Pond + Swales	\$336,300	5	Low	5	High	5	---	5	Pond + Swales	2	Traffic Delays	2		

* Low ongoing cost, high end of life replacement

** Annual cost of Filters

CITY OF RICHLAND

Outfall NR01 Stormwater Retrofit Project – Pre-Design Report



City of Richland
Public Works Dept.
840 Northgate Drive
P.O. Box 190, MS-26
Richland, WA 99352

February 17, 2015

ACKNOWLEDGEMENTS

City of Richland

Outfall NR01 Stormwater Retrofit Project — Pre-Design Report

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City of Richland

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Attachments

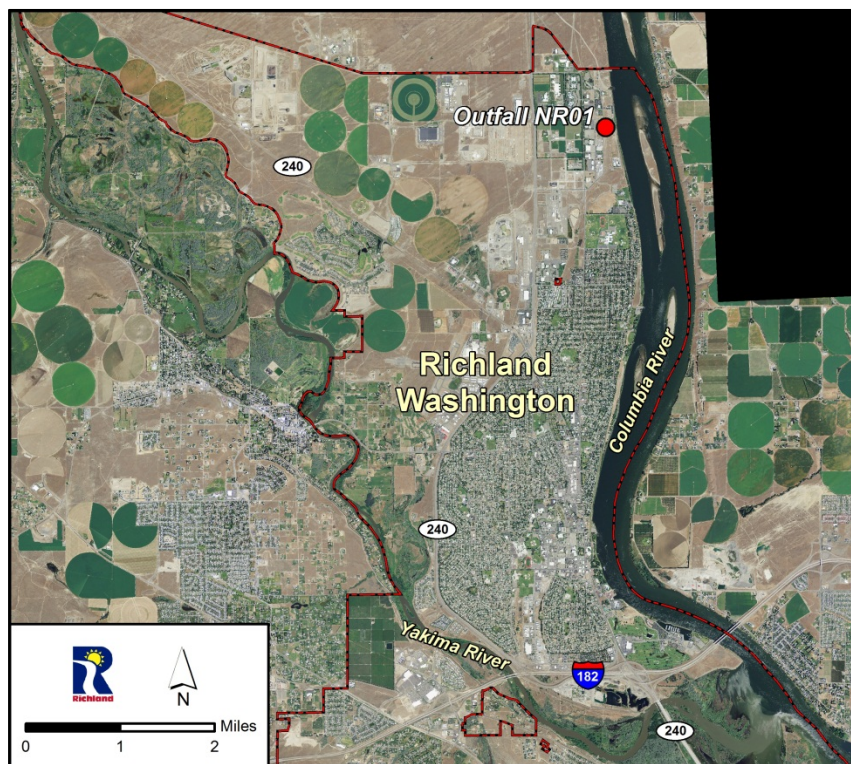
Attachment 1	Preliminary Geotechnical Information
Attachment 2	Existing/Proposed Subbasin Map
Attachment 3	Design Calculations
Attachment 4	Plans and Details
Attachment 5	Pre-Design Level Construction Cost Estimate

Section I—Introduction

As a part of the 2013-2015 Biennial Municipal Stormwater Capacity Grant Program, the Washington State Department of Ecology (Ecology) has provided the City of Richland (City), a NPDES Phase II community, with funds to plan and design retrofit projects which address stormwater pollution runoff from existing development. As a condition for this pre-construction funding, at least one of the retrofit projects must implement low impact development (LID) techniques in accordance with Ecology approved design manuals, primarily the Stormwater Management Manual for Eastern Washington (SWMMEW) and the Eastern Washington Low Impact Development Guidance Manual (E. WA LID Manual).

Based on prior work to develop evaluation criteria and rank all known City outfalls (*City of Richland Updated Stormwater Treatment Retrofit Memorandum*, URS, 2014), City staff have selected Outfall NR01 to develop a stormwater retrofit design to improve water quality discharging to the Columbia River.

The retrofit project location is shown in the vicinity map below and described in detail in Section 2.



Section I—Introduction

Continued

The selection and sizing of stormwater Best Management Practices (BMPs), including potential plant species used in BMPs, is highly dependent on site climate and soil conditions. An overview of Richland’s climate is provided in the table below. Soil information is presented in Section 2.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	40.7	48.6	57.9	66.4	75.3	82.2	90.5	89.3	80.6	66.7	50.7	41.5	65.9
Average Min. Temperature (F)	26.4	30.2	35.1	40.8	48.1	54.7	59.7	58.7	50.8	41.2	33.7	28.2	42.3
Average Total Precipitation (in.)	0.99	0.70	0.61	0.49	0.59	0.54	0.20	0.23	0.28	0.54	0.93	1.05	7.15
Average Total Snowfall (in.)	2.6	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.2	7.1
Avg. Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Source: Western Region Climate Center (2014)

The project site is located in climatic Region 2 (Central Basin) of eastern Washington and receives approximately 7.15 inches of mean annual precipitation, a portion of which falls as snow.

Section 2—Drainage Basin and Site Description

2.1 Outfall NR01

Outfall NR01 serves a sizeable area of Port of Benton and City property. Currently all runoff is collected and conveyed without treatment to the Columbia River. The vacant Port of Benton land immediately to the west of the outfall presents an opportunity to allow stormwater runoff to be retained, treated, and infiltrated, up to a specific storm event, rather than discharging directly to the Columbia River.

2.1.1 Drainage Basin Description

Drainage Basin Delineation

A basin map for the NR01 stormwater drainage system is provided as Attachment 2. The map shows the drainage basin boundary and flow directions for existing and proposed conditions. Peak runoff rates and volume calculations are provided in Attachment 3.



Outfall NR01 Vicinity

Drainage Basin Information

The existing land use consists primarily of business research park with approximately one-third of the drainage basin in vacant pervious condition. In the future, the vacant lots are anticipated to be developed along a similar land use and will be required to retain stormwater on-site for up to the 25-year, 24-hour storm event.

Stormwater quality issues include those typically associated with low to moderate average daily traffic (ADT) roadways, including sediments, hydrocarbons, vehicle fluids, metals, elevated temperature, and other pollutants.

Based on review of Ecology's 2012 303(d) list of impaired receiving waters, the Columbia River is currently listed as impaired for temperature. The States of Washington, Oregon, and Idaho and EPA Region 10 have been working in coordination with the Columbia Basin Tribes since 2001 to develop a Total Maximum Daily Load (TMDL) for temperature on the Columbia and Snake Rivers. However, completion of the TMDL has been delayed to allow for necessary discussions and information exchange. Although specific loading capacities and allocations have yet to be specified, retention and infiltration is a suitable way to reduce temperature increases due to stormwater runoff from impervious surfaces during spring through fall thunderstorms.

Section 2— Drainage Basin and Site Description

Continued

2.1.2 Site Description

Existing Stormwater Controls

The NR01 basin drains to an existing stormwater conveyance system that discharges to the Columbia River (see Attachment 2-1). The portion of the basin served by the stormwater conveyance system (approximately 79 acres) includes no existing stormwater quality or flow control BMPs (the Columbia River is exempt from flow control requirements). A number of properties within the basin (approximately 55 acres) have existing on-site retention/infiltration systems that have been assumed to be functional up to the 25-year, 24-hour storm event and have not been included in this analysis.

Total Area, Impervious Area, Pervious Area

Attachment 2 depicts the Total Basin Area, Connected ISA, Disconnected ISA, and Pervious Area for the NR01 basin. A breakdown of each area is provided below in Table 1. It has been assumed that Pervious and Disconnected ISA areas do not contribute runoff during the 6-month, 24-hour storm event. Peak runoff rates and volume calculations are provided in Attachment 3.

Table 1 – Outfall NR01 Basin Areas

Total Basin Area (acres)	Area Served by Existing On-Site Retention/Infiltration Systems (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)
133.79	55.43	36.56	2.00	39.80

Vegetation and Wetlands

Existing vegetation in the basin includes: maintained turf grass, mature trees, and other shrubbery. No wetlands are present within the immediate project area.

Soils

According to the Benton County Soil Survey, surficial soils at the project site primarily consist of Quincy loamy sand and Burbank loamy fine sand, both are considered to be excessively drained soils with an estimated saturated hydraulic conductivity in the 5.95 to 19.98 inches/hour range (see Attachment 1). This places the native soils in a generally Hydrologic Class A, expected to have high to very high infiltration rates. The water table is expected to be well below the ground surface. This is consistent with the photo below, taken during recent storm line work on the site.

Based on the experience of City staff on a recent stormwater infiltration design project, it is anticipated that the soil will require 18 inches of a treatment soil mix on top of the native soil to meet the water quality design requirements as stated in the SWMMEW and the E. WA LID Manual. Note that a detailed geotechnical investigation will be performed during the design stage.



Soils in the Vicinity of the NR01 Retrofit Site

Access

Access to the site is readily available through the existing City road infrastructure. However, the long term use of the proposed retrofit facility, and ongoing access to the facility for inspections and O&M, may need to be assured through an easement agreement with the Port, if one is not already in existence.

Section 3—Design Alternatives and Analysis

3.1 Alternatives Considered

As part of the City's recent update to the city-wide Stormwater Retrofit Plan, City staff evaluated a number of retrofit alternatives for the NR01 basin. Alternatives included: a surface infiltration facility capable of enhanced treatment, and two proprietary stormwater treatment devices (one capable of basic treatment, and the other enhanced treatment).

The following issues were considered during the BMP selection process:

- Climate/seasonal precipitation patterns.
- Expected traffic use levels within the subbasin.
- Available right-of-way and setback requirements.
- Ability to work with existing drainage patterns and infrastructure to degree possible.
- Review/avoidance of likely utility/existing infrastructure issues.
- Likely soil and groundwater properties/conditions.
- Avoidance of steep or unstable slopes, or other geologic hazard areas.
- Minimizing/avoiding work within exterior roads and sidewalks.
- Typical O&M requirements/level of effort/special equipment.
- Critical areas issues.
- Ability to safely drain overflow water to an appropriate location.
- Ability to prevent significant problems in the event that systems fail or periodically operate below the intended design level.
- Aesthetic compatibility of BMPs with existing site structures and features.
- Consideration of future improvement projects.

Many of these considerations are also feasibility criteria recommended by the Eastern Washington LID and Stormwater Management Manuals.

Section 3—Design Alternatives and Analysis

Continued

3.2 Description of Final Alternative

The City met with the Port of Benton to discuss the proposed retrofit site. Together the two entities decided that the optimum location for a new treatment facility would be east of Richardson Road on vacant Port of Benton property. The preferred stormwater retrofit BMP to carry forward into 90% design is an infiltration basin.

3.2.1 Design Storms

The infiltration basin will be designed to retain, treat, and infiltrate up to the 6-month, 24-hour SCS Type 1A storm event for the contributing area. This should effectively treat, retain, and infiltrate at least 90% of the annual runoff from the contributing drainage basin. The facility will be designed to completely drain down within at most 72-hours in order to meet the following objectives:

- Restore hydraulic capacity to receive runoff from a new storm;
- Maintain infiltration rates; and
- Aerate vegetation and soil to keep the vegetation healthy, prevent anoxic conditions in the treatment soils, and enhance the biodegradation of pollutants and organics.

The inlet pipe to the infiltration basin, as well as other conveyance structures, will be designed to convey the peak discharge from the 6-month, 24-hour SCS Type 1A storm event plus incidental flow due to the expected maximum head on the pipe leading to the infiltration basin. Flows in excess of the peak water quality storm discharge will bypass the infiltration basin and discharge to the Columbia River via the existing storm drain and outfall.

3.2.2 Preliminary Infiltration Characteristics

As discussed in Section 2, based on published Soil Survey information, the saturated hydraulic conductivity of the native soil at the project site is estimated to be 5.95 to 19.98 inches/hour. For purposes of this pre-design report, it was assumed that the long-term infiltration of the 18-inch treatment soil layer will be 3.0 inches/hour. Geotechnical testing will be conducted to verify the native soil infiltration rate; if it is found that the native soil infiltration rate is less than the assumed long-term infiltration of the 18-inch treatment soil layer, infiltration basin sizing calculations will be revisited.

3.2.3 Infiltration Basin

Key aspects of the project will include:

- Excavating the required volume for the infiltration basin including minor grading of the surrounding area to catch existing contours.

- Modifying an existing manhole to create an approximate 2-foot deep sump below the existing 42-inch CMP inverts to allow for sediment storage and the installation of an 8-inch storm pipe to direct the peak flow from the 6-month, 24-hour SCS Type 1A storm event to the infiltration basin.
- Constructing energy dissipation at the outlet of the 8-inch storm pipe within the infiltration basin.
- Constructing an overflow structure within the infiltration basin and connecting a 12-inch overflow pipe back to the existing 42-inch CMP at a new manhole structure.

Refer to the pre-design plan drawings included as Attachment 4 for additional information. Peak runoff rates and volume calculations are provided in Attachment 3.

Water Quality Benefits

The proposed stormwater retrofit will reduce the volume of runoff to outfall NR01 as compared to the existing condition by retaining and infiltrating the 6-month, 24-hour SCS Type 1A storm event from the contributing area. Water quality is also improved from the existing condition since the proposed BMP will provide enhanced treatment and will retain and treat 90% of the annual runoff volume from the contributing drainage basin including all “first flush” storm events.

Preliminary Cost Estimate

The pre-design level construction cost estimate for the Outfall NR01 Stormwater Retrofit project is \$136,084 including a 20% pre-design contingency. See Attachment 5 for a complete breakdown of the pre-design level construction cost estimate.

Section 4—Implementation Considerations

4.1 Design and Operational Considerations to be Addressed Between the Pre-Design Report and 90% Design

The design submitted with this pre-design report is at a preliminary level. Design and operational considerations to be addressed in the next phase of the design process are discussed below.

4.1.1 Existing Utilities

There are sanitary sewer lines in the vicinity of the retrofit site (approximate utility locations are shown in Attachment 4). During the design phase, the City will want to call for locates, perform potholing, and/or utilize as-built information to gain a better understanding of the exact location and depth to the existing sanitary sewer lines as well as any other utilities.

4.1.2 Existing Manhole Retrofit

An existing manholes will be modified to act as a flow splitter that will direct the peak flow from the 6-month, 24-hour SCS Type 1A storm event to the infiltration basin. An approximate 2-foot deep sump will be constructed below the existing 42-inch CMP inverts to allow for sediment storage and the installation of an 8-inch storm pipe to direct runoff to the infiltration basin.

4.1.3 Energy Dissipation

Calculations show that the flow in the 8-inch storm pipe leading to the infiltration basin will have a velocity of approximately 11 feet per second during large storm events when head is expected to build up in the upstream flow splitter manhole. An appropriate energy dissipation measure will be selected during the design process. Possible energy dissipation measures may include a riprap splash pad or bubble-up structure.

4.1.4 Infiltration Basin Depth

Two ponding depth options for the infiltration basin have been included with this pre-design report: 6-inch and 1-foot. The 6-inch ponding depth option has a slightly larger footprint than the 1-foot ponding depth option. Both options will have at least 1-foot of freeboard above the maximum ponding depth.

4.1.5 Recommended Landscaping, Vegetation, and Irrigation

The basin will be designed with an 18-inch modified soil mix treatment layer to achieve Ecology's enhanced treatment criteria. Since the facility will be near a well-traveled pedestrian pathway along the Columbia River, the City may decide to include aesthetically pleasing landscaping features and vegetation, along with appropriate irrigation.

Section 4—Implementation Considerations

Continued

4.1.6 Additional Design and Operational Considerations

Additional design and operational considerations to be addressed in the next phase of the design process include:

- Finalize detailed topographic and utilities survey data.
- Identify, avoid, or otherwise address any utility conflicts.
- Verify high groundwater levels and depth to bedrock.
- Test the soil conditions and infiltration characteristics, and refine the BMP design accordingly.
- Prepare planting and irrigation plans for infiltration basin based on any plant species selected by the City.
- Specify mulching requirements to control weeds and any soil amendments necessary to meet required specifications for treatment soil layer.
- Design flow entrance to provide for sediment control and erosion prevention as described above.
- Verify construction accessibility and traffic/pedestrian control issues.
- Address O&M equipment accessibility and routes.
- Address any easement needs with the Port of Benton.
- Other considerations and limitations per the E. WA LID Manual and the SWMMEW.

4.2 Additional Implementation Considerations

Based on City input, it is expected that permitting requirements include:

- SEPA, Shorelines, Critical Areas, City Construction Stormwater, and City Floodplain Development.
- State mandated cultural resources requirements.

Anticipated City Council involvement includes:

- Approval to submit grant application for construction funding.
- Approval for any contracts associated with project work.
- Approval to place stormwater retrofit project on the City CIP list.

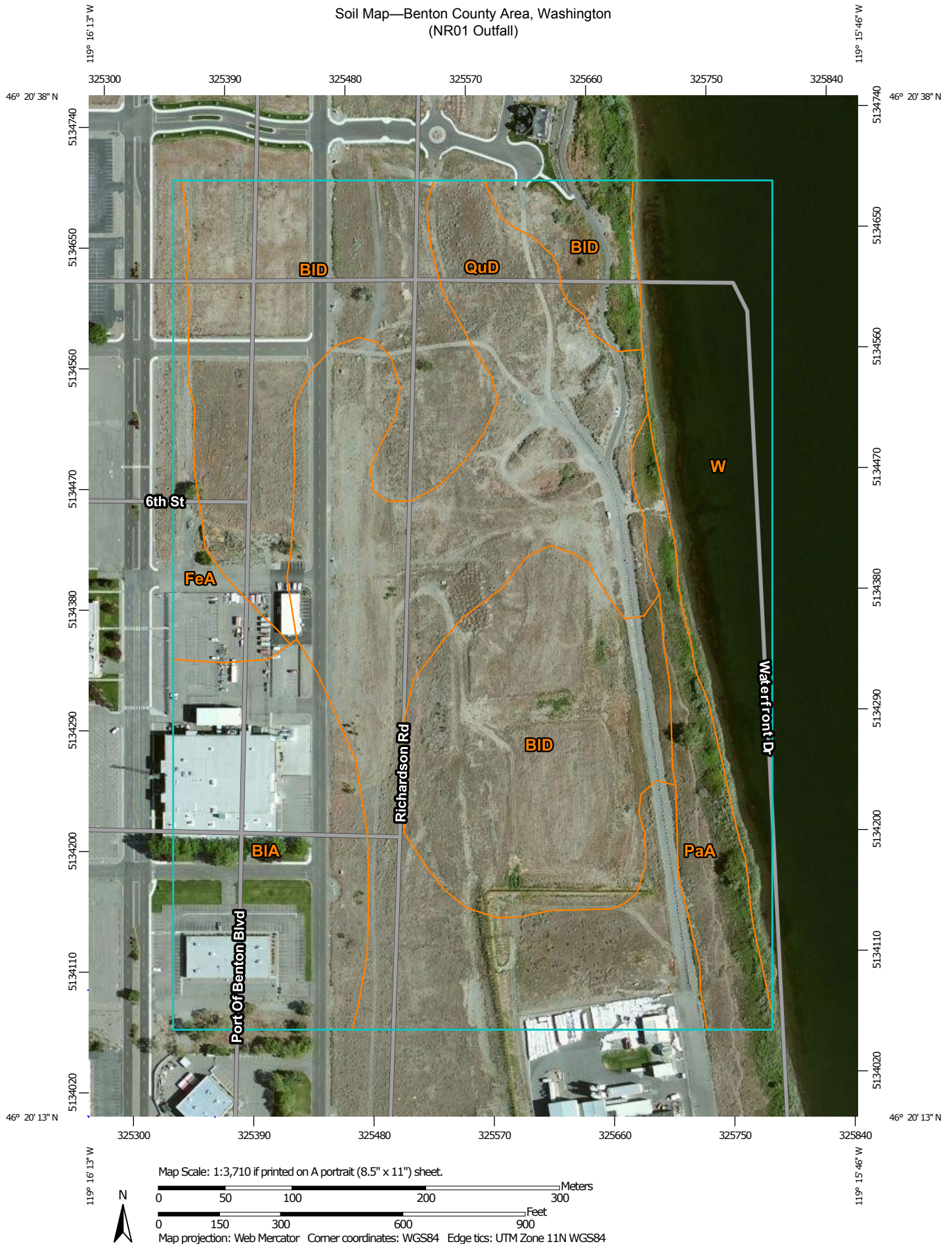
Section 5—Proposed Schedule

The City anticipates completing 90% design by September 2015 and submitting to Ecology for review and acceptance. The 90% design package will include:

- 90% design
- 90% bid schedule
- 90% bid specifications and special provisions
- Engineers estimate of probable project costs
- O&M Guide

ATTACHMENT 1 — PRELIMINARY GEOTECHNICAL INFORMATION

Soil Map—Benton County Area, Washington (NR01 Outfall)



Soil Map—Benton County Area, Washington
(NR01 Outfall)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

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

Date(s) aerial images were photographed: Aug 6, 2010—Oct 17, 2010

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

Benton County Area, Washington (WA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BIA	Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes	9.4	13.3%
BID	Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes	23.9	34.0%
FeA	Finley fine sandy loam, 0 to 2 percent slopes	2.1	3.0%
PaA	Pasco fine sandy loam, 0 to 2 percent slopes	3.7	5.2%
QuD	Quincy loamy sand, 2 to 15 percent slopes	21.8	31.0%
W	Water	9.5	13.5%
Totals for Area of Interest		70.5	100.0%

Benton County Area, Washington

BIA—Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bbb

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

BID—Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2bbc

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

FeA—Finley fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bc6

Elevation: 300 to 1,800 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 135 to 180 days

Farmland classification: Prime farmland if irrigated

Map Unit Composition

Finley and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Finley

Setting

Landform: Flood plains, terraces

Parent material: Alluvium

Typical profile

H1 - 0 to 3 inches: fine sandy loam

H2 - 3 to 13 inches: fine sandy loam

H3 - 13 to 28 inches: very gravelly loam

H4 - 28 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 20 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

PaA—Pasco fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bcw

Elevation: 250 to 700 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 52 to 55 degrees F

Frost-free period: 136 to 190 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Pasco and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pasco

Setting

Landform: Flood plains

Parent material: Alluvium

Typical profile

H1 - 0 to 6 inches: fine sandy loam

H2 - 6 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Poorly drained

Capacity of the most limiting layer to transmit water (Ksat):

Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: About 24 to 36 inches

Frequency of flooding: Occasional

Frequency of ponding: None

Calcium carbonate, maximum in profile: 5 percent

Salinity, maximum in profile: Very slightly saline to slightly saline (4.0 to 8.0 mmhos/cm)

Sodium adsorption ratio, maximum in profile: 10.0

Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 3w

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: C

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

QuD—Quincy loamy sand, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2bd4

Elevation: 200 to 4,500 feet

Mean annual precipitation: 6 to 12 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 200 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Quincy and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Quincy

Setting

Landform: Terraces

Parent material: Eolian sands

Typical profile

H1 - 0 to 9 inches: loamy sand

H2 - 9 to 60 inches: loamy fine sand

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 3 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

ATTACHMENT 2 — EXISTING/PROPOSED SUBBASIN MAP

City of Richland
Stormwater Retrofit
Support Services

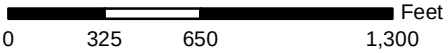
Outfall NR01
Drainage Basin

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Drainage Basin Boundary
- Connected ISA
- Disconnected ISA
- Pervious
- Existing Retention / Infiltration
- Approximate Flow Direction

2011 Aerial Imagery

Attachment 2



Date Created: August 20, 2014

Total Basin Area (acres)	Area Served by Existing On-Site Retention/Infiltration Systems (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)
133.79	55.43	36.56	2.00	39.80	41.80

ATTACHMENT 3 — DESIGN CALCULATIONS

Hydrologic Calculations - Subbasin Area and Time of Conc. Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 8/12/2014	Project: Richland
	Checked By: J. Knutson	Date: 10/7/2014	Project No: 33764797
			Sheet No: 1 of 1

Subbasin	Total Basin Area (acres)	Area Served by Existing On-Site Retention/Infiltration Systems (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)	Imp. CN	Perv. CN	Pervious and Disconnected Weighted CN
NR01	133.79	55.43	36.56	2.00	39.80	41.80	98	68	69

Notes:

(1) It is assumed that existing on-site retention/infiltration systems do not contribute runoff up to the 25-Year, 24-Hour Type 1A storm event.

Subbasin	Sheet Flow					Shallow Concentrated Flow				Open Channel Flow				Time of Concentration
	$T_t = 0.42 * (n_s * L)^{0.8} / ((P_{2yr2hr})^{0.5} * (s_0)^{0.4})$					$T_t = L / (60 * (k * (s_0)^{0.5}))$				$T_t = L / (60 * (k_c * (s_0)^{0.5}))$				$T_c = T_{t1} + T_{t2} + ... T_{tm}$
	n_s	L (ft)	P_{2yr2hr} (in)	s_0 (ft/ft)	T_t (min)	L (ft)	k	s_0 (ft/ft)	T_t (min)	L (ft)	k_c	s_0 (ft/ft)	T_t (min)	T_c (min)
NR01 (Connected ISA)	0.011	59	0.4	0.020	2.25	720	27	0.005	6.29	2708	42	0.005	15.20	23.73
NR01 (Pervious and Disconnected ISA)	0.15	100	0.4	0.010	36.57	139	27	0.010	0.86	2750	42	0.005	15.92	53.34

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.

Hydrologic Calculations - SBUH Results Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 8/12/2014	Project: Richland
	Checked By: J. Knutson	Date: 10/7/2014	Project No: 33764797
			Sheet No: 1 of 1

							24-Hour Type 1A Storm Event		3-Hour Short Duration Storm Event
							6-Month (0.53 in)		25-Year (0.92 in)
Subbasin	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T _c (min)	Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)
NR01 (Connected ISA)	36.56	0.00	1.00	98	68	23.73	2.40	45,566	31.27
NR01 (Pervious and Disconnected ISA)	41.80	41.80	0.00	98	69	53.34	---	---	0.00
NR01 (Total)	---	---	---	---	---	---	---	---	31.27

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.
- (3) It is assumed that Pervious and Disconnected ISA areas do not contribute runoff during the 6-Month, 24-Hour Type 1A Storm Event.
- (4) 25-Year, 3-Hour Short Duration peak flows are provided for high-flow bypass conveyance sizing. Peak flows were determined by summing the hydrographs for the Connected ISA and Pervious and Disconnected ISA areas.

Conceptual BMP Sizing Calculations	Calculated By: E. Pruneda	Date: 10/3/2014	Project: Richland
	Checked By: J. Knutson	Date: 10/7/2014	Project No: 33764797
			Sheet No: 1 of 1

Facility ID (Subbasin)	Available Storage Volume					Predicted Water Quality Volume (cf) from Contributing Area	Assumed Infiltration Rate (in/hr)	Assumed Bottom Infiltration Rate (cfs)	Predicted Max Volume (cf) in Facility During the Water Quality Storm Event
	Top Area (sq-ft)	Bottom Area (sq-ft)	Side Slope (XH:1V)	Depth (ft)	Volume (cf)				
Infiltration Basin Opt1 (NR01)	12966	12125	4	0.5	6,273	45,566	3.0	0.842	6,071
Infiltration Basin Opt2 (NR01)	10322	8826	4	1.0	9,574	45,566	3.0	0.613	9,348

Notes:

(1) The long term infiltration rate of bioretention soil media has been assumed to be 3.0 inches/hour.
The native infiltration rate will be confirmed through geotechnical investigation as the design progresses.

Conceptual Pipe Sizing Calculations

Bentley FlowMaster V8i

Calculated By:	E. Pruneda	Date:	10/3/2014	Project:	Richland
Checked By:	J. Knutson	Date:	10/7/2014	Project No:	33764797
				Sheet No:	1 of 4

8" PVC Pipe to Infiltration Basin - 6-Month, 24-Hour Storm Event

Worksheet : Circular Pipe - 8" PVC - Normal Depth

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Normal Depth Friction Method: Manning Formula

Roughness Coefficient:	0.012		Flow Area:	0.23	ft²
Channel Slope:	0.06500	ft/ft	Wetted Perimeter:	1.22	ft
Normal Depth:	0.42	ft	Hydraulic Radius:	0.19	ft
Diameter:	0.67	ft	Top Width:	0.64	ft
Discharge:	2.40	ft³/s	Critical Depth:	0.65	ft
			Percent Full:	62.7	%
			Critical Slope:	0.02947	ft/ft
			Velocity:	10.40	ft/s
			Velocity Head:	1.68	ft
			Specific Energy:	2.10	ft
			Froude Number:	3.07	
			Maximum Discharge:	3.59	ft³/s
			Discharge Full:	3.34	ft³/s
			Slope Full:	0.03352	ft/ft
			Flow Type:	SuperCritical	

Calculation Successful.

Conceptual Pipe Sizing Calculations

Bentley FlowMaster V8i

Calculated By: E. Pruneda	Date: 10/3/2014	Project: Richland
Checked By: J. Knutson	Date: 10/7/2014	Project No: 33764797
		Sheet No: 2 of 4

8" PVC Pipe to Infiltration Basin - During Large Storm Event (4' Head on Pipe)

Worksheet : Pressure Pipe - 8" PVC - 4' Head

Calculations Messages

Solve For: Discharge Friction Method: Manning Formula

Pressure 1:	4.00	feet H2O	Headloss:	12.50	ft
Pressure 2:	1.00	feet H2O	Energy Grade 1:	376.39	ft
Elevation 1:	370.50	ft	Energy Grade 2:	363.89	ft
Elevation 2:	361.00	ft	Hydraulic Grade 1:	374.50	ft
Length:	145.00	ft	Hydraulic Grade 2:	362.00	ft
Roughness Coefficient:	0.012		Flow Area:	0.35	ft ²
Diameter:	0.67	ft	Wetted Perimeter:	2.10	ft
Discharge:	3.85	ft ³ /s	Velocity:	11.01	ft/s
			Velocity Head:	1.89	ft
			Friction Slope:	0.08621	ft/ft

Calculation Successful.

Conceptual Pipe Sizing Calculations

Bentley FlowMaster V8i

Calculated By: E. Pruneda	Date: 10/3/2014	Project: Richland
Checked By: J. Knutson	Date: 10/7/2014	Project No: 33764797
		Sheet No: 3 of 4

12" PVC Pipe Leaving Infiltration Basin - During Large Storm Event (Discharge Matches 8" PVC with 4' Head)

Worksheet : Circular Pipe - 12" PVC - Normal Depth

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Normal Depth Friction Method: Manning Formula

Roughness Coefficient:	0.012		Flow Area:	0.48	ft ²
Channel Slope:	0.02400	ft/ft	Wetted Perimeter:	1.74	ft
Normal Depth:	0.58	ft	Hydraulic Radius:	0.27	ft
Diameter:	1.00	ft	Top Width:	0.99	ft
Discharge:	3.85	ft ³ /s	Critical Depth:	0.83	ft
			Percent Full:	58.4	%
			Critical Slope:	0.00965	ft/ft
			Velocity:	8.09	ft/s
			Velocity Head:	1.02	ft
			Specific Energy:	1.60	ft
			Froude Number:	2.05	
			Maximum Discharge:	6.43	ft ³ /s
			Discharge Full:	5.98	ft ³ /s
			Slope Full:	0.00995	ft/ft
			Flow Type:	SuperCritical	

Calculation Successful.

Conceptual Pipe Sizing Calculations Rectangular Sharp-Crested Weir	Calculated By: E. Pruneda	Date: 10/3/2014	Project: Richland
	Checked By: J. Knutson	Date: 10/7/2014	Project No: 33764797
			Sheet No: 4 of 4

Rectangular Sharp-Crested Weir Equation
 For use when the head is not greater than one-third of the weir length

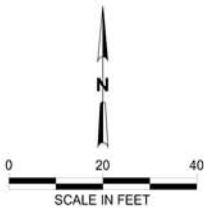
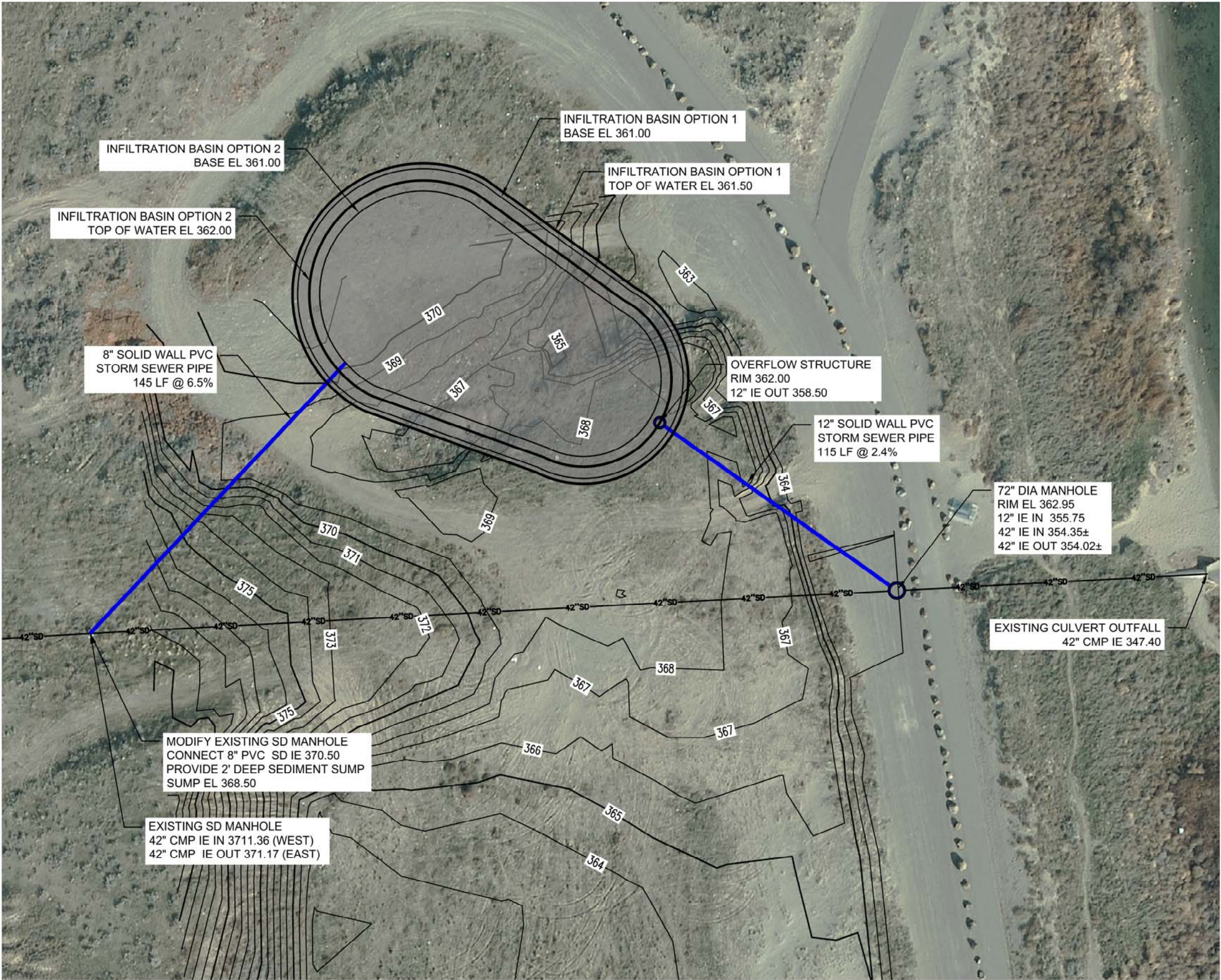
$$Q = 3.33LH^{3/2}$$

Q = Discharge, cfs
 L = Weir Length, ft
 H = Head Above Weir Crest, ft

Q = 3.85 cfs *Discharge into Basin During Large Storm Event, Neglects Basin Infiltration*
 L = 12.57 ft *Perimeter of a 48" Diameter Overflow Structure*
 H = 0.20 ft *Head Above Weir Crest < 1/3 Weir Length*

ATTACHMENT 4 — PLANS AND DETAILS

NO.	DATE	BY	REVISION DESCRIPTION



**CONCEPTUAL DESIGN
NOT FOR CONSTRUCTION**

RICHLAND, WASHINGTON
NR01 OUTFALL STORMWATER
RETROFIT DESIGN PROJECT

**CONCEPTUAL STORMWATER
RETROFIT PLAN
ATTACHMENT 4-1**

DESIGNED BY: EP
DRAWN BY: EP
CHECKED BY: JK
APPROVED BY: _____
REVISION: _____
DATE: 10/6/14



3810 KERN ROAD, SUITE A
YAKIMA, WA 98902
(509) 469-1330

SHEET
1 OF 1
DRAWING NO.
1

City of Richland
Stormwater Retrofit
Support Services

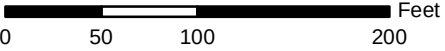
Outfall NR01
Existing Utilities

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Pipe
- Existing Water Pipe

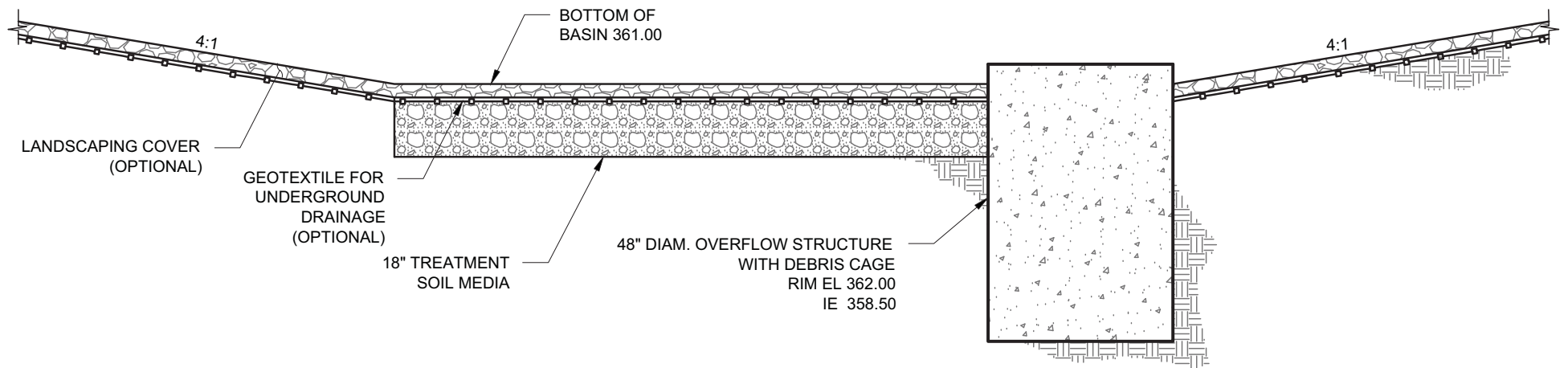
2012 Aerial Imagery

Attachment 4-2



Date Created: October 3, 2014





INFILTRATION BASIN SECTION

SCALE: NTS

ATTACHMENT 5 — PRE-DESIGN LEVEL CONSTRUCTION COST ESTIMATE

Outfall NR01 Stormwater Retrofit Project				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Structure Excavation Class B Incl. Haul	CY	208.6	\$ 10.00	\$ 2,085.54
3	Solid Wall PVC Storm Sewer Pipe 8 In. Diam.	LF	145.0	\$ 40.00	\$ 5,800.00
4	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	115.0	\$ 50.00	\$ 5,750.00
5	Infiltration Basin	LS	1	\$ 20,000.00	\$ 20,000.00
6	Overflow Structure - CB Type 2 48 In. Diam.	EA	1	\$ 3,000.00	\$ 3,000.00
7	Manhole 72 In. Diam. Type 3	EA	1	\$ 5,000.00	\$ 5,000.00
8	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
9	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
10	Debris Cage for Overflow Structure	EA	1	\$ 1,000.00	\$ 1,000.00
11	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
12	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
13	Construction Geotextile for Underground Drainage	SY	1,666.7	\$ 2.50	\$ 4,166.67
14	Gravel Backfill for Pipe Zone Bedding	TON	87.2	\$ 25.00	\$ 2,180.94
15	Energy Dissipation	LS	1	\$ 3,000.00	\$ 3,000.00
16	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Construction Subtotal				\$ 88,183.15
	Design Preparation (10%)				\$ 8,818.31
	Construction Management (10%)				\$ 8,818.31
	WA State Sales Tax (8.6%)				\$ 7,583.75
	Subtotal				\$ 113,403.53
	Pre-Design Contingency (20%)				\$ 22,680.71
	Total				\$ 136,084.23
Notes: • Infiltration Basin includes excavation, grading, soil mix, and landscaping cover.					

CITY OF RICHLAND

Outfall NR02 Stormwater Retrofit Project Pre-Design Report



City of Richland
Public Works Department
840 Northgate Drive
P.O. Box 190, MS-26
Richland, WA 99352

March 10, 2015



ACKNOWLEDGEMENTS

City of Richland

Outfall NR02 Stormwater Retrofit Project — Pre-Design Report

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URS IS A WHOLLY OWNED
SUBSIDIARY OF AECOM
TECHNICAL SERVICES

WORK TO DEVELOP THIS REPORT WAS FUNDED IN PART THROUGH A GRANT
FROM THE WASHINGTON STATE DEPARTMENT OF ECOLOGY

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City of Richland

Outfall NR02 Stormwater Retrofit Project — Pre-Design Report

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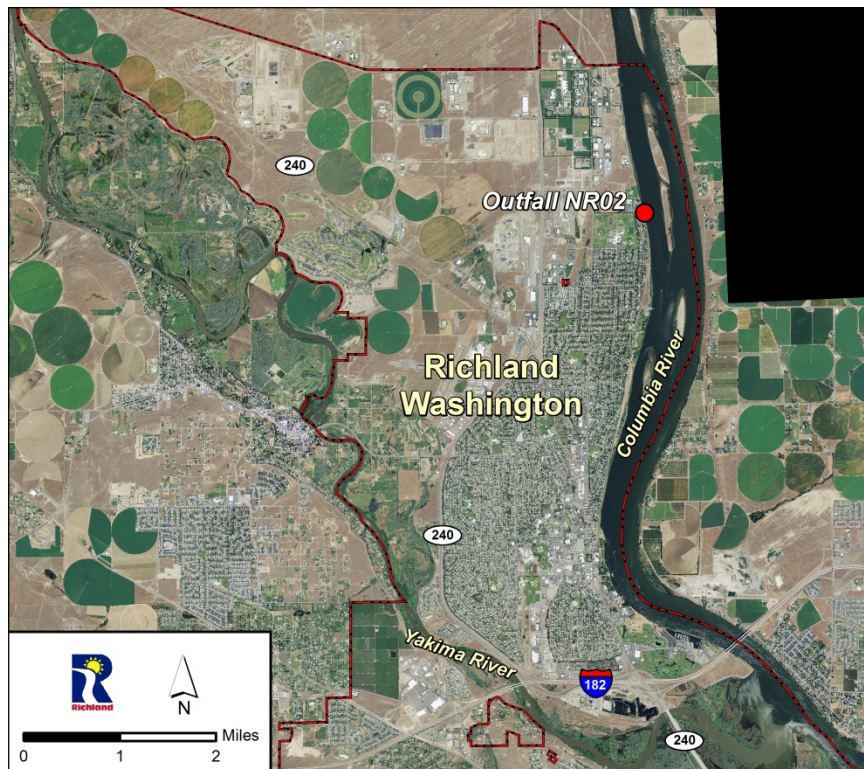
Attachments

Attachment 1	Preliminary Geotechnical Information
Attachment 2	Existing Subbasin Map
Attachment 3	Design Calculations
Attachment 4	Stormwater Retrofit BMP Alternative Matrix
Attachment 5	Plans and Details
Attachment 6	Pre-Design Level Construction Cost Estimate

Section I—Introduction

Based on prior work to evaluate the retrofit potential of all known City stormwater outfalls (City of Richland Updated Stormwater Treatment Retrofit Memorandum, URS, 2014), Richland has selected Outfall NR02 for further retrofit design work. Retrofitting stormwater treatment and retention facilities at the NR02 outfall will reduce stormwater related pollutants discharging to the Columbia River.

The potential retrofit project location is shown in the vicinity map below and described in detail in Section 2.



Section I—Introduction

Continued

An overview of Richland's climate is provided in the table below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	40.7	48.6	57.9	66.4	75.3	82.2	90.5	89.3	80.6	66.7	50.7	41.5	65.9
Average Min. Temperature (F)	26.4	30.2	35.1	40.8	48.1	54.7	59.7	58.7	50.8	41.2	33.7	28.2	42.3
Average Total Precipitation (in.)	0.99	0.70	0.61	0.49	0.59	0.54	0.20	0.23	0.28	0.54	0.93	1.05	7.15
Average Total Snowfall (in.)	2.6	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.2	7.1
Avg. Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Source: Western Region Climate Center (2014)

The project site is located in climatic Region 2 (Central Basin) of eastern Washington and receives approximately 7.15 inches of mean annual precipitation, a portion of which falls as snow.

Section 2—Basin and Site Description

Outfall NR02 receives runoff from a small area consisting of residential property, residential roads, and a portion of the Washington State University (WSU) campus parking lot entrance. Currently all runoff from the NR02 drainage basin is collected and conveyed without treatment to the Columbia River. Available right-of-way along Sprout Road presents an opportunity to allow most stormwater runoff to be retained, treated, and infiltrated rather than discharging directly to the Columbia River.

2.1 Basin Description

2.1.1 Basin Delineation

The drainage basin for NR02 was delineated based on topography and the location of existing drainage system inlets. A basin map for the NR02 stormwater drainage system is provided as Attachment 2. The map shows the drainage basin boundary and flow directions for existing and proposed conditions. Existing and proposed peak runoff rates and volume calculations are provided in Attachment 3.

2.1.2 Basin Information

The NR02 basin is approximately 5 acres in size with an existing land use consisting primarily of low to medium density residential lots and access roads. In addition to being the primary access road to the WSU Tri-Cities campus and local homes, Sprout Road serves as overflow parking for WSU students. There are no expected future land use changes for the basin.

Native soils are generally Hydrologic Class A, expected to have high to very high infiltration rates. The water table is expected to be well below the ground surface at an elevation similar to the Columbia River.

Stormwater quality issues include those typically associated with low average daily traffic (ADT) roadways, including sediments, hydrocarbons, vehicle fluids, metals, elevated temperature, and other pollutants.

Based on reviewing Ecology's 2012 303(d) list of impaired receiving waters, the adjacent reach of the Columbia River is currently listed as impaired for temperature. The States of Washington, Oregon, and Idaho and EPA Region 10 have been working in coordination with the Columbia Basin Tribes since 2001 to develop a Total Maximum Daily Load (TMDL) for temperature on the Columbia and Snake Rivers. However, completion of the TMDL has been delayed to allow for necessary discussions and information exchange. Although specific loading capacities and allocations have yet to be specified, retention and infiltration is a suitable way to reduce temperature increases due to stormwater runoff from impervious surfaces during spring through fall thunderstorms.

Section 2—Basin and Site Description

Continued

2.2 Site Description

2.2.1 Existing Stormwater Controls

The NR02 basin drains to an existing stormwater conveyance system that discharges to the Columbia River (see Attachment 2). The basin has no existing stormwater treatment or flow control BMPs (the Columbia River is exempt from flow control requirements).

2.2.2 Total Area, Impervious Area, Pervious Area

Attachment 2 depicts the Total Basin Area, Connected ISA, Disconnected ISA, and Pervious Area for the NR02 basin. A breakdown of each area is provided below in Table 1. Directly connected impervious areas are areas such as roads, roofs with downspouts to the gutter, driveways sloped towards roads, and parking lots from which runoff can directly enter the drainage system without first traversing an area of pervious ground. Disconnected impervious areas are areas whose runoff must traverse a pervious area as sheet flow, and include areas such as a tennis court in the middle of a lawn, or a roof top or driveway which drains to a yard. Disconnected impervious areas can be weighted/composited with pervious areas during hydrologic calculations or modeling. URS recommends an approach that involves developing a hydrograph for directly connected ISA and one for composited disconnected ISA+ pervious, then summing the hydrographs.

Table 1 – Outfall NR02 Basin Areas

Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)
4.92	3.06	0.56	1.30

2.2.3 Vegetation and Wetlands

Existing vegetation in the basin includes: maintained turf grass, mature trees, and other shrubbery. No wetlands are present within the immediate project area.

2.2.4 Soils

According to the Benton County Soil Survey, surficial soils at the project site primarily consist of Burbank loamy fine sand which is considered to be an excessively drained soil with an estimated saturated hydraulic conductivity in the 6 to 20 inches/hour range (see Attachment 1). Based on the experience of City staff on a recent stormwater infiltration basin design project, it is anticipated that meeting Ecology's infiltration trench stormwater treatment criteria would require using an 18" thick layer of treatment soil mix on top of the native soil. Note that a detailed geotechnical investigation will be performed during the full design stage.

2.2.5 Access

Access to the site is readily available through the existing City road infrastructure.

Section 3—Design Alternatives and Analysis

3.1 Alternatives Considered

A number of retrofit alternatives for the NR02 basin were considered and evaluated, including: surface infiltration facilities, sub-surface infiltration facilities, and proprietary treatment devices. A stormwater retrofit BMP alternative matrix was developed and is included as Attachment 4.

The following issues were considered during the BMP selection and layout process:

- Climate/seasonal precipitation patterns.
- Expected traffic use levels.
- Available right-of-way and setback requirements.
- Ability to work with existing drainage patterns and infrastructure to degree possible.
- Review/avoidance of likely utility/existing infrastructure issues.
- Likely soil and groundwater properties/conditions.
- Avoidance of steep or unstable slopes, or other geologic hazard areas.
- Ability to help address receiving water concerns.
- Minimizing/avoiding work within exterior roads and sidewalks.
- Typical O&M requirements/level of effort/special equipment.
- Critical areas issues.
- Tree related issues such as the effects of roots and leaves on BMPs.
- Ability to safely drain overflow water to an appropriate location.
- Ability to prevent significant problems in the event that systems fail or periodically operate below the intended design level.
- City tree/shrub retention/replacement goals/requirements.
- Corridor beautification goals/standards.
- Aesthetic compatibility of BMPs with existing site structures and features.
- Consideration of future improvement projects.

Many of these considerations are also feasibility criteria recommended by the Eastern Washington LID and Stormwater Management Manuals.

Section 3—Design Alternatives and Analysis

Continued

3.2 Description of Final Alternative

After review of the retrofit alternatives, the City selected a sub-surface infiltration facility (infiltration trench) as the preferred retrofit alternative. Given the space constraints, location and surrounding steep topography, a surface infiltration facility was deemed to not be feasible. The available right-of-way along Sprout Road provides an excellent opportunity to locate an infiltration trench. Given the proximity to the Columbia River, an infiltration trench was chosen over a drywell system to provide greater separation to groundwater.

The preliminary infiltration trench design included in this report follows the Ecology infiltration trench for stormwater treatment design criteria:

- Vadose zone separation between groundwater/impermeable layer and trench base: ≥ 5 feet (current design has approximately 10 feet of separation)
- Depth of soil considered as treatment BMP: ≥ 18 inches (can be part of the 5 feet or required vadose zone separation)
- Soil type: 5 mill equivalents CEC/100 grams soils; organic content unspecified
- Infiltration rate: ≤ 3 inches/hour if relying on native soil for treatment (per recent discussion with Douglas Howie of Ecology). If an 18" treatment soil layer is required beneath the infiltration trench, the limiting infiltration rate may be the flow rate through the treatment media rather than the flow rate into the existing soils.

3.2.1 Design Storms

The infiltration trench will be designed to retain, treat, and infiltrate up to the 6-month, 24-hour SCS Type 1A storm event for the contributing area. This should effectively treat, retain, and infiltrate at least 90% of the annual runoff from the contributing drainage basin. The facility will be designed to completely drain down within at most 72-hours in order to meet the following objectives:

- Restore hydraulic capacity to receive runoff from a new storm;
- Maintain infiltration rates; and
- Aerate soil to prevent anoxic conditions in the treatment soil and enhance the removal and degradation of pollutants.

The inlet pipe to the infiltration trench, as well as other conveyance structures, will be designed to convey the peak discharge from the 6-month, 24-hour SCS Type 1A storm event. Flows in excess of the peak water quality storm discharge will bypass the infiltration trench and discharge to the Columbia River via the existing storm drain and outfall.

3.2.2 Preliminary Infiltration Characteristics

As discussed in Section 2, based on published Soil Survey information, the saturated hydraulic conductivity of the native soil at the project site is estimated to be between about 6 and 20 inches/hour, which can be used as an estimate of the maximum infiltration rate under gravity flow conditions. For purposes of this pre-design report, it was assumed that the long-term infiltration rate of the 18-inch treatment soil layer will be 3.0 inches/hour. Geotechnical testing will be conducted to verify the native soil infiltration rate; if it is found that the native soil infiltration rate is less than the assumed long-term infiltration of the 18-inch treatment soil layer, infiltration trench sizing calculations will be revisited.

3.2.3 Key Aspects, Benefits, and Cost

Key aspects of the project will include:

- Saw cutting the asphalt, curb/gutter, and sidewalk. Excavating the required volume for the infiltration trench as well as other associated stormwater facilities.
- Installing new catch basins and a flow splitter box to redirect runoff up to the water quality storm event to the infiltration trench. Installing a sedimentation manhole with down-turned elbows to capture large sediments as well as trash, debris, and some oil.

Refer to the pre-design plan drawing included in Attachment 5-1 and detail in Attachment 5-2 for additional information. Peak runoff rates and volumes, as well as BMP sizing calculations are provided in Attachment 3.

Water Quality Benefits

The proposed stormwater retrofit will reduce the volume of runoff to outfall NR02 as compared to the existing condition by retaining and infiltrating the 6-month, 24-hour SCS Type 1A storm event from the contributing area. Water quality is also improved from the existing condition since the proposed BMP will provide enhanced treatment and will retain and treat 90% of the annual runoff volume from the contributing drainage basin including all “first flush” storm events.

Preliminary Cost Estimate

The pre-design level construction cost estimate for the Outfall NR02 Stormwater Retrofit project is \$76,200 including a 20% pre-design contingency. See Attachment 6 for a complete breakdown of the pre-design level construction cost estimate.

Section 4—Implementation Considerations

4.1 Design and Operational Considerations to be Addressed Between the Pre-Design Report and 90% Design

The design submitted with this Pre-Design Report is at a preliminary level. Design and operational considerations to be addressed in the next phase of the design process are discussed below.

4.1.1 Existing Utilities

There are multiple utilities running through Sprout Road. During the design phase, the City will want to call for locates, perform potholing, and/or utilize as-built information to gain a better understanding of the exact location and depth to the existing utilities.

4.1.2 Additional Design and Operational Considerations

Additional design and operational considerations to be addressed in the next phase of the design process include:

- Finalize detailed topographic and utilities survey data.
- Identify, avoid, or otherwise address any utility conflicts.
- Verify high groundwater levels and depth to bedrock.
- Test the soil conditions and infiltration characteristics, and refine the BMP design accordingly.
- Investigate the structural stability of the treatment soil layer for use under a roadway.
- Investigate the permeability of a compacted treatment soil layer.
- Determine whether or not the treatment soil layer should be wrapped up the sides of the infiltration trench to prevent the possibility of water bypassing the treatment soil layer along the bottom of the facility.
- As a retrofit project, check and see if the flow control standards for an infiltration trench can be used instead of the treatment standards, which will eliminate the need for the treatment soil layer.
- Design flow splitter box to bypass runoff in excess of the 6-month, 24-hour SCS Type 1A storm event and provide for sediment retention.
- Verify construction accessibility and traffic/pedestrian control issues.
- Address O&M equipment accessibility and routes.
- Other considerations and limitations per the SWMMEW.

Section 4—Implementation Considerations

Continued

4.2 Additional Implementation Considerations

Based on City input, it is expected that permitting requirements include:

- SEPA.
- City construction stormwater (temporary erosion and sediment control, etc.).
- State mandated cultural resources requirements.

Anticipated City Council involvement includes:

- Approval to submit grant application for construction funding.
- Approval for any contracts associated with project work.
- Approval to place stormwater retrofit project on the City CIP list.

Section 5—Proposed Schedule

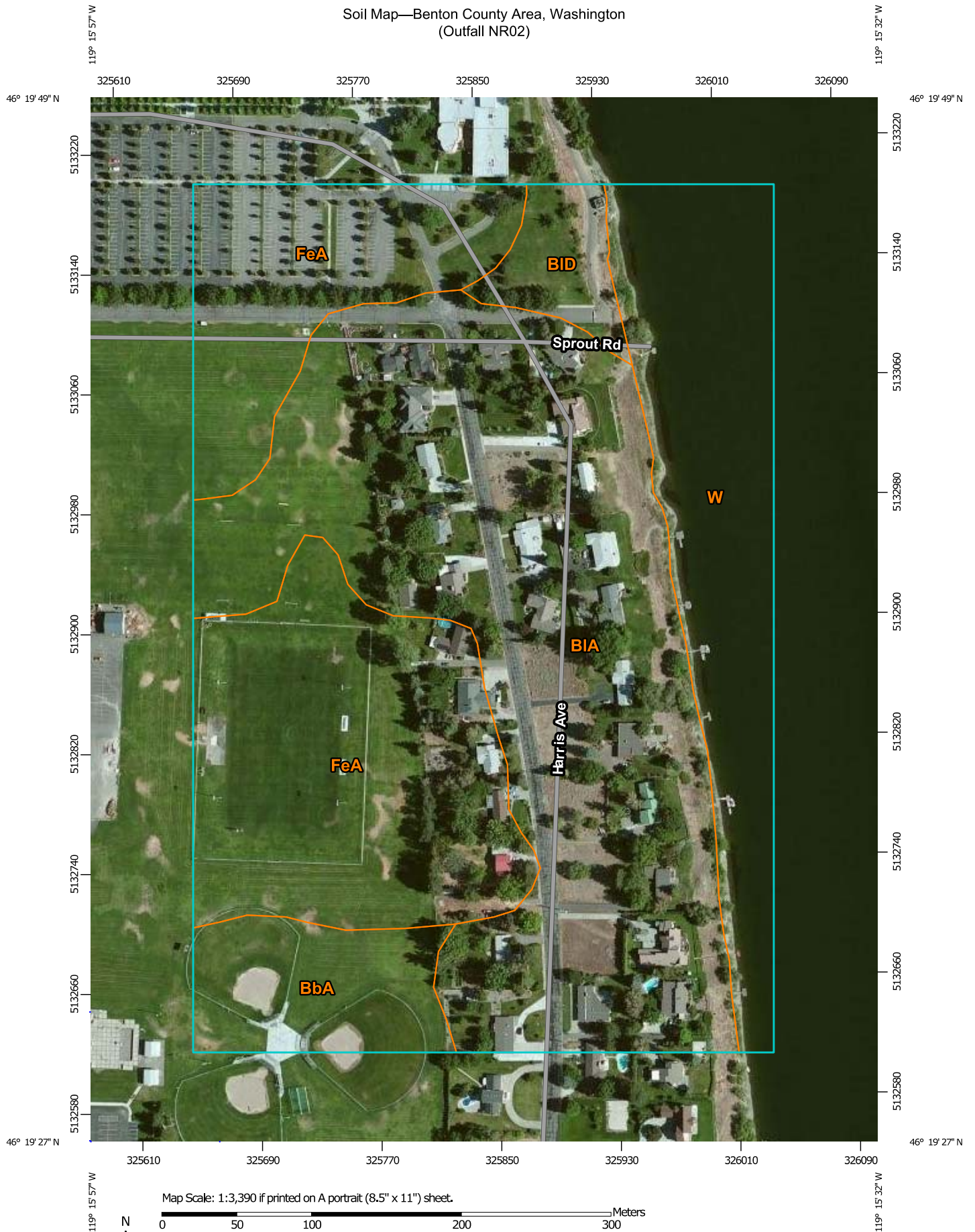
The City anticipates completing 90% design in 2015 (to be submitted to Ecology for review and acceptance). The 90% design package will include:

- 90% design
- 90% bid schedule
- 90% bid specifications and special provisions
- Engineers estimate of probable project costs
- O&M Guide

Following completion of the 90% design, the City may complete and submit an application to a competitive grant program, if available, in hopes of securing grant funding for construction activities.

ATTACHMENT 1 — PRELIMINARY GEOTECHNICAL INFORMATION

Soil Map—Benton County Area, Washington (Outfall NR02)



Soil Map—Benton County Area, Washington
(Outfall NR02)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 10, Sep 3, 2014

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

Date(s) aerial images were photographed: Aug 6, 2010—Oct 17, 2010

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

Benton County Area, Washington (WA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BbA	Burbank loamy fine sand, 0 to 2 percent slopes	3.6	6.4%
BIA	Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes	24.0	43.1%
BID	Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes	1.7	3.0%
FeA	Finley fine sandy loam, 0 to 2 percent slopes	17.2	30.8%
W	Water	9.4	16.8%
Totals for Area of Interest		55.8	100.0%

Benton County Area, Washington

BbA—Burbank loamy fine sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bb5

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 10, Sep 3, 2014

Benton County Area, Washington

BIA—Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bbb

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 10, Sep 3, 2014

Benton County Area, Washington

BID—Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2bbc

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 10, Sep 3, 2014

Benton County Area, Washington

FeA—Finley fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bc6

Elevation: 300 to 1,800 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 135 to 180 days

Farmland classification: Prime farmland if irrigated

Map Unit Composition

Finley and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Finley

Setting

Landform: Terraces, flood plains

Parent material: Alluvium

Typical profile

H1 - 0 to 3 inches: fine sandy loam

H2 - 3 to 13 inches: fine sandy loam

H3 - 13 to 28 inches: very gravelly loam

H4 - 28 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 20 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 10, Sep 3, 2014

Benton County Area, Washington

W—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 10, Sep 3, 2014

ATTACHMENT 2 — EXISTING SUBBASIN MAP



City of Richland Stormwater Retrofit Support Services

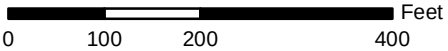
Outfall NR02 Drainage Basin

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- 1999 Contour Data
- Connected ISA
- Pervious and Disconnected ISA
- Approximate Flow Direction

2012 Aerial Imagery

Attachment 2



Date Created: January 19, 2015

Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)
4.92	3.06	0.56	1.30	1.86

ATTACHMENT 3 — DESIGN CALCULATIONS

Hydrologic Calculations - Subbasin Area and Time of Conc. Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 1/20/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Subbasin	Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)	Imp. CN	Perv. CN	Pervious and Disconnected Weighted CN
NR02	4.92	3.06	0.56	1.30	1.86	98	68	77

Outfall ID	Sheet Flow					Shallow Concentrated Flow				Open Channel Flow				Time of Concentration
	$T_t = 0.42 * (n_s * L)^{0.8} / ((P_{2yr2hr})^{0.5} * (s_0)^{0.4})$					$T_t = L / (60 * (k * (s_0)^{0.5}))$				$T_t = L / (60 * (k_c * (s_0)^{0.5}))$				$T_c = T_{t1} + T_{t2} + ... T_{tm}$
	n_s	L (ft)	P_{2yr2hr} (in)	s_0 (ft/ft)	T_t (min)	L (ft)	k	s_0 (ft/ft)	T_t (min)	L (ft)	k_c	s_0 (ft/ft)	T_t (min)	T_c (min)
NR02 (Pervious and Disconnected ISA)	0.15	92	0.4	0.011	32.93	800	27	0.003	9.88	635	42	0.005	3.68	47.22
										411	42	0.049	0.74	
NR02 (Connected ISA)	0.011	40	0.4	0.01	2.17	800	27	0.003	9.88	635	42	0.005	3.68	16.46
										411	42	0.049	0.74	

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.

Hydrologic Calculations - SBUH Results Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 1/20/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

							24-Hour Type 1A Storm Event		3-Hour Short Duration Storm Event
							6-Month (0.53 in)		25-Year (0.92 in)
Outfall ID	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T _c (min)	Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)
NR02 (Connected ISA)	3.06	0.00	1.00	98	68	16.46	0.22	3,814	3.24
NR02 (Pervious and Disconnected ISA)	1.86	1.86	0.00	98	77	47.22	0.00	0	0.03
NR02 (Total)	---	---	---	---	---	---	0.22	3,814	3.24

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.
- (3) 25-Year, 3-Hour Short Duration peak flows are provided for high-flow bypass conveyance sizing. Peak flows were determined by summing the hydrographs for the Connected ISA and Pervious and Disconnected ISA areas.

Conceptual BMP Sizing Calculations	Calculated By: E. Pruneda	Date: 2/25/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 2

Infiltration Trench

Facility Characteristics:

Type of Facility :	Sedimentation manhole with infiltration trench		
Number of Infiltration Trenches:	2		
Length:	40 ft	Per infiltration trench	
Depth:	2 ft	Per infiltration trench	
Width:	10 ft	Per infiltration trench	
Perforated Pipe Dia:	1 ft		

Calculated Areas:

Drain Rock Bottom Area:	400.00 sq ft	Per infiltration trench
Drain Rock Side Wall Area:	100.00 sq ft	Two sides and one end; per infiltration trench

Assumed Infiltration Rate:

Infiltration Rate =	3.00 in/hr	To be updated based on geotechnical analysis
Infiltration Rate =	0.250 ft/hr	Conversion
Infiltration Rate =	6.94E-05 ft/s	Conversion
Bottom:	0.028 cfs	Drain Rock Bottom Area x Infiltration Rate
Side Walls:	0.003 cfs	Drain Rock Side Wall Area x (Infiltration Rate/2) (Division by two reflects zero hydraulic head at the top of the sidewall and full head at the bottom of the sidewall)
Subtotal:	0.0313 cfs	Per infiltration trench
Total:	0.0625 cfs	

Available Storage Capacity:

Perforated Pipe Storage Volume =	31 cf	Per infiltration trench
Drain Rock Void Volume =	307 cf	Assuming 40% voids; per infiltration trench
Subtotal Available Storage =	339 cf	Per infiltration trench
Total Available Storage =	678 cf	

Conceptual BMP Sizing Calculations	Calculated By: E. Pruneda	Date: 2/25/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 2 of 2

Facility ID (Outfall ID)	Available Storage Volume					Predicted Water Quality Volume (cf) from Contributing Area	Assumed Infiltration Rate (in/hr)	Assumed Infiltration Rate (cfs)	Predicted Max Volume (cf) in Facility During the Water Quality Storm Event
	Top Area (sq-ft)	Bottom Area (sq-ft)	Side Slope (H:V)	Depth (ft)	Volume (cf)				
Infiltration Trench (NR02)	See Infiltration Trench Calcs				678	3,814	3.0	0.0625	605

Notes:

- (1) The long term infiltration rate of treatment soil media below the rock gallery has been assumed to be 3.0 inches/hour.
The native infiltration rate will be confirmed through geotechnical investigation as the design progresses.

Worksheet : Circular Pipe - 1

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Normal Depth Friction Method: Manning Formula

Roughness Coefficient: 0.010	Flow Area: 0.06 ft ²
Channel Slope: 0.02000 ft/ft	Wetted Perimeter: 0.72 ft
Normal Depth: 0.13 ft	Hydraulic Radius: 0.08 ft
Diameter: 1.00 ft	Top Width: 0.66 ft
Discharge: 0.22 ft ³ /s	Critical Depth: 0.19 ft
	Percent Full: 12.5 %
	Critical Slope: 0.00344 ft/ft
	Velocity: 3.87 ft/s
	Velocity Head: 0.23 ft
	Specific Energy: 0.36 ft
	Froude Number: 2.32
	Maximum Discharge: 7.05 ft ³ /s
	Discharge Full: 6.55 ft ³ /s
	Slope Full: 0.00002 ft/ft
	Flow Type: Supercritical

Calculation Successful.

ATTACHMENT 4 — STORMWATER RETROFIT BMP ALTERNATIVE MATRIX

NR02 - Stormwater Retrofit BMP Alternative Matrix

BMP Alternative	Description	Benefit	Target Pollutants	Treatment Effectiveness	Relative O&M Effort	Relative Cost
1	Drywells / Infiltration Trenches <i>Convert Existing Inlets to Subsurface Infiltration System with Sedimentation Manhole</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	Mod	Mod	Mod
2	Distributed Bioretention Cells <i>Locate Facilities within Right-of-Way Along Harris Ave and Sprout Rd</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	High	Mod
3	CONTECH SW Management StormFilter with MetalRx Media	Runoff Treatment (Basic, Enhanced)	Sediment and Metals; Limited Nutrients, Pesticides, Bacteria, & Hydrocarbons	Mod	High	High

Notes:

(1) Any BMP that will retain and infiltrate at least the water quality storm event will achieve a high treatment level because of the reduction in pollutant loading to surface waters.

(2) Columbia River is exempt from flow control requirements.

(3) Relative Operation and Maintenance Effort Ratings:

Low = One inspection per year and after major storms; sediment removal as needed.

Moderate = Two inspections per year and after major storms; sediment removal as needed. Similar to "Low" until replacement.

High = One inspection per year and after major storms; irrigation; landscape pruning; enclosed space requirements; sediment removal as needed; cartridge replacement as needed (\$65 per cartridge + installation).

Exact maintenance efforts are difficult to project and will only be revealed based on inspections. Minimizing sediment load to the treatment facilities will reduce annual maintenance costs; this can be accomplished through street sweeping, and routine operation and maintenance of upstream catch basins and manholes.

ATTACHMENT 5 — PLANS AND DETAILS

City of Richland
Stormwater Retrofit
Support Services

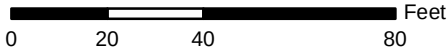
Outfall NR02
Conceptual Stormwater
Treatment Retrofit

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- Contour (NAVD88)
- Parcel Boundary
- Proposed Catch Basin
- Proposed Sed. Manhole
- Proposed Storm Pipe
- Proposed Perforated Pipe
- Proposed Facility

2012 Aerial Imagery

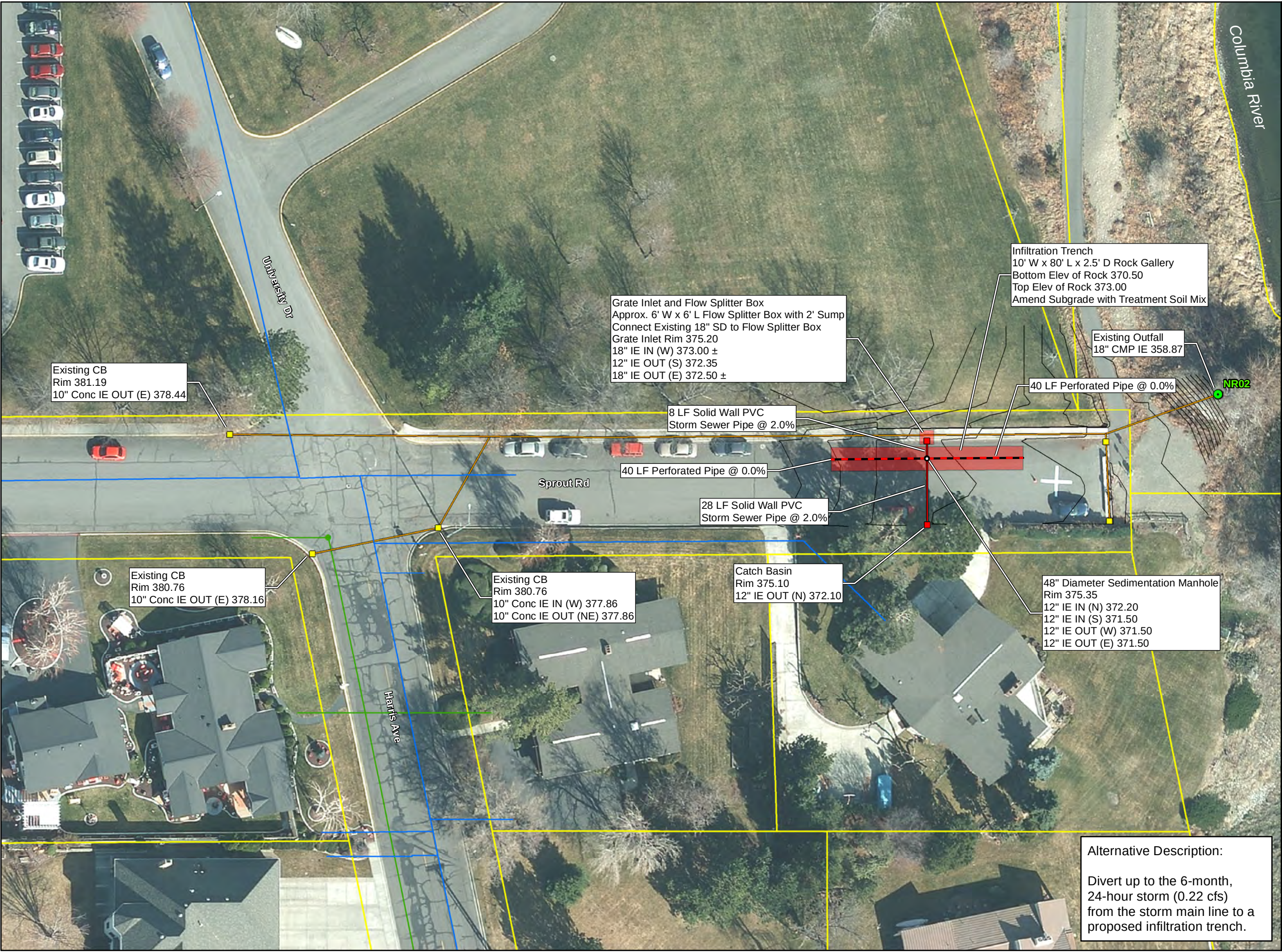
Attachment 5-1

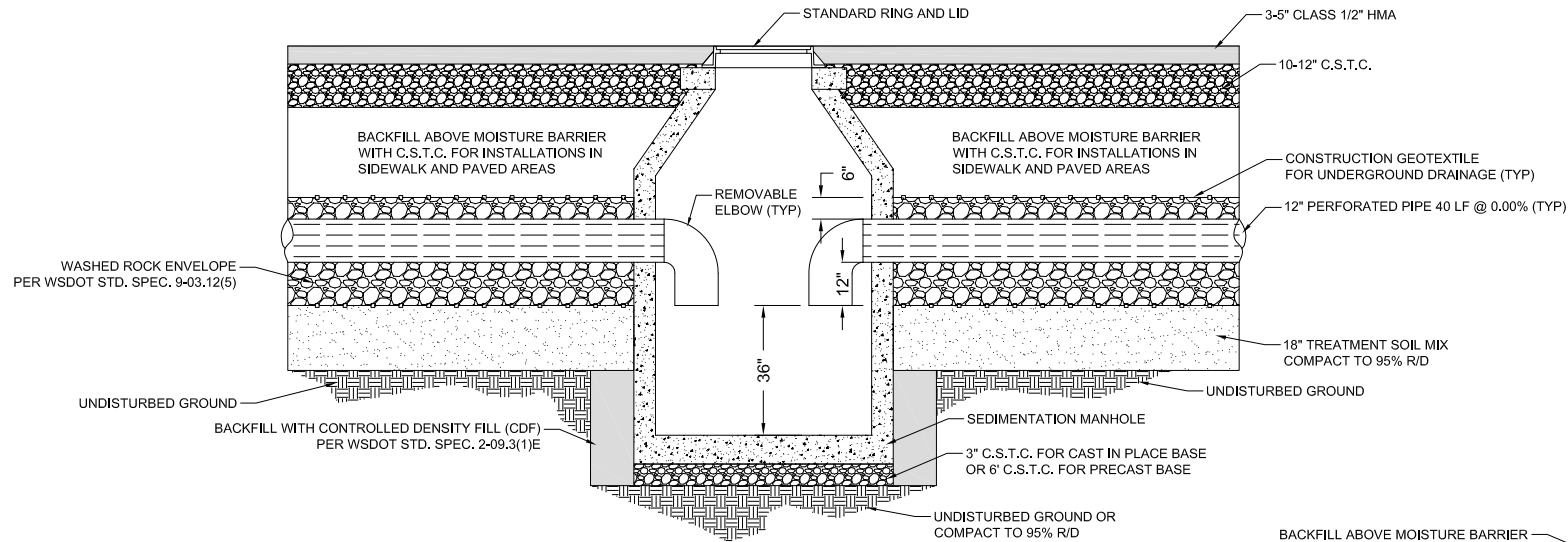


Date Created: February 25, 2015

Alternative Description:

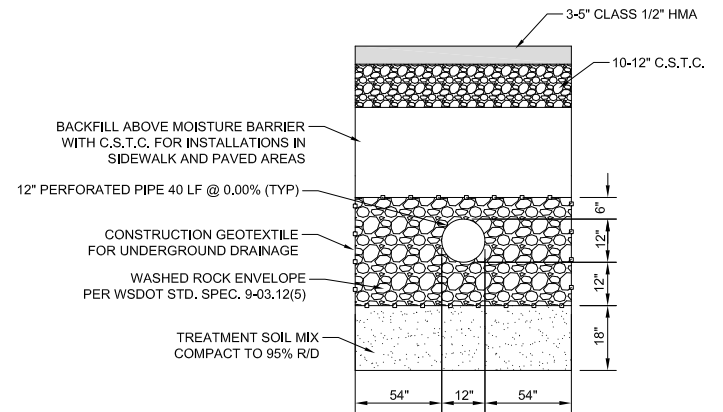
Divert up to the 6-month,
24-hour storm (0.22 cfs)
from the storm main line to a
proposed infiltration trench.





INFILTRATION TRENCH DETAIL

SCALE: NTS



INFILTRATION TRENCH TYPICAL SECTION

SCALE: NTS

ATTACHMENT 6 — PRE-DESIGN LEVEL CONSTRUCTION COST ESTIMATE

Outfall NR02 Stormwater Retrofit Project - Infil. Trench				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 5,000.00	\$ 5,000.00
2	Project Temporary Traffic Control	LS	1	\$ 2,000.00	\$ 2,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 2,500.00	\$ 2,500.00
4	Structure Excavation Class B Incl. Haul	CY	192.3	\$ 10.00	\$ 1,923.18
5	Shoring or Extra Excavation Class A	LS	1	\$ 2,000.00	\$ 2,000.00
6	Crushed Surfacing Base Course	TON	55.6	\$ 20.00	\$ 1,111.11
7	Crushed Surfacing Top Course	TON	37.0	\$ 25.00	\$ 925.93
8	HMA Cl. 1/2-Inch PG 64-28	TON	51.1	\$ 80.00	\$ 4,088.89
9	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	36.0	\$ 45.00	\$ 1,620.00
10	Perforated Storm Drain Pipe 12 In. Diam.	LF	80.0	\$ 50.00	\$ 4,000.00
11	Amended Treatment Soil Mix	CY	44	\$ 20.00	\$ 888.89
12	Infiltration Trench Rock	CY	72	\$ 50.00	\$ 3,587.35
13	Catch Basin Type 1	EA	1	\$ 2,000.00	\$ 2,000.00
14	Grate Inlet and Flow Splitter Box	EA	1	\$ 8,000.00	\$ 8,000.00
15	Sed. Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
16	ESC Lead	DAY	3	\$ 100.00	\$ 300.00
17	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
18	Construction Geotextile for Underground Drainage	SY	227.8	\$ 2.50	\$ 569.44
19	Gravel Backfill for Pipe Zone Bedding	TON	14.0	\$ 25.00	\$ 350.00
20	Cement Concrete Curb and Gutter	LF	10	\$ 25.00	\$ 250.00
21	Cement Concrete Sidewalk, 4-Inch Thick	SY	5	\$ 50.00	\$ 250.00
22	Minor Change	FA	EST	\$ 2,500.00	\$ 2,500.00
	Construction Subtotal				\$ 49,364.78
	Design Preparation (10%)				\$ 4,936.48
	Construction Management (10%)				\$ 4,936.48
	WA State Sales Tax (8.6%)				\$ 4,245.37
	Subtotal				\$ 63,483.11
	Pre-Design Contingency (20%)				\$ 12,696.62
	Total				\$ 76,179.73

CITY OF RICHLAND

Outfall NR03 Stormwater Retrofit Project – Pre-Design Report



City of Richland
Public Works Department
840 Northgate Drive
P.O. Box 190, MS-26
Richland, WA 99352

January 23, 2015

ACKNOWLEDGEMENTS

City of Richland

Outfall NR03 Stormwater Retrofit Project — Pre-Design Report

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City of Richland

Outfall NR03 Stormwater Retrofit Project — Pre-Design Report

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Attachments

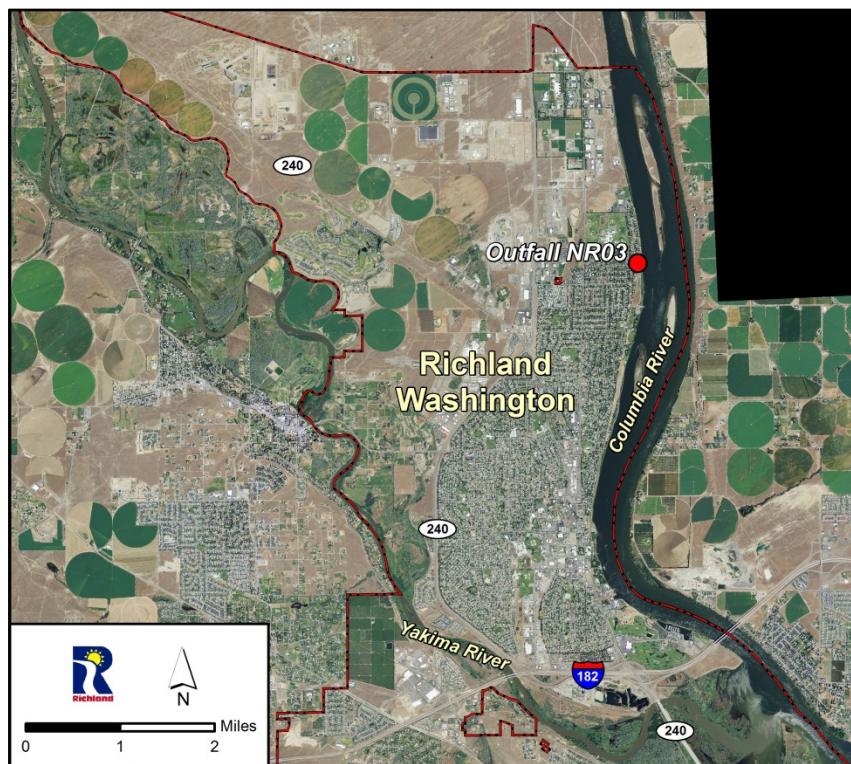
Attachment 1	Preliminary Geotechnical Information
Attachment 2	Existing Subbasin Map
Attachment 3	Design Calculations
Attachment 4	Stormwater Retrofit BMP Alternative Matrix
Attachment 5	Plans and Details
Attachment 6	Pre-Design Level Construction Cost Estimates

Section I—Introduction

As a part of the 2013-2015 Biennial Municipal Stormwater Capacity Grant Program, the Washington State Department of Ecology (Ecology) has provided the City of Richland (City), a NPDES Phase II community, with funds to conduct project specific planning and design (pre-construction) activities for retrofit projects which address stormwater pollution runoff from existing development. As a condition for pre-construction activity funding, at least one of the projects must implement low impact development techniques in accordance with Ecology approved design manuals, primarily the Stormwater Management Manual for Eastern Washington (SWMMEW) and the Eastern Washington Low Impact Development Guidance Manual (E. WA LID Manual).

Based on prior work to develop evaluation criteria and rank all known City outfalls (*City of Richland Updated Stormwater Treatment Retrofit Memorandum*, URS, 2014), City staff have selected Outfall NR03 to develop a stormwater retrofit design to improve water quality discharging to the Columbia River.

The retrofit project location is shown in the vicinity map below and described in detail in Section 2.



Section I—Introduction

Continued

An overview of Richland’s climate is provided in the table below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	40.7	48.6	57.9	66.4	75.3	82.2	90.5	89.3	80.6	66.7	50.7	41.5	65.9
Average Min. Temperature (F)	26.4	30.2	35.1	40.8	48.1	54.7	59.7	58.7	50.8	41.2	33.7	28.2	42.3
Average Total Precipitation (in.)	0.99	0.70	0.61	0.49	0.59	0.54	0.20	0.23	0.28	0.54	0.93	1.05	7.15
Average Total Snowfall (in.)	2.6	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.2	7.1
Avg. Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Source: Western Region Climate Center (2014)

The project site is located in climatic Region 2 (Central Basin) of eastern Washington and receives approximately 7.15 inches of mean annual precipitation, a portion of which falls as snow.

2.1 Outfall NR03

Outfall NR03 serves a small area consisting of residential property. Currently all runoff is collected and conveyed without treatment to the Columbia River. The vacant USACE land immediately to the west of the outfall, as well as the available right-of-way along Ferry Rd and Harris Ave, present an opportunity to allow stormwater runoff to be retained, treated, and infiltrated, up to a specific storm event, rather than discharging directly to the Columbia River.

2.1.1 Basin Description

Basin Delineation

A basin map for the NR03 stormwater drainage system is provided as Attachment 2. The map shows the drainage basin boundary and flow directions for existing and proposed conditions. Existing and proposed peak runoff rates and volume calculations are provided in Attachment 3.



NR03 Outfall to Columbia River

Basin Information

The NR03 basin is approximately 17 acres in size with an existing land use consisting primarily of low density residential. There are no expected future land use changes for the basin.

Native soils are generally Hydrologic Class A, expected to have high to very high infiltration rates. The water table is expected to be well below the ground surface at an elevation similar to the Columbia River.

Stormwater quality issues include those typically associated with low average daily traffic (ADT) roadways, including sediments, hydrocarbons, vehicle fluids, metals, elevated temperature, and other pollutants.

Based on review of Ecology's 2012 303(d) list of impaired receiving waters, the Columbia River is currently listed as impaired for temperature. The States of Washington, Oregon, and Idaho and EPA Region 10 have been working in coordination with the Columbia Basin Tribes since 2001 to develop a Total Maximum Daily Load (TMDL) for temperature on the Columbia and Snake Rivers. However, completion of the TMDL has been delayed to allow for necessary discussions and information exchange. Although specific loading capacities and allocations have yet to be specified, retention and infiltration is a suitable way to reduce

Section 2— Basin and Site Description

Continued

temperature increases due to stormwater runoff from impervious surfaces during spring through fall thunderstorms.

2.1.2 Site Description

Existing Stormwater Controls

The NR03 basin drains to an existing stormwater conveyance system that discharges to the Columbia River (see Attachment 2). The basin has no existing stormwater quality or flow control BMPs (the Columbia River is exempt from flow control requirements).

Total Area, Impervious Area, Pervious Area

Attachment 2 depicts the Total Basin Area, Connected ISA, Disconnected ISA, and Pervious Area for the NR03 basin. A breakdown of each area is provided below in Table 1.

Table 1 – Outfall NR03 Basin Areas

Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)
16.78	5.07	3.85	7.87

Vegetation and Wetlands

Existing vegetation in the basin includes: maintained turf grass, mature trees, and other shrubbery. No wetlands are present within the immediate project area.

Soils

According to the Benton County Soil Survey, surficial soils at the project site primarily consist of Burbank loamy fine sand which is considered to be an excessively drained soil with an estimated saturated hydraulic conductivity in the 5.95 to 19.98 inches/hour range (see Attachment 1). Based on the experience of City staff on a recent stormwater infiltration design project, it is anticipated that the soil will require 18” of a treatment soil mix on top of the native soil to meet the water quality design requirements as stated in the Stormwater Management Manual for Eastern Washington. Note that a detailed geotechnical investigation will be performed during the design stage.

Access

Access to the site is readily available through the existing City road infrastructure.

Section 3—Design Alternatives and Analysis

3.1 Alternatives Considered

City staff evaluated a number of retrofit alternatives for the NR03 basin including: surface infiltration facilities, sub-surface infiltration facilities, and proprietary treatment devices. A stormwater retrofit BMP alternative matrix was developed and is included as Attachment 4.

Two alternatives were evaluated in detail: (1) a surface infiltration facility at the end of Ferry Road on Corps of Engineers property; and (2) drywells along Ferry Road. Conceptual layouts and pre-design level construction cost estimates are provided in Attachment 5 and Attachment 6, respectively.

The following issues were considered during the BMP selection and layout process:

- Climate/seasonal precipitation patterns.
- Expected traffic use levels.
- Available right-of-way and setback requirements.
- Ability to work with existing drainage patterns and infrastructure to degree possible.
- Review/avoidance of likely utility/existing infrastructure issues.
- Likely soil and groundwater properties/conditions.
- Avoidance of steep or unstable slopes, or other geologic hazard areas.
- Ability to help address receiving water concerns.
- Minimizing/avoiding work within exterior roads and sidewalks.
- Typical O&M requirements/level of effort/special equipment.
- Critical areas issues.
- Tree related issues such as the effects of roots and leaves on BMPs.
- Ability to safely drain overflow water to an appropriate location.
- Ability to prevent significant problems in the event that systems fail or periodically operate below the intended design level.
- City tree/shrub retention/replacement goals/requirements.
- Corridor beautification goals/standards.
- Aesthetic compatibility of BMPs with existing site structures and features.
- Consideration of future improvement projects.

Many of these considerations are also feasibility criteria recommended by the Eastern Washington LID and Stormwater Management Manuals.

Section 3—Design Alternatives and Analysis

Continued

3.2 Description of Final Alternative

The City met with the Army Corps of Engineers (Corps) to discuss the retrofit alternatives given that the Corps owns the property adjacent to the Columbia River where a retrofit is likely to be located. Together the two entities decided that an infiltration basin capable of treating the entire basin was the preferred retrofit BMP to carry forward into design, and the following sections of this pre-design report are written as such. However, prior to entering design, the City will present all alternatives to the City Council to obtain final direction.

3.2.1 Design Storms

The infiltration basin will be designed to retain, treat, and infiltrate up to the 6-month, 24-hour SCS Type 1A storm event for the contributing area. This should effectively treat, retain, and infiltrate at least 90% of the annual runoff from the contributing drainage basin. The facility will be designed to completely drain down within at most 72-hours in order to meet the following objectives:

- Restore hydraulic capacity to receive runoff from a new storm;
- Maintain infiltration rates; and
- Aerate vegetation and soil to keep the vegetation healthy, prevent anoxic conditions in the treatment soils, and enhance the biodegradation of pollutants and organics.

The inlet pipe to the infiltration basin, as well as other conveyance structures, will be designed to convey the peak discharge from the 6-month, 24-hour SCS Type 1A storm event plus incidental flow due to the expected maximum head on the pipe leading to the infiltration basin. Flows in excess of the peak water quality storm discharge will bypass the infiltration basin via a weir in a 48-inch diameter manhole and discharge to the Columbia River via the existing storm drain and outfall.

3.2.2 Preliminary Infiltration Characteristics

As discussed in Section 2, based on published Soil Survey information, the saturated hydraulic conductivity of the native soil at the project site is estimated to be 5.95 to 19.98 inches/hour. For purposes of this pre-design report, it was assumed that the long-term infiltration rate through the 18-inch treatment soil layer beneath the infiltration basin will be 3.0 inches/hour. Geotechnical testing will be conducted to verify the native soil infiltration rate; if it is found that the native soil infiltration rate is less than the assumed long-term infiltration of the 18-inch treatment soil layer, infiltration basin sizing calculations will be revisited.

3.2.3 Key Aspects, Benefits, and Cost

Key aspects of the project will include:

- Excavating the required volume for the infiltration basin including minor grading of the surrounding area to catch existing contours and providing an 18-inch treatment soil layer at the bottom of the infiltration basin.
- Redirecting runoff up to the water quality storm event to the infiltration basin by installing a new 48-inch diameter manhole with a flow splitter weir in-line with the existing storm drain and an 8-inch storm pipe that leads to the infiltration basin.
- Constructing energy dissipation at the outlet of the 8-inch storm pipe within the infiltration basin.
- Constructing an overflow structure within the infiltration basin and connecting a 8-inch overflow pipe back to the existing 42-inch CMP at an existing manhole structure.

Refer to the pre-design plan drawing included as Attachment 5-1 for additional information. Peak runoff rates and volumes, as well as BMP sizing calculations are provided in Attachment 3.

Water Quality Benefits

The proposed stormwater retrofit will reduce the volume of runoff to outfall NR03 as compared to the existing condition by retaining and infiltrating the 6-month, 24-hour SCS Type 1A storm event from the contributing area. Water quality is also improved from the existing condition since the proposed BMP will provide enhanced treatment and will retain and treat 90% of the annual runoff volume from the contributing drainage basin including all “first flush” storm events.

Preliminary Cost Estimate

The pre-design level construction cost estimate for the preferred infiltration basin alternative is \$92,000 including a 20% pre-design contingency. See Attachment 6 for a complete breakdown of the pre-design level construction cost estimate.

Section 4—Implementation Considerations

4.1 Design and Operational Considerations to be Addressed Between the Pre-Design Report and 90% Design

The design submitted with this Pre-Design Report is at a preliminary level. Design and operational considerations to be addressed in the next phase of the design process are discussed below.

4.1.1 Existing Utilities

There are multiple utilities running through Ferry Road, but none are anticipated to be encountered at the infiltration basin location off of Ferry Road. During the design phase, the City will want to call for locates, perform potholing, and/or utilize as-built information to gain a better understanding of the exact location and depth to the existing utilities.

4.1.2 Land Acquisition

Siting the infiltration basin on Corps of Engineers property will require the City to complete necessary easement/permitting during the design process.

4.1.3 Infiltration Basin Footprint

The infiltration basin footprint shown in Attachment 5 is rectangular in shape for purposes of quickly calculating and displaying the estimated size of the facility required to retain, treat, and infiltrate stormwater runoff up to the 6-month, 24-hour SCS Type 1A storm event. The actual design should be aesthetically pleasing with respect to shape, landscaping, cover, and vegetation selection.

4.1.4 Energy Dissipation

Calculations show that the flow in the 8-inch storm pipe leading to the infiltration basin will have a velocity of approximately 3.5 feet per second during large storm events when head is expected to build up in the upstream flow splitter manhole. An appropriate energy dissipation measure will be selected during the design process. Possible energy dissipation measures may include a riprap splash pad or appropriate vegetative cover.

4.1.5 Recommended Landscaping, Vegetation, and Irrigation

The basin will be designed with an 18-inch treatment soil layer to achieve Ecology's enhanced treatment criteria. Since the facility will be near a well-traveled pedestrian pathway along the Columbia River, the City may decide to include aesthetically pleasing landscaping features and vegetation, along with appropriate irrigation.

Section 4—Implementation Considerations

Continued

4.1.6 Additional Design and Operational Considerations

Additional design and operational considerations to be addressed in the next phase of the design process include:

- Finalize detailed topographic and utilities survey data.
- Identify, avoid, or otherwise address any utility conflicts.
- Verify high groundwater levels and depth to bedrock.
- Test the soil conditions and infiltration characteristics, and refine the BMP design accordingly.
- Prepare planting and irrigation plans for infiltration basin based on any plant species selected by the City.
- Specify mulching requirements to control weeds and any soil amendments necessary to meet required specifications for treatment soil layer.
- Design flow entrance to provide for sediment control and erosion prevention as described above.
- Specify/design the flow splitter weir and manhole.
- Verify construction accessibility and traffic/pedestrian control issues.
- Address O&M equipment accessibility and routes.
- Address any easement/permit needs with the Corps of Engineers.
- Other considerations and limitations per the E. WA LID Manual and the SWMMEW.

4.2 Additional Implementation Considerations

Based on City input, it is expected that permitting requirements include:

- SEPA, Shorelines, Critical Areas, City Construction Stormwater, and City Floodplain Development.
- State mandated cultural resources requirements.
- Corps of Engineers.

Anticipated City Council involvement includes:

- Approval to submit grant application for construction funding.
- Approval for any contracts associated with project work.
- Approval to place stormwater retrofit project on the City CIP list.

Section 5—Proposed Schedule

The City anticipates completing 90% design in 2015 (to be submitted to Ecology for review and acceptance). The 90% design package will include:

- 90% design
- 90% bid schedule
- 90% bid specifications and special provisions
- Engineers estimate of probable project costs
- O&M Guide

Following completion of the 90% design, the City may complete and submit an application to a competitive grant program, if available, in hopes of securing grant funding for construction activities.

ATTACHMENT 1 — PRELIMINARY GEOTECHNICAL INFORMATION

Soil Map—Benton County Area, Washington (NR03 Outfall)



Map Scale: 1:6,150 if printed on A portrait (8.5" x 11") sheet.

0 50 100 200 300 Meters

0 250 500 1000 1500 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

9/17/2014
Page 1 of 3

Soil Map—Benton County Area, Washington
(NR03 Outfall)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

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

Date(s) aerial images were photographed: Aug 6, 2010—Oct 17, 2010

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

Benton County Area, Washington (WA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BbA	Burbank loamy fine sand, 0 to 2 percent slopes	11.7	15.1%
BIA	Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes	24.7	31.9%
BID	Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes	9.2	11.9%
FeA	Finley fine sandy loam, 0 to 2 percent slopes	2.3	3.0%
PaA	Pasco fine sandy loam, 0 to 2 percent slopes	6.9	8.9%
QuA	Quincy loamy sand, 0 to 2 percent slopes	1.6	2.0%
QuD	Quincy loamy sand, 2 to 15 percent slopes	6.1	7.9%
W	Water	14.9	19.2%
Totals for Area of Interest		77.3	100.0%

Benton County Area, Washington

BbA—Burbank loamy fine sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bb5

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

BIA—Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bbb

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

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Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

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Land capability classification (nonirrigated): 6e

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Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

BID—Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2bbc

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

FeA—Finley fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bc6

Elevation: 300 to 1,800 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 135 to 180 days

Farmland classification: Prime farmland if irrigated

Map Unit Composition

Finley and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Finley

Setting

Landform: Flood plains, terraces

Parent material: Alluvium

Typical profile

H1 - 0 to 3 inches: fine sandy loam

H2 - 3 to 13 inches: fine sandy loam

H3 - 13 to 28 inches: very gravelly loam

H4 - 28 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 20 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

PaA—Pasco fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bcw

Elevation: 250 to 700 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 52 to 55 degrees F

Frost-free period: 136 to 190 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Pasco and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pasco

Setting

Landform: Flood plains

Parent material: Alluvium

Typical profile

H1 - 0 to 6 inches: fine sandy loam

H2 - 6 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Poorly drained

Capacity of the most limiting layer to transmit water (Ksat):

Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: About 24 to 36 inches

Frequency of flooding: Occasional

Frequency of ponding: None

Calcium carbonate, maximum in profile: 5 percent

Salinity, maximum in profile: Very slightly saline to slightly saline (4.0 to 8.0 mmhos/cm)

Sodium adsorption ratio, maximum in profile: 10.0

Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 3w

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: C

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

QuA—Quincy loamy sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bd3

Elevation: 200 to 4,500 feet

Mean annual precipitation: 6 to 12 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 200 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Quincy and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Quincy

Setting

Landform: Terraces

Parent material: Eolian sands

Typical profile

H1 - 0 to 9 inches: loamy sand

H2 - 9 to 60 inches: loamy fine sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 3 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

QuD—Quincy loamy sand, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2bd4

Elevation: 200 to 4,500 feet

Mean annual precipitation: 6 to 12 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 200 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Quincy and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Quincy

Setting

Landform: Terraces

Parent material: Eolian sands

Typical profile

H1 - 0 to 9 inches: loamy sand

H2 - 9 to 60 inches: loamy fine sand

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 3 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

W—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

ATTACHMENT 2 — EXISTING SUBBASIN MAP

City of Richland
Stormwater Retrofit
Support Services

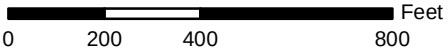
Outfall NR03
Drainage Basin

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Drainage Basin Boundary
- Connected ISA
- Disconnected ISA
- Pervious
- Approximate Flow Direction

2011 Aerial Imagery

Attachment 2



Date Created: August 20, 2014

Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)
16.78	5.07	3.85	7.87	11.72

ATTACHMENT 3 — DESIGN CALCULATIONS

Hydrologic Calculations - Subbasin Area and Time of Conc. Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 10/24/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Subbasin	Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)	Imp. CN	Perv. CN	Pervious and Disconnected Weighted CN
NR03	16.78	5.07	3.85	7.87	11.72	98	68	78

Subbasin	Sheet Flow					Shallow Concentrated Flow				Open Channel Flow				Time of Concentration
	$T_t = 0.42 * (n_s * L)^{0.8} / ((P_{2yr2hr})^{0.5} * (s_0)^{0.4})$					$T_t = L / (60 * (k * (s_0)^{0.5}))$				$T_t = L / (60 * (k_c * (s_0)^{0.5}))$				$T_c = T_{t1} + T_{t2} + ... T_{tm}$
	n_s	L (ft)	P_{2yr2hr} (in)	s_0 (ft/ft)	T_t (min)	L (ft)	k	s_0 (ft/ft)	T_t (min)	L (ft)	k_c	s_0 (ft/ft)	T_t (min)	T_c (min)
NR03 (Connected ISA)	0.011	27	0.4	0.020	1.20	1804	27	0.002	24.90					26.10
NR03 (Pervious and Disconnected ISA)	0.15	60	0.4	0.010	24.30	1708	27	0.002	23.58	37	42	0.02	0.10	47.98

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.

Hydrologic Calculations - SBUH Results

Stormwater Management Manual for Eastern Washington

Calculated By: E. Pruneda

Date: 10/24/2014

Project: Richland

Checked By:

Date:

Project No: 33764797

Sheet No: 1 of 1

							24-Hour Type 1A Storm Event		3-Hour Short Duration Storm Event	
							6-Month (0.53 in)		25-Year (0.92 in)	50-Year (1.14 in)
Subbasin	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T _c (min)	Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)	Peak Flow (cfs)
NR03 (Connected ISA)	5.07	0.00	1.00	98	68	26.10	0.32	6,313	4.09	5.32
NR03 (Pervious and Disconnected ISA)	11.72	11.72	0.00	98	78	47.98	---	---	0.21	0.61
NR03 (Total)	---	---	---	---	---	---	---	---	4.20	5.76

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.
- (3) It is assumed that Pervious and Disconnected ISA areas do not contribute runoff during the 6-Month, 24-Hour Type 1A Storm Event.
- (4) 25-Year, 3-Hour Short Duration peak flows are provided for high-flow bypass conveyance sizing. Peak flows were determined by summing the hydrographs for the Connected ISA and Pervious and Disconnected ISA areas.

Conceptual BMP Sizing Calculations	Calculated By: E. Pruneda	Date: 10/24/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Facility ID (Subbasin)	Available Storage Volume					Predicted Water Quality Volume (cf) from Contributing Area	Assumed Infiltration Rate (in/hr)	Assumed Bottom Infiltration Rate (cfs)	Predicted Max Volume (cf) in Facility During the Water Quality Storm Event
	Top Area (sq-ft)	Bottom Area (sq-ft)	Side Slope (H:V)	Depth (ft)	Volume (cf)				
Infiltration Basin (NR03)	2,014	1,333	3:1	1.0	1,674	6,313	3	0.093	1,153

Notes:

(1) The long term infiltration rate of treatment soil media has been assumed to be 3.0 inches/hour.

The native infiltration rate will be confirmed through geotechnical investigation as the design progresses.

Conceptual Pipe Sizing Calculations

Calculated By: E. Pruneda	Date: 1/22/2015	Project: Richland
Checked By:	Date:	Project No: 33764797
		Sheet No: 1 of 4

8" PVC Pipe to Infiltration Basin - 6-Month, 24-Hour Storm Event

Worksheet : Circular Pipe IN - 8" PVC Normal Depth 6mo Storm

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Discharge Friction Method: Manning Formula

Roughness Coefficient:	0.010		Flow Area:	0.09	ft ²
Channel Slope:	0.01000	ft/ft	Wetted Perimeter:	0.78	ft
Normal Depth:	0.205	ft	Hydraulic Radius:	0.116	ft
Diameter:	0.667	ft	Top Width:	0.62	ft
Discharge:	0.32	ft ³ /s	Critical Depth:	0.26	ft
			Percent Full:	30.7	%
			Critical Slope:	0.00389	ft/ft
			Velocity:	3.54	ft/s
			Velocity Head:	0.19	ft
			Specific Energy:	0.40	ft
			Froude Number:	1.62	
			Maximum Discharge:	1.69	ft ³ /s
			Discharge Full:	1.57	ft ³ /s
			Slope Full:	0.00042	ft/ft
			Flow Type:	SuperCritical	

Calculation Successful.

Conceptual Pipe Sizing Calculations

Calculated By: E. Pruneda	Date: 1/22/2015	Project: Richland
Checked By:	Date:	Project No: 33764797
		Sheet No: 2 of 4

8" PVC Pipe to Infiltration Basin - During 50-yr, 3-hr Storm Event

Worksheet : Pressure Pipe IN - 8" PVC Full Pipe 50yr Storm

Calculations Messages

Solve For: Discharge Friction Method: Manning Formula

Pressure 1:	0.70	feet H2O	Headloss:	0.40	ft
Pressure 2:	1.00	feet H2O	Energy Grade 1:	366.58	ft
Elevation 1:	365.70	ft	Energy Grade 2:	366.18	ft
Elevation 2:	365.00	ft	Hydraulic Grade 1:	366.40	ft
Length:	70.00	ft	Hydraulic Grade 2:	366.00	ft
Roughness Coefficient:	0.010		Flow Area:	0.35	ft ²
Diameter:	0.667	ft	Wetted Perimeter:	2.09	ft
Discharge:	1.19	ft ³ /s	Velocity:	3.40	ft/s
			Velocity Head:	0.18	ft
			Friction Slope:	0.00571	ft/ft

Calculation Successful.

Conceptual Pipe Sizing Calculations

Calculated By: E. Pruneda	Date: 1/22/2015	Project: Richland
Checked By:	Date:	Project No: 33764797
		Sheet No: 3 of 4

8" PVC Pipe Leaving Infiltration Basin - During 50-yr, 3-hr Storm Event (Discharge Matches 8" PVC Entering Infiltration Basin)

Worksheet: Circular Pipe OUT - 8" PVC Normal Depth 50yr Storm

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Discharge Friction Method: Manning Formula

Roughness Coefficient:	0.010		Flow Area:	0.16	ft ²
Channel Slope:	0.02900	ft/ft	Wetted Perimeter:	1.00	ft
Normal Depth:	0.312	ft	Hydraulic Radius:	0.160	ft
Diameter:	0.667	ft	Top Width:	0.67	ft
Discharge:	1.19	ft ³ /s	Critical Depth:	0.52	ft
			Percent Full:	46.8	%
			Critical Slope:	0.00643	ft/ft
			Velocity:	7.45	ft/s
			Velocity Head:	0.86	ft
			Specific Energy:	1.17	ft
			Froude Number:	2.67	
			Maximum Discharge:	2.88	ft ³ /s
			Discharge Full:	2.68	ft ³ /s
			Slope Full:	0.00576	ft/ft
			Flow Type:	SuperCritical	

Calculation Successful.

Conceptual Pipe Sizing Calculations	Calculated By: E. Pruneda	Date: 1/22/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 4 of 4

Flow Over Flow Splitter Weir - During 50-yr, 3-hr Storm Event

Worksheet : Rectangular Weir - 50yr, 3hr Storm

Calculations Messages

Solve For: Discharge

Discharge:	4.71	ft³/s	Headwater Height Above Crest:	0.50	ft
Headwater Elevation:	366.40	ft	Tailwater Height Above Crest:	-1.90	ft
Crest Elevation:	365.90	ft	Flow Area:	2.00	ft²
Tailwater Elevation:	364.00	ft	Velocity:	2.35	ft/s
Weir Coefficient:	3.33	US	Wetted Perimeter:	5.00	ft
Crest Length:	4.00	ft	Top Width:	4.00	ft
Number Of Contractions:	0				

Calculation Successful.

Drywell Sizing Calculations	Calculated By: E. Pruneda	Date: 1/13/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 3

Facility Characteristics:

Drywell Radius (Outside):	2.5	ft	
Drywell Radius (Inside):	2	ft	
Drywell Depth:	8	ft	
Drain Rock Radius Top (R ₁):	8.83	ft	
Drain Rock Radius Bottom (R ₂):	4	ft	
Drain Rock Depth (h):	9.66	ft	<i>Drywell sits on 1 ft of Drain Rock</i>
Cover:	3	ft	<i>Ground surface to top of Drain Rock</i>

Calculated Areas:

Drain Rock Surface Area:	485.6	sq ft	<i>Per equation (1) from WSDOT Paper*</i>
Drain Rock Bottom Area:	50.27	sq ft	$\pi * R_2^2$
Drain Rock Side Wall Area:	435.33	sq ft	<i>(sides and bottom) - (bottom)</i>

Assumed Infiltration Rate:

Infiltration Rate =	5.00	in/hr	<i>To be updated based on geotechnical analysis</i>
Infiltration Rate =	0.417	ft/hr	<i>Conversion</i>
Infiltration Rate =	1.16E-04	ft/s	<i>Conversion</i>
Bottom:	0.006	cfs	<i>Drain Rock Bottom Area x Infiltration Rate</i>
Side Walls:	0.025	cfs	<i>Drain Rock Side Wall Area x (Infiltration Rate/2)</i> <i>(Division by two reflects zero hydraulic head at the top of the sidewall and full head at the bottom of the sidewall)</i>
Total:	0.0310	cfs	<i>Per drywell</i>

Available Storage Capacity:

Excavation Volume at Depth h =	1,308	cf	<i>Conical Frustum Volume Equation</i>
Drywell Storage Volume =	101	cf	
Drain Rock Void Volume =	483	cf	<i>Excavation Volume - Drywell Storage Volume</i> <i>Neglects footing and drywell sidewall volume</i>
Total Available Storage =	583	cf	<i>Per drywell</i>

* WSDOT (2004) *An Approach for Estimating Infiltration Rates for Stormwater Infiltration Dry Wells*

Drywell Sizing Calculations	Calculated By: E. Pruneda	Date: 1/13/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 2 of 3

Drywell Stage-Storage-Discharge Table

$\Delta t =$ 0.1 hr
 # Drywells = 4

dia/width(in)= elev(ft)=					orifice #1	orifice #2	weir #1	weir #2	infiltration	total outflow cfs
elev. ft	area s.f.	storage cu.ft.	storage (ac.ft)	storage (cfs-hr)	outflow cfs	outflow cfs	outflow cfs	outflow cfs	outflow cfs	
100.00	---	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000
101.00	---	259	0.006	0.072	0.000	0.000	0.000	0.000	0.014	0.014
102.00	---	518	0.012	0.144	0.000	0.000	0.000	0.000	0.027	0.027
103.00	---	777	0.018	0.216	0.000	0.000	0.000	0.000	0.041	0.041
104.00	---	1036	0.024	0.288	0.000	0.000	0.000	0.000	0.054	0.054
105.00	---	1295	0.030	0.360	0.000	0.000	0.000	0.000	0.068	0.068
106.00	---	1554	0.036	0.432	0.000	0.000	0.000	0.000	0.082	0.082
107.00	---	1814	0.042	0.504	0.000	0.000	0.000	0.000	0.095	0.095
108.00	---	2073	0.048	0.576	0.000	0.000	0.000	0.000	0.109	0.109
109.00	---	2332	0.054	0.648	0.000	0.000	0.000	0.000	0.122	0.122

Time (min)	Inflow, I (cfs)	I ₁ + I ₂ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	(2S ₁ /Δt) - O ₁ (cfs)	(2S ₂ /Δt) + O ₂ (cfs)
Before	0	0	0	0.000	0.00	0.00
0	0.00	0.000	0.000	0.000	0.00	0.000
6	0.00	0.000	0.000	0.000	0.00	0.000
12	0.00	0.000	0.000	0.000	0.00	0.000
18	0.00	0.000	0.000	0.000	0.00	0.000
24	0.00	0.000	0.000	0.000	0.00	0.000
30	0.00	0.000	0.000	0.000	0.00	0.000
36	0.00	0.000	0.000	0.000	0.00	0.000
42	0.00	0.000	0.000	0.000	0.00	0.000
48	0.00	0.000	0.000	0.000	0.00	0.000
54	0.00	0.000	0.000	0.000	0.00	0.000
60	0.00	0.000	0.000	0.000	0.00	0.000
66	0.00	0.000	0.000	0.000	0.00	0.000
72	0.00	0.000	0.000	0.000	0.00	0.000
78	0.00	0.000	0.000	0.000	0.00	0.000
84	0.00	0.000	0.000	0.000	0.00	0.000
90	0.00	0.000	0.000	0.000	0.00	0.000
96	0.00	0.000	0.000	0.000	0.00	0.000
102	0.00	0.000	0.000	0.000	0.00	0.000
108	0.00	0.000	0.000	0.000	0.00	0.000
114	0.00	0.000	0.000	0.000	0.00	0.000
120	0.00	0.000	0.000	0.000	0.00	0.000
126	0.00	0.000	0.000	0.000	0.00	0.000
132	0.00	0.000	0.000	0.000	0.00	0.000
138	0.00	0.000	0.000	0.000	0.00	0.000
144	0.00	0.000	0.000	0.000	0.00	0.000
150	0.00	0.000	0.000	0.000	0.00	0.000
156	0.00	0.000	0.000	0.000	0.00	0.000
162	0.00	0.000	0.000	0.000	0.00	0.000
168	0.00	0.000	0.000	0.000	0.00	0.000
174	0.00	0.000	0.000	0.000	0.00	0.000
180	0.00	0.001	0.000	0.000	0.00	0.001
186	0.00	0.002	0.000	0.000	0.00	0.003
192	0.00	0.003	0.000	0.000	0.00	0.005
198	0.00	0.004	0.000	0.000	0.01	0.010
204	0.00	0.007	0.000	0.000	0.01	0.016
210	0.00	0.008	0.000	0.001	0.02	0.024
216	0.00	0.011	0.000	0.001	0.02	0.034
222	0.01	0.013	0.000	0.002	0.03	0.047
228	0.01	0.016	0.000	0.002	0.05	0.063
234	0.01	0.019	0.001	0.003	0.06	0.080
240	0.01	0.022	0.001	0.004	0.08	0.101
246	0.01	0.025	0.001	0.005	0.10	0.124
252	0.01	0.027	0.001	0.006	0.12	0.149
258	0.01	0.030	0.001	0.007	0.15	0.177
264	0.02	0.034	0.002	0.009	0.17	0.207
270	0.02	0.038	0.002	0.010	0.20	0.241
276	0.02	0.041	0.002	0.012	0.24	0.277
282	0.02	0.044	0.003	0.014	0.27	0.316
288	0.02	0.048	0.003	0.016	0.31	0.359
294	0.03	0.053	0.003	0.018	0.35	0.405
300	0.03	0.057	0.004	0.020	0.40	0.454
306	0.03	0.061	0.004	0.022	0.45	0.507
312	0.03	0.065	0.005	0.025	0.50	0.562
318	0.03	0.070	0.005	0.028	0.55	0.621
324	0.04	0.075	0.006	0.031	0.61	0.685
330	0.04	0.080	0.006	0.034	0.67	0.752
336	0.04	0.085	0.007	0.037	0.74	0.823
342	0.04	0.089	0.008	0.041	0.81	0.897
348	0.05	0.094	0.008	0.044	0.88	0.974
354	0.05	0.099	0.009	0.048	0.96	1.054
360	0.05	0.106	0.010	0.052	1.03	1.140
366	0.05	0.114	0.011	0.056	1.12	1.233
372	0.06	0.121	0.012	0.061	1.21	1.330
378	0.06	0.128	0.012	0.066	1.31	1.434
384	0.07	0.137	0.013	0.071	1.41	1.544
390	0.07	0.143	0.014	0.076	1.51	1.658
396	0.07	0.147	0.016	0.082	1.63	1.774
402	0.07	0.151	0.017	0.088	1.74	1.891
408	0.08	0.155	0.018	0.094	1.86	2.011
414	0.08	0.160	0.019	0.100	1.97	2.134
420	0.08	0.168	0.020	0.106	2.09	2.262
426	0.09	0.179	0.021	0.112	2.22	2.398
432	0.09	0.191	0.022	0.119	2.35	2.544
438	0.10	0.205	0.024	0.126	2.50	2.701
444	0.11	0.222	0.025	0.134	2.65	2.872
450	0.12	0.261	0.027	0.142	2.82	3.079
456	0.15	0.340	0.029	0.153	3.02	3.361
462	0.19	0.438	0.031	0.166	3.30	3.736
468	0.24	0.527	0.035	0.185	3.67	4.193
474	0.28	0.600	0.039	0.208	4.11	4.714
480	0.32	0.638	0.044	0.233	4.63	5.264
486	0.32	0.634	0.049	0.261	5.17	5.799
492	0.31	0.605	0.054	0.287	5.69	6.295
498	0.29	0.570	0.059	0.312	6.18	6.747
504	0.28	0.531	0.063	0.334	6.62	7.152
510	0.26	0.496	0.067	0.354	7.02	7.514
516	0.24	0.468	0.070	0.372	7.37	7.841
522	0.23	0.444	0.073	0.388	7.69	8.138
528	0.22	0.419	0.076	0.403	7.99	8.405
534	0.20	0.397	0.079	0.416	8.25	8.644
540	0.19	0.378	0.081	0.428	8.48	8.861
546	0.18	0.359	0.083	0.439	8.70	9.054
552	0.17	0.340	0.085	0.448	8.88	9.225
558	0.17	0.323	0.086	0.457	9.05	9.374
564	0.16	0.307	0.088	0.464	9.20	9.506
570	0.15	0.292	0.089	0.471	9.33	9.620
576	0.14	0.281	0.090	0.477	9.44	9.721
582	0.14	0.272	0.091	0.481	9.54	9.811
588	0.13	0.265	0.092	0.486	9.63	9.892
594	0.13	0.258	0.093	0.490	9.71	9.965
600	0.13	0.249	0.093	0.494	9.78	10.027
606	0.12	0.243	0.094	0.497	9.84	10.083
612	0.12	0.238	0.094	0.499	9.89	10.132
618	0.12	0.232	0.095	0.502	9.94	10.175
624	0.11	0.225	0.095	0.504	9.98	10.209
630	0.11	0.222	0.096	0.506	10.02	10.240
636	0.11	0.220	0.096	0.507	10.05	10.268
642	0.11	0.215	0.096	0.509	10.08	10.291
648	0.11	0.215	0.096	0.510	10.10	10.313
654	0.11	0.214	0.097	0.511	10.12	10.334
660	0.11	0.209	0.097	0.512	10.14	10.349
666	0.10	0.205	0.097	0.513	10.16	10.360
672	0.10	0.204	0.097	0.513	10.17	10.371
678	0.10	0.202	0.097	0.514	10.18	10.378
684	0.10	0.197	0.097	0.514	10.18	10.381
690	0.10	0.194	0.097	0.514	10.19	10.380
696	0.10	0.191	0.097	0.514	10.19	10.377
702	0.09	0.189	0.097	0.514	10.18	10.371
708	0.09	0.185	0.097	0.514	10.18	10.362
714	0.09	0.179	0.097	0.513	10.17	10.348
720	0.09	0.178	0.097	0.513	10.15	10.331

Time (min)	Inflow, I (cfs)	I ₁ + I ₂ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	(2S ₁ /Δt) - O ₁ (cfs)	(2S ₂ /Δt) + O ₂ (cfs)
726	0.09	0.176	0.097	0.512	10.14	10.314
732	0.09	0.173	0.097	0.511	10.12	10.294
738	0.09	0.172	0.096	0.510	10.10	10.273
744	0.09	0.174	0.096	0.509	10.08	10.255
750	0.09	0.176	0.096	0.508	10.06	10.240
756	0.09	0.175	0.096	0.507	10.05	10.223
762	0.09	0.172	0.096	0.506	10.03	10.204
768	0.09	0.170	0.096	0.505	10.01	10.183
774	0.08	0.168	0.095	0.504	9.99	10.160
780	0.08	0.169	0.095	0.503	9.97	10.139
786	0.09	0.170	0.095	0.502	9.95	10.119
792	0.08	0.168	0.095	0.501	9.93	10.097
798	0.08	0.169	0.095	0.500	9.91	10.077
804	0.09	0.170	0.094	0.499	9.89	10.058
810	0.08	0.166	0.094	0.498	9.87	10.036
816	0.08	0.163	0.094	0.497	9.85	10.011
822	0.08	0.163	0.094	0.496	9.82	9.986
828	0.08	0.163	0.093	0.495	9.80	9.962
834	0.08	0.163	0.093	0.493	9.78	9.938
840	0.08	0.160	0.093	0.492	9.75	9.912
846	0.08	0.158	0.093	0.491	9.73	9.885
852	0.08	0.159	0.093	0.490	9.70	9.860
858	0.08	0.158	0.092	0.488	9.68	9.833
864	0.08	0.157	0.092	0.487	9.65	9.805
870	0.08	0.158	0.092	0.486	9.62	9.780
876	0.08	0.157	0.092	0.484	9.60	9.754
882	0.08	0.156	0.091	0.483	9.57	9.727
888	0.08	0.158	0.091	0.482	9.54	9.702
894	0.08	0.157	0.091	0.481	9.52	9.677
900	0.08	0.153	0.091	0.479	9.50	9.650
906	0.08	0.153	0.090	0.478	9.47	9.622
912	0.08	0.156	0.090	0.477	9.44	9.598
918	0.08	0.155	0.090	0.475	9.42	9.573
924	0.08	0.152	0.090	0.474	9.39	9.546
930	0.08	0.150	0.089	0.473	9.37	9.517
936	0.07	0.151	0.089	0.471	9.34	9.490
942	0.08	0.154	0.089	0.470	9.31	9.466
948	0.08	0.154	0.089	0.469	9.29	9.443
954	0.08	0.151	0.088	0.468	9.27	9.417
960	0.08	0.149	0.088	0.466	9.24	9.390
966	0.07	0.148	0.088	0.465	9.21	9.363
972	0.07	0.147	0.088	0.464	9.19	9.334
978	0.07	0.146	0.087	0.462	9.16	9.305
984	0.07	0.145	0.087	0.461	9.13	9.276
990	0.07	0.145	0.087	0.459	9.10	9.247
996	0.07	0.144	0.087	0.458	9.07	9.219
1002	0.07	0.144	0.086	0.457	9.05	9.190
1008	0.07	0.144	0.086	0.455	9.02	9.162
1014	0.07	0.144	0.086	0.454	8.99	9.134
1020	0.07	0.144	0.085	0.452	8.96	9.106</

ATTACHMENT 4 — STORMWATER RETROFIT BMP ALTERNATIVE MATRIX

NR03 - Stormwater Retrofit BMP Alternative Matrix

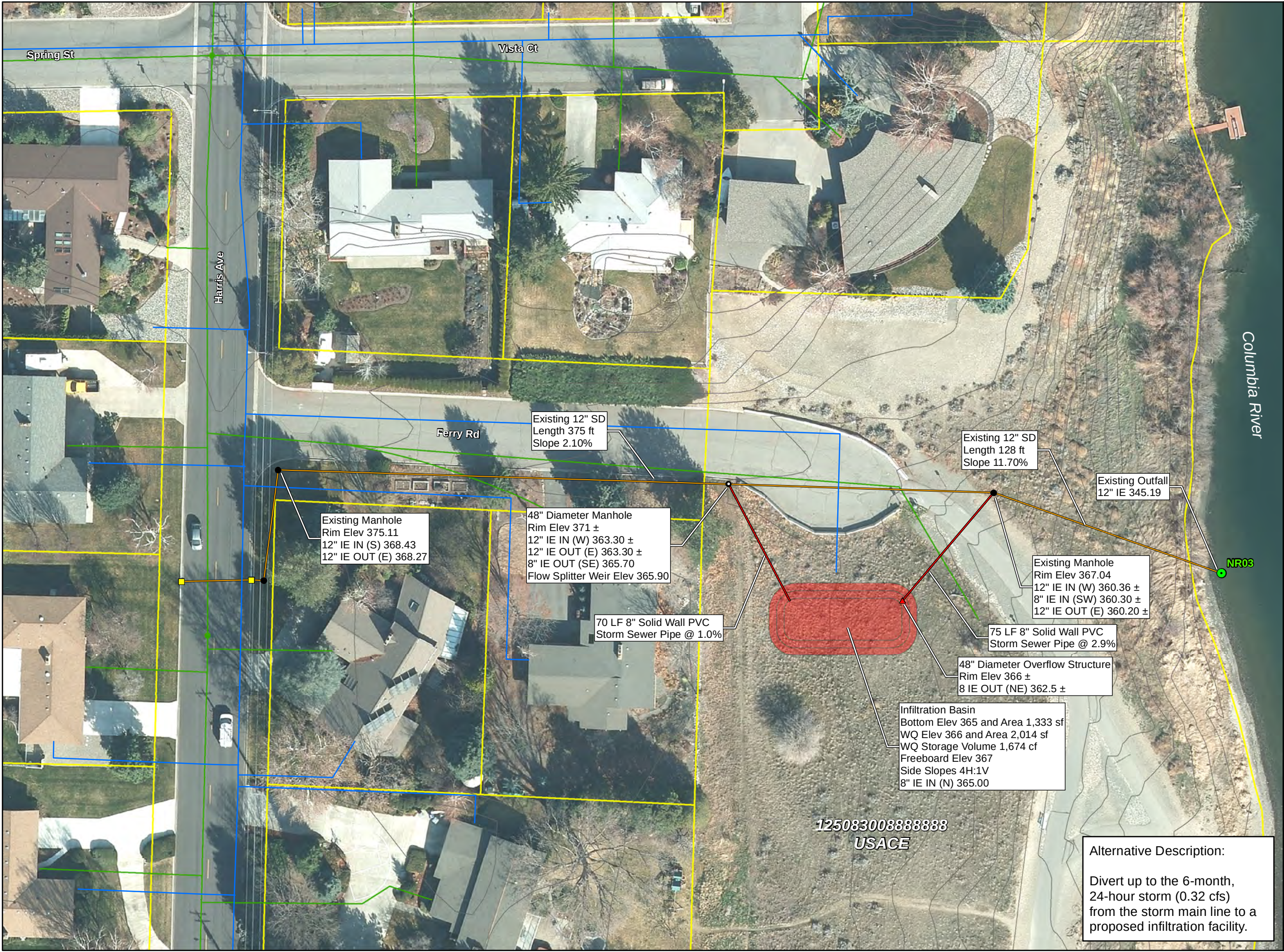
BMP Alternative	Description	Benefit	Target Pollutants	Treatment Effectiveness	Relative O&M Effort	Relative Cost
1	Infiltration Basin - S Side Ferry Rd <i>Daylight Existing Storm Pipe and Direct to Bioretention Area</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	Low	Low
2	Distributed Drywells <i>Convert Existing Inlets to Drywell System with Sed Manhole</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	Mod	Mod	Mod
3	Infiltration Basin - N Side Ferry Rd <i>Collects Gutter Flow from E Side Harris Ave and N Side Ferry Rd</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	Low	Low
4	Distributed Bioretention Cells <i>Locate Facilities within Right-of-Way Along Harris Ave</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	High	High
5	CONTECH Media Filtration System	Runoff Treatment (Basic)	Sediment; Limited Nutrients, Pesticides, & Bacteria	Low	High	High
6	CONTECH SW Management StormFilter with MetalRx Media	Runoff Treatment (Basic, Enhanced)	Sediment and Metals; Limited Nutrients, Pesticides, Bacteria, & Hydrocarbons	Mod	High	High

Notes:

- (1) Alternative 1 & 2 will require drainage easement/agreement between City and USACE.
- (2) Alternative 3 will require voluntary landowner participation and assumed ongoing maintenance of facility.
- (3) Any BMP that will retain and infiltrate at least the water quality storm event will achieve a high treatment level because of the reduction in pollutant loading to surface waters.
- (4) Columbia River is exempt from flow control requirements.
- (5) Relative Operation and Maintenance Effort Ratings:
 Low = One inspection per year and after major storms; sediment removal as needed.
 Moderate = Two inspections per year and after major storms; sediment removal as needed. Similar to "Low" until replacement.
 High = One inspection per year and after major storms; irrigation; landscape pruning; enclosed space requirements; sediment removal as needed; cartridge replacement as needed (\$65 per cartridge + installation).

Exact maintenance efforts are difficult to project and will only be revealed based on inspections. Minimizing sediment load to the treatment facilities will reduce annual maintenance costs; this can be accomplished through street sweeping, and routine operation and maintenance of upstream catch basins and manholes.

ATTACHMENT 5 — PLANS AND DETAILS



City of Richland Stormwater Retrofit Support Services

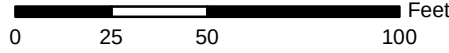
Outfall NR03 Conceptual Stormwater Treatment Retrofit

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Manhole
- Proposed Overflow Structure
- Proposed Storm Pipe
- Proposed Facility

2012 Aerial Imagery

Attachment 5-1

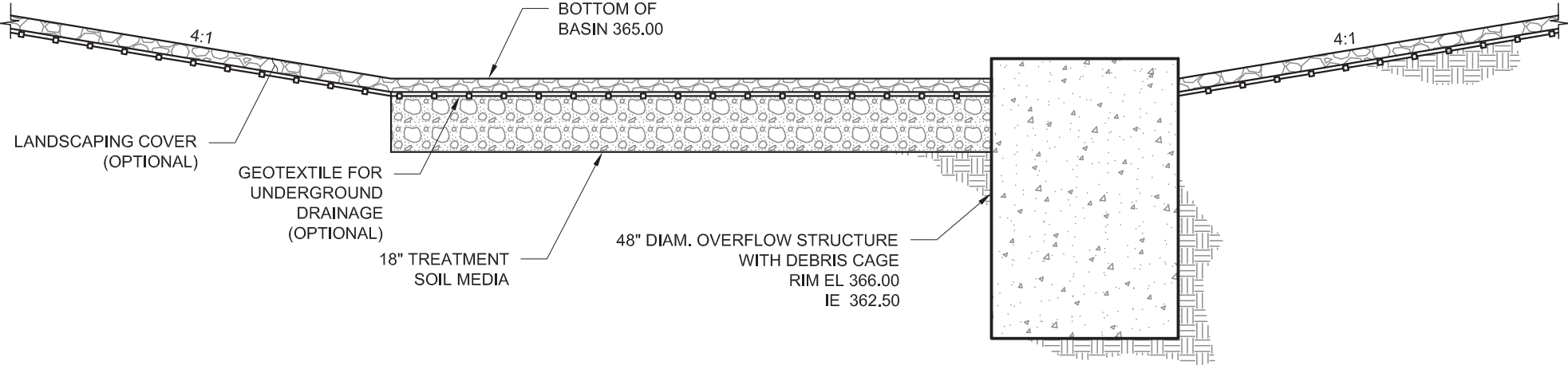


Date Created: January 22, 2015

Alternative Description:
Divert up to the 6-month,
24-hour storm (0.32 cfs)
from the storm main line to a
proposed infiltration facility.

125083008888888
USACE

Attachment 5-2



INFILTRATION BASIN SECTION

SCALE: NTS

City of Richland
Stormwater Retrofit
Support Services

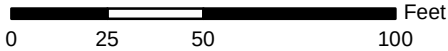
Outfall NR03
Conceptual Stormwater
Treatment Retrofit

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Drywell
- Proposed Manhole
- Proposed Storm Pipe

2012 Aerial Imagery

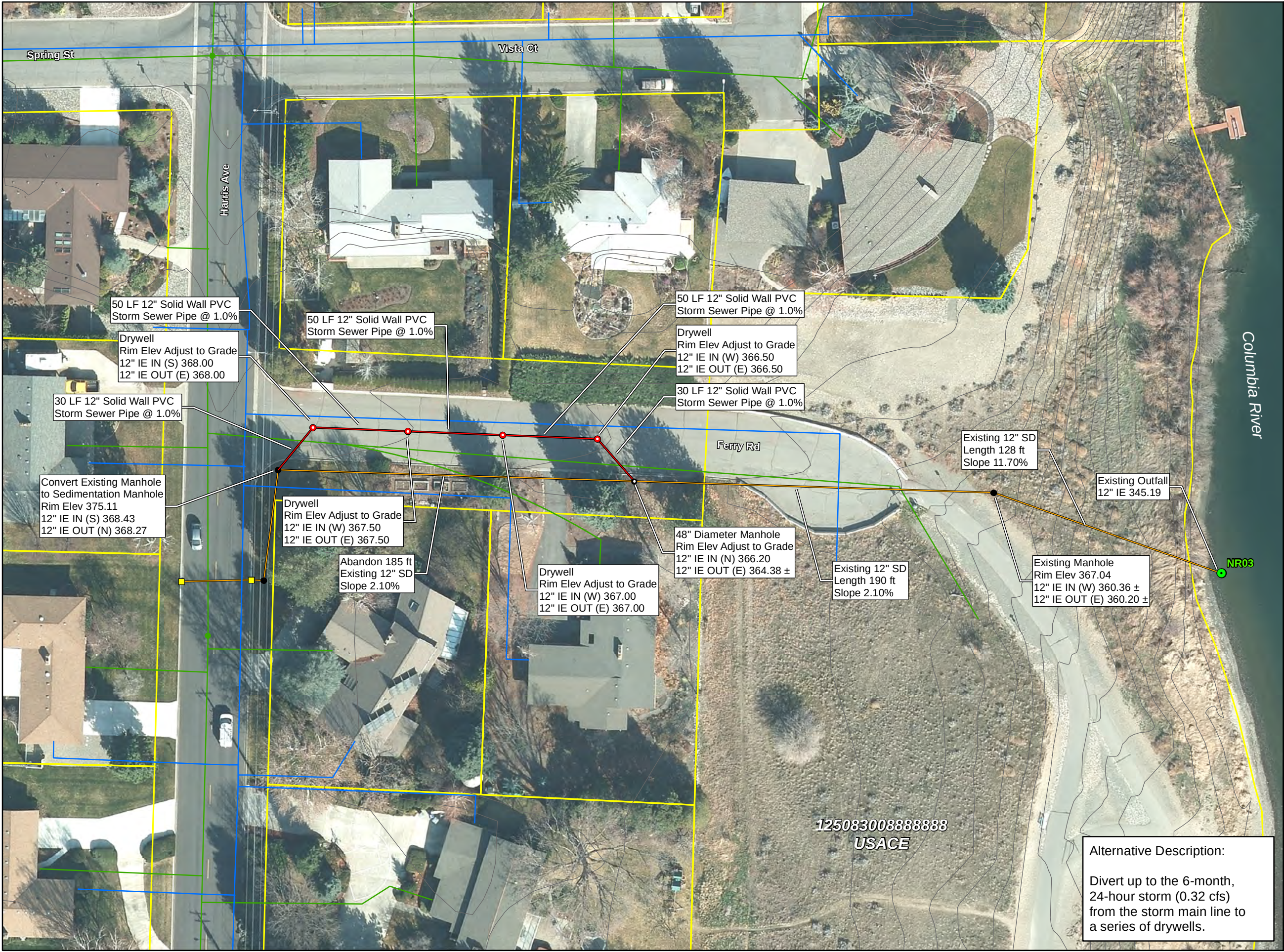
Attachment 5-3



Date Created: January 13, 2015

Alternative Description:

Divert up to the 6-month,
24-hour storm (0.32 cfs)
from the storm main line to
a series of drywells.



ATTACHMENT 6 — PRE-DESIGN LEVEL CONSTRUCTION COST ESTIMATE

Outfall NR03 Stormwater Retrofit Project - Infil. Basin				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
2	Structure Excavation Class B Incl. Haul	CY	77.0	\$ 10.00	\$ 770.17
3	Solid Wall PVC Storm Sewer Pipe 8 In. Diam.	LF	145.0	\$ 35.00	\$ 5,075.00
4	Infiltration Basin	LS	1	\$ 20,000.00	\$ 20,000.00
5	Overflow Structure - CB Type 2 48 In. Diam.	EA	1	\$ 3,000.00	\$ 3,000.00
6	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
7	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
8	Debris Cage for Overflow Structure	EA	1	\$ 1,000.00	\$ 1,000.00
9	ESC Lead	DAY	3	\$ 100.00	\$ 300.00
10	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
11	Construction Geotextile for Underground Drainage	SY	400.0	\$ 2.50	\$ 1,000.00
12	Gravel Backfill for Pipe Zone Bedding	TON	42.5	\$ 25.00	\$ 1,062.89
13	Energy Dissipation	LS	1	\$ 500.00	\$ 500.00
14	Irrigation System	LS	1	\$ 5,000.00	\$ 5,000.00
15	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Construction Subtotal				\$ 59,208.05
	Design Preparation (10%)				\$ 5,920.81
	Construction Management (10%)				\$ 5,920.81
	WA State Sales Tax (8.6%)				\$ 5,091.89
	Subtotal				\$ 76,141.56
	Pre-Design Contingency (20%)				\$ 15,228.31
	Total				\$ 91,369.87
Notes: • Infiltration Basin includes excavation, grading, treatment soil mix, landscaping cover, and planting.					

Outfall NR03 Stormwater Retrofit Project - Drywells				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
2	Project Temporary Traffic Control	LS	1	\$ 3,000.00	\$ 3,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 8,000.00	\$ 8,000.00
4	Structure Excavation Class B Incl. Haul	CY	152.9	\$ 10.00	\$ 1,528.66
5	Crushed Surfacing Base Course	TON	200.0	\$ 20.00	\$ 4,000.00
6	Crushed Surfacing Top Course	TON	133.3	\$ 25.00	\$ 3,333.33
7	HMA Cl. 1/2-Inch PG 64-28	TON	184.0	\$ 80.00	\$ 14,720.00
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	210.0	\$ 40.00	\$ 8,400.00
9	Precast Concrete Drywell	EA	4	\$ 6,000.00	\$ 24,000.00
10	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
11	Manhole 48 In. Diam. Type 3	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	2	\$ 1,000.00	\$ 2,000.00
13	ESC Lead	DAY	4	\$ 100.00	\$ 400.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Gravel Backfill for Pipe Zone Bedding	TON	81.7	\$ 25.00	\$ 2,041.67
16	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Construction Subtotal				\$ 94,923.66
	Design Preparation (10%)				\$ 9,492.37
	Construction Management (10%)				\$ 9,492.37
	WA State Sales Tax (8.6%)				\$ 8,163.43
	Subtotal				\$ 122,071.83
	Pre-Design Contingency (20%)				\$ 24,414.37
	Total				\$ 146,486.20

Technical Memorandum



To: Jay Marlow, City of Richland
From: John Knutson, PE; Erik Pruneda, PE, CFM, CPESC; Bill Rice
Copies: File
Date: March 10, 2015
Subject: NR04 Up-Basin Stormwater Retrofits
Project: 33764797—Stormwater Retrofit Project Support Services

Background & Purpose

The City of Richland (City) desires to implement several stormwater outfall retrofit projects that are intended to improve water quality by reducing pollutant loadings to local receiving waters. The City has hired URS Corporation (URS) to identify up-basin stormwater retrofit concepts for the outfall NR04 drainage basin that would be equivalent to the treatment and infiltration capabilities of the proposed Leslie Groves Regional Infiltration Facility.

The purpose of this Technical Memorandum is to: (1) provide a general description of the outfall NR04 drainage basin; (2) present the stormwater retrofit concepts identified; (3) describe basic retrofit project design and implementation information; and (4) present the retrofit cut-sheets with costs and schematics.

NR04 Drainage Basin

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River (see Attachment 1-1). Land use consists almost entirely of low-medium density residential. Previous estimates of basin size ranged from 200 to 220 acres, which is roughly 100 acres smaller than the current delineation.

Stormwater Retrofit BMP Alternative Matrix

A Stormwater Retrofit BMP Alternative Matrix was developed to present each of the BMP alternatives developed for the NR04 drainage basin (see Attachment 2). The matrix describes each BMP alternative, the stormwater quality benefit, the target pollutants the BMP can remove, relative operations and maintenance (O&M) effort, and relative cost.

Hydrology Calculations and Assumptions

Based on a representative sample area (see Figure 1), the outfall NR04 drainage basin was estimated to have 25% connected impervious surface area (ISA) with a curve number (CN) value of 98 and 75% pervious and disconnected ISA with a CN value of 75. Connected ISA includes areas such as streets, parking lots, driveways, and roofs from which runoff directly enters the drainage system without first traversing an area of pervious ground cover. Disconnected ISA includes areas whose runoff is dispersed over pervious areas as sheet flow (e.g., tennis court in the middle of a grassed area).

The time of concentration for the drainage basin was estimated to be 48.5 minutes. Utilizing the Santa Barbara Urban Hydrograph (SBUH) method, the peak flow and volume estimates for the 6-month, 24-hour SCS Type IA storm event (0.53 inches of precipitation) are provided in Table 1, with calculations provided in Attachment 3.

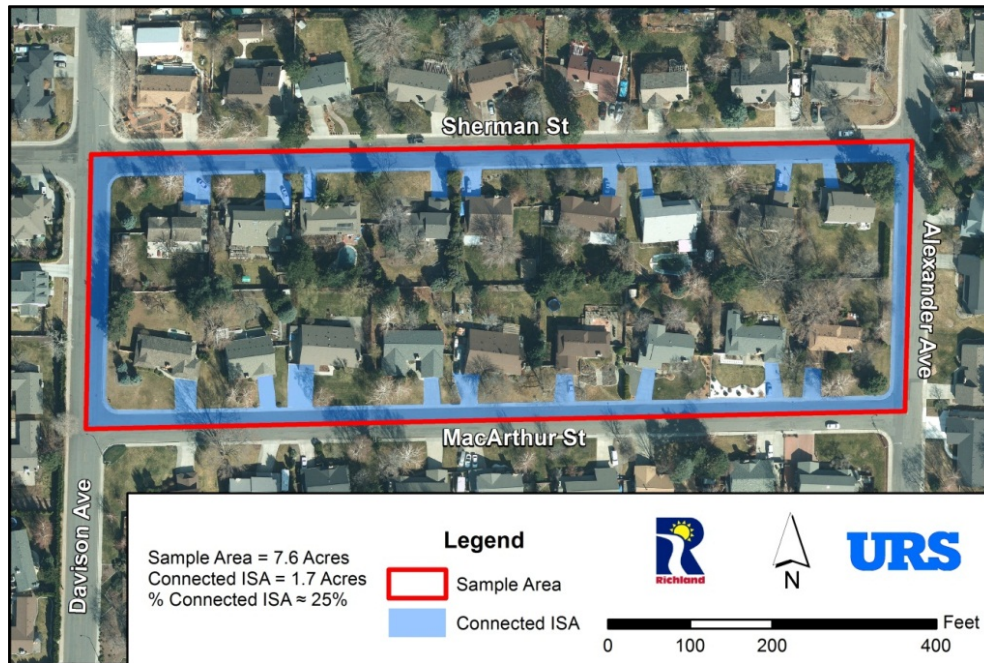


Figure 1 – Sample Connected ISA Measurement

Table 1 Outfall NR04 Peak Flow and Volume for the 6-month, 24-hour SCS Type IA Storm Event (0.53 inches)		
Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

Note: The 6-month, 24-hour storm event is also referred to as the Water Quality Storm Event.

Previous estimates of the peak flow and volume for the 6-month, 24-hour storm event were reported in the *Richland Storm Retrofit Evaluation, TM 2 – Conceptual Design and Cost Estimate of Water Quality Retrofits for Recommended Basins* (HDR, 2011), and are provided in Table 2 below. The report did not indicate the methodology or precipitation amount used to determine the peak flow and volume.

Table 2 Previous Estimates of Outfall NR04 Peak Flow and Volume for the 6-month, 24-hour Storm Event		
Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.72	76,000	1.74

Leslie Groves Regional Infiltration Facility

The goal of this project is to identify up-basin retrofits that would be equivalent to the treatment and infiltration capabilities of the proposed Leslie Groves Regional Infiltration Facility. Based on review of the construction plan set (dated 2/5/2014), the infiltration facility can store approximately 60,500 cubic feet of stormwater runoff (at the overflow elevation of 361 feet) and has an approximate infiltrating area of 10,420 square feet. It is our understanding that the design did not take into account infiltration within the facility during a storm event; however, based on an estimated infiltration rate of 3.0 inches per hour, the predicted max runoff volume in the facility during the 6-month, 24-hour storm event would only be 41,570 cubic feet.

Alternative 1 – Treatment for Entire NR04 Drainage Basin

A number of up-basin retrofit alternatives were developed to be equivalent to the treatment and infiltration capabilities of the proposed Leslie Groves Regional Infiltration Facility. The alternatives presented in Table 3 are, at a conceptual level, capable of treating and infiltrating the full 6-month, 24-hour storm event within the outfall NR04 drainage basin. See Attachment 3 for calculations and Attachment 4 for template designs.

Table 3 Alternative 1 Retrofit Opportunities		
Alternative	Description	Cost Estimate
Original Design Concept		
1	Leslie Groves Regional Infiltration Facility	\$212K
Alternative 1 Retrofit Opportunities		
1A	51 Drywells Distributed throughout the drainage basin	\$2,315K
1B	32 Infiltration Trenches Distributed throughout the drainage basin	\$1,326K
1C	378 "Bump-Out" Bioretention Facilities Includes 189 pairs distributed throughout the drainage basin	\$4,492K
1D	122 "Linear" Bioretention Facilities Includes 61 pairs distributed throughout the drainage basin	\$2,801K
1E	224 - 18" Contech StormFilter Cartridges Inside a 30' x 45' Conspan Vault	\$786K
1F	Leslie Groves Park Soccer Field Infiltration Trench	\$462K
1G	Leslie Groves Regional Infiltration Trench	\$478K

Note: Cost estimates do not include annual operation and maintenance costs. Exact maintenance efforts are difficult to project and will only be revealed based on inspections. Minimizing sediment load to the treatment facilities will reduce annual maintenance costs; this can be accomplished through street sweeping, and proper operation and maintenance of upstream catch basins and manholes. Anticipated Contech StormFilter Cartridge replacement cost is approximately \$65 per cartridge plus installation.

Alternative 2 – Snyder St Infiltration Facility & Remaining NR04 Drainage Basin

An additional set of alternatives were developed that involve routing stormwater runoff from the Benton Avenue storm system lateral at Snyder Street to a small regional infiltration facility off of Snyder Street in Leslie Groves Park. The Benton Avenue storm system lateral serves approximately 117 acres of the NR04 drainage basin at the proposed point of diversion (see Attachment 1-2). The peak flow and volume estimates for the 6-month, 24-hour storm event (0.53 inches of precipitation) are provided in Table 4. As configured in Attachment 4-5, the proposed infiltration facility off of Snyder Street has approximately 9,770 square feet of infiltrating area and can store 5,416 cubic feet of stormwater runoff. Accounting for infiltration during the storm, at a rate of 3.0 inches per hour, allows the size of the facility to be smaller than the predicted total runoff volume from the 6-month, 24-hour storm event (36,437 cubic feet). The alternatives presented in Table 5 would also be conceptually capable of treating and infiltrating the full 6-month, 24-hour storm event within the outfall NR04 drainage basin. See Attachment 3 for calculations and Attachment 4 for template designs.

Challenges associated with constructing the Snyder Street Infiltration Facility include:

- Acquiring a drainage easements and permits from the USACE;
- Deep trenching or horizontal boring; and
- Vicinity to large diameter water mains and proximity to other utilities.

Table 4 Snyder Street and Remaining NR04 Drainage Basin Peak Flow and Volume for the 6-month, 24-hour SCS Type IA Storm Event (0.53 inches) Assuming the Snyder Street Infiltration Facility is Constructed			
Basin	Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
Snyder Street	1.70	36,437	0.84
Remaining NR04	2.27	56,822	1.30

Table 5 Alternative 2 Retrofit Opportunities		
Alternative	Description	Cost Estimate
2A	Snyder St Infiltration Facility plus 31 Drywells Distributed throughout the remaining NR04 drainage basin	\$1,983K
2B	Snyder St Infiltration Facility plus 20 Infiltration Trenches Distributed throughout the remaining NR04 drainage basin	\$1,404K
2C	Snyder St Infiltration Facility plus 232 "Bump-Out" Bioretention Facilities Includes 116 pairs distributed throughout the remaining NR04 drainage basin	\$3,332K
2D	Snyder St Infiltration Facility plus 74 "Linear" Bioretention Facilities Includes 37 pairs distributed throughout the remaining NR04 drainage basin	\$2,274K
2E	Snyder St Infiltration Facility plus 136 - 18" Contech StormFilter Cartridges Inside a 30' x 30' Conspan Vault	\$1,116K

Note: Cost estimates do not include annual operation and maintenance costs. Exact maintenance efforts are difficult to project and will only be revealed based on inspections. Minimizing sediment load to the treatment facilities will reduce annual maintenance costs; this can be accomplished through street sweeping, and proper operation and maintenance of upstream catch basins and manholes. Anticipated Contech StormFilter Cartridge replacement cost is approximately \$65 per cartridge plus installation.

Alternative 3 – Snyder St Dispersion Facility & Remaining NR04 Drainage Basin

A third set of alternatives were developed that are similar to Alternative 2 and involve routing stormwater runoff from the Benton Avenue storm system lateral at Snyder Street to a dispersion facility in Leslie Groves Park. Dispersion is a practice where stormwater runoff is allowed to flow over a vegetated surface and naturally infiltrate into the ground. A requirement of dispersion is that stormwater runoff enters the dispersion area as sheet flow, typically a depth of 0.1 feet or less. To accomplish this, a flow spreader will be installed at the end of the pipe run that will spread the stormwater to a width of approximately 50 feet, which at the predicted inflow of 1.70 cfs, results in a depth of 0.05 feet of stormwater that will spill over a level weir and enter the dispersion area. Attachment 4-6 presents a conceptual layout of the system and area of Leslie Groves Park to be set aside for dispersion. The alternatives presented in Table 6 would also be conceptually capable of treating and infiltrating the full 6-month, 24-hour storm event within the outfall NR04 drainage basin. See Attachment 3 for calculations and Attachment 4 for template designs.

Table 6 Alternative 3 Retrofit Opportunities		
Alternative	Description	Cost Estimate
3A	Snyder St Dispersion Facility plus 31 Drywells Distributed throughout the remaining NR04 drainage basin	\$2,011K
3B	Snyder St Dispersion Facility plus 20 Infiltration Trenches Distributed throughout the remaining NR04 drainage basin	\$1,432
3C	Snyder St Dispersion Facility plus 232 "Bump-Out" Bioretention Facilities Includes 116 pairs distributed throughout the remaining NR04 drainage basin	\$3,360K
3D	Snyder St Dispersion Facility plus 74 "Linear" Bioretention Facilities Includes 37 pairs distributed throughout the remaining NR04 drainage basin	\$2,302K
3E	Snyder St Dispersion Facility plus 136 - 18" Contech StormFilter Cartridges Inside a 30' x 30' Conspan Vault	\$1,143K

Note: Cost estimates do not include annual operation and maintenance costs. Exact maintenance efforts are difficult to project and will only be revealed based on inspections. Minimizing sediment load to the treatment facilities will reduce annual maintenance costs; this can be accomplished through street sweeping, and proper operation and maintenance of upstream catch basins and manholes. Anticipated Contech StormFilter Cartridge replacement cost is approximately \$65 per cartridge plus installation.

Cut Sheets

Cut sheets have been prepared to summarize the retrofit alternatives and are included in Attachment 5.

Recommendation

The original Leslie Groves Regional Infiltration Facility is the most cost effective option at \$212K. After accounting for infiltration during the design storm, the original facility as designed is capable of providing enhanced treatment and infiltrating 90% of the annual runoff volume from the contributing drainage basin including all "first flush" storm events. The next best cost effective option is the Leslie Groves Park Soccer Field Infiltration Trench option at \$462K.

ATTACHMENT 1 — DRAINAGE BASIN MAPS



City of Richland Stormwater Retrofit Support Services

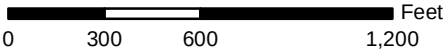
Outfall NR04 Drainage Basin

Legend

- Existing CB/Inlet
- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- NR04 Drainage Basin (299 Acres)
- Approximate Surface Flow Direction

2011 Aerial Imagery

Attachment 1-1



Date Created: October 16, 2014



City of Richland Stormwater Retrofit Support Services

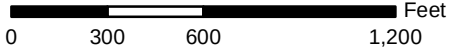
Snyder St Drainage Basin

Legend

- Existing CB/Inlet
- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Snyder St Drainage Basin (117 Acres)
- NR04 Drainage Basin (299 Acres)
- BMP Location
- Approximate Surface Flow Direction

2011 Aerial Imagery

Attachment 1-2



Date Created: October 21, 2014

ATTACHMENT 2 — STORMWATER RETROFIT BMP ALTERNATIVE MATRIX

NR04 - Stormwater Retrofit BMP Alternative Matrix

Description	Benefit	Target Pollutants	Treatment Effectiveness	Relative O&M Effort	Relative Cost
Leslie Groves Infiltration Facility with High Flow Bypass	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	Low	Low
Saint Street Infiltration Facility with High Flow Bypass <i>Infiltration Trench System with CDS</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	Mod	Mod
Snyder St Infiltration Facility with High Flow Bypass NE Harris Ave & Snyder St Intersection	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	Low	Mod
Distributed Drywells <i>Convert Existing Inlets to Drywell System with Sed Manhole</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	Mod	Mod	High
Distributed Infiltration Trenches <i>Convert Existing Inlets to Infil. Trench System with Sed Manhole</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	Mod	Mod	High
Distributed "Bump-Out" Bioretention <i>Convert Existing Street Parking to "Bump-Out" Bioretention Facilities</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	High	High
Distributed "Linear" Bioretention <i>Convert Existing Street Parking to "Linear" Bioretention Facilities</i>	Runoff Treatment (Basic, Enhanced, Phos) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	High	High
CONTECH SW Management StormFilter with MetalRx Media	Runoff Treatment (Basic, Enhanced)	Sediment and Metals; Limited Nutrients, Pesticides, Bacteria, & Hydrocarbons	Mod	High	Mod

Notes:

- (1) Any BMP that will retain and infiltrate at least the water quality storm event will achieve a high treatment level because of the reduction in pollutant loading to surface waters.
- (2) Columbia River is exempt from flow control requirements.
- (3) Relative Operation and Maintenance Effort Ratings:
 Low = One inspection per year and after major storms; sediment removal as needed.
 Moderate = Two inspections per year and after major storms; sediment removal as needed. Similar to "Low" until replacement.
 High = One inspection per year and after major storms; irrigation; landscape pruning; enclosed space requirements; sediment removal as needed; cartridge replacement as needed (\$65 per cartridge + installation).

Exact maintenance efforts are difficult to project and will only be revealed based on inspections. Minimizing sediment load to the treatment facilities will reduce annual maintenance costs; this can be accomplished through street sweeping, and routine operation and maintenance of upstream catch basins and manholes.

ATTACHMENT 3 — CALCULATIONS

Hydrologic Calculations - Time of Concentration and SBUH Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 10/15/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Time of Concentration Results

Subbasin	Sheet Flow					Shallow Concentrated Flow				Open Channel Flow				Time of Concentration
	$T_t = 0.42 * (n_s * L)^{0.8} / ((P_{2yr2hr})^{0.5} * (s_0)^{0.4})$					$T_t = L / (60 * (k * (s_0)^{0.5}))$				$T_t = L / (60 * (k_c * (s_0)^{0.5}))$				$T_c = T_{t1} + T_{t2} + ... T_{tm}$
	n_s	L (ft)	P_{2yr2hr} (in)	s_0 (ft/ft)	T_t (min)	L (ft)	k	s_0 (ft/ft)	T_t (min)	L (ft)	k_c	s_0 (ft/ft)	T_t (min)	T_c (min)
NR04	0.011	42	0.4	0.020	1.71	1806	27	0.022	7.52	6260	42	0.004	39.28	48.51
NR04 Snyder St	0.011	41	0.4	0.020	1.68	848	27	0.007	6.26	5432	42	0.007	25.76	33.70

SBUH Results

Subbasin	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T_c (min)	24-Hour Type 1A Storm Event		3-Hour Short Duration Storm Event	
							6-Month (0.53 in)		25-Year (0.92 in)	50-Year (1.14 in)
							Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)	Peak Flow (cfs)
NR04	299.33	224.50	0.25	98	75	48.51	3.73	93,254	39.83	56.28
NR04 Snyder Street	116.94	87.71	0.25	98	75	33.70	1.70	36,437	20.10	28.02
Remaining NR04	182.39	136.79	0.25	98	75	48.51	2.27	56,822	24.27	34.29

Note:

(1) 25-Year and 50-Year, 3-Hour Short Duration peak flows are provided for any high-flow bypass conveyance sizing.

Hydrologic Calculations - Drywell Calculations	Calculated By: E. Pruneda	Date: 10/16/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Facility Characteristics:

Drywell Radius (Outside):	2.5	ft	
Drywell Radius (Inside):	2	ft	
Drywell Depth:	8	ft	
Drain Rock Radius Top (R ₁):	8.83	ft	
Drain Rock Radius Bottom (R ₂):	4	ft	
Drain Rock Depth (h):	9.66	ft	<i>Drywell sits on 1 ft of Drain Rock</i>
Cover:	3	ft	<i>Ground surface to top of Drain Rock</i>

Calculated Areas:

Drain Rock Surface Area:	485.6	sq ft	<i>Per equation (1) from WSDOT Paper*</i>
Drain Rock Bottom Area:	50.27	sq ft	$\pi * R_2^2$
Drain Rock Side Wall Area:	435.33	sq ft	<i>(sides and bottom) - (bottom)</i>

Assumed Infiltration Rate:

Infiltration Rate =	3.00	in/hr	<i>To be updated based on geotechnical analysis</i>
Infiltration Rate =	0.250	ft/hr	<i>Conversion</i>
Infiltration Rate =	6.94E-05	ft/s	<i>Conversion</i>
Bottom:	0.003	cfs	<i>Drain Rock Bottom Area x Infiltration Rate</i>
Side Walls:	0.015	cfs	<i>Drain Rock Side Wall Area x (Infiltration Rate/2)</i>
			<i>(Division by two reflects zero hydraulic head at the top of the sidewall and full head at the bottom of the sidewall)</i>
Total:	0.0186	cfs	<i>Per drywell</i>

Available Storage Capacity:

Excavation Volume at Depth h =	1,308	cf	<i>Conical Frustum Volume Equation</i>
Drywell Storage Volume =	101	cf	
Drain Rock Void Volume =	483	cf	<i>Excavation Volume - Drywell Storage Volume</i>
			<i>Neglects footing and drywell sidewall volume</i>
Total Available Storage =	583	cf	<i>Per drywell</i>

* WSDOT (2004) *An Approach for Estimating Infiltration Rates for Stormwater Infiltration Dry Wells*

Hydrologic Calculations - Infiltration Trench Calculations	Calculated By: E. Pruneda	Date: 10/16/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Infiltration Trench

Facility Characteristics:

Type of Facility :	Sedimentation manhole with infiltration trench		
Number of Infiltration Trenches:	2		
Length:	32 ft	<i>Per infiltration trench</i>	
Depth:	4 ft	<i>Per infiltration trench</i>	
Width:	5 ft	<i>Per infiltration trench</i>	
Perforated Pipe Dia:	1 ft		

Calculated Areas:

Drain Rock Bottom Area:	160.00 sq ft	<i>Per infiltration trench</i>
Drain Rock Side Wall Area:	276.00 sq ft	<i>Two sides and one end; per infiltration trench</i>

Assumed Infiltration Rate:

Infiltration Rate =	3.00 in/hr	<i>To be updated based on geotechnical analysis</i>
Infiltration Rate =	0.250 ft/hr	<i>Conversion</i>
Infiltration Rate =	6.94E-05 ft/s	<i>Conversion</i>
Bottom:	0.011 cfs	<i>Drain Rock Bottom Area x Infiltration Rate</i>
Side Walls:	0.010 cfs	<i>Drain Rock Side Wall Area x (Infiltration Rate/2)</i> <i>(Division by two reflects zero hydraulic head at the top of the sidewall and full head at the bottom of the sidewall)</i>
Subtotal:	0.0207 cfs	<i>Per infiltration trench</i>
Total:	0.0414 cfs	

Available Storage Capacity:

Perforated Pipe Storage Volume =	25 cf	<i>Per infiltration trench</i>
Drain Rock Void Volume =	246 cf	<i>Assuming 40% voids; per infiltration trench</i>
Subtotal Available Storage =	271 cf	<i>Per infiltration trench</i>
Total Available Storage =	542 cf	

Hydrologic Calculations - Saint St. Infil. Trench Calculations	Calculated By: E. Pruneda	Date: 2/27/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Saint Street Infiltration Trench

Facility Characteristics:

Type of Facility :	Infiltration trench		
Number of Infiltration Trenches:	8		
Length:	270	ft	<i>Per infiltration trench</i>
Depth:	2.25	ft	<i>Per infiltration trench</i>
Width:	7.5	ft	<i>Per infiltration trench</i>
Perforated Pipe Dia:	1	ft	

Calculated Areas:

Drain Rock Bottom Area:	2025.00	sq ft	<i>Per infiltration trench</i>
Drain Rock Side Wall Area:	1231.88	sq ft	<i>Two sides and one end; per infiltration trench</i>

Assumed Infiltration Rate:

Infiltration Rate =	3.00	in/hr	<i>To be updated based on geotechnical analysis</i>
Infiltration Rate =	0.250	ft/hr	<i>Conversion</i>
Infiltration Rate =	6.94E-05	ft/s	<i>Conversion</i>
Bottom:	0.141	cfs	<i>Drain Rock Bottom Area x Infiltration Rate</i>
Side Walls:	0.043	cfs	<i>Drain Rock Side Wall Area x (Infiltration Rate/2)</i> <i>(Division by two reflects zero hydraulic head at the top of the sidewall and full head at the bottom of the sidewall)</i>
Subtotal:	0.1834	cfs	<i>Per infiltration trench</i>
Total:	1.4672	cfs	

Available Storage Capacity:

Perforated Pipe Storage Volume =	106	cf	<i>Assumed to be half diameter; per infiltration trench</i>
Drain Rock Void Volume =	1780	cf	<i>Assuming 40% voids; per infiltration trench</i>
Subtotal Available Storage =	1886	cf	<i>Per infiltration trench</i>
Total Available Storage =	15089	cf	

Hydrologic Calculations - Leslie Groves Infil. Trench Calculations	Calculated By: E. Pruneda	Date: 2/27/2015	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Leslie Groves Infiltration Trench

Facility Characteristics:

Type of Facility :	Infiltration trench
Number of Infiltration Trenches:	1
Length:	128.16 ft <i>Per infiltration trench</i>
Depth:	3 ft <i>Per infiltration trench</i>
Width:	128.16 ft <i>Per infiltration trench</i>
Perforated Pipe Dia:	1.5 ft

Calculated Areas:

Drain Rock Bottom Area:	16424.99 sq ft	<i>Per infiltration trench</i>
Drain Rock Side Wall Area:	1153.44 sq ft	<i>Two sides and one end; per infiltration trench</i>

Assumed Infiltration Rate:

Infiltration Rate =	3.00 in/hr	<i>To be updated based on geotechnical analysis</i>
Infiltration Rate =	0.250 ft/hr	<i>Conversion</i>
Infiltration Rate =	6.94E-05 ft/s	<i>Conversion</i>
Bottom:	1.141 cfs	<i>Drain Rock Bottom Area x Infiltration Rate</i>
Side Walls:	0.040 cfs	<i>Drain Rock Side Wall Area x (Infiltration Rate/2)</i>
		<i>(Division by two reflects zero hydraulic head at the top of the sidewall and full head at the bottom of the sidewall)</i>
Subtotal:	1.1807 cfs	<i>Per infiltration trench</i>
Total:	1.1807 cfs	

Available Storage Capacity:

Perforated Pipe Storage Volume =	3105 cf	<i>Per infiltration trench</i>
Drain Rock Void Volume =	18468 cf	<i>Assuming 40% voids; per infiltration trench</i>
Subtotal Available Storage =	21573 cf	<i>Per infiltration trench</i>
Total Available Storage =	21573 cf	

Conceptual BMP Sizing Calculations

Leslie Groves Infiltration Facility, Saint St. Infiltration Facility,
Snyder Street Infiltration Facility, and Snyder Street Dispersion Facility

Calculated By: E. Pruneda	Date: 2/24/2015	Project: Richland
Checked By:	Date:	Project No: 33764797
		Sheet No: 1 of 3

Facility ID	Available Storage Volume					Predicted Water Quality Volume (cf) from Contributing Area	Assumed Infiltration Rate (in/hr)	Assumed Infiltration Rate (cfs)	Predicted Max Volume (cf) in Facility During the Water Quality Storm Event
	Top Area (sq-ft)	Bottom Area (sq-ft)	Side Slope (XH:1V)	Depth (ft)	Volume (cf)				
Leslie Groves Infil. Facility	---	10,416	---	---	60,500	93,254	3	0.7233	41,571
Leslie Groves Infil. Trench	See Leslie Groves Infil. Trench Calcs				21,573	93,254	3	1.1807	20,439
Saint Street Infil. Trench	See Saint St. Infil. Trench Calcs				15,089	93,254	3	1.4672	14,704
Snyder Street Infil. Facility	11,892	9,770	6	0.5	5,416	36,437	3	0.6785	4,634

Notes:

- (1) The Leslie Groves Infiltration Pond volume and area at the overflow (Elev = 361) were taken from the Leslie Groves Regional Infiltration Facility plan set dated 2/5/2014.
- (2) The long term infiltration rate of treatment soil media has been assumed to be 3.0 inches/hour.
The native infiltration rate will be confirmed through geotechnical investigation as the design progresses.

Leslie Groves Infil. Trench Flow Splitter Weir Calculation (50-yr, 3-hr storm - 3.73 cfs)

Worksheet: Rectangular Weir - 1

Calculations Messages

Solve For: Headwater Elevation

Discharge:	52.55	ft ³ /s	Headwater Height Above Crest:	1.57	ft
Headwater Elevation:	361.57	ft	Tailwater Height Above Crest:	-0.60	ft
Crest Elevation:	360.00	ft	Flow Area:	12.58	ft ²
Tailwater Elevation:	359.40	ft	Velocity:	4.18	ft/s
Weir Coefficient:	3.33	US	Wetted Perimeter:	11.15	ft
Crest Length:	8.00	ft	Top Width:	8.00	ft
Number Of Contractions:	0				

Calculation Successful.

Saint St. Infil. Trench Flow Splitter Weir Calculation (50-yr, 3-hr storm - 3.73 cfs)

Worksheet: Rectangular Weir - 1

Calculations Messages

Solve For: Headwater Elevation

Discharge:	52.55	ft ³ /s	Headwater Height Above Crest:	1.57	ft
Headwater Elevation:	358.82	ft	Tailwater Height Above Crest:	-3.55	ft
Crest Elevation:	357.25	ft	Flow Area:	12.58	ft ²
Tailwater Elevation:	353.70	ft	Velocity:	4.18	ft/s
Weir Coefficient:	3.33	US	Wetted Perimeter:	11.15	ft
Crest Length:	8.00	ft	Top Width:	8.00	ft
Number Of Contractions:	0				

Calculation Successful.

Conceptual BMP Sizing Calculations

Leslie Groves Infiltration Facility, Leslie Groves Infiltration Trench,
Saint St. Infiltration Trench, Snyder Street Infiltration Facility,
and Snyder Street Dispersion Facility

Calculated By: E. Pruneda Date: 2/24/2015 Project: Richland

Checked By: Date: Project No: 33764797

Sheet No: 2 of 3

Snyder Street Infiltration Facility Pipe Sizing Calculation

Worksheet: Circular Pipe - 1

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Discharge Friction Method: Manning Formula

Roughness Coefficient:	0.011		Flow Area:	0.63	ft ²
Channel Slope:	0.00200	ft/ft	Wetted Perimeter:	2.09	ft
Normal Depth:	0.75	ft	Hydraulic Radius:	0.30	ft
Diameter:	1.00	ft	Top Width:	0.87	ft
Discharge:	1.72	ft ³ /s	Critical Depth:	0.56	ft
			Percent Full:	75.0	%
			Critical Slope:	0.00465	ft/ft
			Velocity:	2.72	ft/s
			Velocity Head:	0.11	ft
			Specific Energy:	0.86	ft
			Froude Number:	0.56	
			Maximum Discharge:	2.03	ft ³ /s
			Discharge Full:	1.88	ft ³ /s
			Slope Full:	0.00166	ft/ft
			Flow Type:	SubCritical	

Calculation Successful.

Snyder Street Dispersion Facility Flow Spreader (Weir) Sizing Calculation

Worksheet: Rectangular Weir - 1

Calculations | Messages

Solve For: Discharge

Discharge:	1.71	ft ³ /s	Headwater Height Above Crest:	0.05	ft
Headwater Elevation:	0.25	ft	Tailwater Height Above Crest:	-0.20	ft
Crest Elevation:	0.20	ft	Flow Area:	2.30	ft ²
Tailwater Elevation:	0.00	ft	Velocity:	0.74	ft/s
Weir Coefficient:	3.33	US	Wetted Perimeter:	46.10	ft
Crest Length:	46.00	ft	Top Width:	46.00	ft
Number Of Contractions:	0				

Calculation Successful.

Conceptual BMP Sizing Calculations Drywell, Infiltration Trench, Bump-Out Bioretention, and Linear Bioretention	Calculated By: E. Pruneda	Date: 10/20/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 3 of 3

Facility ID	Available Storage Volume					Assumed Infiltration Rate (in/hr)	Assumed Infiltration Rate (cfs)
	Top Area (sq-ft)	Bottom Area (sq-ft)	Side Slope (XH:1V)	Depth (ft)	Volume (cf)		
Template Drywell	See Drywell Calculations				583	3	0.0186
Template Infil. Trench	See Infil. Trench Calculations				542	3	0.0414
Template Bump-Out Bioretention	126	51	3	0.5	44	3	0.0036
Template Linear Bioretention	355	167	3	0.5	130	3	0.0116

Note:

(1) The long term infiltration rate of treatment soil media has been assumed to be 3.0 inches/hour.

The native infiltration rate will be confirmed through geotechnical investigation as the design progresses.

Facility ID	Number of Template Facilities Required to Treat the Water Quality Storm Event for the Entire NR04 Basin	Total Template Facilities Infil Rate (cfs)	Total Template Facilities Volume (cf)	Predicted Max Volume (cf) in Template Facilities During the Water Quality Storm Event
Template Drywell	51	0.9486	29,733	29,027
Template Infil. Trench	32	1.3244	17,344	17,157
Template Bump-Out Bioretention	378	1.3479	16,717	16,706
Template Linear Bioretention	122	1.4110	15,899	15,609

Facility ID	Number of Template Facilities Required to Treat the Water Quality Storm Event Assuming the Construction of the Snyder Street Infiltration Facility	Total Template Facilities Infil Rate (cfs)	Total Template Facilities Volume (cf)	Predicted Max Volume (cf) in Template Facilities During the Water Quality Storm Event
Template Drywell	31	0.5766	18,073	17,754
Template Infil. Trench	20	0.8278	10,840	10,059
Template Bump-Out Bioretention	232	0.8273	10,260	10,068
Template Linear Bioretention	74	0.8558	9,644	9,577

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 3.73 cfs

Maximum Flow: 3.8 cfs

Saint Street Infiltration Trench
Pipe Calculation
Alternative 1F

Table 1 - Summary of Culvert Flows at Crossing: NR04 Soccer Field

Headwater Elevation (ft)	Total Discharge (cfs)	15" Pipe to Infil Trench Discharge (cfs)	Roadway Discharge (cfs)	Iterations
356.00	0.00	0.00	0.00	1
356.32	0.38	0.38	0.00	1
356.46	0.76	0.76	0.00	1
356.57	1.14	1.14	0.00	1
356.68	1.52	1.52	0.00	1
356.78	1.90	1.90	0.00	1
356.88	2.28	2.28	0.00	1
356.97	2.66	2.66	0.00	1
357.05	3.04	3.04	0.00	1
357.13	3.42	3.42	0.00	1
357.20	3.73	3.73	0.00	1
364.50	16.27	16.27	0.00	Overtopping

Rating Curve Plot for Crossing: NR04 Soccer Field

Total Rating Curve

Crossing: NR04 Soccer Field

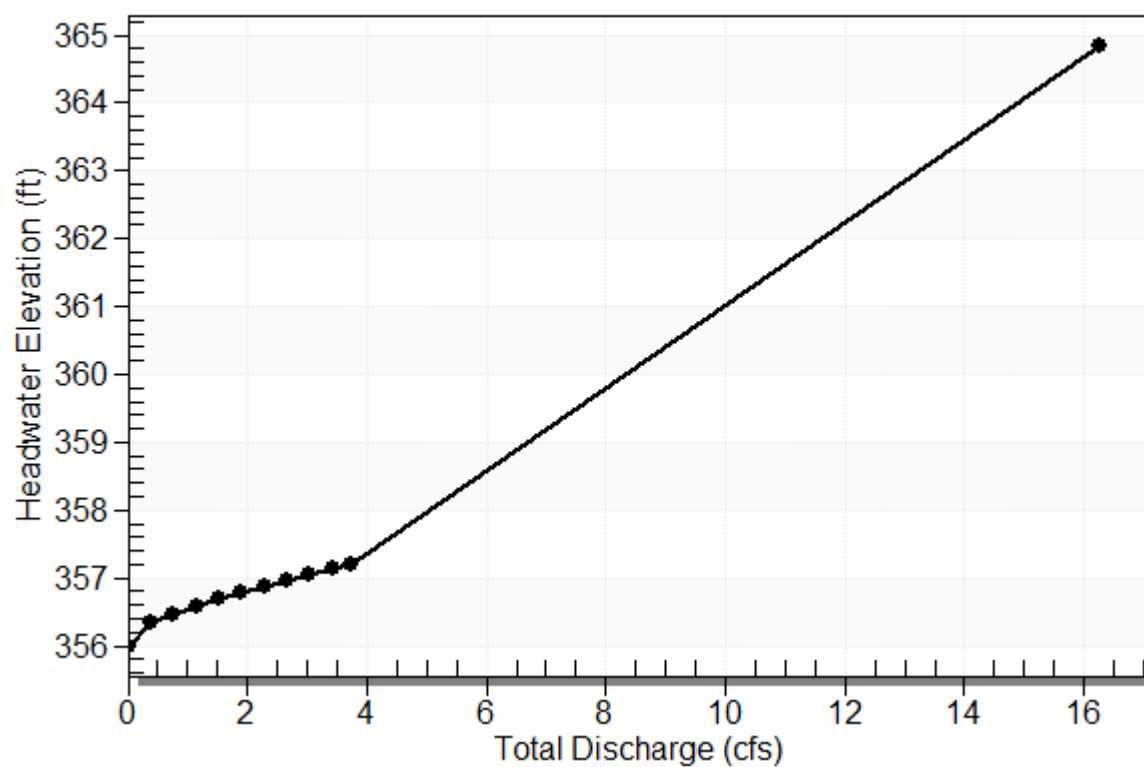


Table 2 - Culvert Summary Table: 15" Pipe to Infil Trench

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	356.00	0.000	0.000	0-NF	0.000	0.000	0.750	0.750	0.000	0.000
0.38	0.38	356.32	0.325	0.0*	1-JS1t	0.177	0.233	0.750	0.750	0.495	0.000
0.76	0.76	356.46	0.464	0.0*	1-JS1t	0.256	0.339	0.750	0.750	0.989	0.000
1.14	1.14	356.57	0.575	0.0*	1-JS1t	0.316	0.417	0.750	0.750	1.484	0.000
1.52	1.52	356.68	0.682	0.0*	1-JS1t	0.367	0.485	0.750	0.750	1.979	0.000
1.90	1.90	356.78	0.785	0.0*	1-S2n	0.413	0.548	0.413	0.750	5.361	0.000
2.28	2.28	356.88	0.879	0.0*	1-S2n	0.457	0.603	0.457	0.750	5.611	0.000
2.66	2.66	356.97	0.966	0.0*	1-S2n	0.496	0.653	0.496	0.750	5.900	0.000
3.04	3.04	357.05	1.049	0.038	1-S2n	0.534	0.698	0.534	0.750	6.074	0.000
3.42	3.42	357.13	1.131	0.115	1-S2n	0.572	0.744	0.572	0.750	6.252	0.000
3.73	3.73	357.20	1.199	0.211	1-S2n	0.600	0.777	0.600	0.750	6.406	0.000

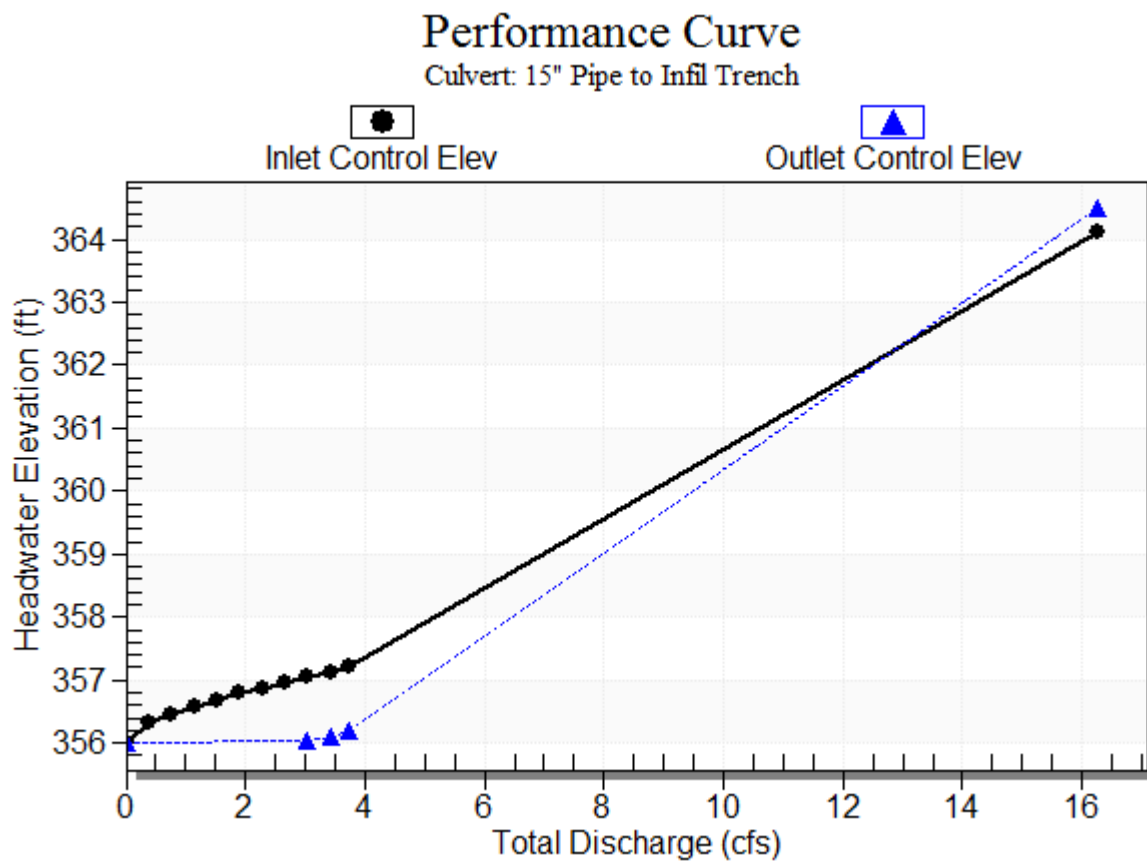
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 356.00 ft, Outlet Elevation (invert): 355.00 ft

Culvert Length: 92.01 ft, Culvert Slope: 0.0109

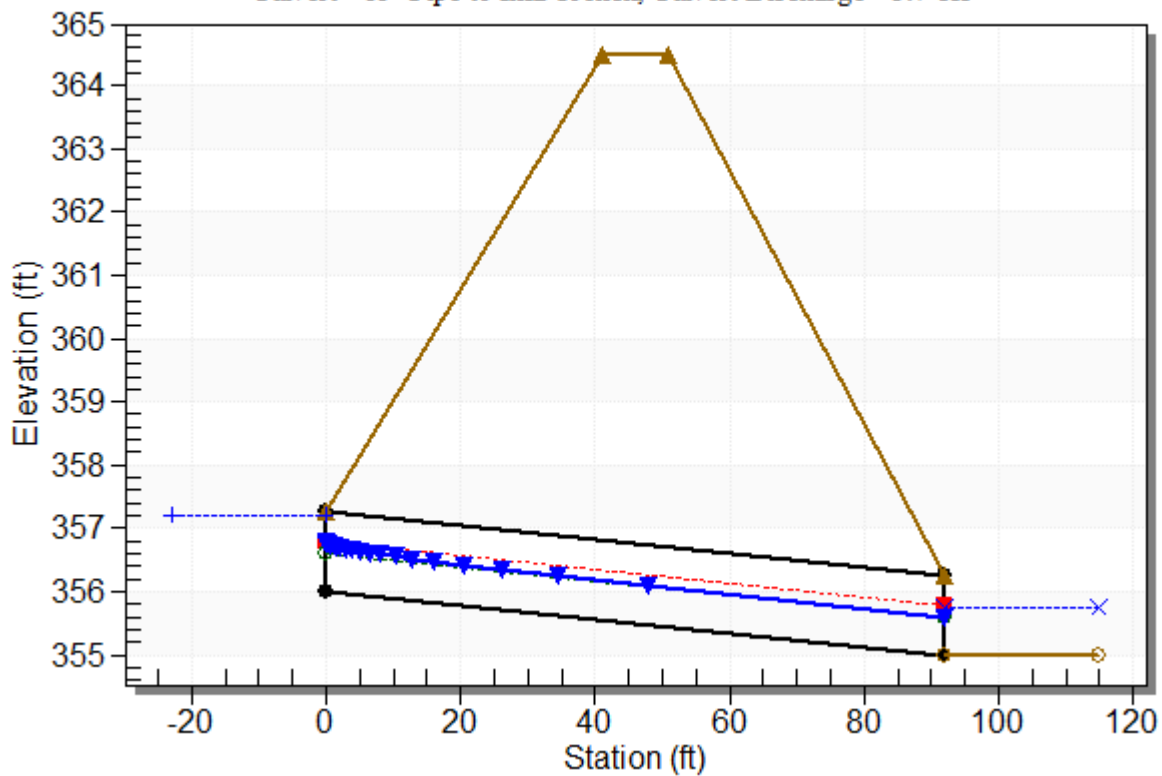
Culvert Performance Curve Plot: 15" Pipe to Infil Trench



Water Surface Profile Plot for Culvert: 15" Pipe to Infil Trench

Crossing - NR04 Soccer Field, Design Discharge - 3.7 cfs

Culvert - 15" Pipe to Infil Trench, Culvert Discharge - 3.7 cfs



Site Data - 15" Pipe to Infil Trench

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 356.00 ft

Outlet Station: 92.00 ft

Outlet Elevation: 355.00 ft

Number of Barrels: 1

Culvert Data Summary - 15" Pipe to Infil Trench

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: PVC

Embedment: 0.00 in

Barrel Manning's n: 0.0110

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: NR04 Soccer Field)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	355.75	0.75
0.38	355.75	0.75
0.76	355.75	0.75
1.14	355.75	0.75
1.52	355.75	0.75
1.90	355.75	0.75
2.28	355.75	0.75
2.66	355.75	0.75
3.04	355.75	0.75
3.42	355.75	0.75
3.73	355.75	0.75

Tailwater Channel Data - NR04 Soccer Field

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 355.75 ft

Roadway Data for Crossing: NR04 Soccer Field

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 364.50 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 3.73 cfs

Maximum Flow: 3.8 cfs

Leslie Groves Regional Infiltration Trench
Pipe Calculation
Alternative 1G

Table 1 - Summary of Culvert Flows at Crossing: NR04 Leslie Groves Trench

Headwater Elevation (ft)	Total Discharge (cfs)	15 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
358.90	0.00	0.00	0.00	1
359.07	0.38	0.38	0.00	1
359.21	0.76	0.76	0.00	1
359.33	1.14	1.14	0.00	1
359.43	1.52	1.52	0.00	1
359.54	1.90	1.90	0.00	1
359.63	2.28	2.28	0.00	1
359.72	2.66	2.66	0.00	1
359.80	3.04	3.04	0.00	1
359.88	3.42	3.42	0.00	1
359.95	3.73	3.73	0.00	1
373.50	22.36	22.36	0.00	Overtopping

Rating Curve Plot for Crossing: NR04 Leslie Groves Trench

Total Rating Curve
Crossing: NR04 Leslie Groves Trench

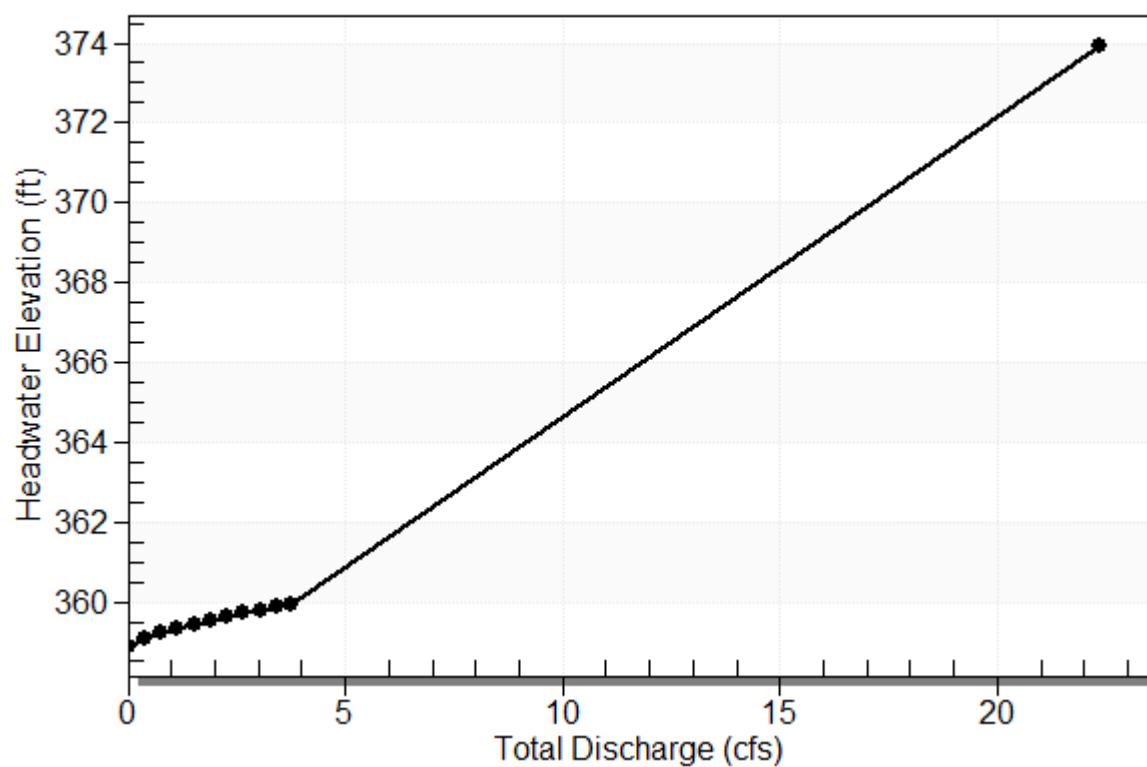


Table 2 - Culvert Summary Table: 15

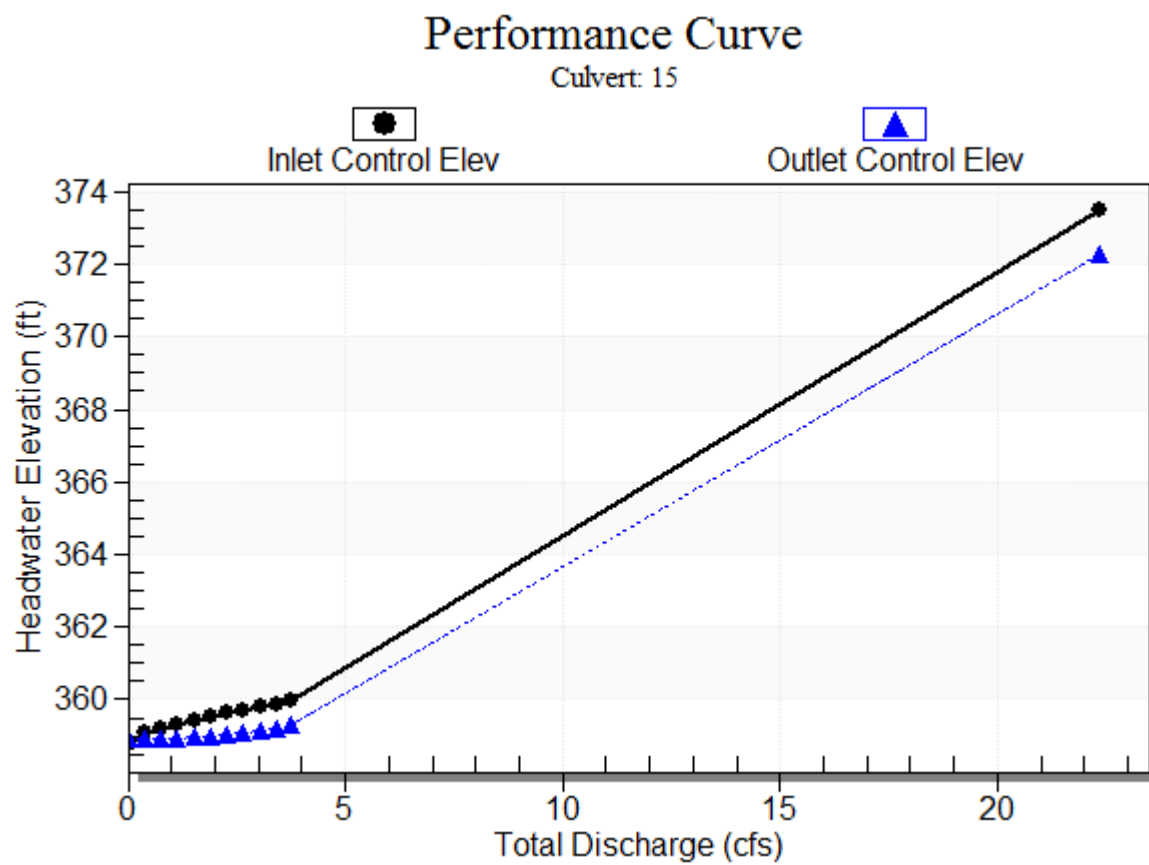
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	358.90	0.000	0.150	0-NF	0.000	0.000	0.750	0.750	0.000	0.000
0.38	0.38	359.07	0.325	0.154	1-S2n	0.181	0.233	0.181	0.750	3.367	0.000
0.76	0.76	359.21	0.465	0.165	1-JS1t	0.261	0.339	0.750	0.750	0.989	0.000
1.14	1.14	359.33	0.575	0.183	1-JS1t	0.324	0.417	0.750	0.750	1.484	0.000
1.52	1.52	359.43	0.682	0.209	1-JS1t	0.375	0.485	0.750	0.750	1.979	0.000
1.90	1.90	359.54	0.785	0.243	1-JS1t	0.422	0.548	0.750	0.750	2.473	0.000
2.28	2.28	359.63	0.879	0.284	1-S2n	0.467	0.603	0.471	0.750	5.395	0.000
2.66	2.66	359.72	0.966	0.332	1-S2n	0.507	0.653	0.514	0.750	5.588	0.000
3.04	3.04	359.80	1.050	0.388	1-S2n	0.547	0.698	0.554	0.750	5.792	0.000
3.42	3.42	359.88	1.132	0.451	1-S2n	0.585	0.744	0.593	0.750	5.973	0.000
3.73	3.73	359.95	1.199	0.535	1-S2n	0.615	0.777	0.624	0.750	6.095	0.000

Straight Culvert

Inlet Elevation (invert): 358.75 ft, Outlet Elevation (invert): 358.15 ft

Culvert Length: 60.00 ft, Culvert Slope: 0.0100

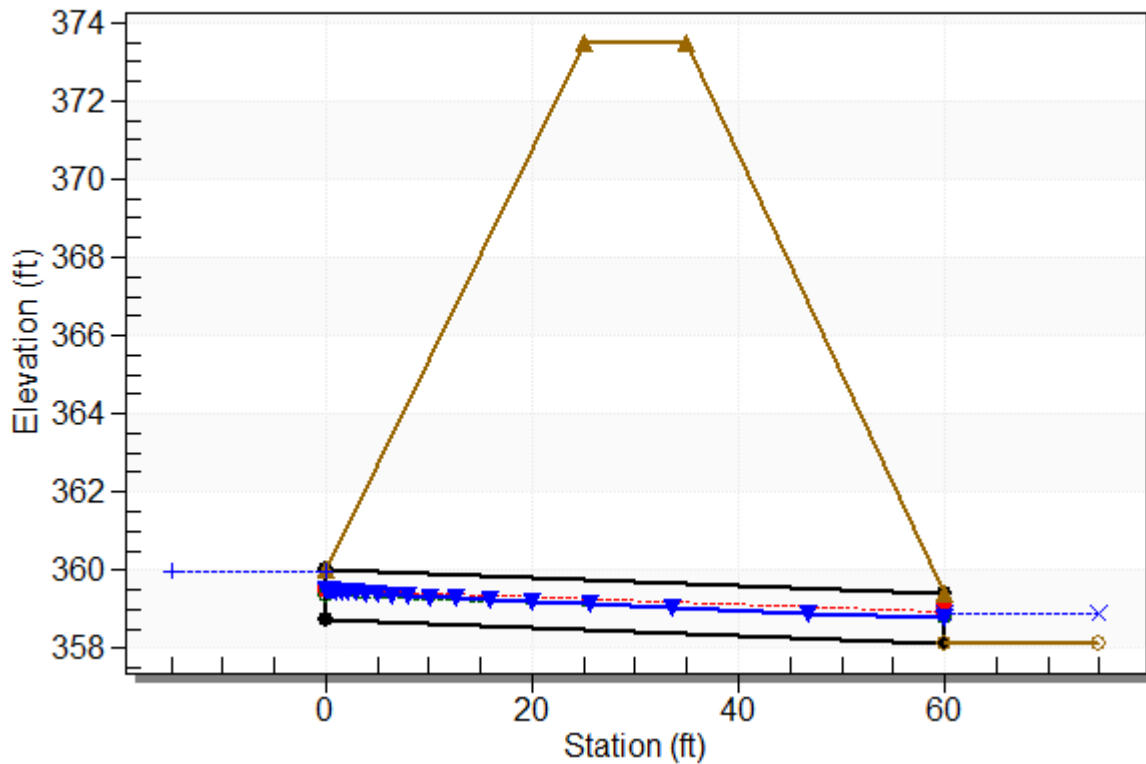
Culvert Performance Curve Plot: 15



Water Surface Profile Plot for Culvert: 15

Crossing - NR04 Leslie Groves Trench, Design Discharge - 3.7 cfs

Culvert - 15, Culvert Discharge - 3.7 cfs



Site Data - 15

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 358.75 ft

Outlet Station: 60.00 ft

Outlet Elevation: 358.15 ft

Number of Barrels: 1

Culvert Data Summary - 15

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: PVC

Embedment: 0.00 in

Barrel Manning's n: 0.0110

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: NR04 Leslie Groves Trench)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	358.90	0.75
0.38	358.90	0.75
0.76	358.90	0.75
1.14	358.90	0.75
1.52	358.90	0.75
1.90	358.90	0.75
2.28	358.90	0.75
2.66	358.90	0.75
3.04	358.90	0.75
3.42	358.90	0.75
3.73	358.90	0.75

Tailwater Channel Data - NR04 Leslie Groves Trench

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 358.90 ft

Roadway Data for Crossing: NR04 Leslie Groves Trench

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 373.50 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

ATTACHMENT 4 — TEMPLATE BMP DESIGNS

City of Richland
Stormwater Retrofit
Support Services

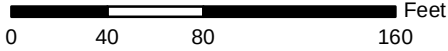
Outfall NR04
Leslie Groves Regional
Infiltration Facility
Alternative 1

Legend

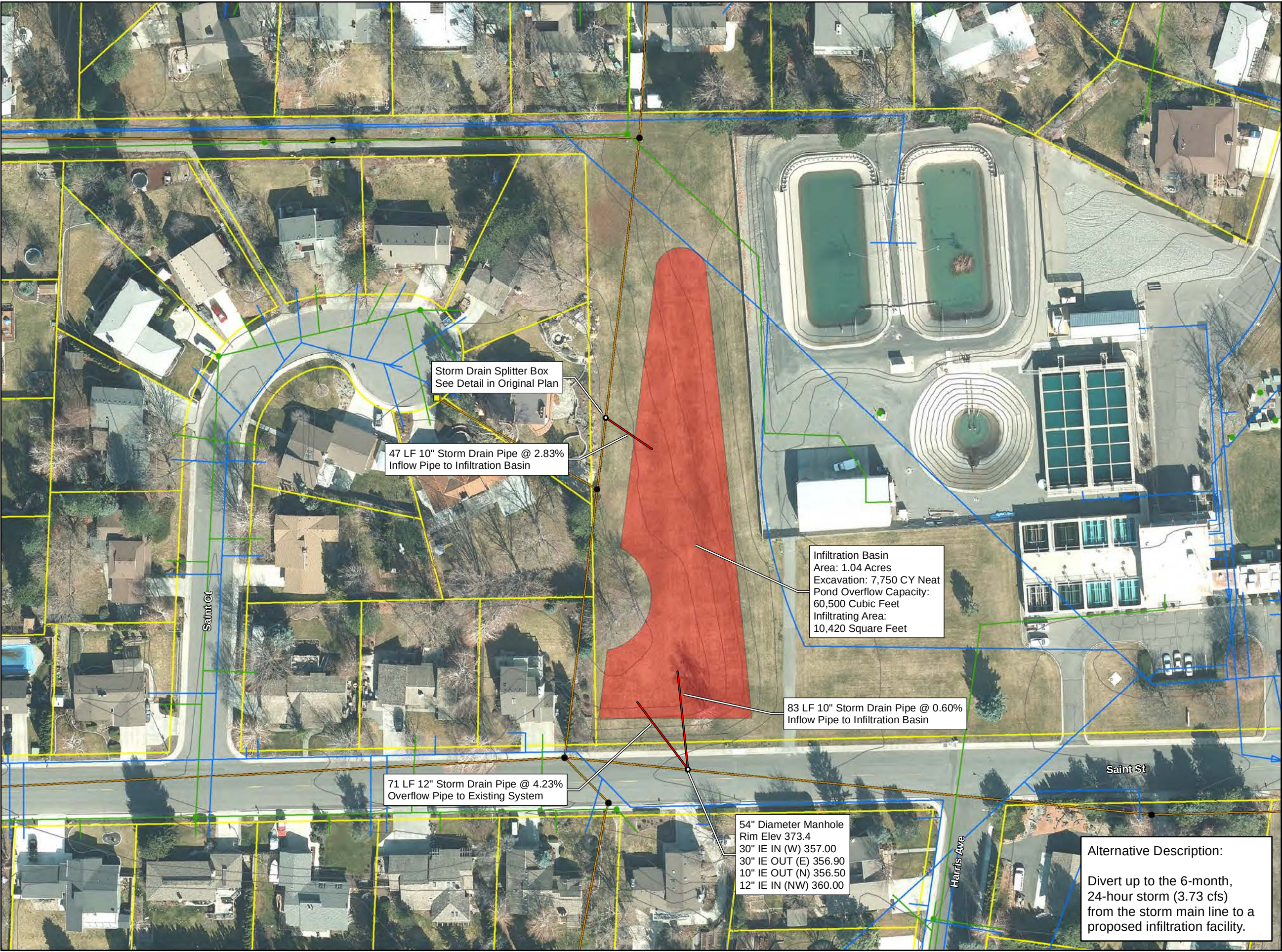
- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Manhole
- Proposed Storm Pipe
- Proposed Facility

2012 Aerial Imagery

Attachment 4-1a



Date Created: February 27, 2015



Storm Drain Splitter Box
See Detail in Original Plan

47 LF 10" Storm Drain Pipe @ 2.83%
Inflow Pipe to Infiltration Basin

Infiltration Basin
Area: 1.04 Acres
Excavation: 7,750 CY Neat
Pond Overflow Capacity:
60,500 Cubic Feet
Infiltrating Area:
10,420 Square Feet

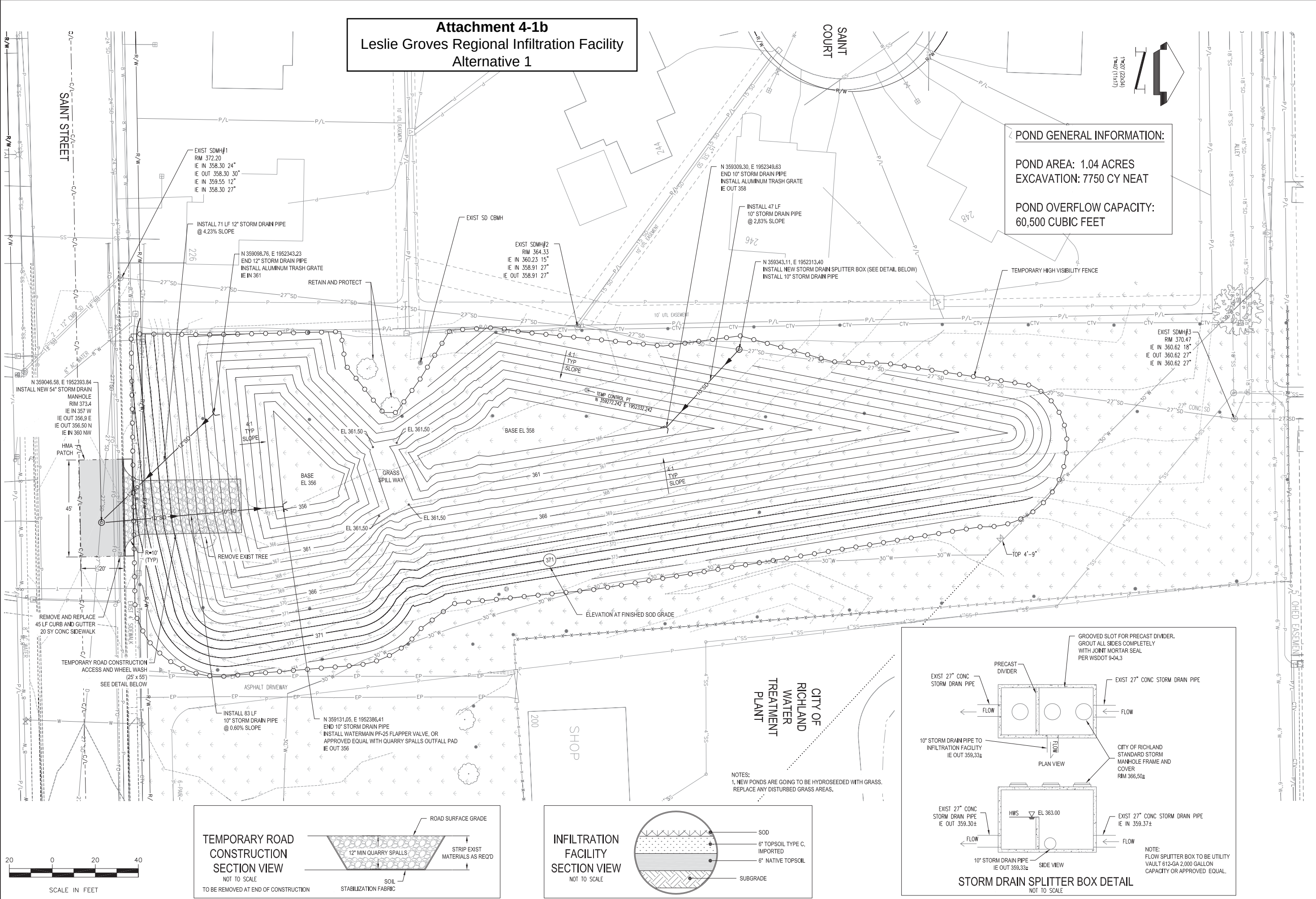
83 LF 10" Storm Drain Pipe @ 0.60%
Inflow Pipe to Infiltration Basin

71 LF 12" Storm Drain Pipe @ 4.23%
Overflow Pipe to Existing System

54" Diameter Manhole
Rim Elev 373.4
30" IE IN (W) 357.00
30" IE OUT (E) 356.90
10" IE OUT (N) 356.50
12" IE IN (NW) 360.00

Alternative Description:

Divert up to the 6-month,
24-hour storm (3.73 cfs)
from the storm main line to a
proposed infiltration facility.



Attachment 4-1b
Leslie Groves Regional Infiltration Facility
Alternative 1

POND GENERAL INFORMATION:

POND AREA: 1.04 ACRES
EXCAVATION: 7750 CY NEAT

POND OVERFLOW CAPACITY:
60,500 CUBIC FEET



CITY OF RICHLAND

PUBLIC WORKS DEPARTMENT

REVISION

NO.	DESCRIPTION	BY	DATE

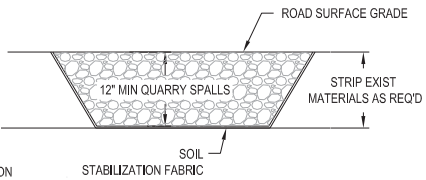
Leslie Groves Regional Infiltration Facility
City of Richland

Pond Plan View

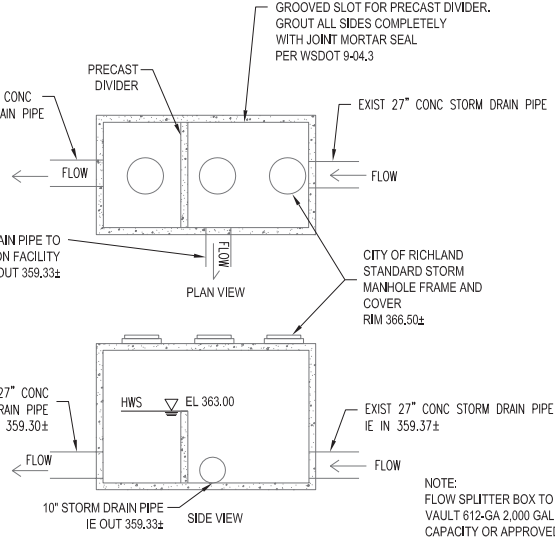
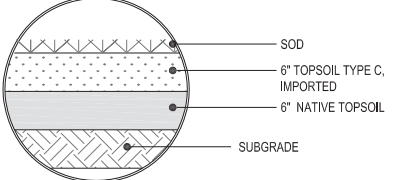
ONE INCH
AT FULL SIZE, IF NOT ONE INCH,
SCALE ACCORDINGLY

CAD DWG:
leslie groves_plan set
CONTRACT NO: SB 14-08
DATE: 2-5-2014
DRAWN BY: LD
DESIGN BY: JVA
RECORD DWG: ##-###
SHEET

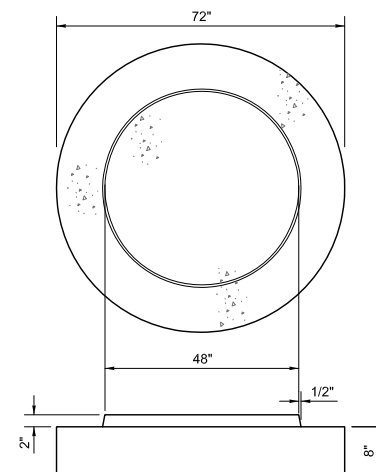
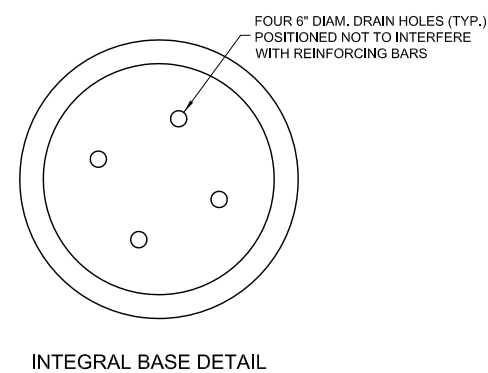
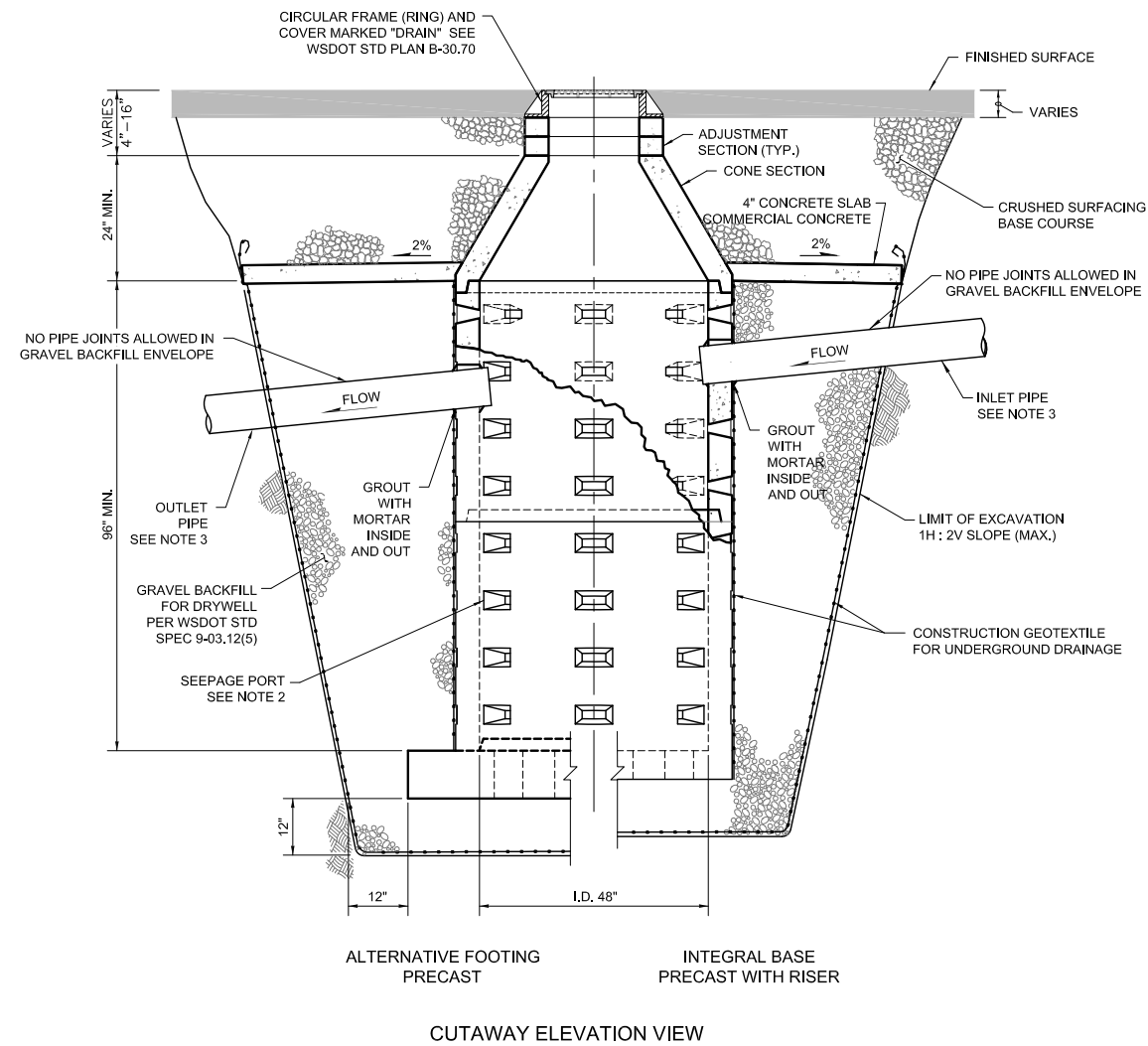
**TEMPORARY ROAD
CONSTRUCTION
SECTION VIEW**
NOT TO SCALE
TO BE REMOVED AT END OF CONSTRUCTION



**INFILTRATION
FACILITY
SECTION VIEW**
NOT TO SCALE



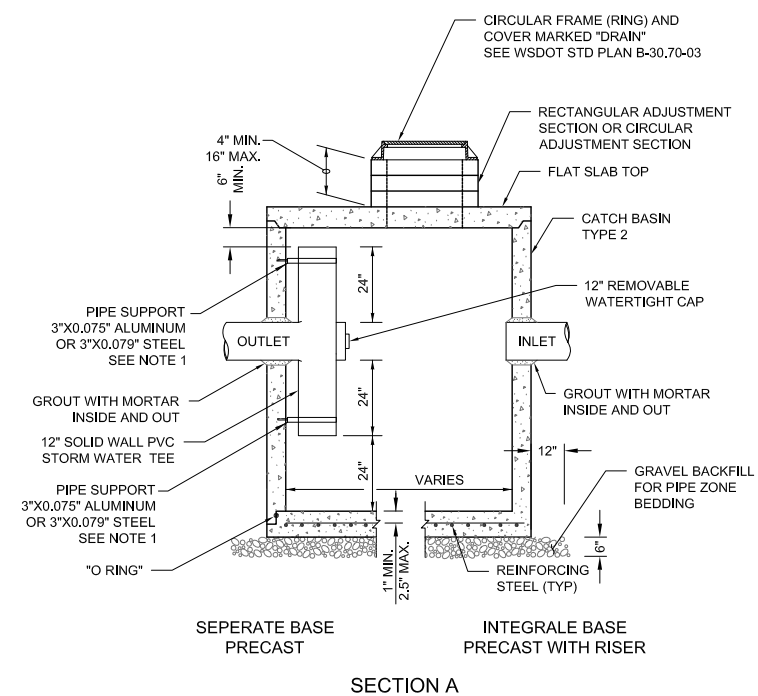
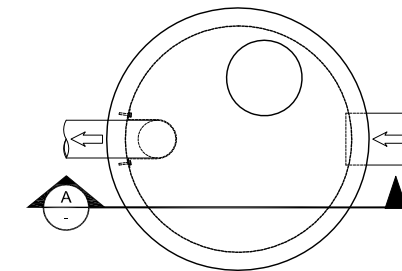
NOTE:
FLOW SPLITTER BOX TO BE UTILITY
VAULT 612-GA 2,000 GALLON
CAPACITY OR APPROVED EQUAL.



- ### NOTES
1. PRECAST CONCRETE CONE SECTIONS MAY BE ECCENTRIC OR CONCENTRIC.
 2. SEEPAGE PORT ORIENTATION VARIES AMONG MANUFACTURERS.
 3. CONNECT INLET AND OUTLET PIPES TO STRUCTURE USING PRECAST HOLE OR CORE DRILLED HOLE.
 4. FOR DEPTHS OVER 16'-2" USE 72"x8" ALTERNATIVE PRECAST FOOTING.
 5. WHEN NECESSARY, KNOCKOUTS ON PRECAST CONE, DRYWELL BASE AND RISER SECTIONS SHALL HAVE A WALL THICKNESS OF 1-1/2" MINIMUM AND 2" MAXIMUM.

DRYWELL DETAIL

SCALE: NTS



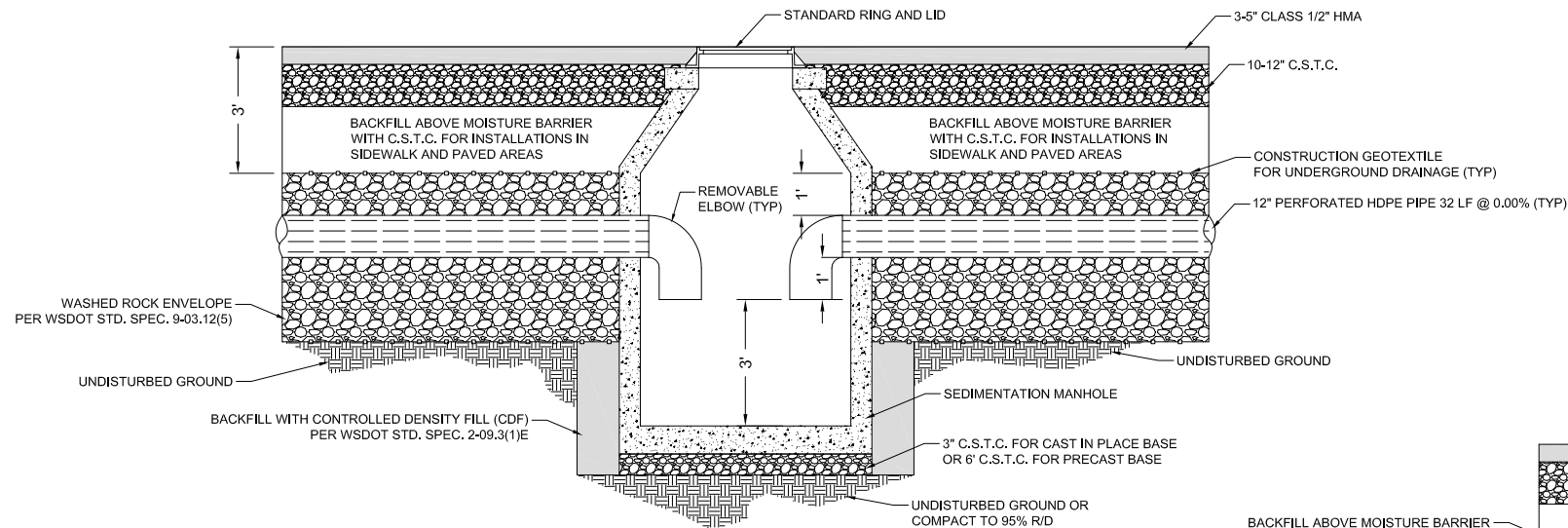
NOTES

1. ATTACH THE PIPE SUPPORTS TO THE MANHOLE WITH 5/8" STAINLESS STEEL EXPANSION BOLTS OR EMBED THE SUPPORTS INTO THE MANHOLE WALL 2".
2. THE FRAME SHALL BE OFFSET SO THAT THE CLIMB-DOWN SPACE IS CLEAR OF THE RISER.

SEDIMENTATION MANHOLE DETAIL

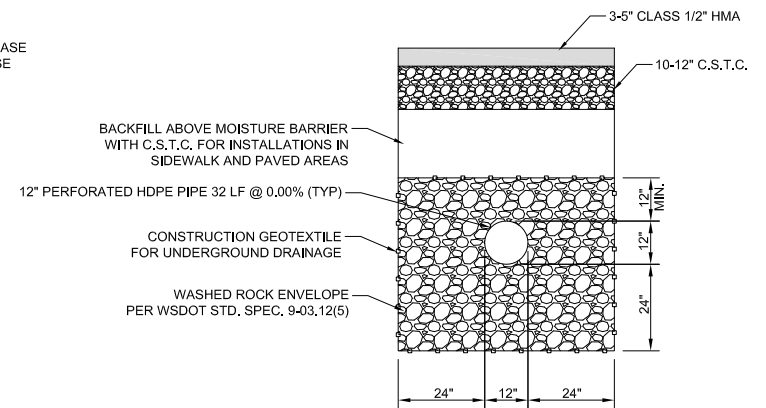
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Attachment 4-2
Alternative 1A, 2A, 3A



INFILTRATION TRENCH DETAIL

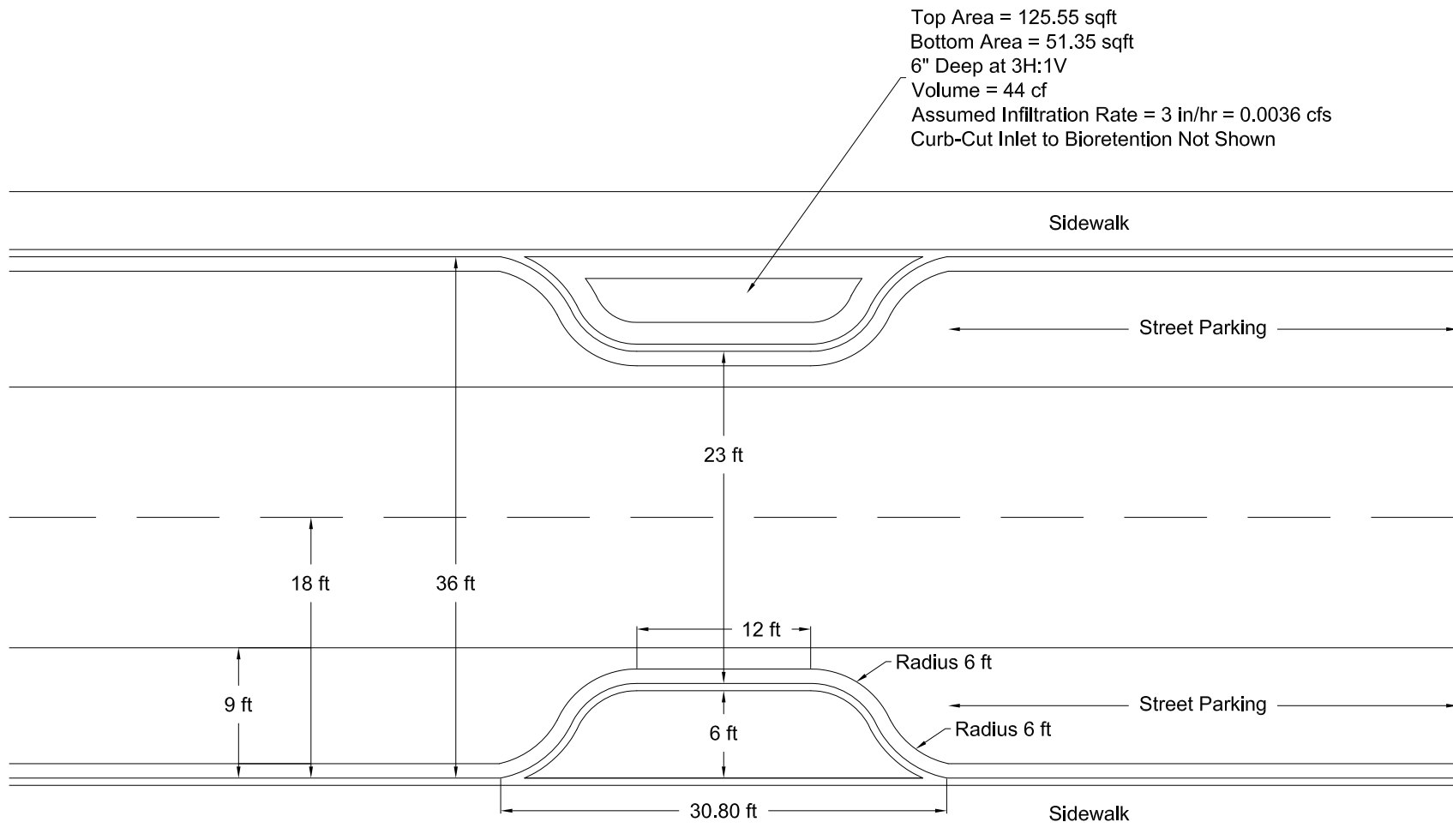
SCALE: NTS



INFILTRATION TRENCH TYPICAL SECTION

SCALE: NTS

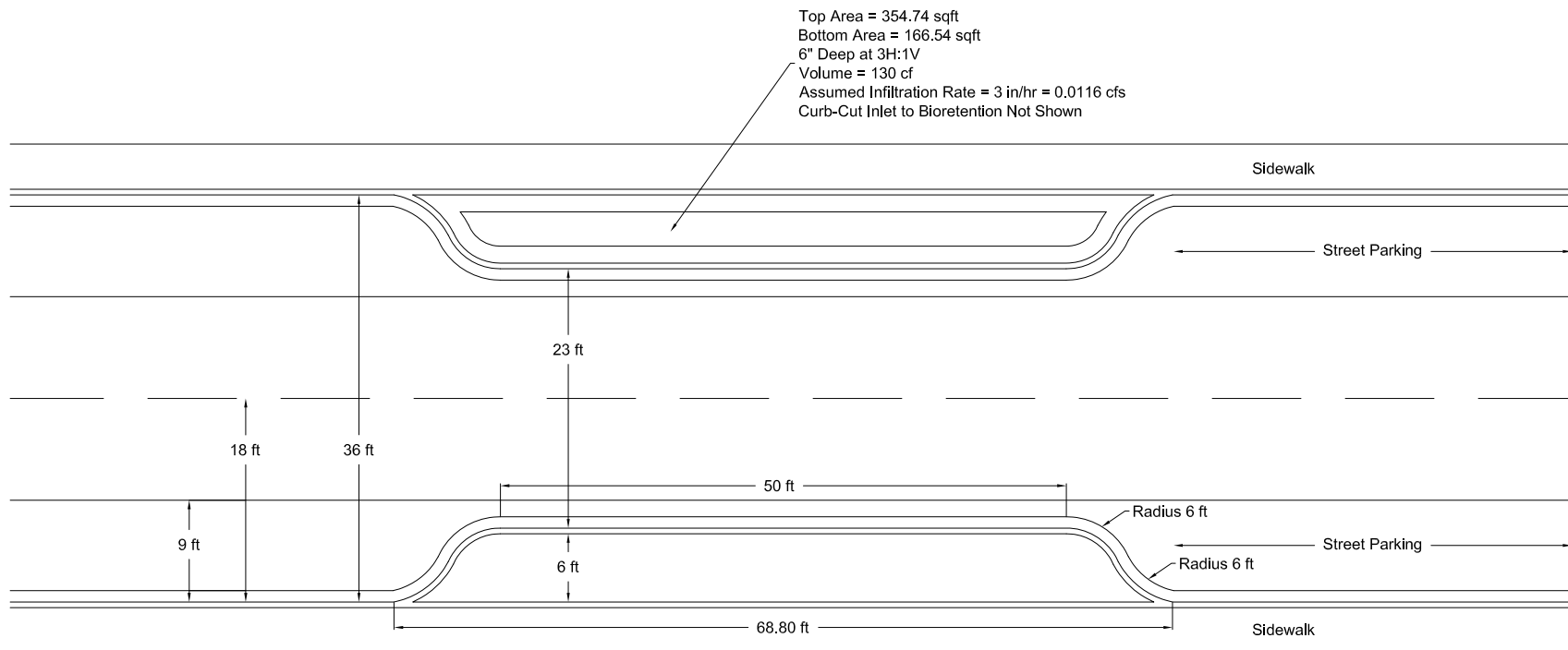
Attachment 4-3
Alternative 1B, 2B, 3B



"BUMP-OUT" BIORETENTION DETAIL

SCALE: NTS

Attachment 4-4
 Alternative 1C, 2C, 3C



"LINEAR" BIORETENTION DETAIL

SCALE: NTS

Attachment 4-5
Alternative 1D, 2D, 3D

City of Richland
Stormwater Retrofit
Support Services

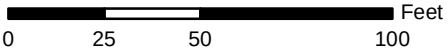
Outfall NR04
Contech StormFilter
Alternative 1E

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Facility

2012 Aerial Imagery

Attachment 4-6a



Date Created: February 27, 2015

Alternative Description:
Divert up to the 6-month,
24-hour storm (3.73 cfs)
from the storm main line to a
proposed treatment facility.

224 - 18" Contech StormFilters
Inside a 30' x 45' Conspan Vault



City of Richland
Stormwater Retrofit
Support Services

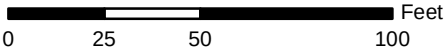
Outfall NR04
Contech StormFilter
Alternative 2E & 3E

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Facility

2012 Aerial Imagery

Attachment 4-6b

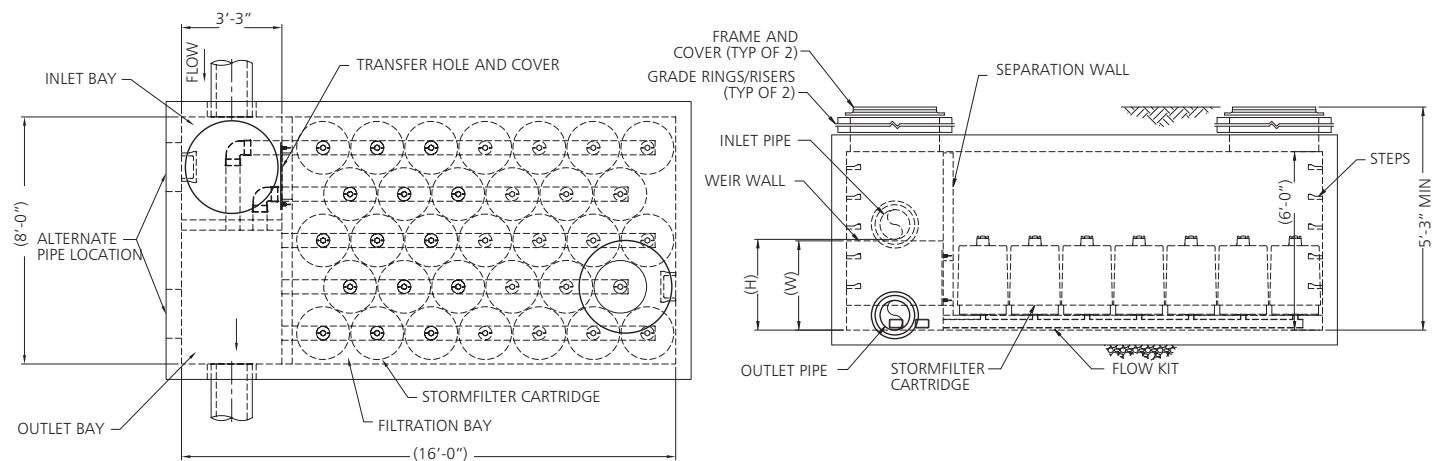


Date Created: February 27, 2015

Alternative Description:
Divert up to the 6-month,
24-hour storm (3.73 cfs)
from the storm main line to a
proposed treatment facility.

136 - 18" Contech StormFilters
Inside a 30' x 30' Conspan Vault





Peak Diversion StormFilter

Attachment 4-6c
Alternative 1E, 2E, 3E

City of Richland
Stormwater Retrofit
Support Services

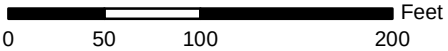
Outfall NR04
Saint Street Regional
Infiltration Trench
Alternative 1F

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Manhole
- Proposed Flow Splitter Box
- Proposed Storm Pipe
- Proposed Perforated Pipe
- Proposed Facility

2012 Aerial Imagery

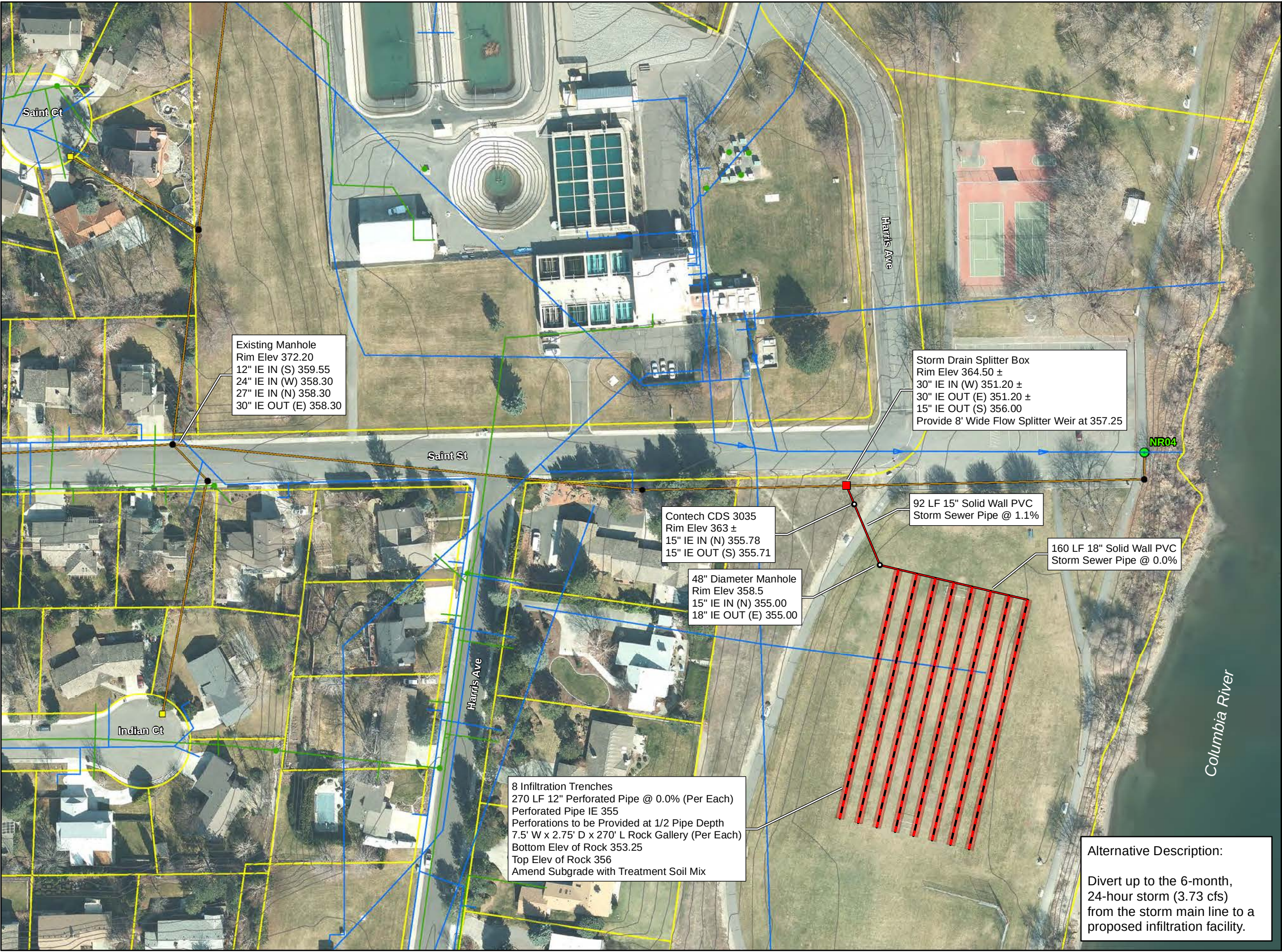
Attachment 4-7a



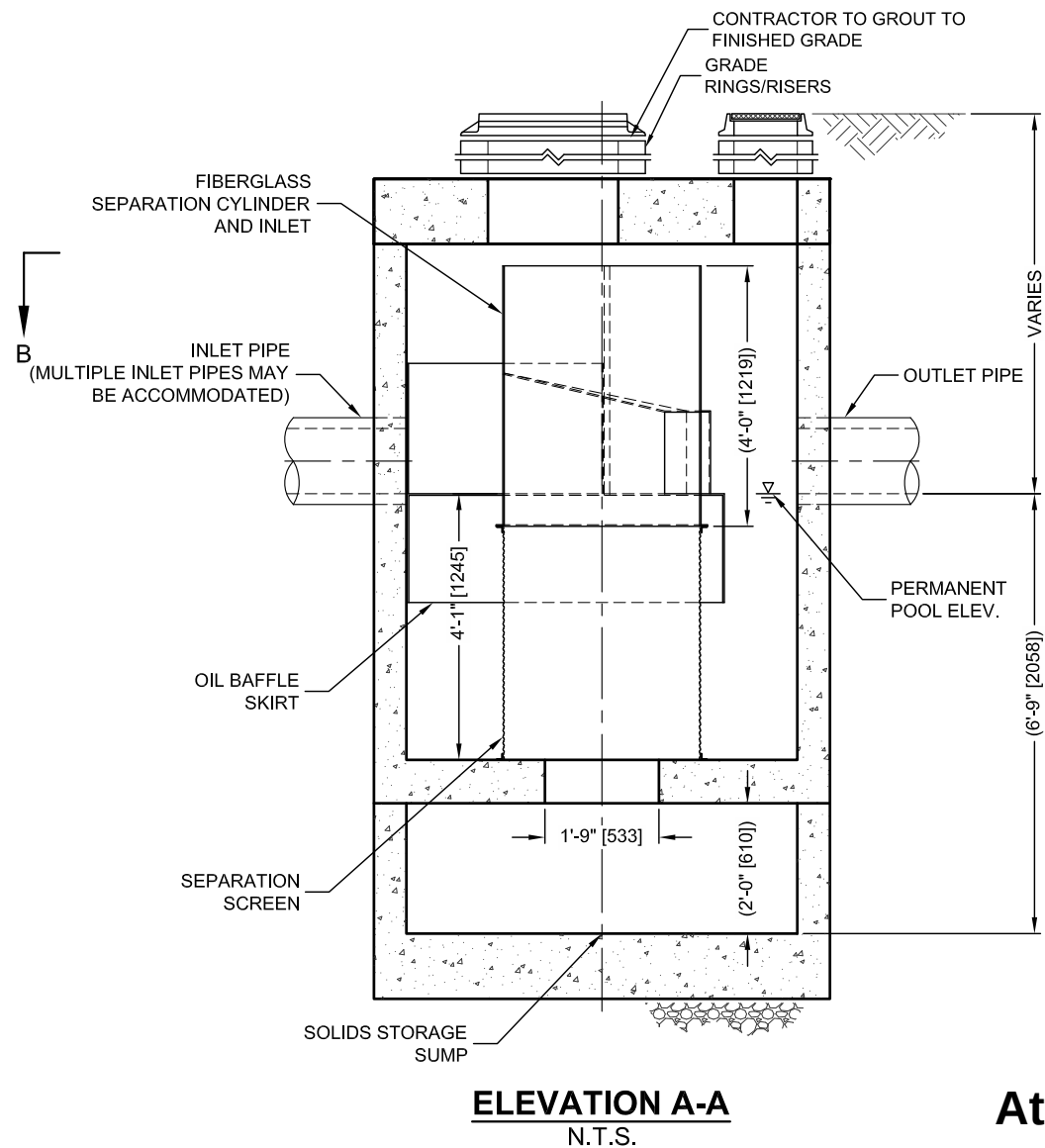
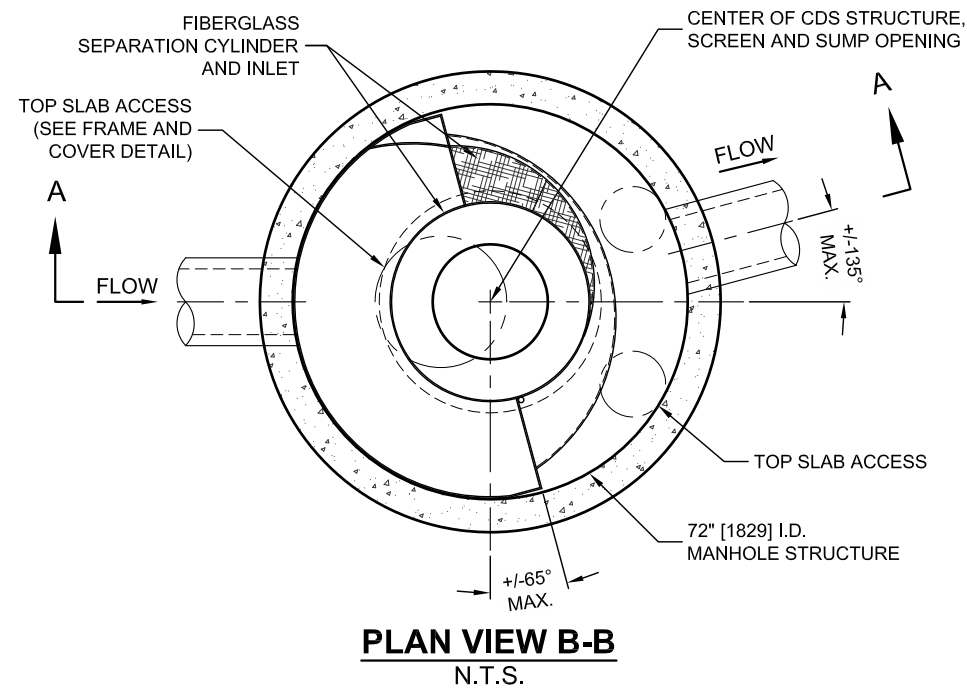
Date Created: February 19, 2015

Alternative Description:

Divert up to the 6-month,
24-hour storm (3.73 cfs)
from the storm main line to a
proposed infiltration facility.



I:\STORMWATER\COMMO\PS122 CDS40 STANDARD DRAWINGS\INLINE (CDS-C)\DWG\CDS3035-6-C-DTL.DWG 5/13/2014 5:58 PM



THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 6,788,848; 6,841,722; 6,911,505; 6,981,782. RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

Attachment 4-7b Alternative 1F

CDS3035-6-C DESIGN NOTES

CDS3035-6-C RATED TREATMENT CAPACITY IS 3.8 CFS [107.6 L/s], OR PER LOCAL REGULATIONS. MAXIMUM HYDRAULIC INTERNAL BYPASS CAPACITY IS 20.0 CFS [566 L/s]. IF THE SITE CONDITIONS EXCEED 20.0 CFS [566 L/s], AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

THE STANDARD CDS3035-6-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION

GRATED INLET ONLY (NO INLET PIPE)

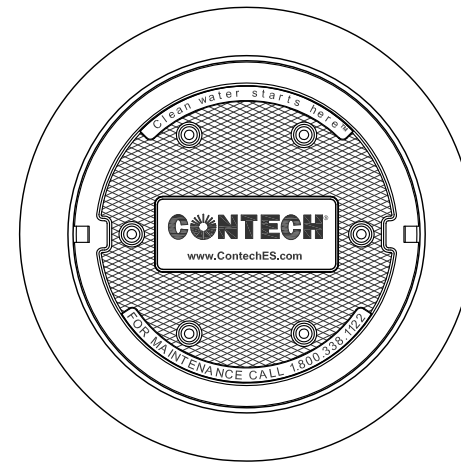
GRATED INLET WITH INLET PIPE OR PIPES

CURB INLET ONLY (NO INLET PIPE)

CURB INLET WITH INLET PIPE OR PIPES

SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)

SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER (DIAMETER VARIES) N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS OR L/s)			*
PEAK FLOW RATE (CFS OR L/s)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*
NOTES/SPECIAL REQUIREMENTS:			
* PER ENGINEER OF RECORD			

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH () ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES

- A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
- B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
- C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
- D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
- E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.



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9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069

800-338-1122

513-645-7000

513-645-7993 FAX

CDS3035-6-C
INLINE CDS
STANDARD DETAIL

City of Richland
Stormwater Retrofit
Support Services

Outfall NR04
Leslie Groves Regional
Infiltration Trench
Alternative 1G

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Manhole
- Proposed Storm Pipe
- Proposed Perforated Pipe
- Proposed Facility

2012 Aerial Imagery

Attachment 4-8a



Date Created: February 27, 2015

Infiltration Trench Gallery
1,757 LF 18" Perforated Pipe @ 0.0%
Perforated Pipe IE 358.15
Perforations to be Provided at 1/2 Pipe Depth
16,425 sqft x 3.00' D Rock Gallery
Bottom Elev of Rock 357.00
Top Elev of Rock 360.00
Amend Subgrade with Treatment Soil Mix

45 LF 18" Solid Wall PVC
Storm Sewer Pipe @ 0.0%

Existing Manhole
Rim Elev 372.20
12" IE IN (S) 359.55
24" IE IN (W) 358.30
27" IE IN (N) 358.30
30" IE OUT (E) 358.30

Storm Drain Splitter Box
Rim Elev 373.50
30" IE IN (W) 357.00
30" IE OUT (E) 356.90
15" IE OUT (N) 358.75
Provide 8' Wide Flow Splitter Weir at 360.00

48" Diameter Manhole
Rim Elev 365.00
15" IE IN (S) 358.15
18" IE OUT (E) 358.15
18" IE OUT (W) 358.15

15 LF 18" Solid Wall PVC
Storm Sewer Pipe @ 0.0%

30 LF 15" Solid Wall PVC
Storm Sewer Pipe @ 1.0%

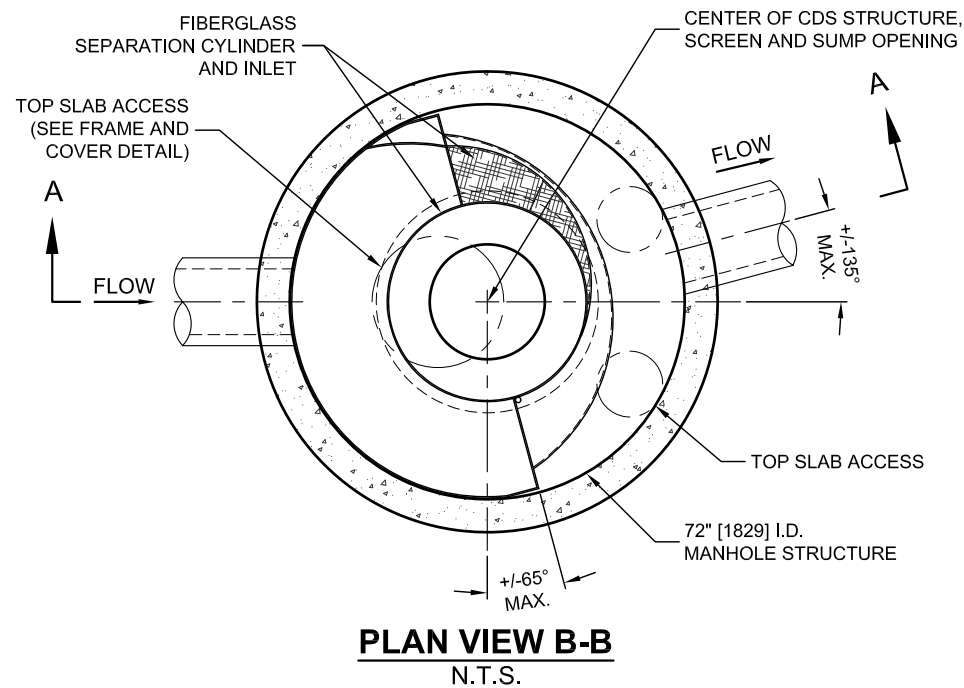
Contech CDS 3035
Rim Elev 369.00
15" IE IN (S) 358.45
15" IE OUT (N) 358.45

30 LF 15" Solid Wall PVC
Storm Sewer Pipe @ 1.0%

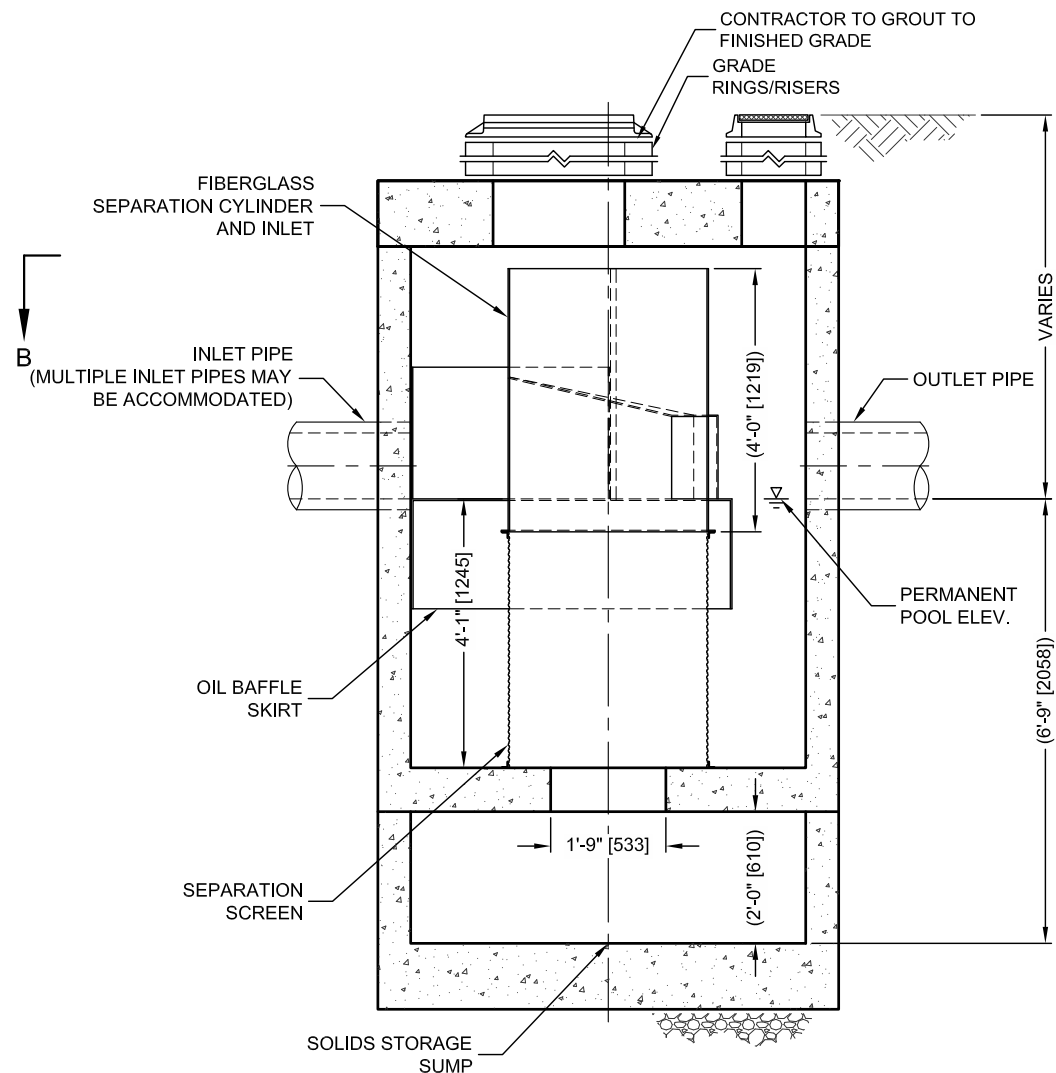
Alternative Description:

Divert up to the 6-month,
24-hour storm (3.73 cfs)
from the storm main line to a
proposed infiltration facility.

I:\STORMWATER\COMMO\PS122 CDS40 STANDARD DRAWINGS\INLINE (CDS-C)\DWG\CDS3035-6-C-DTL.DWG 5/13/2014 5:58 PM



PLAN VIEW B-B
N.T.S.



ELEVATION A-A
N.T.S.



THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 6,788,848; 6,841,722; 6,911,505; 6,981,782. RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

Attachment 4-8b Alternative 1G

CDS3035-6-C DESIGN NOTES

CDS3035-6-C RATED TREATMENT CAPACITY IS 3.8 CFS [107.6 L/s], OR PER LOCAL REGULATIONS. MAXIMUM HYDRAULIC INTERNAL BYPASS CAPACITY IS 20.0 CFS [566 L/s]. IF THE SITE CONDITIONS EXCEED 20.0 CFS [566 L/s], AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

THE STANDARD CDS3035-6-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION

GRATED INLET ONLY (NO INLET PIPE)

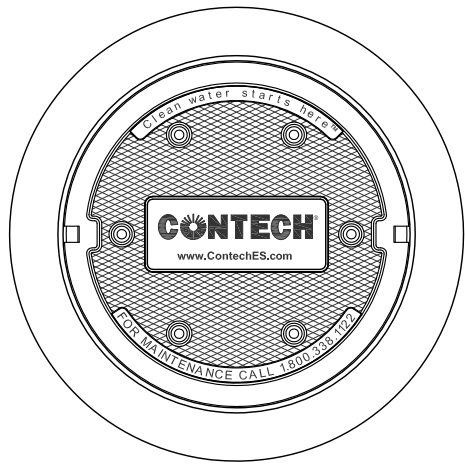
GRATED INLET WITH INLET PIPE OR PIPES

CURB INLET ONLY (NO INLET PIPE)

CURB INLET WITH INLET PIPE OR PIPES

SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)

SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS OR L/s)			*
PEAK FLOW RATE (CFS OR L/s)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*
NOTES/SPECIAL REQUIREMENTS:			
* PER ENGINEER OF RECORD			

GENERAL NOTES

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2. DIMENSIONS MARKED WITH () ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
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5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES

- A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
- B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
- C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
- D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
- E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.



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CDS3035-6-C
INLINE CDS
STANDARD DETAIL

City of Richland
Stormwater Retrofit
Support Services

Outfall NR04
Snyder Street
Infiltration Facility
Alternative 2

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Manhole
- Proposed Storm Pipe
- Proposed Facility

2012 Aerial Imagery

Attachment 4-9



0 60 120 240 Feet

Date Created: December 17, 2014

Alternative Description:

Divert up to the 6-month,
24-hour storm (1.70 cfs)
from the storm main line to a
proposed infiltration facility.



City of Richland
Stormwater Retrofit
Support Services

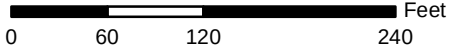
Outfall NR04
Snyder Street
Dispersion Facility
Alternative 3

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Manhole
- Proposed Storm Pipe
- Proposed Flow Spreader
- Proposed Dispersion Area

2012 Aerial Imagery

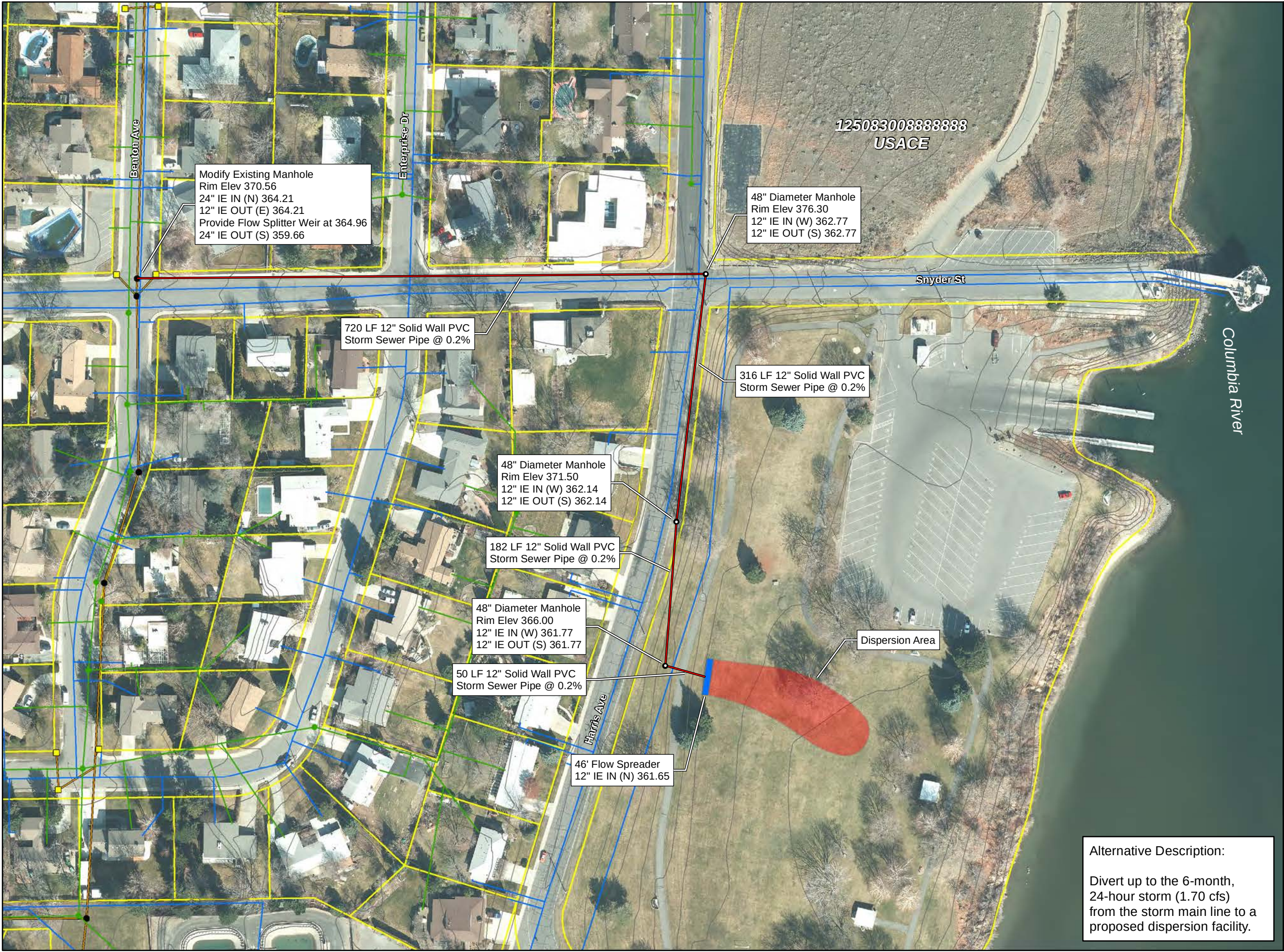
Attachment 4-10a



Date Created: January 13, 2015

Alternative Description:

Divert up to the 6-month,
24-hour storm (1.70 cfs)
from the storm main line to a
proposed dispersion facility.



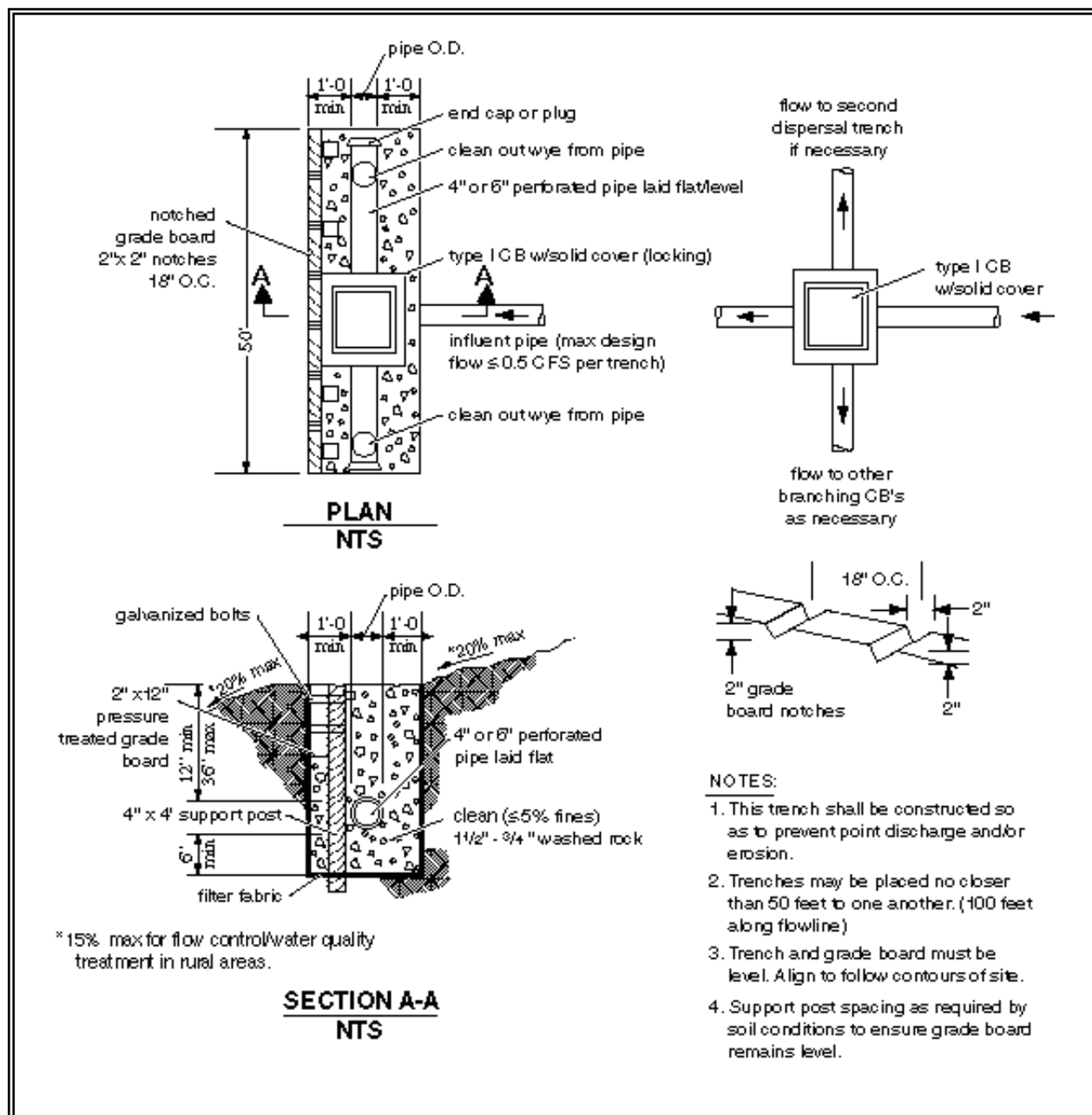


Figure 6.5.3 – Standard dispersion trench with notched grade board

Attachment 4-10b

Example Flow Spreader

Alternative 3

ATTACHMENT 5 — STORMWATER RETROFIT CUT SHEETS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1 (Original Design Concept)
Project Location: Saint St and Harris Ave west of Water Treatment Plant

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

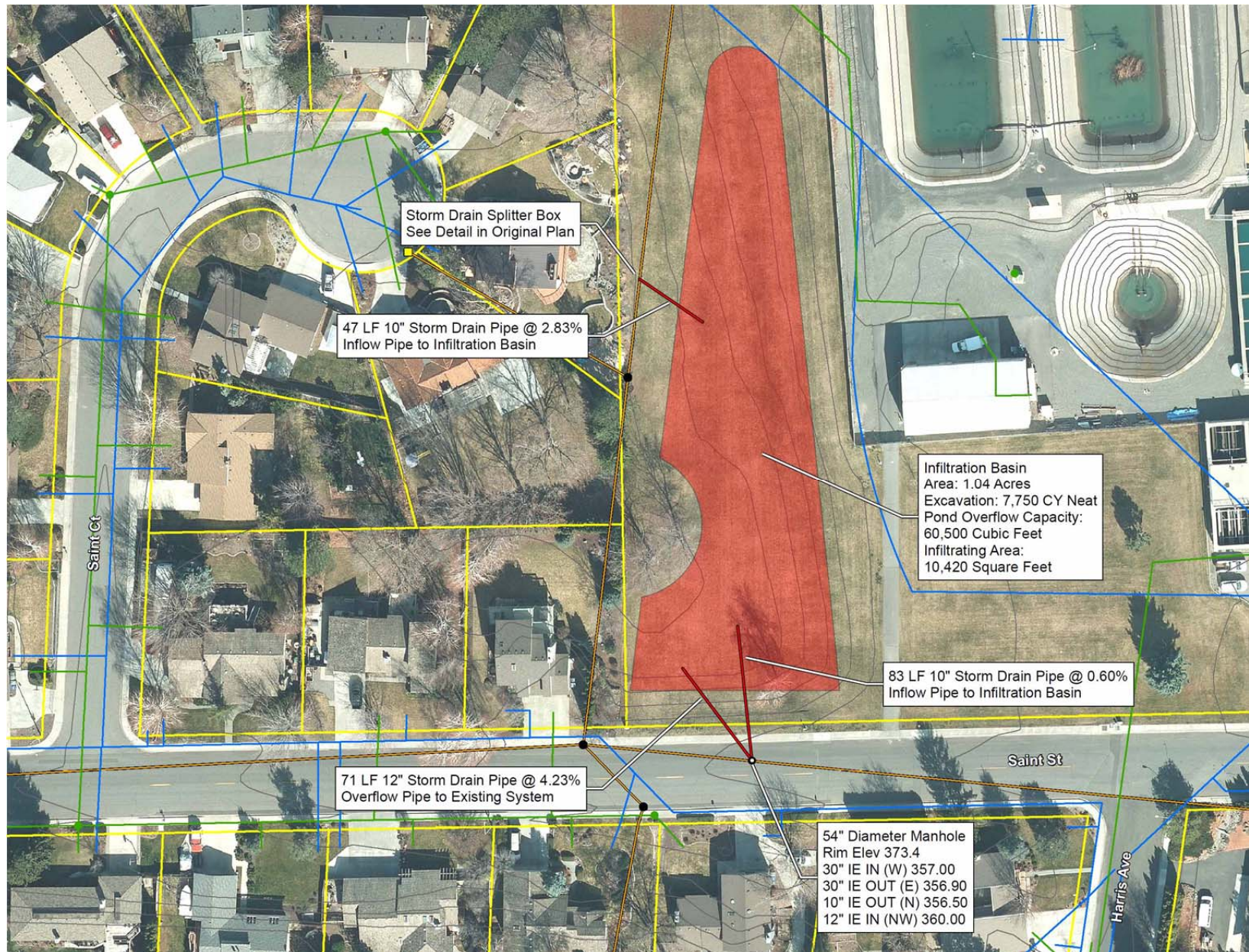
PROPOSED SOLUTION

Install a surface infiltration facility in the existing grassed area west of the Water Treatment Plant to provide treatment for the 6-month, 24-hour storm event within the basin.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1 Leslie Groves Regional Infiltration Facility				Engineer's Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 9,000.00	\$ 9,000.00
2	SPCC plan	LS	1	\$ 750.00	\$ 750.00
3	ESC lead	DAY	8	\$ 80.00	\$ 640.00
4	Project temporary traffic control	LS	1	\$ 5,000.00	\$ 5,000.00
5	Flaggers & spotters	HR	40	\$ 50.00	\$ 2,000.00
6	Stabilized construction entrance	SY	155	\$ 20.00	\$ 3,100.00
7	Street cleaning	HR	32	\$ 60.00	\$ 1,920.00
8	High visibility fence	LF	1110	\$ 3.50	\$ 3,885.00
9	Removal of structures & obstructions	LS	1	\$ 2,000.00	\$ 2,000.00
10	Irrigation system	LS	1	\$ 5,000.00	\$ 5,000.00
11	Seeded lawn installation	SY	5100	\$ 1.50	\$ 7,650.00
12	Topsoil Type C	AC	1.1	\$ 8,000.00	\$ 8,800.00
13	Site restoration	LS	1	\$ 1,000.00	\$ 1,000.00
14	Clearing & grubbing	LS	1	\$ 2,500.00	\$ 2,500.00
15	Roadway excavation including haul	CY	7750	\$ 6.00	\$ 46,500.00
16	Unsuitable foundation excavation including haul	CY	1000	\$ 8.00	\$ 8,000.00
17	Cement concrete curb & gutter	LF	45	\$ 35.00	\$ 1,575.00
18	Cement concrete sidewalk, 4"	SY	20	\$ 45.00	\$ 900.00
19	Asphalt patching (2" HMA & 4" CSTC)	SY	100	\$ 85.00	\$ 8,500.00
20	Trench safety	LF	201	\$ 2.00	\$ 402.00
21	Pipe bedding	LF	201	\$ 2.00	\$ 402.00
22	Underground utility crossings - marked & unmarked	EA	10	\$ 150.00	\$ 1,500.00
23	Solid wall PVC storm sewer pipe 10" diameter	LF	130	\$ 18.00	\$ 2,340.00
24	Trash gate 10" diameter	EA	1	\$ 300.00	\$ 300.00
25	Trash gate 12" diameter	EA	1	\$ 350.00	\$ 350.00
26	Manhole 54" diameter Type - City Storm	EA	1	\$ 8,000.00	\$ 8,000.00
27	Storm drain splitter box	EA	1	\$ 15,000.00	\$ 15,000.00
28	Flapper valve 10" diameter	EA	1	\$ 500.00	\$ 500.00
29	Quarry spalls	CY	5	\$ 80.00	\$ 400.00
30	Solid wall PVC storm sewer pipe 12" diameter	LF	71	\$ 20.00	\$ 1,420.00
Construction Subtotal					\$ 149,334.00
Construction Management (10%)					\$ 14,933.40
WA State Sales Tax (8.6%)					\$ 12,842.72
Subtotal					\$ 177,110.12
Contingency (20%)					\$ 35,422.02
Total					\$ 212,532.15
Note: Description of Item, Unit, Estimated Quantity, and Unit Price taken from Leslie Groves Regional Infiltration Facility bid tabulation (SB# 14-08 PW). Total cost has been revised to include Construction Management (10%), WA State Sales Tax (8.6%), and a Contingency (20%).					

PROPOSED SOLUTION FIGURES / DETAILS





Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1A
Project Location: 51 Drywells distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

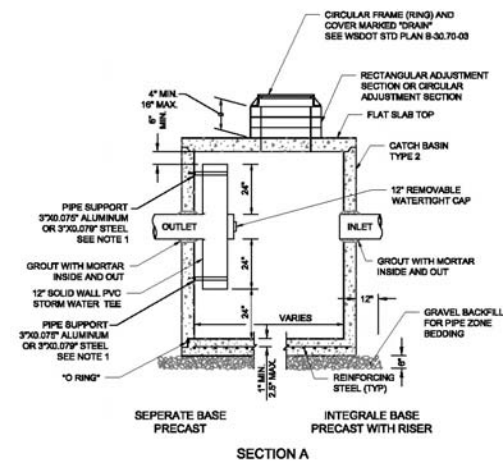
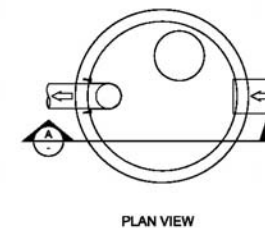
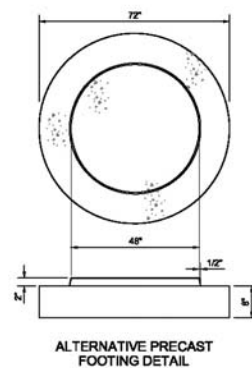
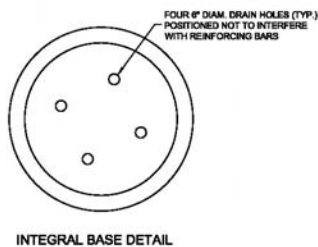
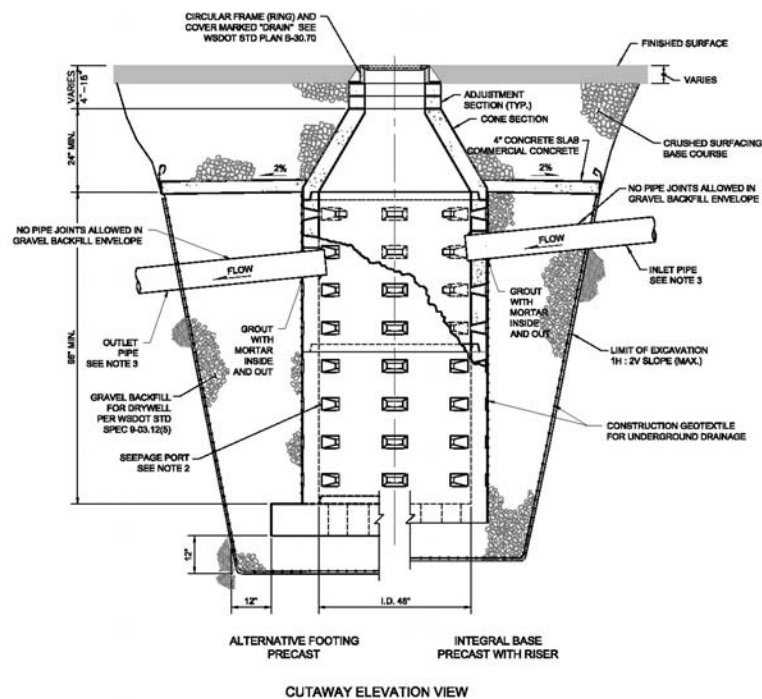
PROPOSED SOLUTION

Install 51 drywells distributed throughout the drainage basin to provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1A Drywells				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Per Drywell				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Structure Excavation Class B Incl. Haul	CY	27.0	\$ 20.00	\$ 540.48
4	Crushed Surfacing Base Course	TON	83.3	\$ 20.00	\$ 1,666.67
5	Crushed Surfacing Top Course	TON	55.6	\$ 25.00	\$ 1,388.89
6	HMA Cl. 1/2-Inch PG 64-28	TON	76.7	\$ 80.00	\$ 6,133.33
7	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	40.0	\$ 40.00	\$ 1,600.00
8	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
9	Precast Concrete Drywell	EA	1	\$ 6,000.00	\$ 6,000.00
10	Connection to Drainage Structure	EA	3	\$ 1,000.00	\$ 3,000.00
11	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
12	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
13	Gravel Backfill for Pipe Zone Bedding	TON	15.6	\$ 25.00	\$ 388.89
14	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Per Drywell Subtotal				\$ 29,418.26
	Total Drywells	EA	51	\$ 29,418.26	\$ 1,500,331.07
	Construction Subtotal				\$ 1,500,331.07
	Design Preparation (10%)				\$ 150,033.11
	Construction Management (10%)				\$ 150,033.11
	WA State Sales Tax (8.6%)				\$ 129,028.47
	Subtotal				\$ 1,929,425.76
	Pre-Design Contingency (20%)				\$ 385,885.15
	Total				\$ 2,315,310.91

PROPOSED SOLUTION FIGURES / DETAILS



- NOTES**
1. ATTACH THE PIPE SUPPORTS TO THE MANHOLE WITH 5/8" STAINLESS STEEL EXPANSION BOLTS OR EMBED THE SUPPORTS INTO THE MANHOLE WALL 2".
 2. THE FRAME SHALL BE OFFSET SO THAT THE CLIMB-DOWN SPACE IS CLEAR OF THE RISER.

SEDIMENTATION MANHOLE DETAIL
SCALE: NTS

- NOTES**
1. PRECAST CONCRETE CONE SECTIONS MAY BE ECCENTRIC OR CONCENTRIC.
 2. SEEPAGE PORT ORIENTATION VARIES AMONG MANUFACTURERS.
 3. CONNECT INLET AND OUTLET PIPES TO STRUCTURE USING PRECAST HOLE OR CORE DRILLED HOLE.
 4. FOR DEPTHS OVER 12'-2" USE 12"x24" ALTERNATIVE PRECAST FOOTING.
 5. WHEN NECESSARY, KNUCKOUTS ON PRECAST CONE, DRYWELL BASE AND RISER SECTIONS SHALL HAVE A WALL THICKNESS OF 1'-12" MINIMUM AND 2" MAXIMUM.

DRYWELL DETAIL

SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1B
Project Location: 32 Infiltration Trenches distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

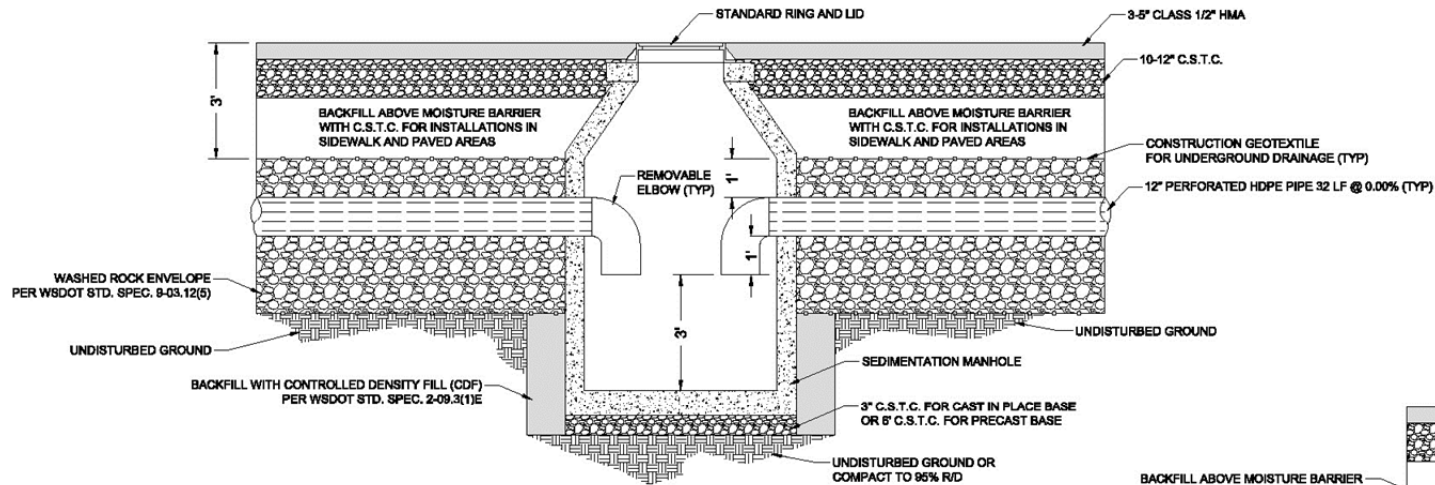
PROPOSED SOLUTION

Install 32 infiltration trenches distributed throughout the drainage basin to provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

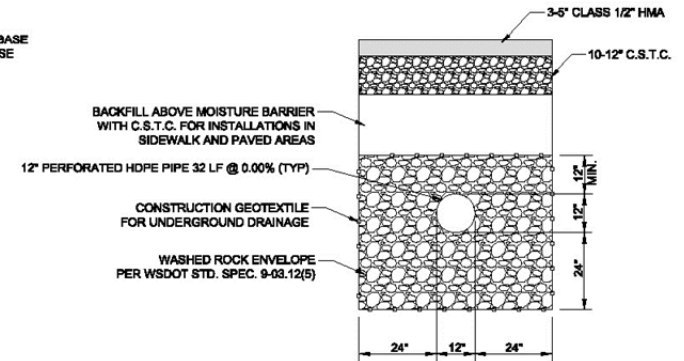
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1B Infiltration Trenches				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Per Infiltration Trench				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Structure Excavation Class B Incl. Haul	CY	16.7	\$ 20.00	\$ 333.07
4	Crushed Surfacing Base Course	TON	83.3	\$ 20.00	\$ 1,666.67
5	Crushed Surfacing Top Course	TON	55.6	\$ 25.00	\$ 1,388.89
6	HMA Cl. 1/2-Inch PG 64-28	TON	76.7	\$ 80.00	\$ 6,133.33
7	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	20.0	\$ 40.00	\$ 800.00
8	Underdrain Pipe, 12 In. Diam.	LF	64	\$ 30.00	\$ 1,920.00
9	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
10	Connection to Drainage Structure	EA	3	\$ 1,000.00	\$ 3,000.00
11	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
12	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
13	Geotextile for Underground Drainage	SY	137	\$ 2.50	\$ 342.22
14	Gravel Backfill for Pipe Zone Bedding	TON	7.8	\$ 25.00	\$ 194.44
15	Gravel Backfill for Drain	CY	47	\$ 50.00	\$ 2,370.37
16	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Per Infiltration Trench Subtotal				\$ 26,849.00
	Total Infiltration Trenches	EA	32	\$ 26,849.00	\$ 859,167.91
	Construction Subtotal				\$ 859,167.91
	Design Preparation (10%)				\$ 85,916.79
	Construction Management (10%)				\$ 85,916.79
	WA State Sales Tax (8.6%)				\$ 73,888.44
	Subtotal				\$ 1,104,889.93
	Pre-Design Contingency (20%)				\$ 220,977.99
	Total				\$ 1,325,867.91

PROPOSED SOLUTION FIGURES / DETAILS



INFILTRATION TRENCH DETAIL
SCALE: NTS



INFILTRATION TRENCH TYPICAL SECTION
SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1C

Project Location: 189 Pairs of "Bump-Out" Bioretention Facilities distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

PROPOSED SOLUTION

Install 189 pairs of "Bump-Out" bioretention facilities distributed throughout the drainage basin to provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

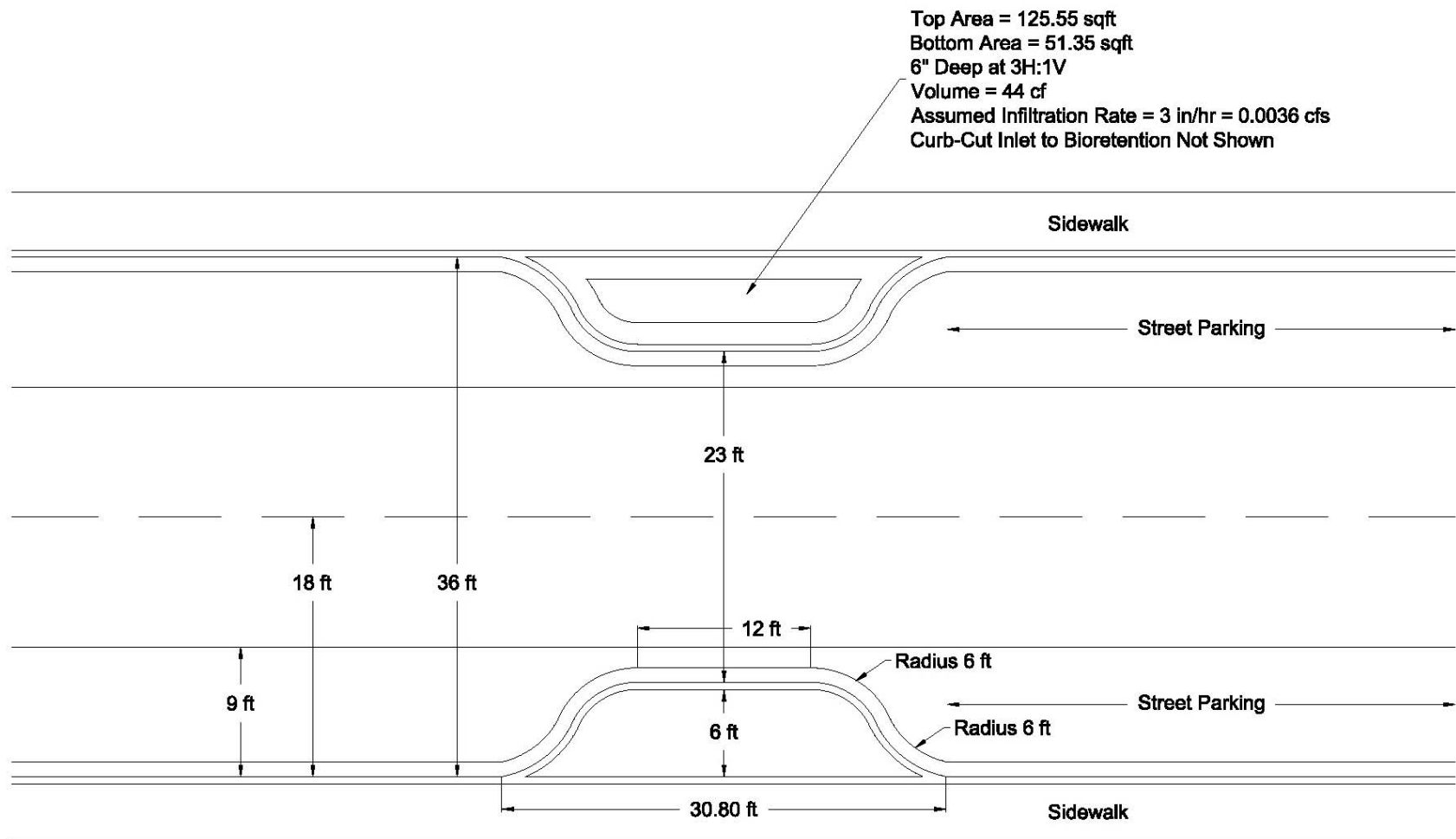
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1C "Bump-Out" Bioretention				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Per "Bump-Out" Bioretention Pair				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 2,000.00	\$ 2,000.00
4	Bioretention Facilities	LS	1	\$ 5,000.00	\$ 5,000.00
5	Curb and Gutter	LF	80	\$ 25.00	\$ 2,000.00
6	Standing Curb	LF	60	\$ 20.00	\$ 1,200.00
7	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
8	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
9	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Per "Bump-Out" Bioretention Pair Subtotal				\$ 15,400.00
	Total "Bump-Out" Bioretention Pairs	EA	189	\$ 15,400.00	\$ 2,910,600.00
	Construction Subtotal				\$ 2,910,600.00
	Design Preparation (10%)				\$ 291,060.00
	Construction Management (10%)				\$ 291,060.00
	WA State Sales Tax (8.6%)				\$ 250,311.60
	Subtotal				\$ 3,743,031.60
	Pre-Design Contingency (20%)				\$ 748,606.32
	Total				\$ 4,491,637.92

Notes:

- Bioretention Facilities includes excavation, grading, soil mix, irrigation, landscaping cover, and planting.

PROPOSED SOLUTION FIGURES / DETAILS



"BUMP-OUT" BIORETENTION DETAIL

SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1D
Project Location: 61 Pairs of "Linear" Bioretention Facilities distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

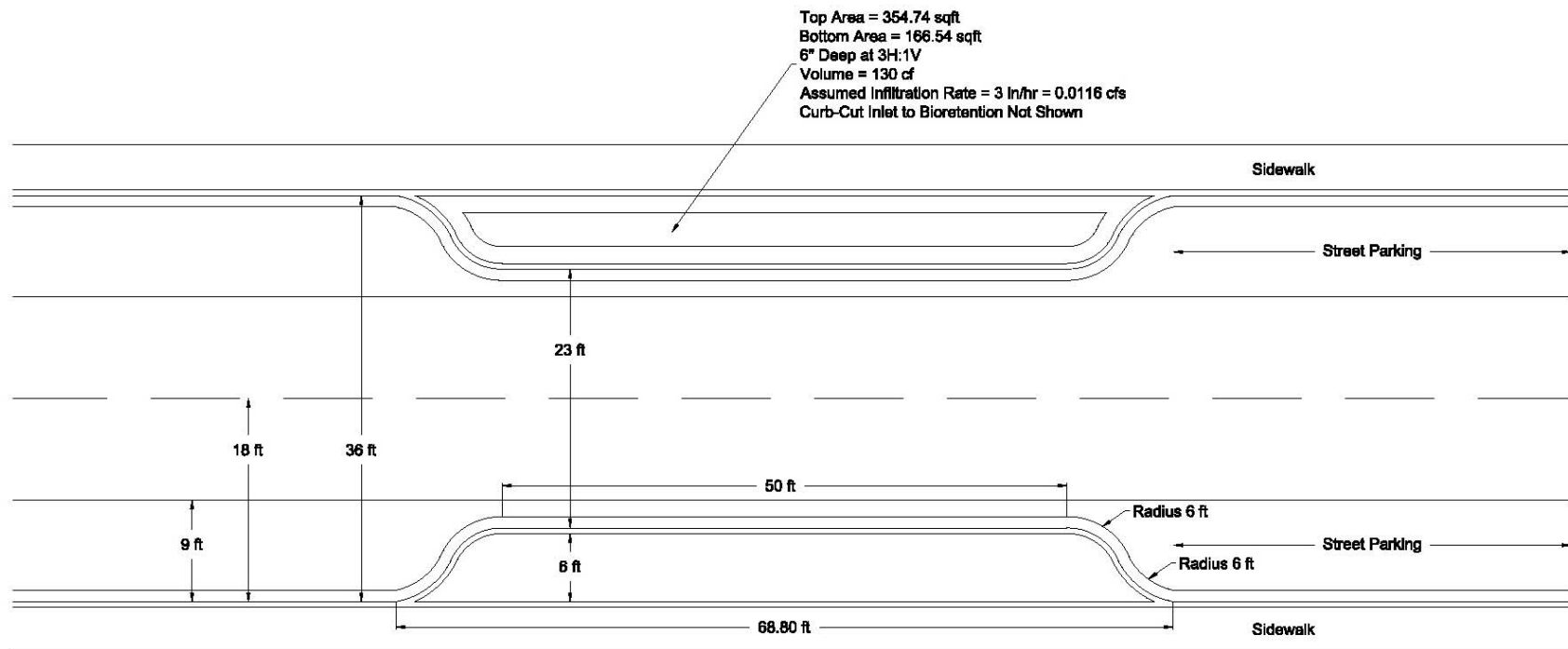
PROPOSED SOLUTION

Install 61 pairs of "Linear" bioretention facilities distributed throughout the drainage basin to provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1D "Linear" Bioretention				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Per "Linear" Bioretention Pair				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 6,000.00	\$ 6,000.00
4	Bioretention Facilities	LS	1	\$ 12,000.00	\$ 12,000.00
5	Curb and Gutter	LF	150	\$ 25.00	\$ 3,750.00
6	Standing Curb	LF	140	\$ 20.00	\$ 2,800.00
7	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
8	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
9	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Per "Linear" Bioretention Pair Subtotal				\$ 29,750.00
	Total "Linear" Bioretention Pairs	EA	61	\$ 29,750.00	\$ 1,814,750.00
	Construction Subtotal				\$ 1,814,750.00
	Design Preparation (10%)				\$ 181,475.00
	Construction Management (10%)				\$ 181,475.00
	WA State Sales Tax (8.6%)				\$ 156,068.50
	Subtotal				\$ 2,333,768.50
	Pre-Design Contingency (20%)				\$ 466,753.70
	Total				\$ 2,800,522.20
Notes: • Bioretention Facilities includes excavation, grading, soil mix, irrigation, landscaping cover, and planting.					

PROPOSED SOLUTION FIGURES / DETAILS



"LINEAR" BIORETENTION DETAIL

SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1E
Project Location: 224 – 18" Contech StormFilter Cartridges and 30' x 45' Conspan Vault near outfall.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

PROPOSED SOLUTION

Install 224 – 18" Contech StormFilter Cartridges inside a 30' x 45' Conspan Vault located near the outfall to provide treatment for the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1E Contech StormFilter System				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 5,000.00	\$ 5,000.00
2	Project Temporary Traffic Control	LS	1	\$ 2,500.00	\$ 2,500.00
3	Structure Excavation Class B Incl. Haul	CY	650	\$ 10.00	\$ 6,500.00
4	Shoring or Extra Excavation Class A	LS	1	\$ 5,000.00	\$ 5,000.00
5	Cement Concrete Foundation, 30' x 45'	LS	1	\$ 25,000.00	\$ 25,000.00
6	224 - 18" Contech StormFilter Cartridges and 30' x 45' Conspan Arches	LS	1	\$ 450,000.00	\$ 450,000.00
7	Gravel Backfill for Pipe Zone Bedding	TON	250	\$ 25.00	\$ 6,250.00
8	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
9	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
10	Roadside Restoration	LS	1	\$ 3,000.00	\$ 3,000.00
11	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Construction Subtotal				\$ 509,450.00
	Design Preparation (10%)				\$ 50,945.00
	Construction Management (10%)				\$ 50,945.00
	WA State Sales Tax (8.6%)				\$ 43,812.70
	Subtotal				\$ 655,152.70
	Pre-Design Contingency (20%)				\$ 131,030.54
	Total				\$ 786,183.24

PROPOSED SOLUTION FIGURES / DETAILS





Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1F
Project Location: Saint St and Harris Ave in Leslie Groves Park

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

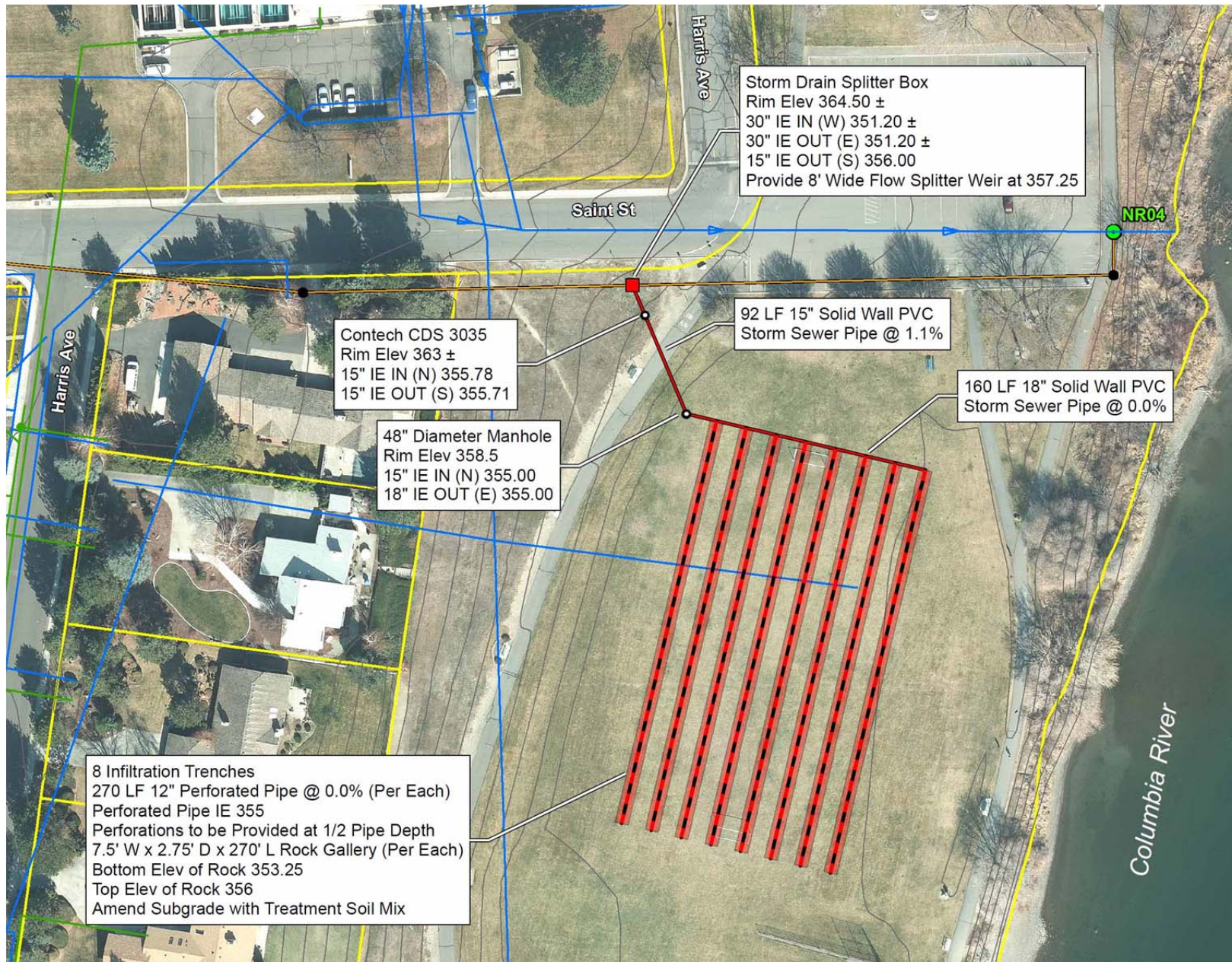
PROPOSED SOLUTION

Install a Contech CDS unit and 8 parallel infiltration trenches located underneath the existing soccer field within Leslie Groves Park to provide treatment for the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1F Leslie Groves Park Soccer Field Infiltration Trench				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 5,000.00	\$ 5,000.00
2	Project Temporary Traffic Control	LS	1	\$ 2,500.00	\$ 2,500.00
3	Structure Excavation Class B Incl. Haul	CY	3,816	\$ 10.00	\$ 38,156.08
4	Shoring or Extra Excavation Class A	LS	1	\$ 5,000.00	\$ 5,000.00
5	Removal of Structure and Obstruction	LS	1	\$ 1,000.00	\$ 1,000.00
6	Solid Wall PVC Storm Sewer Pipe 15 In. Diam.	LF	92	\$ 40.00	\$ 3,680.00
7	Solid Wall PVC Storm Sewer Pipe 18 In. Diam.	LF	160	\$ 50.00	\$ 8,000.00
8	Underdrain Pipe, 12 In. Diam.	LF	2,160	\$ 30.00	\$ 64,800.00
9	Manhole 48 In. Diam.	EA	1	\$ 3,000.00	\$ 3,000.00
10	Contech CDS 3035	EA	1	\$ 30,000.00	\$ 30,000.00
11	Storm Drain Splitter Box	EA	1	\$ 15,000.00	\$ 15,000.00
12	ESC Lead	DAY	3	\$ 100.00	\$ 300.00
13	Erosion and Water Pollution Control	FA	EST	\$ 3,000.00	\$ 3,000.00
14	Roadside Restoration	LS	1	\$ 10,000.00	\$ 10,000.00
15	Gravel Backfill for Pipe Zone Bedding	TON	132	\$ 25.00	\$ 3,300.35
16	Gravel Backfill for Infiltration Trench	TON	2,381	\$ 30.00	\$ 71,422.57
17	Amended Treatment Soil Mix	CY	900	\$ 20.00	\$ 18,000.00
18	Geotextile for Underground Drainage	SY	4,957	\$ 2.50	\$ 12,391.67
19	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
Construction Subtotal					\$ 299,550.66
Design Preparation (10%)					\$ 29,955.07
Construction Management (10%)					\$ 29,955.07
WA State Sales Tax (8.6%)					\$ 25,761.36
Subtotal					\$ 385,222.14
Pre-Design Contingency (20%)					\$ 77,044.43
Total					\$ 462,266.57

PROPOSED SOLUTION FIGURES / DETAILS





Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 1G
Project Location: Saint St and Harris Ave west of Water Treatment Plant

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

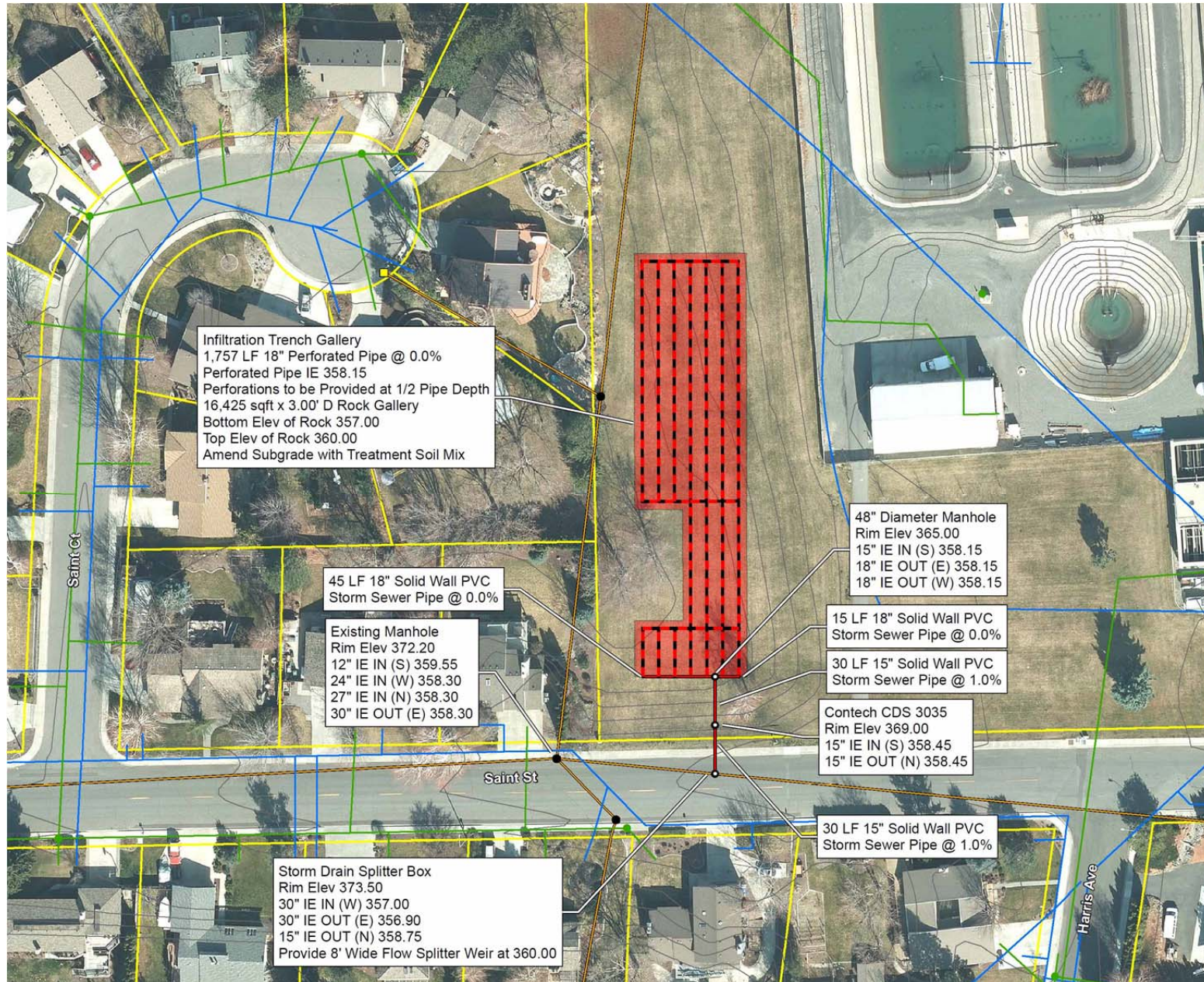
PROPOSED SOLUTION

Install a Contech CDS unit and a infiltration trench gallery located underneath the existing grassed area west of the Water Treatment Plant to provide treatment for the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 1G Leslie Groves Regional Infiltration Trench				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 5,000.00	\$ 5,000.00
2	Project Temporary Traffic Control	LS	1	\$ 2,500.00	\$ 2,500.00
3	Structure Excavation Class B Incl. Haul	CY	6,210	\$ 10.00	\$ 62,096.82
4	Shoring or Extra Excavation Class A	LS	1	\$ 5,000.00	\$ 5,000.00
5	Removal of Structure and Obstruction	LS	1	\$ 1,000.00	\$ 1,000.00
6	Solid Wall PVC Storm Sewer Pipe 15 In. Diam.	LF	60	\$ 40.00	\$ 2,400.00
7	Solid Wall PVC Storm Sewer Pipe 18 In. Diam.	LF	60	\$ 50.00	\$ 3,000.00
8	Underdrain Pipe, 12 In. Diam.	LF	1,757	\$ 30.00	\$ 52,710.00
9	Manhole 48 In. Diam.	EA	1	\$ 3,000.00	\$ 3,000.00
10	Contech CDS 3035	EA	1	\$ 30,000.00	\$ 30,000.00
11	Storm Drain Splitter Box	EA	1	\$ 15,000.00	\$ 15,000.00
12	ESC Lead	DAY	3	\$ 100.00	\$ 300.00
13	Erosion and Water Pollution Control	FA	EST	\$ 3,000.00	\$ 3,000.00
14	Roadside Restoration	LS	1	\$ 10,000.00	\$ 10,000.00
15	Gravel Backfill for Pipe Zone Bedding	TON	61	\$ 25.00	\$ 1,536.46
16	Gravel Backfill for Infiltration Trench	TON	2,661	\$ 30.00	\$ 79,825.09
17	Amended Treatment Soil Mix	CY	913	\$ 20.00	\$ 18,250.00
18	Geotextile for Underground Drainage	SY	3,890	\$ 2.50	\$ 9,725.00
19	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Construction Subtotal				\$ 309,343.37
	Design Preparation (10%)				\$ 30,934.34
	Construction Management (10%)				\$ 30,934.34
	WA State Sales Tax (8.6%)				\$ 26,603.53
	Subtotal				\$ 397,815.57
	Pre-Design Contingency (20%)				\$ 79,563.11
	Total				\$ 477,378.68

PROPOSED SOLUTION FIGURES / DETAILS





Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 2A

Project Location: Snyder St and Harris Ave as well as 31 Drywells distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

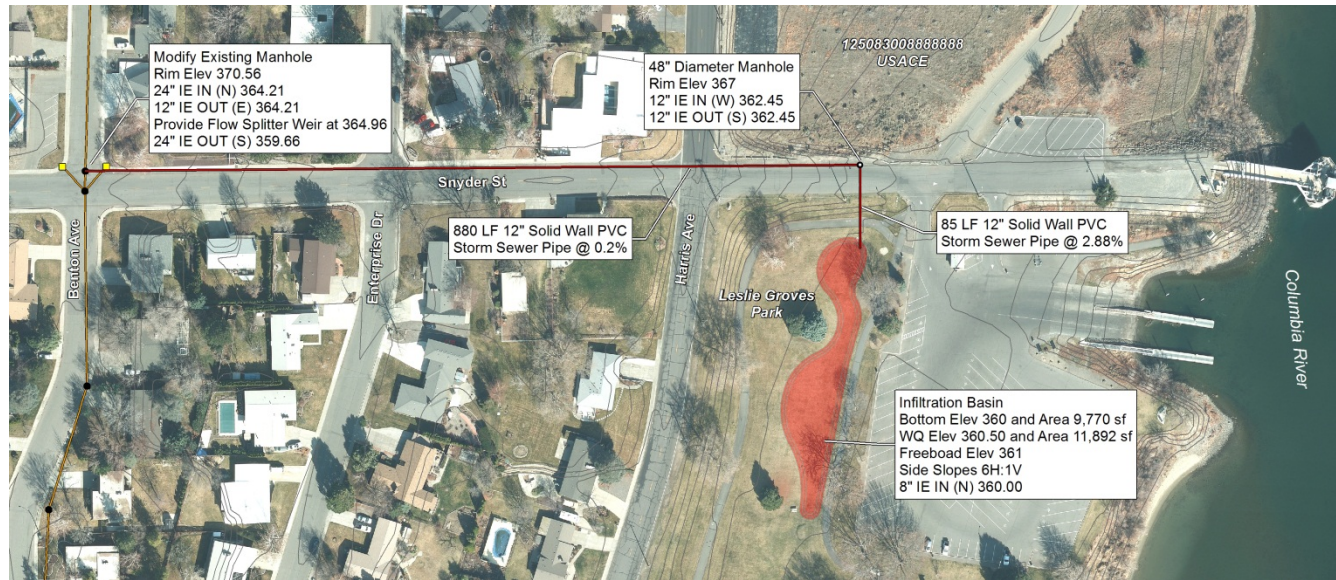
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a small regional infiltration facility located at the north end of Leslie Groves Park **AND** install 31 drywells distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

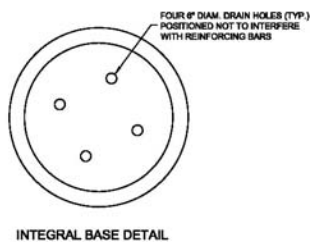
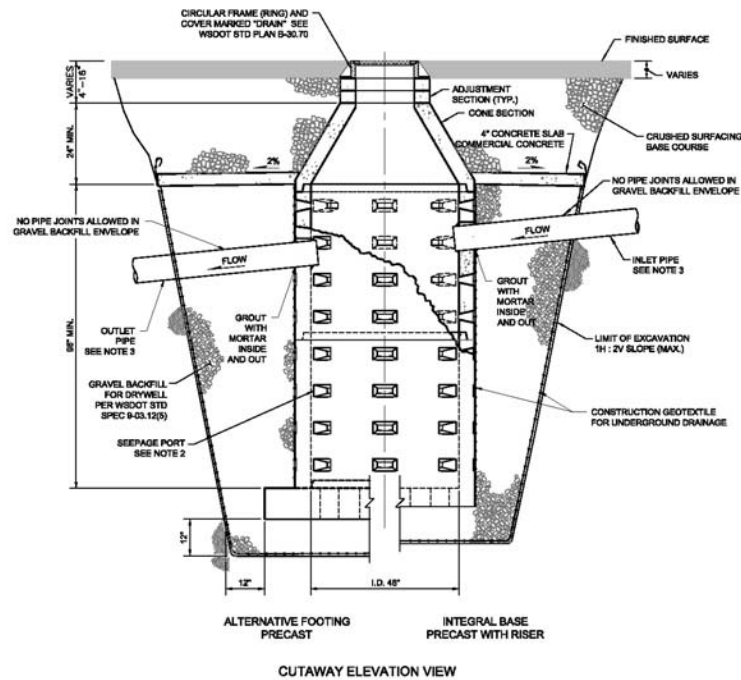
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 2A Snyder St Infil. Facility and Drywells				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Infiltration Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,132.9	\$ 10.00	\$ 21,328.57
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	160.8	\$ 20.00	\$ 3,216.67
6	Crushed Surfacing Top Course	TON	107.2	\$ 25.00	\$ 2,680.56
7	HMA Cl. 1/2-Inch PG 64-28	TON	148.0	\$ 80.00	\$ 11,837.33
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	965.0	\$ 40.00	\$ 38,600.00
9	Infiltration Facility	LS	1	\$ 15,000.00	\$ 15,000.00
10	Manhole 48 In. Diam. Type 3	EA	1	\$ 3,000.00	\$ 3,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	1,333.3	\$ 2.50	\$ 3,333.33
16	Gravel Backfill for Pipe Zone Bedding	TON	375.3	\$ 25.00	\$ 9,381.94
17	Energy Dissipation	LS	1	\$ 3,000.00	\$ 3,000.00
18	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 372,878.41
	Per Drywell				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Structure Excavation Class B Incl. Haul	CY	27.0	\$ 20.00	\$ 540.48
4	Crushed Surfacing Base Course	TON	83.3	\$ 20.00	\$ 1,666.67
5	Crushed Surfacing Top Course	TON	55.6	\$ 25.00	\$ 1,388.89
6	HMA Cl. 1/2-Inch PG 64-28	TON	76.7	\$ 80.00	\$ 6,133.33
7	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	40.0	\$ 40.00	\$ 1,600.00
8	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
9	Precast Concrete Drywell	EA	1	\$ 6,000.00	\$ 6,000.00
10	Connection to Drainage Structure	EA	3	\$ 1,000.00	\$ 3,000.00
11	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
12	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
13	Gravel Backfill for Pipe Zone Bedding	TON	15.6	\$ 25.00	\$ 388.89
14	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 29,418.26
	Total Drywells	EA	31	\$ 29,418.26	\$ 911,965.95
	Construction Subtotal				\$ 1,284,844.35
	Design Preparation (10%)				\$ 128,484.44
	Construction Management (10%)				\$ 128,484.44
	WA State Sales Tax (8.6%)				\$ 110,496.61
	Subtotal				\$ 1,652,309.84
	Pre-Design Contingency (20%)				\$ 330,461.97
	Total				\$ 1,982,771.80
Notes: • Infiltration Facility includes excavation, grading, soil mix, and landscaping cover.					

PROPOSED SOLUTION FIGURES / DETAILS

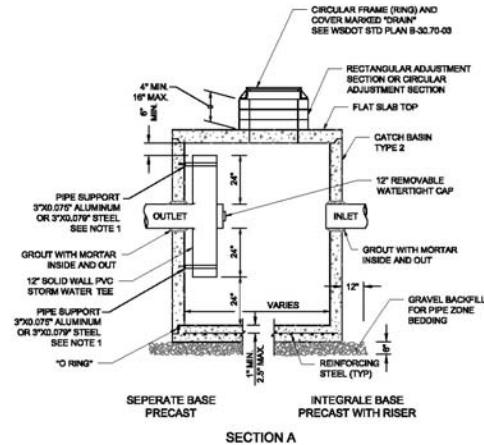
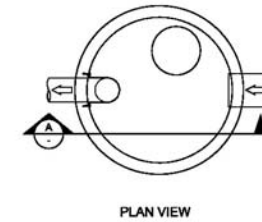
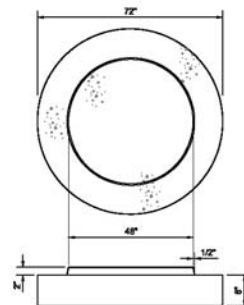


PROPOSED SOLUTION FIGURES / DETAILS



- NOTES
1. PRECAST CONCRETE CONE SECTIONS MAY BE ECCENTRIC OR CONCENTRIC.
 2. SEEPAGE PORT ORIENTATION VARIES AMONG MANUFACTURERS.
 3. CONNECT INLET AND OUTLET PIPES TO STRUCTURE USING PRECAST HOLE OR CORE DRILLED HOLE.
 4. FOR DEPTHS OVER 18'-2" USE 72"x9" ALTERNATIVE PRECAST FOOTING.
 5. WHEN NECESSARY, KNOCKOUTS ON PRECAST CONE, DRYWELL BASE AND RISER SECTIONS SHALL HAVE A WALL THICKNESS OF 1-1/2" MINIMUM AND 2" MAXIMUM.

DRYWELL DETAIL
SCALE: NTS



NOTES

1. ATTACH THE PIPE SUPPORTS TO THE MANHOLE WITH 1/2" STAINLESS STEEL EXPANSION BOLTS OR EMBED THE SUPPORTS INTO THE MANHOLE WALL 2".
2. THE FRAME SHALL BE OFFSET SO THAT THE CLIMB-DOWN SPACE IS CLEAR OF THE RISER.

SEDIMENTATION MANHOLE DETAIL

SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 2B
Project Location: Snyder St and Harris Ave as well as 20 Infiltration Trenches distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

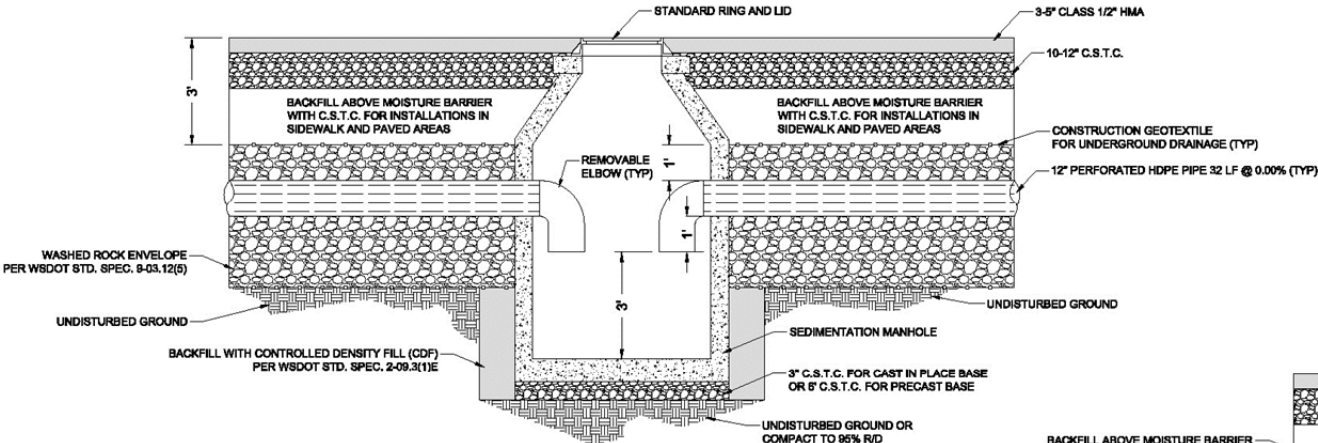
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a small regional infiltration facility located at the north end of Leslie Groves Park **AND** install 20 infiltration trenches distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

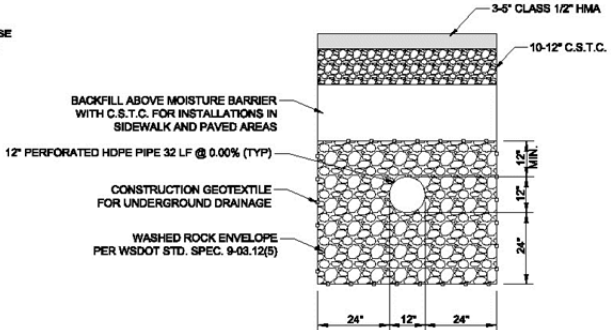
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 2B Snyder St Infil. Facility and Infiltration Trenches				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Infiltration Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,132.9	\$ 10.00	\$ 21,328.57
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	160.8	\$ 20.00	\$ 3,216.67
6	Crushed Surfacing Top Course	TON	107.2	\$ 25.00	\$ 2,680.56
7	HMA Cl. 1/2-Inch PG 64-28	TON	148.0	\$ 80.00	\$ 11,837.33
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	965.0	\$ 40.00	\$ 38,600.00
9	Infiltration Facility	LS	1	\$ 15,000.00	\$ 15,000.00
10	Manhole 48 In. Diam. Type 3	EA	1	\$ 3,000.00	\$ 3,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	1,333.3	\$ 2.50	\$ 3,333.33
16	Gravel Backfill for Pipe Zone Bedding	TON	375.3	\$ 25.00	\$ 9,381.94
17	Energy Dissipation	LS	1	\$ 3,000.00	\$ 3,000.00
18	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 372,878.41
	Per Infiltration Trench				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Structure Excavation Class B Incl. Haul	CY	16.7	\$ 20.00	\$ 333.07
4	Crushed Surfacing Base Course	TON	83.3	\$ 20.00	\$ 1,666.67
5	Crushed Surfacing Top Course	TON	55.6	\$ 25.00	\$ 1,388.89
6	HMA Cl. 1/2-Inch PG 64-28	TON	76.7	\$ 80.00	\$ 6,133.33
7	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	20.0	\$ 40.00	\$ 800.00
8	Underdrain Pipe, 12 In. Diam.	LF	64	\$ 30.00	\$ 1,920.00
9	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
10	Connection to Drainage Structure	EA	3	\$ 1,000.00	\$ 3,000.00
11	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
12	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
13	Geotextile for Underground Drainage	SY	137	\$ 2.50	\$ 342.22
14	Gravel Backfill for Pipe Zone Bedding	TON	7.8	\$ 25.00	\$ 194.44
15	Gravel Backfill for Drain	CY	47	\$ 50.00	\$ 2,370.37
16	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 26,849.00
	Total Infiltration Trenches	EA	20	\$ 26,849.00	\$ 536,979.94
	Construction Subtotal				\$ 909,858.35
	Design Preparation (10%)				\$ 90,985.83
	Construction Management (10%)				\$ 90,985.83
	WA State Sales Tax (8.6%)				\$ 78,247.82
	Subtotal				\$ 1,170,077.83
	Pre-Design Contingency (20%)				\$ 234,015.57
	Total				\$ 1,404,093.40
Notes: • Infiltration Facility includes excavation, grading, soil mix, and landscaping cover.					

PROPOSED SOLUTION FIGURES / DETAILS



INFILTRATION TRENCH DETAIL
SCALE: NTS



INFILTRATION TRENCH TYPICAL SECTION
SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 2C
Project Location: Snyder St and Harris Ave as well as 116 Pairs of “Bump-Out” Bioretention Facilities distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

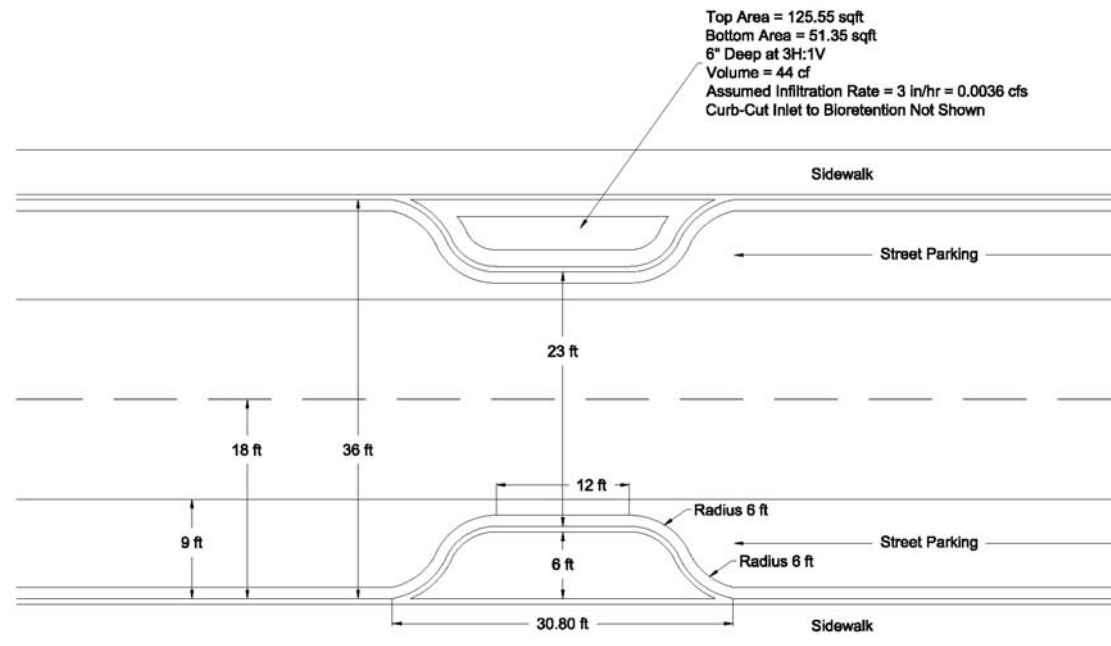
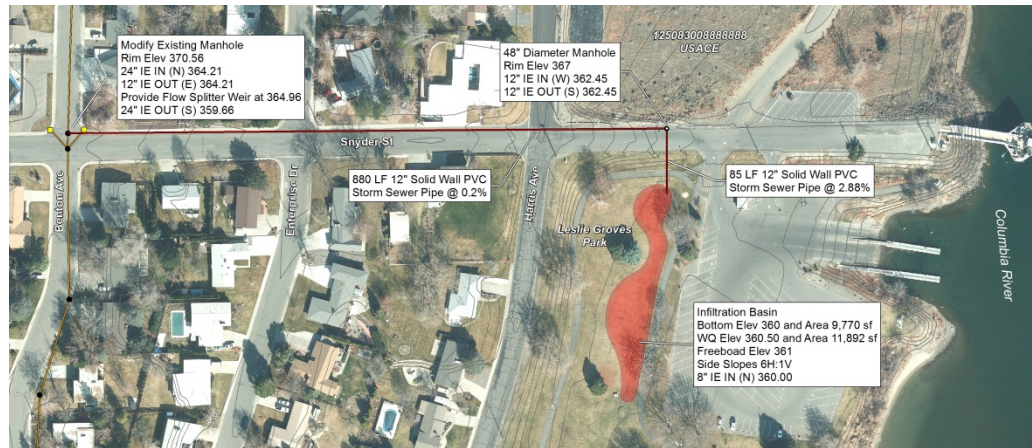
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a small regional infiltration facility located at the north end of Leslie Groves Park **AND** install 116 pairs of “Bump-Out” bioretention facilities distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 2C Snyder St Infil. Facility and "Bump-Out" Bioretention				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Infiltration Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,132.9	\$ 10.00	\$ 21,328.57
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	160.8	\$ 20.00	\$ 3,216.67
6	Crushed Surfacing Top Course	TON	107.2	\$ 25.00	\$ 2,680.56
7	HMA Cl. 1/2-Inch PG 64-28	TON	148.0	\$ 80.00	\$ 11,837.33
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	965.0	\$ 40.00	\$ 38,600.00
9	Infiltration Facility	LS	1	\$ 15,000.00	\$ 15,000.00
10	Manhole 48 In. Diam. Type 3	EA	1	\$ 3,000.00	\$ 3,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	1,333.3	\$ 2.50	\$ 3,333.33
16	Gravel Backfill for Pipe Zone Bedding	TON	375.3	\$ 25.00	\$ 9,381.94
17	Energy Dissipation	LS	1	\$ 3,000.00	\$ 3,000.00
18	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 372,878.41
	Per "Bump-Out" Bioretention Pair				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 2,000.00	\$ 2,000.00
4	Bioretention Facilities	LS	1	\$ 5,000.00	\$ 5,000.00
5	Curb and Gutter	LF	80	\$ 25.00	\$ 2,000.00
6	Standing Curb	LF	60	\$ 20.00	\$ 1,200.00
7	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
8	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
9	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 15,400.00
	Total "Bump-Out" Bioretention Pairs	EA	116	\$ 15,400.00	\$ 1,786,400.00
	Construction Subtotal				\$ 2,159,278.41
	Design Preparation (10%)				\$ 215,927.84
	Construction Management (10%)				\$ 215,927.84
	WA State Sales Tax (8.6%)				\$ 185,697.94
	Subtotal				\$ 2,776,832.03
	Pre-Design Contingency (20%)				\$ 555,366.41
	Total				\$ 3,332,198.44
Notes: • Infiltration Facility includes excavation, grading, soil mix, and landscaping cover. • Bioretention Facilities includes excavation, grading, soil mix, irrigation, landscaping cover, and planting.					

PROPOSED SOLUTION FIGURES / DETAILS



"BUMP-OUT" BIORETENTION DETAIL
SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 2D
Project Location: Snyder St and Harris Ave as well as 37 Pairs of “Linear” Bioretention Facilities distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a small regional infiltration facility located at the north end of Leslie Groves Park **AND** install 37 pairs of “Linear” bioretention facilities distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

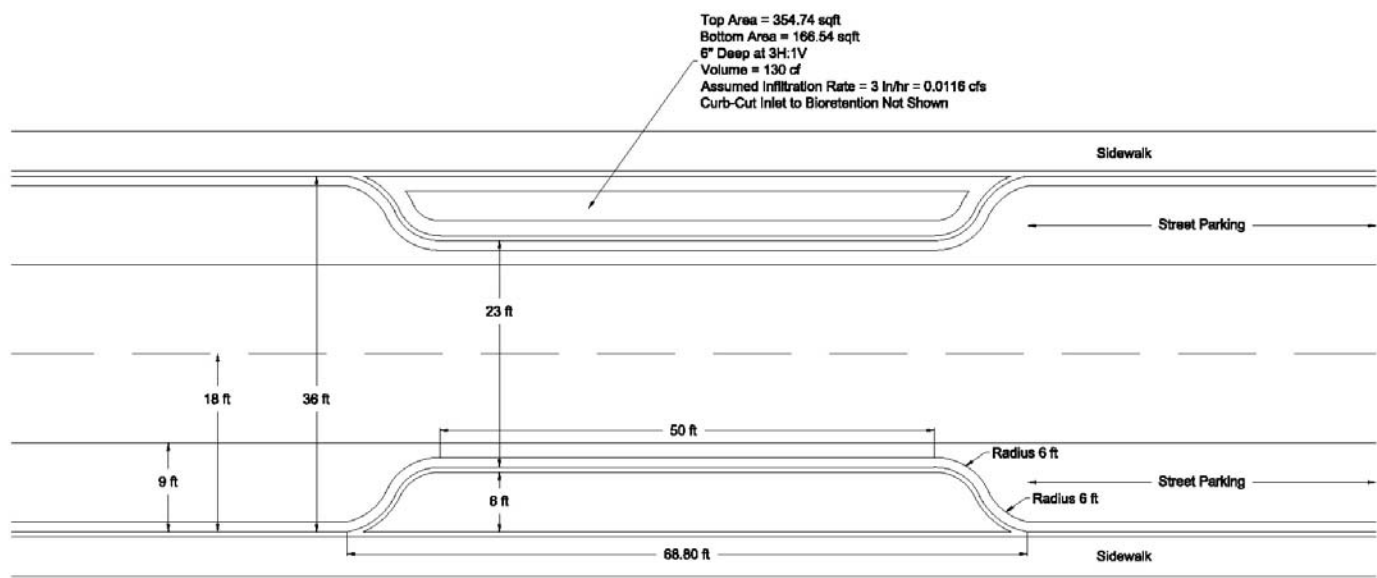
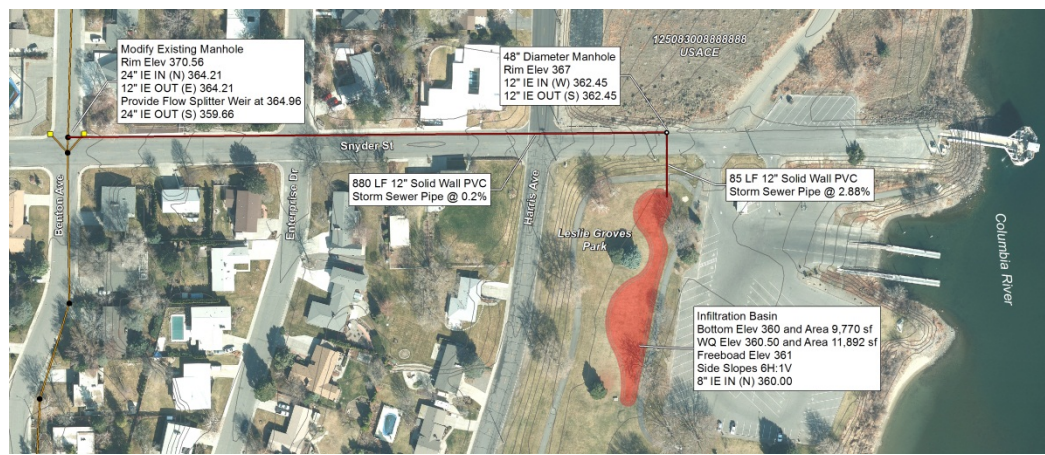
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 2D Snyder St Infil. Facility and "Linear" Bioretention				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Infiltration Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,132.9	\$ 10.00	\$ 21,328.57
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	160.8	\$ 20.00	\$ 3,216.67
6	Crushed Surfacing Top Course	TON	107.2	\$ 25.00	\$ 2,680.56
7	HMA Cl. 1/2-Inch PG 64-28	TON	148.0	\$ 80.00	\$ 11,837.33
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	965.0	\$ 40.00	\$ 38,600.00
9	Infiltration Facility	LS	1	\$ 15,000.00	\$ 15,000.00
10	Manhole 48 In. Diam. Type 3	EA	1	\$ 3,000.00	\$ 3,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	1,333.3	\$ 2.50	\$ 3,333.33
16	Gravel Backfill for Pipe Zone Bedding	TON	375.3	\$ 25.00	\$ 9,381.94
17	Energy Dissipation	LS	1	\$ 3,000.00	\$ 3,000.00
18	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 372,878.41
	Per "Linear" Bioretention Pair				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 6,000.00	\$ 6,000.00
4	Bioretention Facilities	LS	1	\$ 12,000.00	\$ 12,000.00
5	Curb and Gutter	LF	150	\$ 25.00	\$ 3,750.00
6	Standing Curb	LF	140	\$ 20.00	\$ 2,800.00
7	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
8	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
9	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 29,750.00
	Total "Linear" Bioretention Pairs	EA	37	\$ 29,750.00	\$ 1,100,750.00
	Construction Subtotal				\$ 1,473,628.41
	Design Preparation (10%)				\$ 147,362.84
	Construction Management (10%)				\$ 147,362.84
	WA State Sales Tax (8.6%)				\$ 126,732.04
	Subtotal				\$ 1,895,086.13
	Pre-Design Contingency (20%)				\$ 379,017.23
	Total				\$ 2,274,103.36

Notes:

- Infiltration Facility includes excavation, grading, soil mix, and landscaping cover.
- Bioretention Facilities includes excavation, grading, soil mix, irrigation, landscaping cover, and planting.

PROPOSED SOLUTION FIGURES / DETAILS



"LINEAR" BIORETENTION DETAIL

SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 2E
Project Location: Snyder St and Harris Ave as well as 136 – 18” Contech StormFilter Cartridges and 30’ x 30’ Conspan Vault near outfall.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

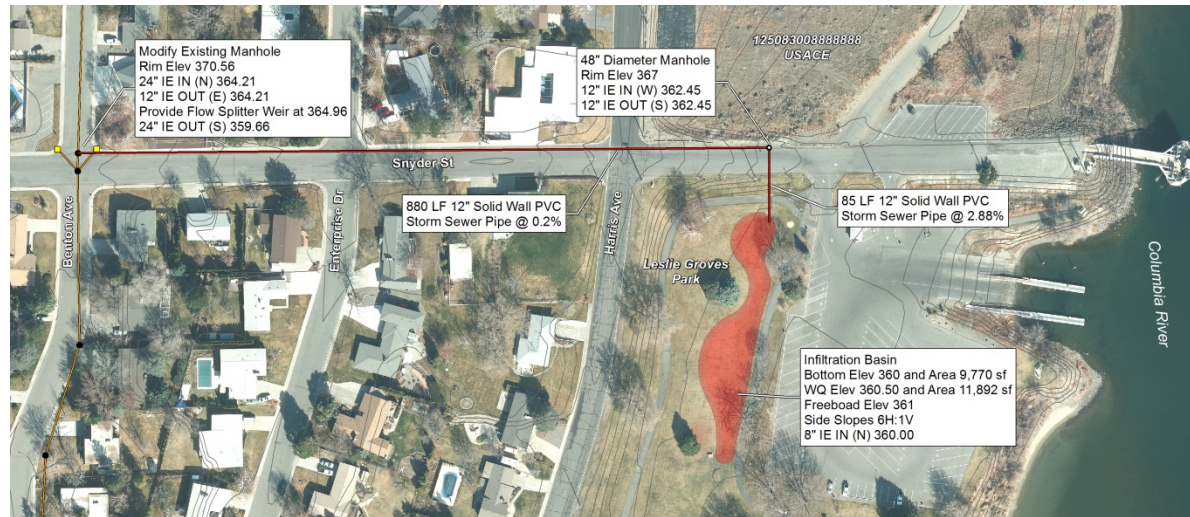
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a small regional infiltration facility located at the north end of Leslie Groves Park **AND** install 136 – 18” Contech StormFilter Cartridges inside a 30’ x 30’ Conspan Vault located near the outfall capable of treating a peak flow of 2.27 cfs from the remaining basin area. Together the facilities will provide treatment for the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 2E Snyder St Infil. Facility and Contech StormFilter System				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Infiltration Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,132.9	\$ 10.00	\$ 21,328.57
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	160.8	\$ 20.00	\$ 3,216.67
6	Crushed Surfacing Top Course	TON	107.2	\$ 25.00	\$ 2,680.56
7	HMA Cl. 1/2-Inch PG 64-28	TON	148.0	\$ 80.00	\$ 11,837.33
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	965.0	\$ 40.00	\$ 38,600.00
9	Infiltration Facility	LS	1	\$ 15,000.00	\$ 15,000.00
10	Manhole 48 In. Diam. Type 3	EA	1	\$ 3,000.00	\$ 3,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	1,333.3	\$ 2.50	\$ 3,333.33
16	Gravel Backfill for Pipe Zone Bedding	TON	375.3	\$ 25.00	\$ 9,381.94
17	Energy Dissipation	LS	1	\$ 3,000.00	\$ 3,000.00
18	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 372,878.41
	Contech StormFilter System				
1	Mobilization	LS	1	\$ 5,000.00	\$ 5,000.00
2	Project Temporary Traffic Control	LS	1	\$ 2,500.00	\$ 2,500.00
3	Structure Excavation Class B Incl. Haul	CY	460	\$ 10.00	\$ 4,600.00
4	Shoring or Extra Excavation Class A	LS	1	\$ 5,000.00	\$ 5,000.00
5	Cement Concrete Foundation, 30' x 30'	LS	1	\$ 20,000.00	\$ 20,000.00
6	136 - 18" Contech StormFilter Cartridges and 30' x 30' Conspan Vault	LS	1	\$ 300,000.00	\$ 300,000.00
7	Gravel Backfill for Pipe Zone Bedding	TON	190	\$ 25.00	\$ 4,750.00
8	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
9	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
10	Roadside Restoration	LS	1	\$ 2,000.00	\$ 2,000.00
11	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Subtotal				\$ 350,050.00
	Construction Subtotal				\$ 722,928.41
	Design Preparation (10%)				\$ 72,292.84
	Construction Management (10%)				\$ 72,292.84
	WA State Sales Tax (8.6%)				\$ 62,171.84
	Subtotal				\$ 929,685.93
	Pre-Design Contingency (20%)				\$ 185,937.19
	Total				\$ 1,115,623.12
Notes: • Infiltration Facility includes excavation, grading, soil mix, and landscaping cover.					

PROPOSED SOLUTION FIGURES / DETAILS





Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 3A

Project Location: Snyder St and Harris Ave as well as 31 Drywells distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

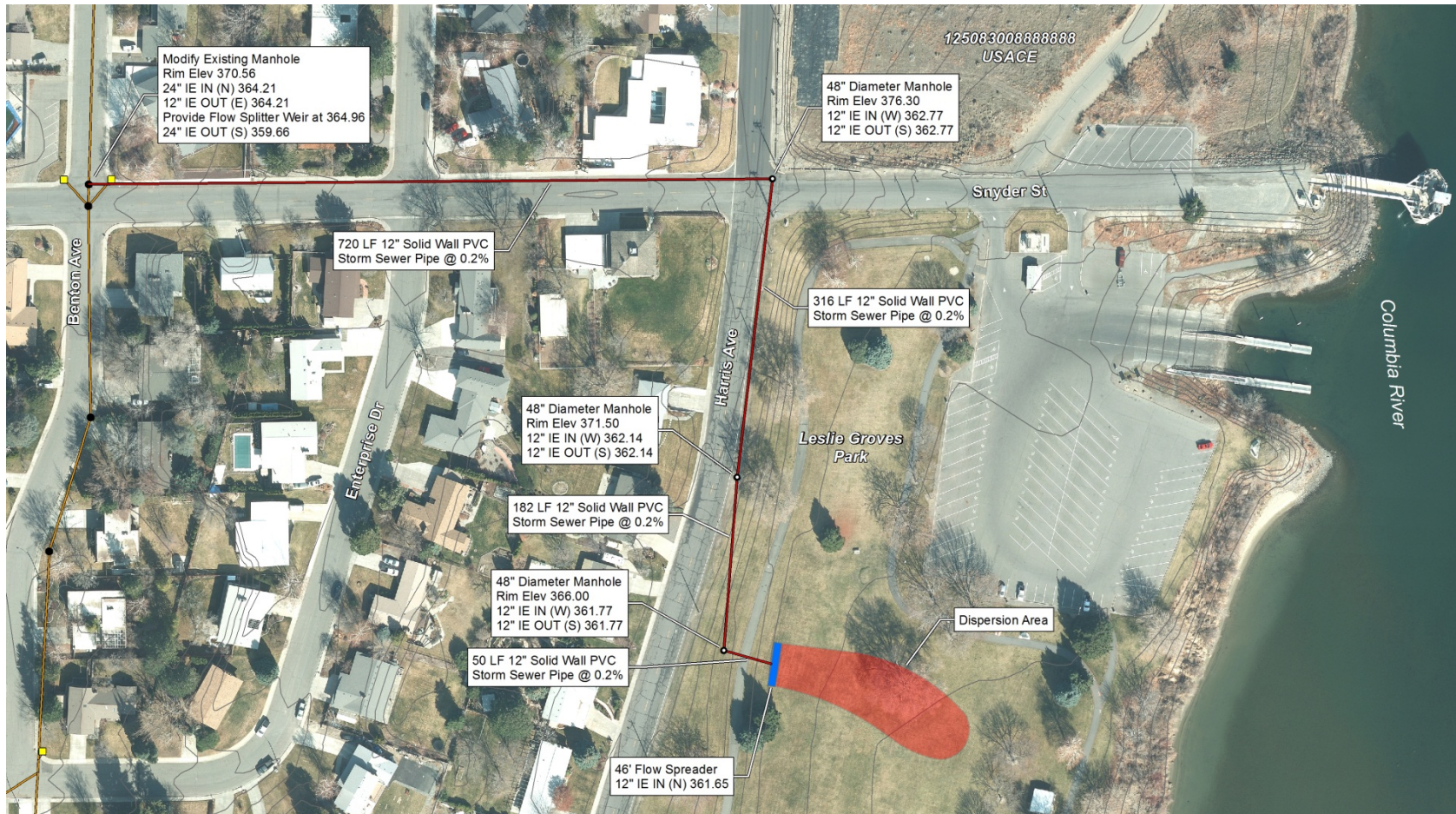
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a dispersion facility located at the north end of Leslie Groves Park **AND** install 31 drywells distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

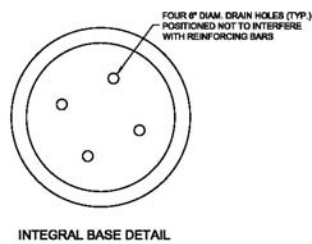
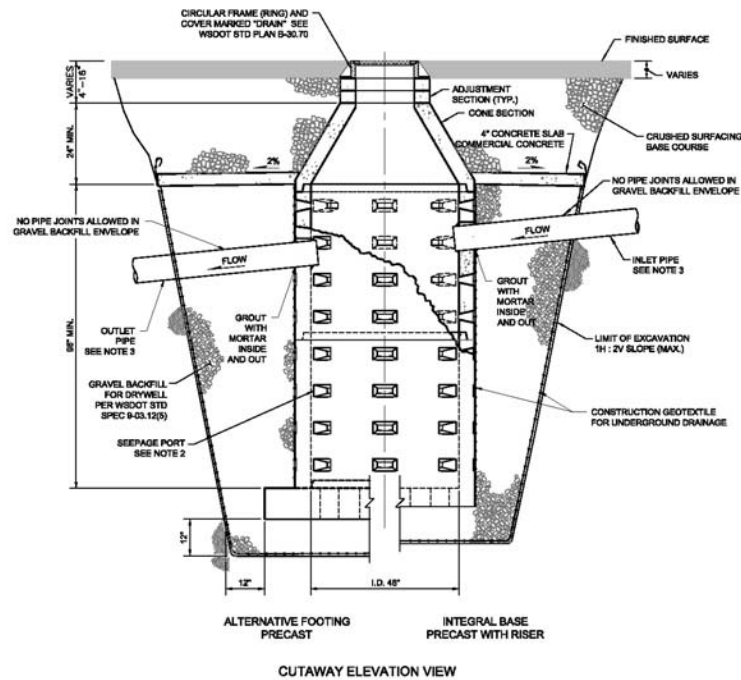
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 3A Snyder St Disp. Facility and Drywells				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Dispersion Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,813.1	\$ 10.00	\$ 28,131.46
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	172.7	\$ 20.00	\$ 3,453.33
6	Crushed Surfacing Top Course	TON	115.1	\$ 25.00	\$ 2,877.78
7	HMA Cl. 1/2-Inch PG 64-28	TON	158.9	\$ 80.00	\$ 12,708.27
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	1,268.0	\$ 40.00	\$ 50,720.00
9	Flow Spreader	LS	1	\$ 10,000.00	\$ 10,000.00
10	Manhole 48 In. Diam. Type 3	EA	3	\$ 3,000.00	\$ 9,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	70.0	\$ 2.50	\$ 175.00
16	Gravel Backfill for Pipe Zone Bedding	TON	493.1	\$ 25.00	\$ 12,327.78
17	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 390,893.61
	Per Drywell				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Structure Excavation Class B Incl. Haul	CY	27.0	\$ 20.00	\$ 540.48
4	Crushed Surfacing Base Course	TON	83.3	\$ 20.00	\$ 1,666.67
5	Crushed Surfacing Top Course	TON	55.6	\$ 25.00	\$ 1,388.89
6	HMA Cl. 1/2-Inch PG 64-28	TON	76.7	\$ 80.00	\$ 6,133.33
7	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	40.0	\$ 40.00	\$ 1,600.00
8	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
9	Precast Concrete Drywell	EA	1	\$ 6,000.00	\$ 6,000.00
10	Connection to Drainage Structure	EA	3	\$ 1,000.00	\$ 3,000.00
11	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
12	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
13	Gravel Backfill for Pipe Zone Bedding	TON	15.6	\$ 25.00	\$ 388.89
14	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 29,418.26
	Total Drywells	EA	31	\$ 29,418.26	\$ 911,965.95
	Construction Subtotal				\$ 1,302,859.56
	Design Preparation (10%)				\$ 130,285.96
	Construction Management (10%)				\$ 130,285.96
	WA State Sales Tax (8.6%)				\$ 112,045.92
	Subtotal				\$ 1,675,477.39
	Pre-Design Contingency (20%)				\$ 335,095.48
	Total				\$ 2,010,572.87

PROPOSED SOLUTION FIGURES / DETAILS

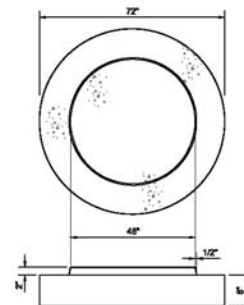


PROPOSED SOLUTION FIGURES / DETAILS

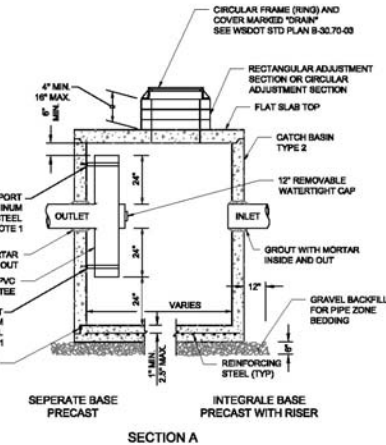
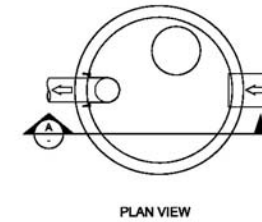


- NOTES
1. PRECAST CONCRETE CONE SECTIONS MAY BE ECCENTRIC OR CONCENTRIC.
 2. SEEPAGE PORT ORIENTATION VARIES AMONG MANUFACTURERS.
 3. CONNECT INLET AND OUTLET PIPES TO STRUCTURE USING PRECAST HOLE OR CORE DRILLED HOLE.
 4. FOR DEPTHS OVER 16'-2\"/>

DRYWELL DETAIL
SCALE: NTS



**ALTERNATIVE PRECAST
FOOTING DETAIL**



- NOTES
1. ATTACH THE PIPE SUPPORTS TO THE MANHOLE WITH 1/4\"/>

SEDIMENTATION MANHOLE DETAIL
SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 3B
Project Location: Snyder St and Harris Ave as well as 20 Infiltration Trenches distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

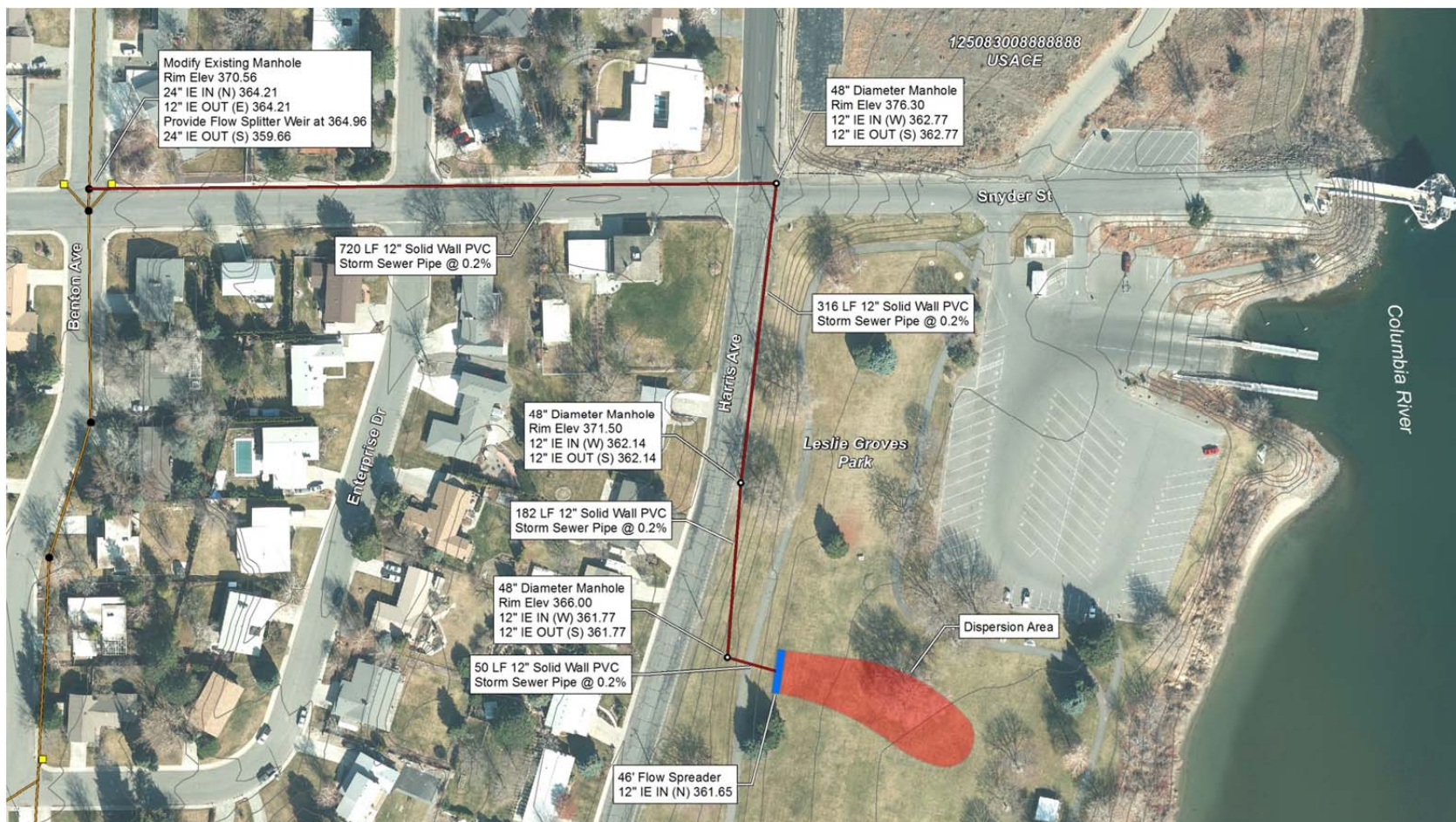
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a dispersion facility located at the north end of Leslie Groves Park **AND** install 20 infiltration trenches distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

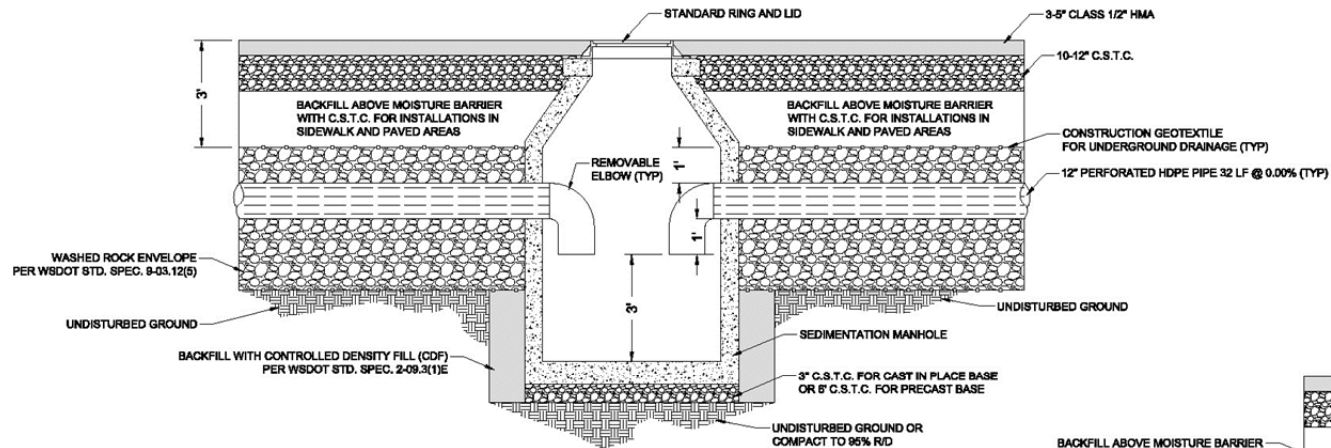
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 3B Snyder St Disp. Facility and Infiltration Trenches				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Dispersion Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,813.1	\$ 10.00	\$ 28,131.46
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	172.7	\$ 20.00	\$ 3,453.33
6	Crushed Surfacing Top Course	TON	115.1	\$ 25.00	\$ 2,877.78
7	HMA Cl. 1/2-Inch PG 64-28	TON	158.9	\$ 80.00	\$ 12,708.27
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	1,268.0	\$ 40.00	\$ 50,720.00
9	Flow Spreader	LS	1	\$ 10,000.00	\$ 10,000.00
10	Manhole 48 In. Diam. Type 3	EA	3	\$ 3,000.00	\$ 9,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	70.0	\$ 2.50	\$ 175.00
16	Gravel Backfill for Pipe Zone Bedding	TON	493.1	\$ 25.00	\$ 12,327.78
17	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 390,893.61
	Per Infiltration Trench				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Structure Excavation Class B Incl. Haul	CY	16.7	\$ 20.00	\$ 333.07
4	Crushed Surfacing Base Course	TON	83.3	\$ 20.00	\$ 1,666.67
5	Crushed Surfacing Top Course	TON	55.6	\$ 25.00	\$ 1,388.89
6	HMA Cl. 1/2-Inch PG 64-28	TON	76.7	\$ 80.00	\$ 6,133.33
7	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	20.0	\$ 40.00	\$ 800.00
8	Underdrain Pipe, 12 In. Diam.	LF	64	\$ 30.00	\$ 1,920.00
9	Sedimentation Manhole 48 In. Diam.	EA	1	\$ 3,500.00	\$ 3,500.00
10	Connection to Drainage Structure	EA	3	\$ 1,000.00	\$ 3,000.00
11	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
12	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
13	Geotextile for Underground Drainage	SY	137	\$ 2.50	\$ 342.22
14	Gravel Backfill for Pipe Zone Bedding	TON	7.8	\$ 25.00	\$ 194.44
15	Gravel Backfill for Drain	CY	47	\$ 50.00	\$ 2,370.37
16	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 26,849.00
	Total Infiltration Trenches	EA	20	\$ 26,849.00	\$ 536,979.94
	Construction Subtotal				\$ 927,873.55
	Design Preparation (10%)				\$ 92,787.36
	Construction Management (10%)				\$ 92,787.36
	WA State Sales Tax (8.6%)				\$ 79,797.13
	Subtotal				\$ 1,193,245.39
	Pre-Design Contingency (20%)				\$ 238,649.08
	Total				\$ 1,431,894.47

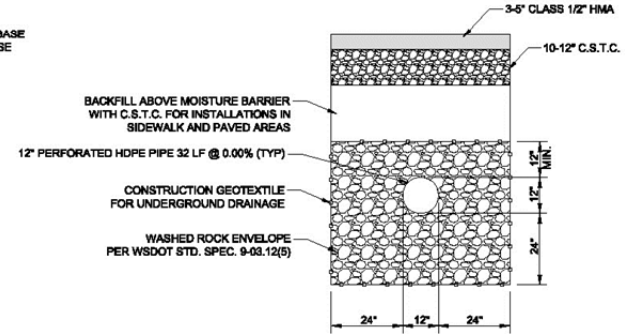
PROPOSED SOLUTION FIGURES / DETAILS



PROPOSED SOLUTION FIGURES / DETAILS



INFILTRATION TRENCH DETAIL
SCALE: NTS



INFILTRATION TRENCH TYPICAL SECTION
SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 3C
Project Location: Snyder St and Harris Ave as well as 116 Pairs of “Bump-Out” Bioretention Facilities distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

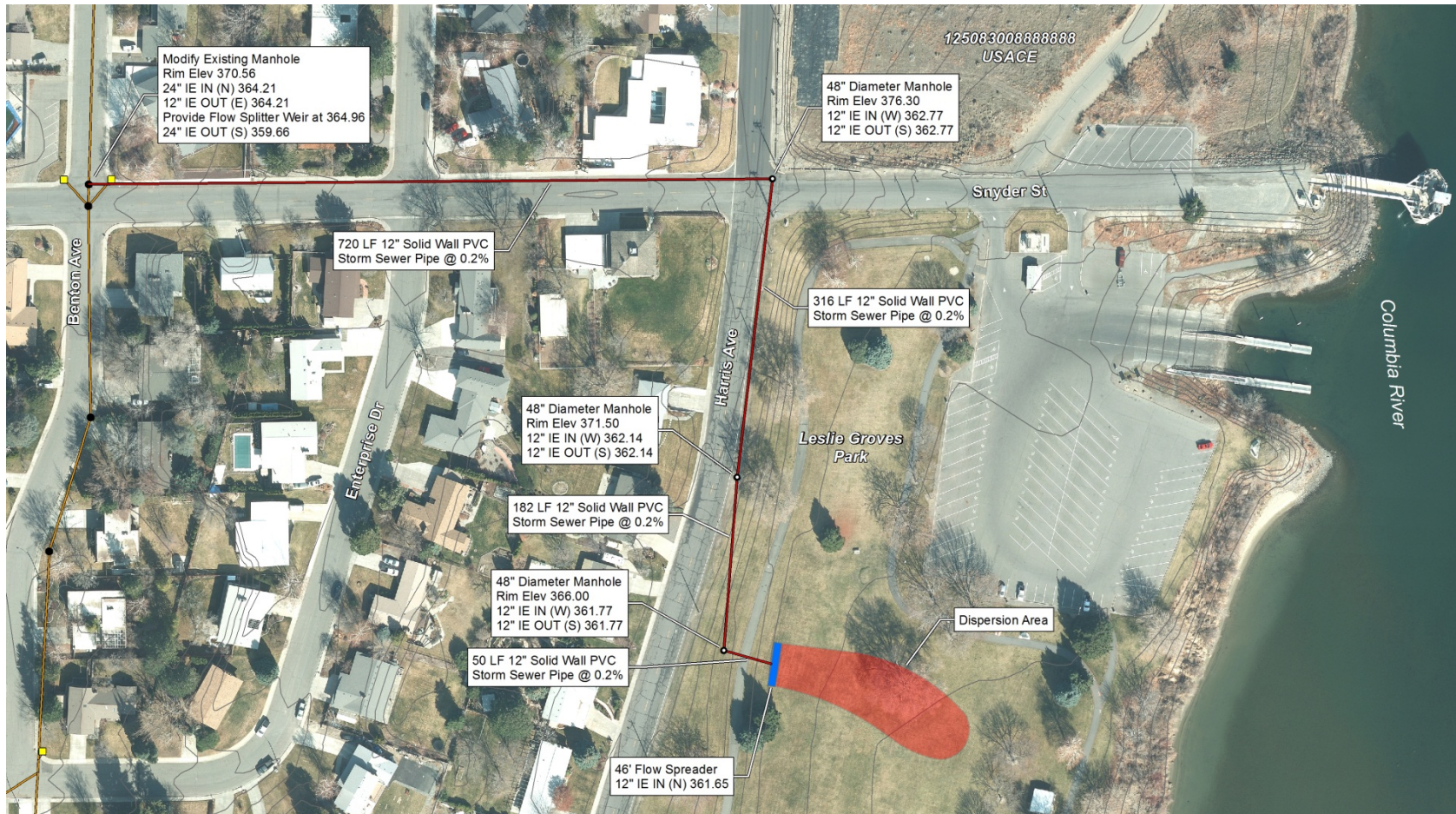
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a dispersion facility located at the north end of Leslie Groves Park **AND** install 116 pairs of “Bump-Out” bioretention facilities distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

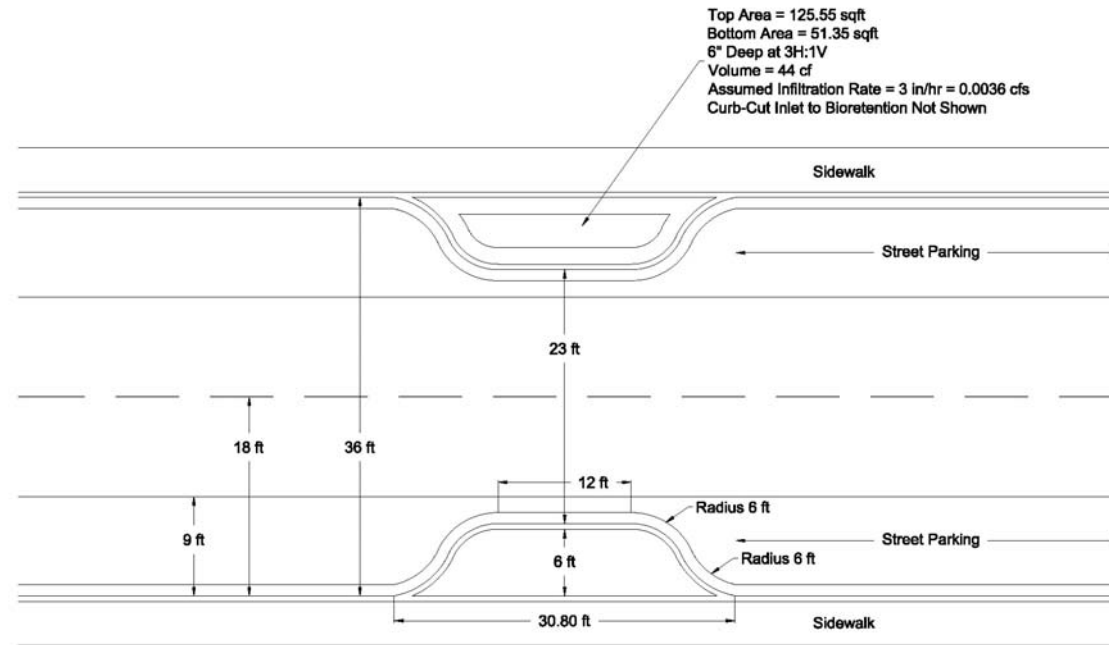
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 3C Snyder St Disp. Facility and "Bump-Out" Bioretention				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Dispersion Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,813.1	\$ 10.00	\$ 28,131.46
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	172.7	\$ 20.00	\$ 3,453.33
6	Crushed Surfacing Top Course	TON	115.1	\$ 25.00	\$ 2,877.78
7	HMA Cl. 1/2-Inch PG 64-28	TON	158.9	\$ 80.00	\$ 12,708.27
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	1,268.0	\$ 40.00	\$ 50,720.00
9	Flow Spreader	LS	1	\$ 10,000.00	\$ 10,000.00
10	Manhole 48 In. Diam. Type 3	EA	3	\$ 3,000.00	\$ 9,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	70.0	\$ 2.50	\$ 175.00
16	Gravel Backfill for Pipe Zone Bedding	TON	493.1	\$ 25.00	\$ 12,327.78
17	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 390,893.61
	Per "Bump-Out" Bioretention Pair				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 2,000.00	\$ 2,000.00
4	Bioretention Facilities	LS	1	\$ 5,000.00	\$ 5,000.00
5	Curb and Gutter	LF	80	\$ 25.00	\$ 2,000.00
6	Standing Curb	LF	60	\$ 20.00	\$ 1,200.00
7	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
8	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
9	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 15,400.00
	Total "Bump-Out" Bioretention Pairs	EA	116	\$ 15,400.00	\$ 1,786,400.00
	Construction Subtotal				\$ 2,177,293.61
	Design Preparation (10%)				\$ 217,729.36
	Construction Management (10%)				\$ 217,729.36
	WA State Sales Tax (8.6%)				\$ 187,247.25
	Subtotal				\$ 2,799,999.59
	Pre-Design Contingency (20%)				\$ 559,999.92
	Total				\$ 3,359,999.51
Notes: • Bioretention Facilities includes excavation, grading, soil mix, irrigation, landscaping cover, and planting.					

PROPOSED SOLUTION FIGURES / DETAILS



PROPOSED SOLUTION FIGURES / DETAILS



"BUMP-OUT" BIORETENTION DETAIL
SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 3D
Project Location: Snyder St and Harris Ave as well as 37 Pairs of “Linear” Bioretention Facilities distributed throughout the drainage basin.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

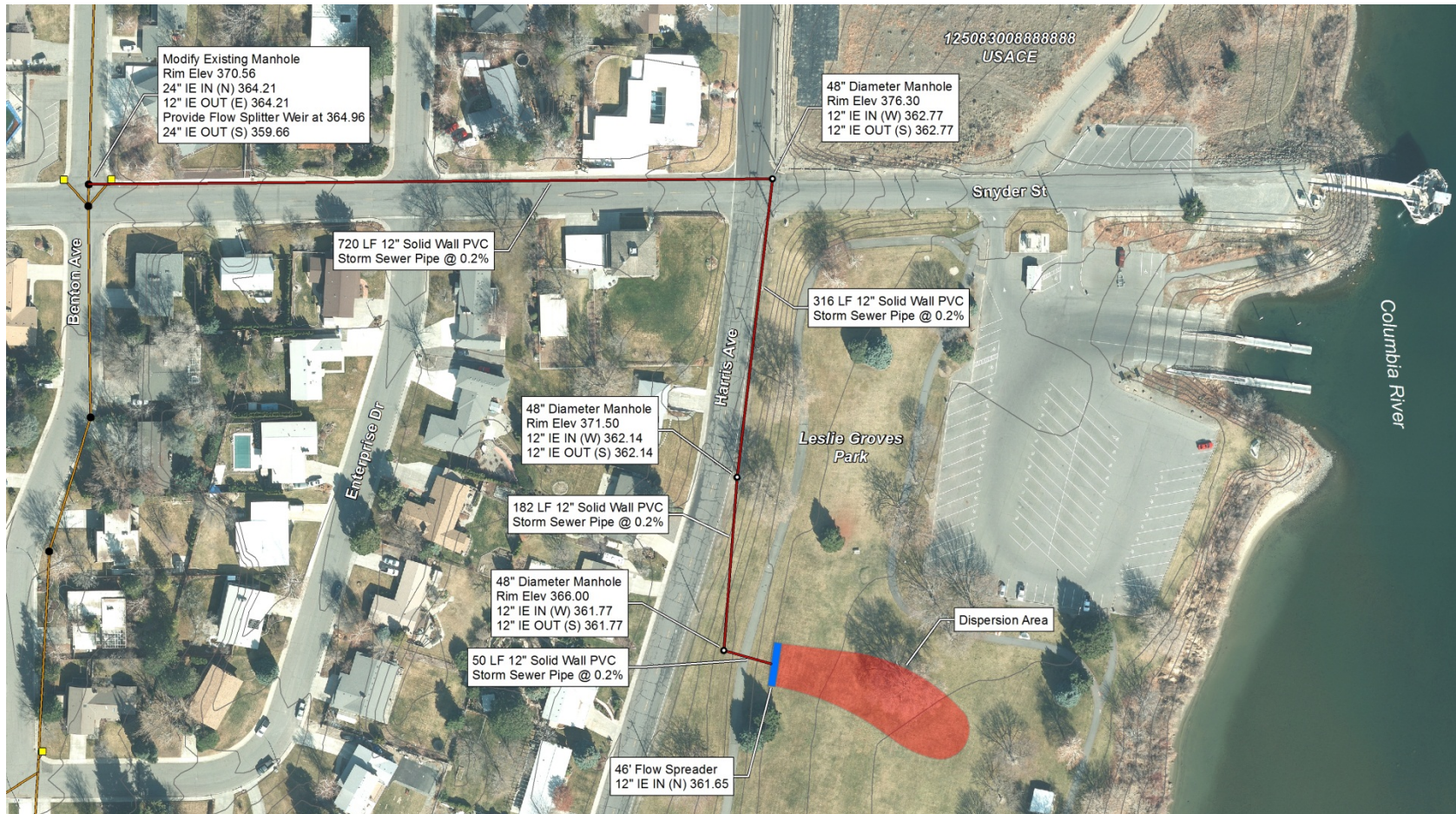
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a dispersion facility located at the north end of Leslie Groves Park **AND** install 37 pairs of “Linear” bioretention facilities distributed throughout the remaining drainage basin. Together the facilities will provide treatment for and infiltration of the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment and infiltration capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

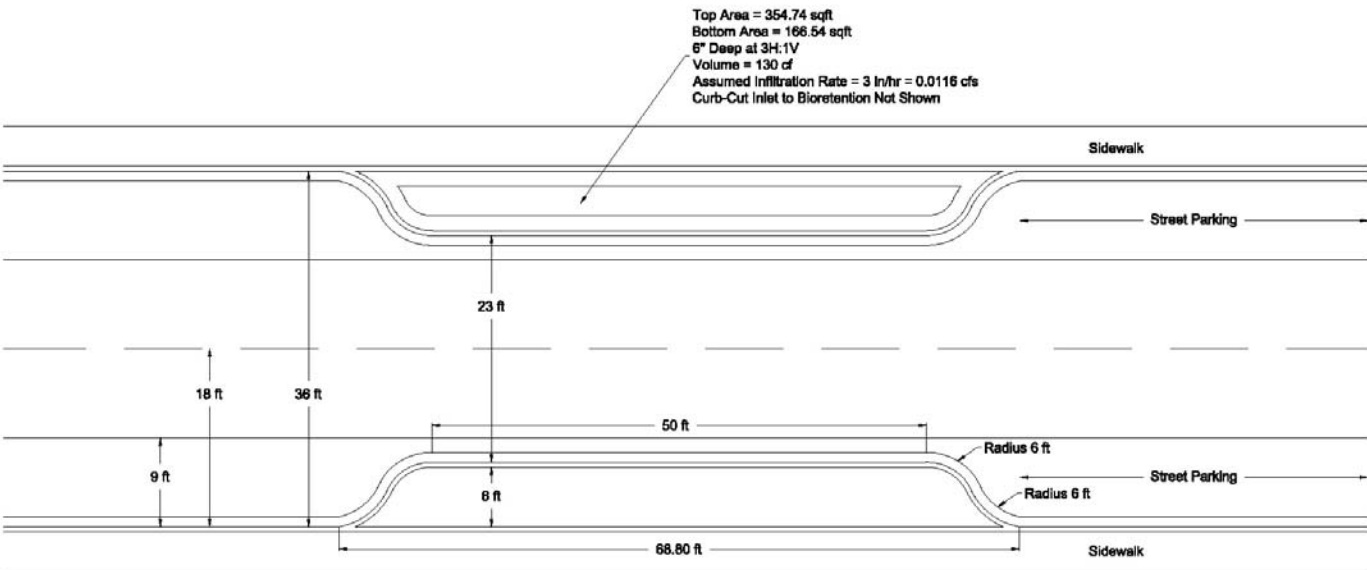
PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 3D Snyder St Disp. Facility and "Linear" Bioretention				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Dispersion Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,813.1	\$ 10.00	\$ 28,131.46
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	172.7	\$ 20.00	\$ 3,453.33
6	Crushed Surfacing Top Course	TON	115.1	\$ 25.00	\$ 2,877.78
7	HMA Cl. 1/2-Inch PG 64-28	TON	158.9	\$ 80.00	\$ 12,708.27
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	1,268.0	\$ 40.00	\$ 50,720.00
9	Flow Spreader	LS	1	\$ 10,000.00	\$ 10,000.00
10	Manhole 48 In. Diam. Type 3	EA	3	\$ 3,000.00	\$ 9,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	70.0	\$ 2.50	\$ 175.00
16	Gravel Backfill for Pipe Zone Bedding	TON	493.1	\$ 25.00	\$ 12,327.78
17	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 390,893.61
	Per "Linear" Bioretention Pair				
1	Mobilization	LS	1	\$ 1,000.00	\$ 1,000.00
2	Project Temporary Traffic Control	LS	1	\$ 1,000.00	\$ 1,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 6,000.00	\$ 6,000.00
4	Bioretention Facilities	LS	1	\$ 12,000.00	\$ 12,000.00
5	Curb and Gutter	LF	150	\$ 25.00	\$ 3,750.00
6	Standing Curb	LF	140	\$ 20.00	\$ 2,800.00
7	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
8	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
9	Minor Change	FA	EST	\$ 2,000.00	\$ 2,000.00
	Subtotal				\$ 29,750.00
	Total "Linear" Bioretention Pairs	EA	37	\$ 29,750.00	\$ 1,100,750.00
	Construction Subtotal				\$ 1,491,643.61
	Design Preparation (10%)				\$ 149,164.36
	Construction Management (10%)				\$ 149,164.36
	WA State Sales Tax (8.6%)				\$ 128,281.35
	Subtotal				\$ 1,918,253.69
	Pre-Design Contingency (20%)				\$ 383,650.74
	Total				\$ 2,301,904.43
Notes: • Bioretention Facilities includes excavation, grading, soil mix, irrigation, landscaping cover, and planting.					

PROPOSED SOLUTION FIGURES / DETAILS



PROPOSED SOLUTION FIGURES / DETAILS



"LINEAR" BIORETENTION DETAIL

SCALE: NTS



Stormwater Retrofit Cut Sheets

PROJECT INFORMATION

Project Name: Outfall NR04 – Alternative 3E
Project Location: Snyder St and Harris Ave as well as 136 – 18” Contech StormFilter Cartridges and 30’ x 30’ Conspan Vault near outfall.

EXISTING CONDITIONS

The outfall NR04 drainage basin is approximately 299 acres in size and is drained by an existing storm drainage system that discharges to the Columbia River without any pretreatment. Land use consists almost entirely of low-medium density residential. Potential pollutants include sediment, metals, nutrients, pesticides, and oil/grease.

Peak Flow and Volume for the 6-Month, 24-Hour Type 1A Storm Event (0.53 in).

Peak Flow (cfs)	Volume (cf)	Volume (ac-ft)
3.73	93,254	2.14

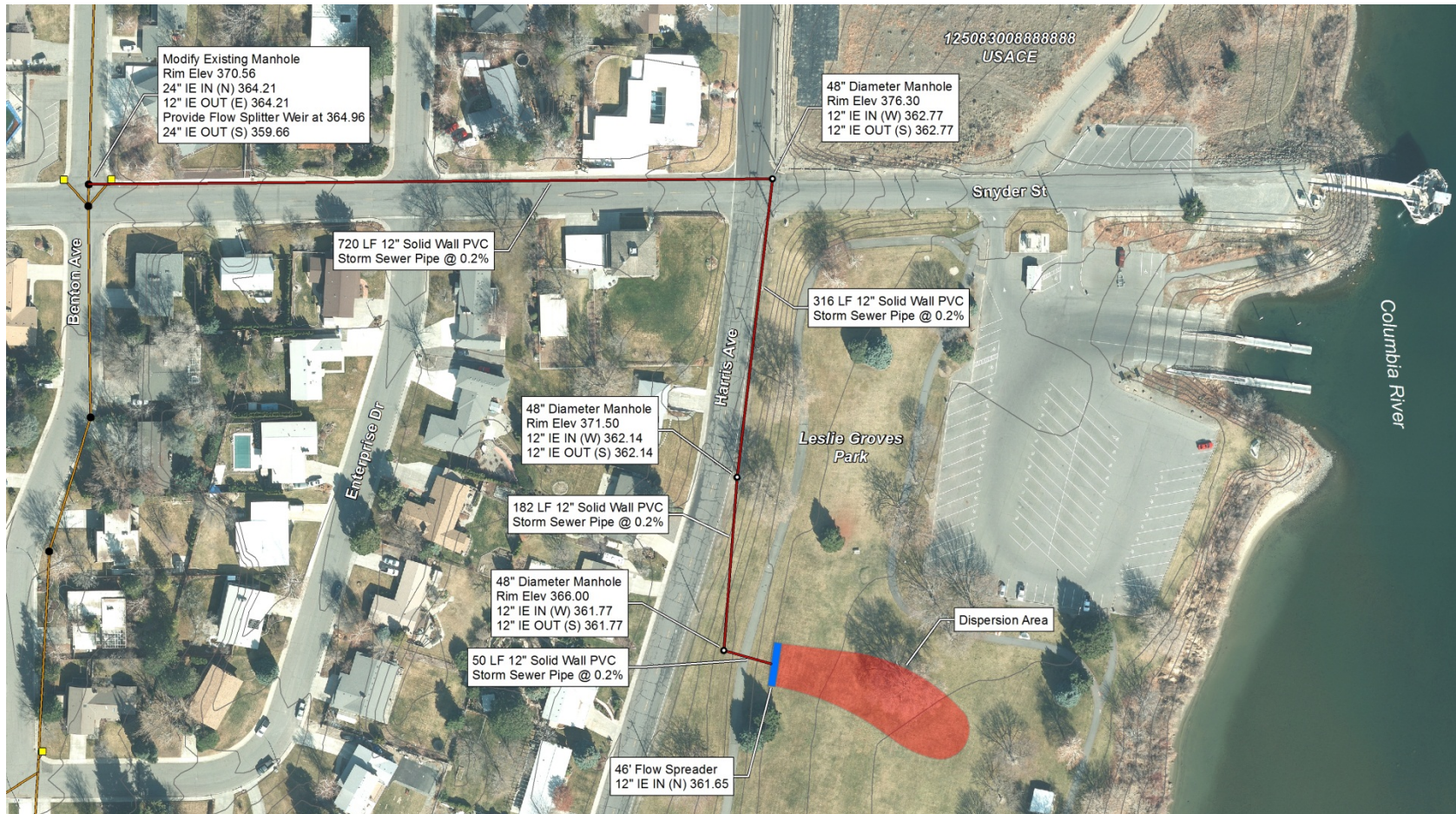
PROPOSED SOLUTION

Route stormwater runoff from the Benton Ave storm system lateral at Snyder St (approximately 1.70 cfs) to a dispersion facility located at the north end of Leslie Groves Park **AND** install 136 – 18” Contech StormFilter Cartridges inside a 30’ x 30’ Conspan Vault located near the outfall capable of treating a peak flow of 2.27 cfs from the remaining basin area. Together the facilities will provide treatment for the 6-month, 24-hour storm event within the basin. This alternative would be equivalent to the treatment capabilities of the previously proposed Leslie Groves Regional Infiltration Facility.

PRELIMINARY COST ESTIMATE

Outfall NR04 Stormwater Retrofit Project Alternative 3E Snyder St Disp. Facility and Contech StormFilter System				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
	Snyder Dispersion Facility				
1	Mobilization	LS	1	\$ 20,000.00	\$ 20,000.00
2	Project Temporary Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Structure Excavation Class B Incl. Haul	CY	2,813.1	\$ 10.00	\$ 28,131.46
4	Shoring or Extra Excavation Class A	LS	1	\$ 200,000.00	\$ 200,000.00
5	Crushed Surfacing Base Course	TON	172.7	\$ 20.00	\$ 3,453.33
6	Crushed Surfacing Top Course	TON	115.1	\$ 25.00	\$ 2,877.78
7	HMA Cl. 1/2-Inch PG 64-28	TON	158.9	\$ 80.00	\$ 12,708.27
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	1,268.0	\$ 40.00	\$ 50,720.00
9	Flow Spreader	LS	1	\$ 10,000.00	\$ 10,000.00
10	Manhole 48 In. Diam. Type 3	EA	3	\$ 3,000.00	\$ 9,000.00
11	Adjust Manhole	EA	1	\$ 3,000.00	\$ 3,000.00
12	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
13	ESC Lead	DAY	5	\$ 100.00	\$ 500.00
14	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
15	Construction Geotextile for Underground Drainage	SY	70.0	\$ 2.50	\$ 175.00
16	Gravel Backfill for Pipe Zone Bedding	TON	493.1	\$ 25.00	\$ 12,327.78
17	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Subtotal				\$ 390,893.61
	Contech StormFilter System				
1	Mobilization	LS	1	\$ 5,000.00	\$ 5,000.00
2	Project Temporary Traffic Control	LS	1	\$ 2,500.00	\$ 2,500.00
3	Structure Excavation Class B Incl. Haul	CY	460	\$ 10.00	\$ 4,600.00
4	Shoring or Extra Excavation Class A	LS	1	\$ 5,000.00	\$ 5,000.00
5	Cement Concrete Foundation, 30' x 30'	LS	1	\$ 20,000.00	\$ 20,000.00
6	136 - 18" Contech StormFilter Cartridges and 30' x 30' Conspan Vault	LS	1	\$ 300,000.00	\$ 300,000.00
7	Gravel Backfill for Pipe Zone Bedding	TON	190	\$ 25.00	\$ 4,750.00
8	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
9	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
10	Roadside Restoration	LS	1	\$ 2,000.00	\$ 2,000.00
11	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Subtotal				\$ 350,050.00
	Construction Subtotal				\$ 740,943.61
	Design Preparation (10%)				\$ 74,094.36
	Construction Management (10%)				\$ 74,094.36
	WA State Sales Tax (8.6%)				\$ 63,721.15
	Subtotal				\$ 952,853.49
	Pre-Design Contingency (20%)				\$ 190,570.70
	Total				\$ 1,143,424.19

PROPOSED SOLUTION FIGURES / DETAILS



PROPOSED SOLUTION FIGURES / DETAILS



CITY OF RICHLAND

Outfall NR05 Stormwater Retrofit Project – Pre-Design Report



City of Richland
Public Works Department
840 Northgate Drive
P.O. Box 190, MS-26
Richland, WA 99352

February 17, 2015

ACKNOWLEDGEMENTS

City of Richland

Outfall NR05 Stormwater Retrofit Project — Pre-Design Report

Prepared for:



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City of Richland

Outfall NR05 Stormwater Retrofit Project — Pre-Design Report

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Attachments

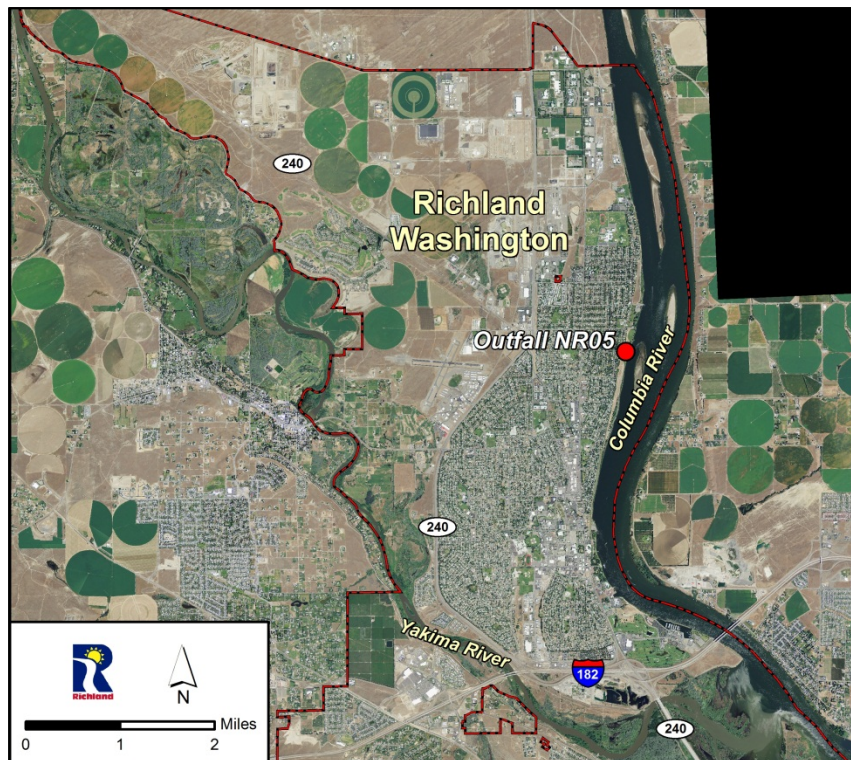
Attachment 1	Preliminary Geotechnical Information
Attachment 2	Existing Subbasin Map
Attachment 3	Design Calculations
Attachment 4	Stormwater Retrofit BMP Alternative Matrix
Attachment 5	Plans and Details
Attachment 6	Pre-Design Level Construction Cost Estimates

Section I—Introduction

As a part of the 2013-2015 Biennial Municipal Stormwater Capacity Grant Program, the Washington State Department of Ecology (Ecology) has provided the City of Richland (City), a NPDES Phase II community, with funds to conduct project specific planning and design (pre-construction) activities for retrofit projects which address stormwater pollution runoff from existing development. As a condition for pre-construction activity funding, at least one of the projects must implement low impact development techniques in accordance with Ecology approved design manuals, primarily the Stormwater Management Manual for Eastern Washington (SWMMEW) and the Eastern Washington Low Impact Development Guidance Manual (E. WA LID Manual). A primary purpose of LID is to retain and infiltrate stormwater; therefore, Ecology has stated that properly designed subsurface infiltration systems, such as drywells and infiltration trenches, will be considered equivalent to LID for the purposes of the design and construction grants. This will improve receiving water quality by allowing retention facility retrofits in areas with limited space.

Based on prior work to develop evaluation criteria and rank all known City outfalls (*City of Richland Updated Stormwater Treatment Retrofit Memorandum*, URS, 2014), City staff have selected Outfall NR05 to develop a stormwater retrofit design to improve water quality discharging to the Columbia River.

The retrofit project location is shown in the vicinity map below and described in detail in Section 2.



Section I—Introduction

Continued

An overview of Richland’s climate is provided in the table below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	40.7	48.6	57.9	66.4	75.3	82.2	90.5	89.3	80.6	66.7	50.7	41.5	65.9
Average Min. Temperature (F)	26.4	30.2	35.1	40.8	48.1	54.7	59.7	58.7	50.8	41.2	33.7	28.2	42.3
Average Total Precipitation (in.)	0.99	0.70	0.61	0.49	0.59	0.54	0.20	0.23	0.28	0.54	0.93	1.05	7.15
Average Total Snowfall (in.)	2.6	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.2	7.1
Avg. Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Source: Western Region Climate Center (2014)

The project site is located in climatic Region 2 (Central Basin) of eastern Washington and receives approximately 7.15 inches of mean annual precipitation, a portion of which falls as snow.

2.1 Outfall NR05

Outfall NR05 serves a small area consisting of residential property. Currently all runoff is collected and conveyed without treatment to the Columbia River. Unused space at the entrance to Leslie Groves Park off of Park Street, immediately to the west of the outfall, as well as available right-of-way space along Park Street, present an opportunity to allow stormwater runoff to be retained, treated, and infiltrated rather than discharging directly to the Columbia River.

2.1.1 Basin Description

Basin Delineation

A basin map for the NR05 stormwater drainage system is provided as Attachment 2. The map shows the drainage basin boundary and flow directions for existing and proposed conditions. Existing and proposed peak runoff rates and volume calculations are provided in Attachment 3.



Leslie Groves Park Looking South Near Outfall

Basin Information

The NR05 basin is approximately 24 acres in size with an existing land use consisting primarily of low density residential. There are no expected future land use changes for the basin.

Native soils are generally Hydrologic Class A, expected to have high to very high infiltration rates. The water table is expected to be well below the ground surface at an elevation similar to the Columbia River.

Stormwater quality issues include those typically associated with low average daily traffic (ADT) roadways, including sediments, hydrocarbons, vehicle fluids, metals, elevated temperature, and other pollutants.

Based on review of Ecology's 2012 303(d) list of impaired receiving waters, the Columbia River is currently listed as impaired for temperature. The States of Washington, Oregon, and Idaho and EPA Region 10 have been working in coordination with the Columbia Basin Tribes since 2001 to develop a Total Maximum Daily Load (TMDL) for temperature on the Columbia and Snake Rivers. However, completion of the TMDL has been delayed to allow for necessary discussions and information exchange. Although specific loading capacities and allocations have yet to be specified, retention and infiltration is a suitable way to reduce temperature increases due to stormwater runoff from impervious surfaces during spring through fall thunderstorms.

Section 2—Basin and Site Description

Continued

2.1.2 Site Description

Existing Stormwater Controls

The NR05 basin drains to an existing stormwater conveyance system that discharges to the Columbia River (see Attachment 2). The basin has no existing stormwater quality or flow control BMPs (the Columbia River is exempt from flow control requirements).

Total Area, Impervious Area, Pervious Area

Attachment 2 depicts the Total Basin Area, Connected ISA, Disconnected ISA, and Pervious Area for the NR05 basin. A breakdown of each area is provided below in Table 1.

Table 1 – Outfall NR05 Basin Areas

Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)
24.45	5.07	4.53	14.86

Vegetation and Wetlands

Existing vegetation in the basin includes: maintained turf grass, mature trees, and other shrubbery. No wetlands are present within the immediate project area.

Soils

According to the Benton County Soil Survey, surficial soils at the project site primarily consist of Burbank loamy fine sand and Quincy loamy sand, both are considered to be excessively drained soils with an estimated saturated hydraulic conductivity in the 5.95 to 19.98 inches/hour range (see Attachment 1). Note that a detailed geotechnical investigation will be performed during the design stage.

Access

Access to the site is readily available through the existing City road infrastructure.

Section 3—Design Alternatives and Analysis

3.1 Alternatives Considered

City staff evaluated a number of retrofit alternatives for the NR05 basin including: surface infiltration facilities, sub-surface infiltration facilities, and proprietary treatment devices. A stormwater retrofit BMP alternative matrix was developed and is included as Attachment 4.

Three alternatives were evaluated in detail: (1) engineered dispersion within Leslie Groves Park; (2) a surface infiltration facility at the Park Street roundabout; and (3) drywells along Park Street. Conceptual layouts and pre-design level construction cost estimates are provided in Attachment 5 and Attachment 6, respectively.

The City met with the Army Corps of Engineers (Corps) to discuss the retrofit alternatives given that the Corps owns the Leslie Groves Park property adjacent to the Columbia River. Together the two entities believe that the dispersion option (Attachment 5-1) would likely be too disruptive to the current use of Leslie Groves Park plus the use of that area by water fowl has caused an increase in fecal deposits on the ground surface that may do more harm than good to the stormwater quality. It was decided that a surface infiltration facility at the entrance of the park (Attachment 5-2) or drywells (Attachment 5-3) would be acceptable alternatives.

The following issues were considered during the BMP selection and layout process:

- Climate/seasonal precipitation patterns.
- Expected traffic use levels.
- Available right-of-way and setback requirements.
- Ability to work with existing drainage patterns and infrastructure to degree possible.
- Review/avoidance of likely utility/existing infrastructure issues.
- Likely soil and groundwater properties/conditions.
- Avoidance of steep or unstable slopes, or other geologic hazard areas.
- Ability to help address receiving water concerns.
- Minimizing/avoiding work within exterior roads and sidewalks.
- Typical O&M requirements/level of effort/special equipment.
- Critical areas issues.
- Ability to safely drain overflow water to an appropriate location.
- Ability to prevent significant problems in the event that systems fail or periodically operate below the intended design level.
- Aesthetic compatibility of BMPs with existing site structures and features.
- Consideration of future improvement projects.

Section 3—Design Alternatives and Analysis

Continued

Many of these considerations are also feasibility criteria recommended by the Eastern Washington LID and Stormwater Management Manuals.

3.2 Description of Final Alternative

After review of the three alternatives (dispersion, surface infiltration facility, or drywells), it was decided that the surface infiltration facility (Attachment 5-2) would be the preferred retrofit BMP to carry forward into design and the following sections of this pre-design report are written as such. However, prior to entering design, the City will present all alternatives to the City Council to obtain final direction.

3.2.1 Design Storms

The infiltration basin will be designed to retain, treat, and infiltrate up to the 6-month, 24-hour SCS Type 1A storm event for the contributing area. This should effectively treat, retain, and infiltrate at least 90% of the annual runoff from the contributing drainage basin. The drywells will be designed to completely drain down within at most 72-hours in order to meet the following objectives:

- Restore hydraulic capacity to receive runoff from a new storm; and
- Maintain infiltration rates.

The inlet pipe to the infiltration basin will be designed to convey the peak discharge from the 6-month, 24-hour SCS Type 1A storm event plus incidental flow due to the expected maximum head on the pipe leading to the infiltration basin. Flows in excess of the peak water quality storm discharge will bypass the infiltration basin via a weir in the 72" diameter manhole and discharge to the Columbia River via the existing storm drain and outfall.

3.2.2 Preliminary Infiltration Characteristics

As discussed in Section 2, based on published Soil Survey information, the saturated hydraulic conductivity of the native soil at the project site is estimated to be 5.95 to 19.98 inches/hour. For purposes of this pre-design report, it was assumed that the long-term infiltration rate through the 18-inch treatment soil layer beneath the infiltration facility will be 3.0 inches/hour. Geotechnical testing will be conducted to verify the native soil infiltration rate; if it is found that the native soil infiltration rate is less than the assumed long-term infiltration of the 18-inch treatment soil layer, infiltration basin sizing calculations will be revisited.

3.2.3 Key Aspects, Benefits, and Cost

Key aspects of the project will include:

- Excavating the required volume for the infiltration basin including minor grading of the surrounding area to catch existing contours.

- Redirecting runoff up to the water quality storm event to the infiltration basin by installing a new 72” diameter manhole with a flow splitter weir in-line with the existing storm drain and an 8-inch storm pipe that leads to the infiltration basin. Stormwater will back up in the existing storm pipe for a distance of approximately 600 feet to an elevation of 363.80 feet before flowing into the infiltration basin.
- Constructing energy dissipation at the outlet of the 8-inch storm pipe within the infiltration basin.
- Providing an 18-inch treatment soil layer at the bottom of the infiltration basin.
- Selecting appropriate plant species for the infiltration basin and providing irrigation.

Refer to the infiltration basin pre-design plan drawing included as Attachment 5-2 and detail as Attachment 5-4 for additional information. Peak runoff rates and volumes, as well as BMP sizing calculations are provided in Attachment 3.

Water Quality Benefits

The proposed stormwater retrofit will reduce the volume of runoff to outfall NR05 as compared to the existing condition by retaining and infiltrating the 6-month, 24-hour SCS Type 1A storm event from the contributing area. Water quality is also improved from the existing condition since the proposed BMP will provide enhanced treatment and will retain and treat 90% of the annual runoff volume from the contributing drainage basin including all “first flush” storm events.

Preliminary Cost Estimate

The pre-design level construction cost estimate for the preferred infiltration basin alternative is \$114,000 including a 20% pre-design contingency. See Attachment 6 for a complete breakdown of the pre-design level construction cost estimate.

Section 4—Implementation Considerations

4.1 Design and Operational Considerations to be Addressed Between the Pre-Design Report and 90% Design

The design submitted with this Pre-Design Report is at a preliminary level. Design and operational considerations to be addressed in the next phase of the design process are discussed below.

4.1.1 Existing Utilities

There are multiple utilities running through Park Street. During the design phase, the City will want to call for locates, perform potholing, and/or utilize as-built information to gain a better understanding of the exact location and depth to the existing utilities and modify the design accordingly.

4.1.2 Land Acquisition

Siting the infiltration basin on Corps of Engineers property will require the City to complete necessary easement/permitting during the design process.

4.1.3 Energy Dissipation

Calculations show that the flow in the 8-inch storm pipe leading to the infiltration basin will have a velocity of approximately 7 feet per second during large storm events when head is expected to build up in the upstream flow splitter manhole. An appropriate energy dissipation measure will be selected during the design process. Possible energy dissipation measures may include a riprap splash pad or appropriate vegetative cover.

4.1.4 Recommended Landscaping, Vegetation, and Irrigation

The infiltration basin will be designed with an 18-inch treatment soil layer to achieve Ecology's enhanced treatment criteria. Since the facility will be at the entrance to Leslie Groves Park, the City may decide to include aesthetically pleasing landscaping features and vegetation, along with appropriate irrigation.

4.1.5 Additional Design and Operational Considerations

Additional design and operational considerations to be addressed in the next phase of the design process include:

- Finalize detailed topographic and utilities survey data.
- Identify, avoid, or otherwise address any utility conflicts.
- Verify high groundwater levels and depth to bedrock.

Section 4—Implementation Considerations

Continued

- Test the soil conditions and infiltration characteristics, and refine the BMP design accordingly.
- Prepare planting and irrigation plans for infiltration basin based on any plant species selected by the City.
- Specify mulching requirements to control weeds and any soil amendments necessary to meet required specifications for treatment soil layer.
- Specify/design the flow splitter weir and manhole.
- Verify construction accessibility and traffic/pedestrian control issues.
- Address O&M equipment accessibility and routes.
- Address any easement/permit needs with the Corps of Engineers.
- Other considerations and limitations per the E. WA LID Manual and the SWMMEW.

4.2 Additional Implementation Considerations

Based on City input, it is expected that permitting requirements include:

- SEPA and City Construction Stormwater.
- State mandated cultural resources requirements.
- Corps of Engineers.

Anticipated City Council involvement includes:

- Approval to submit grant application for construction funding.
- Approval for any contracts associated with project work.
- Approval to place stormwater retrofit project on the City CIP list.

Section 5—Proposed Schedule

The City anticipates completing 90% design in 2015 (to be submitted to Ecology for review and acceptance). The 90% design package will include:

- 90% design
- 90% bid schedule
- 90% bid specifications and special provisions
- Engineers estimate of probable project costs
- O&M Guide

Following completion of the 90% design, the City may complete and submit an application to a competitive grant program, if available, in hopes of securing grant funding for construction activities.

ATTACHMENT 1 — PRELIMINARY GEOTECHNICAL INFORMATION

Soil Map—Benton County Area, Washington (Outfall NR05)



Map Scale: 1:4,430 if printed on A landscape (11" x 8.5") sheet.

0 50 100 200 300 Meters

0 200 400 800 1200 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

9/17/2014
Page 1 of 3

Soil Map—Benton County Area, Washington
(Outfall NR05)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

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

Date(s) aerial images were photographed: Aug 6, 2010—Oct 17, 2010

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

Benton County Area, Washington (WA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BIA	Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes	10.3	15.1%
BID	Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes	40.9	59.9%
PITS	Pits	1.1	1.6%
QuA	Quincy loamy sand, 0 to 2 percent slopes	8.2	12.0%
QuD	Quincy loamy sand, 2 to 15 percent slopes	1.6	2.4%
W	Water	6.2	9.1%
Totals for Area of Interest		68.3	100.0%

Benton County Area, Washington

BIA—Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bbb

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

BID—Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2bbc

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Farmland classification: Not prime farmland

Map Unit Composition

Burbank and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Typical profile

H1 - 0 to 5 inches: loamy fine sand

H2 - 5 to 16 inches: loamy sand

H3 - 16 to 30 inches: very gravelly loamy sand

H4 - 30 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

PITS—Pits

Map Unit Composition

Pits: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pits

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

QuA—Quincy loamy sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2bd3

Elevation: 200 to 4,500 feet

Mean annual precipitation: 6 to 12 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 200 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Quincy and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Quincy

Setting

Landform: Terraces

Parent material: Eolian sands

Typical profile

H1 - 0 to 9 inches: loamy sand

H2 - 9 to 60 inches: loamy fine sand

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 3 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

QuD—Quincy loamy sand, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2bd4

Elevation: 200 to 4,500 feet

Mean annual precipitation: 6 to 12 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 200 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Quincy and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Quincy

Setting

Landform: Terraces

Parent material: Eolian sands

Typical profile

H1 - 0 to 9 inches: loamy sand

H2 - 9 to 60 inches: loamy fine sand

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 3 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: A

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

W—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

ATTACHMENT 2 — EXISTING SUBBASIN MAP



City of Richland
Stormwater Retrofit
Support Services

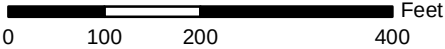
Outfall NR05
Drainage Basin

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Drainage Basin Boundary
- Connected ISA
- Disconnected ISA
- Pervious
- Approximate Flow Direction

2012 Aerial Imagery

Attachment 2



Date Created: August 20, 2014

Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)
24.45	5.07	4.53	14.86	19.38

ATTACHMENT 3 — DESIGN CALCULATIONS

Hydrologic Calculations - Subbasin Area and Time of Conc. Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 11/24/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Subbasin	Total Basin Area (acres)	Connected ISA (acres)	Disconnected ISA (acres)	Pervious Area (acres)	Disconnected ISA and Pervious Area (acres)	Imp. CN	Perv. CN	Pervious and Disconnected Weighted CN
NR05	24.45	5.07	4.53	14.86	19.38	98	68	75

Outfall ID	Sheet Flow					Shallow Concentrated Flow				Open Channel Flow				Time of Concentration
	$T_t = 0.42 * (n_s * L)^{0.8} / ((P_{2\text{yr}2\text{hr}})^{0.5} * (s_0)^{0.4})$					$T_t = L / (60 * (k * (s_0)^{0.5}))$				$T_t = L / (60 * (k_c * (s_0)^{0.5}))$				$T_c = T_{t1} + T_{t2} + \dots T_{tm}$
	n_s	L (ft)	$P_{2\text{yr}2\text{hr}}$ (in)	s_0 (ft/ft)	T_t (min)	L (ft)	k	s_0 (ft/ft)	T_t (min)	L (ft)	k_c	s_0 (ft/ft)	T_t (min)	T_c (min)
NR05 (Connected ISA)	0.011	30	0.4	0.020	1.31	1312	27	0.005	11.45	304	42	0.005	1.71	14.47
NR05 (Pervious and Disconnected ISA)	0.15	100	0.4	0.010	36.57	582	11	0.010	8.82	310	42	0.005	1.79	47.18

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.

Hydrologic Calculations - SBUH Results Stormwater Management Manual for Eastern Washington	Calculated By: E. Pruneda	Date: 11/24/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Outfall ID	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T _c (min)	24-Hour Type 1A Storm Event		3-Hour Short Duration Storm Event	
							6-Month (0.53 in)		25-Year (0.92 in)	50-Year (1.14 in)
							Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)	Peak Flow (cfs)
NR05 (Connected ISA)	5.07	0.00	1.00	98	68	14.47	0.38	6,314	5.79	7.54
NR05 (Pervious and Disconnected ISA)	19.38	19.38	0.00	98	75	47.18	---	---	0.14	0.56
NR05 (Total)	---	---	---	---	---	---	---	---	5.79	7.67

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.
- (3) It is assumed that Pervious and Disconnected ISA areas do not contribute runoff during the 6-Month, 24-Hour Type 1A Storm Event.
- (4) 25-Year, 3-Hour Short Duration peak flows are provided for high-flow bypass conveyance sizing. Peak flows were determined by summing the hydrographs for the Connected ISA and Pervious and Disconnected ISA areas.

Conceptual BMP Sizing Calculations	Calculated By: E. Pruneda	Date: 12/18/2014	Project: Richland
	Checked By:	Date:	Project No: 33764797
			Sheet No: 1 of 1

Facility ID (Outfall ID)	Available Storage Volume					Predicted Water Quality Volume (cf) from Contributing Area	Assumed Infiltration Rate (in/hr)	Assumed Bottom Infiltration Rate (cfs)	Predicted Max Volume (cf) in Facility During the Water Quality Storm Event
	Top Area at Elev 364 (sq-ft)	Bottom Area at Elev 362 (sq-ft)	Side Slope (H:V)	Depth (ft)	Volume (cf)				
Infiltration Basin (NR05)	1880	855	4:1	2.00	2,735	6,314	3	0.059	2,241

Notes:

(1) The long term infiltration rate of treatment soil media has been assumed to be 3.0 inches/hour.
The native infiltration rate will be confirmed through geotechnical investigation as the design progresses.

Conceptual Pipe Sizing Calculations

Calculated By: E. Pruneda	Date: 12/18/2014	Project: Richland
Checked By:	Date:	Project No: 33764797
		Sheet No: 1 of 3

Worksheet : Existing Circular Pipe

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Discharge Friction Method: Manning Formula

Roughness Coefficient:	0.011		
Channel Slope:	0.02100	ft/ft	
Normal Depth:	0.90	ft	
Diameter:	1.00	ft	
Discharge:	6.50	ft ³ /s	
Flow Area:	0.74	ft ²	
Wetted Perimeter:	2.50	ft	
Hydraulic Radius:	0.30	ft	
Top Width:	0.60	ft	
Critical Depth:	0.97	ft	
Percent Full:	90.0	%	
Critical Slope:	0.02093	ft/ft	
Velocity:	8.73	ft/s	
Velocity Head:	1.19	ft	
Specific Energy:	2.09	ft	
Froude Number:	1.38		
Maximum Discharge:	6.56	ft ³ /s	
Discharge Full:	6.10	ft ³ /s	
Slope Full:	0.02385	ft/ft	
Flow Type:	SuperCritical		

Calculation Successful.

Conceptual Pipe Sizing Calculations

Calculated By: E. Pruneda	Date: 12/18/2014	Project: Richland
Checked By:	Date:	Project No: 33764797
		Sheet No: 2 of 3

Worksheet : New Circular Pipe to Infiltration Basin

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Discharge Friction Method: Manning Formula

Roughness Coefficient:	0.011			Flow Area:	0.05	ft ²
Channel Slope:	0.07500	ft/ft		Wetted Perimeter:	0.63	ft
Normal Depth:	0.14	ft		Hydraulic Radius:	0.08	ft
Diameter:	0.67	ft		Top Width:	0.54	ft
Discharge:	0.38	ft ³ /s		Critical Depth:	0.29	ft
				Percent Full:	21.0	%
				Critical Slope:	0.00478	ft/ft
				Velocity:	7.09	ft/s
				Velocity Head:	0.78	ft
				Specific Energy:	0.92	ft
				Froude Number:	3.99	
				Maximum Discharge:	4.21	ft ³ /s
				Discharge Full:	3.92	ft ³ /s
				Slope Full:	0.00070	ft/ft
				Flow Type:	SuperCritical	

Calculation Successful.

Conceptual Pipe Sizing Calculations

Calculated By: E. Pruneda	Date: 12/18/2014	Project: Richland
Checked By:	Date:	Project No: 33764797
		Sheet No: 3 of 3

Worksheet : Rectangular Weir - 50-Yr, 3-Hr

Calculations Messages

Solve For: Discharge

Discharge:	7.71	ft ³ /s	Headwater Height Above Crest:	0.53	ft
Headwater Elevation:	364.53	ft	Tailwater Height Above Crest:	-6.00	ft
Crest Elevation:	364.00	ft	Flow Area:	3.18	ft ²
Tailwater Elevation:	358.00	ft	Velocity:	2.42	ft/s
Weir Coefficient:	3.33	US	Wetted Perimeter:	7.06	ft
Crest Length:	6.00	ft	Top Width:	6.00	ft
Number Of Contractions:	0				

Calculation Successful.

ATTACHMENT 4 — STORMWATER RETROFIT BMP ALTERNATIVE MATRIX

NR05 - Stormwater Retrofit BMP Alternative Matrix

BMP Alternative	Description	Benefit	Target Pollutants	Treatment Effectiveness	Relative O&M Effort	Relative Cost
1	Dispersion into Leslie Groves Park	Runoff Treatment (<i>Basic, Enhanced, Phos</i>) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	Low	Low
2	Infiltration Basin at Park Street Roundabout	Runoff Treatment (<i>Basic, Enhanced, Phos</i>) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	High	Low	Low
3	Distributed Drywells <i>Convert Existing Inlets to Drywell System with Sed Manhole</i>	Runoff Treatment (<i>Basic, Enhanced, Phos</i>) Flow Control	Sediment, Metals, Nutrients, Pesticides, & Bacteria; Limited Hydrocarbons	Mod	Mod	Med
4	CONTECH Media Filtration System	Runoff Treatment (<i>Basic</i>)	Sediment; Limited Nutrients, Pesticides, & Bacteria	Low	High	High
5	CONTECH SW Management StormFilter with MetalRx Media	Runoff Treatment (<i>Basic, Enhanced</i>)	Sediment and Metals; Limited Nutrients, Pesticides, Bacteria, & Hydrocarbons	Mod	High	High

Notes:

- (1) Any BMP that will retain and infiltrate at least the water quality storm event will achieve a high treatment level because of the reduction in pollutant loading to surface waters.
- (2) Columbia River is exempt from flow control requirements.
- (3) Relative Operation and Maintenance Effort Ratings:
 Low = One inspection per year and after major storms; sediment removal as needed.
 Moderate = Two inspections per year and after major storms; sediment removal as needed. Similar to "Low" until replacement.
 High = One inspection per year and after major storms; irrigation; landscape pruning; enclosed space requirements; sediment removal as needed; cartridge replacement as needed (\$65 per cartridge + installation).

Exact maintenance efforts are difficult to project and will only be revealed based on inspections. Minimizing sediment load to the treatment facilities will reduce annual maintenance costs; this can be accomplished through street sweeping, and routine operation and maintenance of upstream catch basins and manholes.

ATTACHMENT 5 — PLANS AND DETAILS

City of Richland
Stormwater Retrofit
Support Services

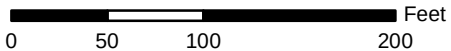
Outfall NR05
Conceptual Stormwater
Treatment Retrofit
Alternative 1

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Bubble Up
- Proposed Manhole
- Proposed Storm Pipe
- Natural Dispersion Area

2012 Aerial Imagery

Attachment 5-1



Date Created: October 24, 2014

Alternative Description:

Divert up to the 6-month, 24-hour storm (0.38 cfs) from the storm main line to a proposed bubble up structure and natural dispersion area.



City of Richland
Stormwater Retrofit
Support Services

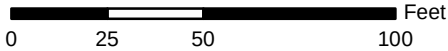
Outfall NR05
Conceptual Stormwater
Treatment Retrofit
Alternative 2

Legend

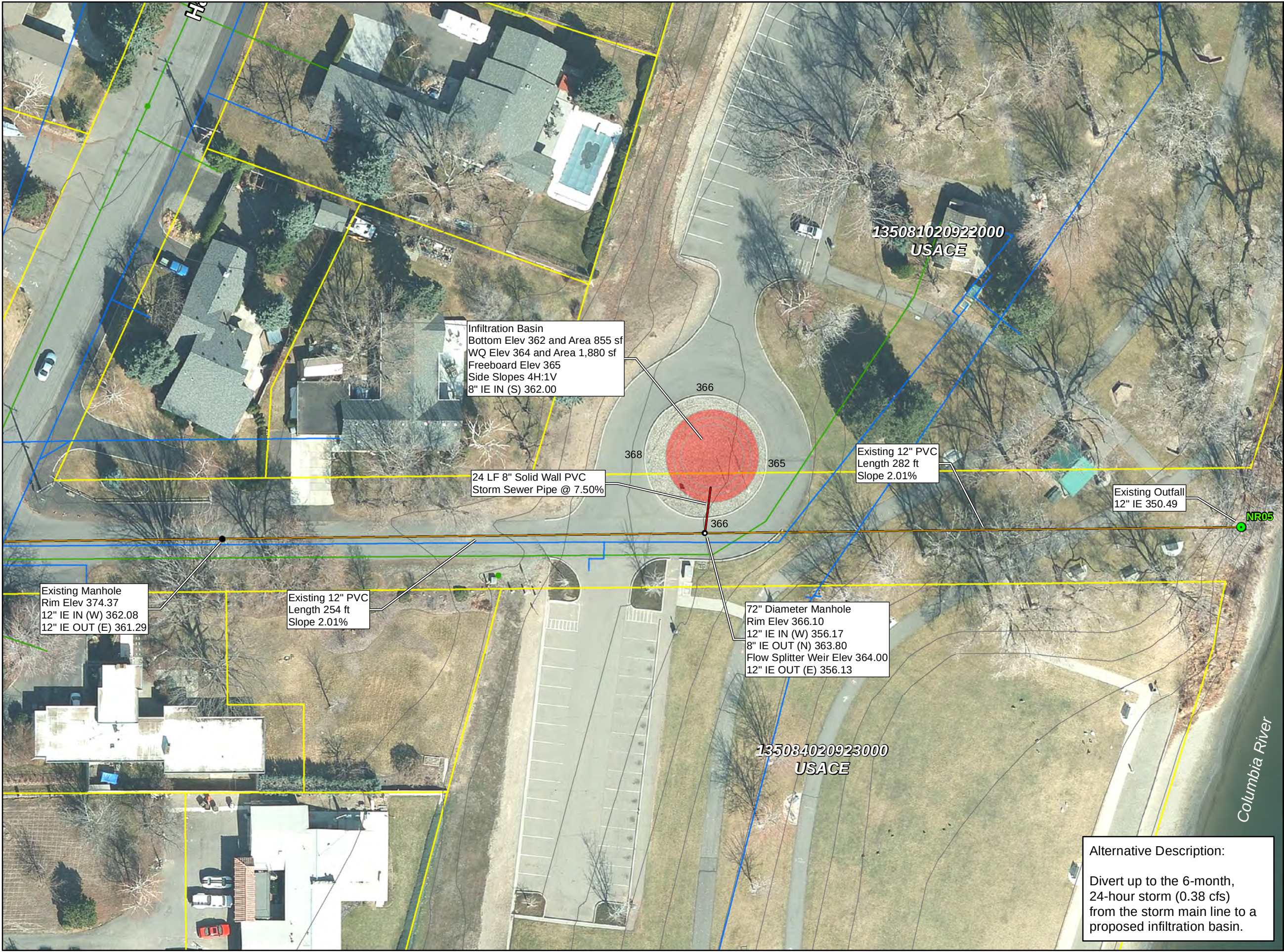
- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Bubble Up
- Proposed Manhole
- Proposed Storm Pipe

2012 Aerial Imagery

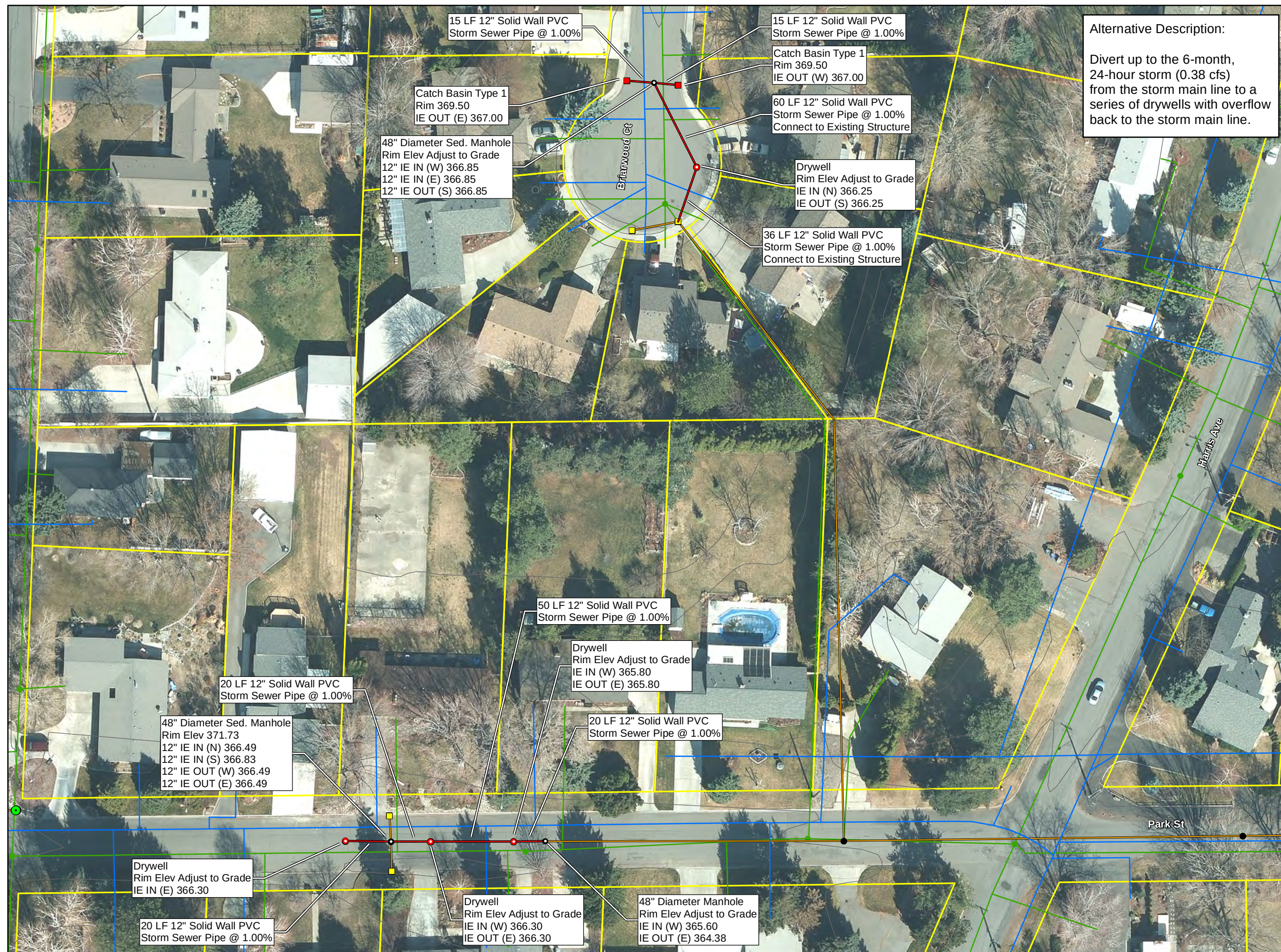
Attachment 5-2



Date Created: December 17, 2014



Alternative Description:
Divert up to the 6-month,
24-hour storm (0.38 cfs)
from the storm main line to a
proposed infiltration basin.



Alternative Description:
Divert up to the 6-month, 24-hour storm (0.38 cfs) from the storm main line to a series of drywells with overflow back to the storm main line.

City of Richland Stormwater Retrofit Support Services

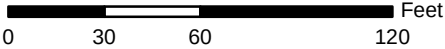
Outfall NR05 Conceptual Stormwater Treatment Retrofit Alternative 3

Legend

- Existing Bubble Up
- Existing Outfall
- Existing Drywell
- Existing CB/Inlet
- Existing Manhole
- Existing Culvert
- Existing Storm Pipe
- Existing Perforated Pipe
- Existing Open Channel
- Existing Sewer Manhole
- Existing Sewer Main
- Existing Water Main
- 1999 Contour Data
- Parcel Boundary
- Proposed Catch Basin
- Proposed Drywell
- Proposed Sed. Manhole
- Proposed Storm Pipe

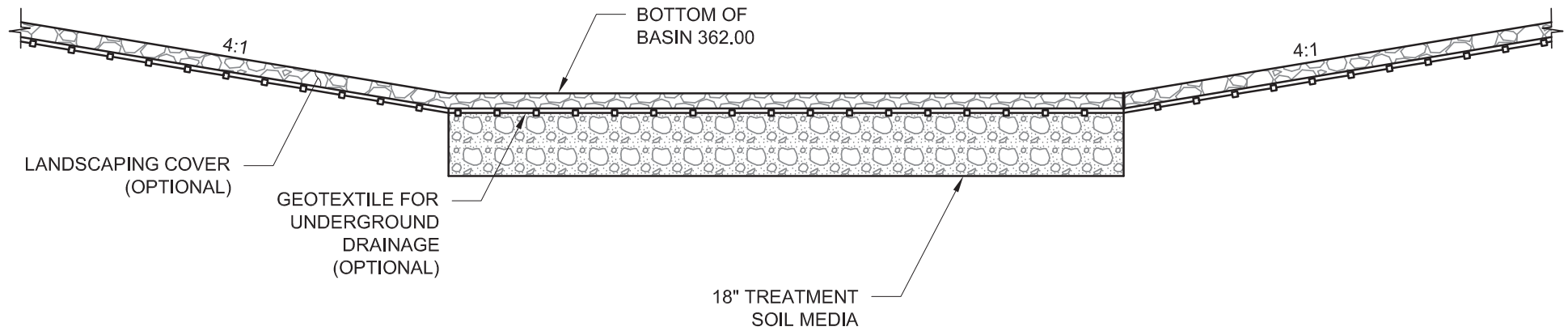
2012 Aerial Imagery

Attachment 5-3



Date Created: January 12, 2015

Attachment 5-4



INFILTRATION BASIN SECTION

SCALE: NTS

ATTACHMENT 6 — PRE-DESIGN LEVEL CONSTRUCTION COST ESTIMATES

Outfall NR05 Stormwater Retrofit Project - Alt 1 - Dispersion				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
2	Project Temporary Traffic Control	LS	1	\$ 8,000.00	\$ 8,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 1,000.00	\$ 1,000.00
4	Structure Excavation Class B Incl. Haul	CY	106.5	\$ 10.00	\$ 1,065.06
5	Shoring or Extra Excavation Class A	LS	1	\$ 3,000.00	\$ 3,000.00
6	Crushed Surfacing Base Course	TON	4.1	\$ 20.00	\$ 82.37
7	Crushed Surfacing Top Course	TON	2.7	\$ 25.00	\$ 68.65
8	HMA Cl. 1/2-Inch PG 64-28	TON	3.8	\$ 80.00	\$ 303.14
9	Solid Wall PVC Storm Sewer Pipe 8 In. Diam.	LF	160.0	\$ 40.00	\$ 6,400.00
10	48 In. Diam. Manhole Type 3	EA	3	\$ 3,000.00	\$ 9,000.00
11	ESC Lead	DAY	3	\$ 100.00	\$ 300.00
12	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
13	Gravel Backfill for Pipe Zone Bedding	TON	46.9	\$ 25.00	\$ 1,172.84
14	Cement Concrete Curb and Gutter	LF	10	\$ 25.00	\$ 250.00
15	Cement Concrete Sidewalk, 4-Inch Thick	SY	3	\$ 50.00	\$ 150.00
16	Re-Planting	LS	1	\$ 2,000.00	\$ 2,000.00
17	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Construction Subtotal				\$ 48,792.06
	Design Preparation (10%)				\$ 4,879.21
	Construction Management (10%)				\$ 4,879.21
	WA State Sales Tax (8.6%)				\$ 4,196.12
	Subtotal				\$ 62,746.58
	Pre-Design Contingency (20%)				\$ 12,549.32
	Total				\$ 75,295.90

Outfall NR05 Stormwater Retrofit Project - Alt 2 - Infil. Basin				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
2	Project Temporary Traffic Control	LS	1	\$ 8,000.00	\$ 8,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 2,000.00	\$ 2,000.00
4	Structure Excavation Class B Incl. Haul	CY	32.7	\$ 10.00	\$ 326.61
5	Shoring or Extra Excavation Class A	LS	1	\$ 3,000.00	\$ 3,000.00
6	Crushed Surfacing Base Course	TON	8.3	\$ 20.00	\$ 165.03
7	Crushed Surfacing Top Course	TON	5.5	\$ 25.00	\$ 137.53
8	HMA Cl. 1/2-Inch PG 64-28	TON	7.6	\$ 80.00	\$ 607.33
9	Solid Wall PVC Storm Sewer Pipe 8 In. Diam.	LF	24.0	\$ 40.00	\$ 960.00
10	Infiltration Basin	EA	1	\$ 15,000.00	\$ 15,000.00
11	Sedimentation Manhole 72 In. Diam.	EA	1	\$ 15,000.00	\$ 15,000.00
12	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
13	Erosion and Water Pollution Control	FA	EST	\$ 1,000.00	\$ 1,000.00
14	Construction Geotextile for Underground Drainage	SY	210.0	\$ 2.50	\$ 525.00
15	Gravel Backfill for Pipe Zone Bedding	TON	7.0	\$ 25.00	\$ 175.93
16	Energy Dissipation	LS	1	\$ 500.00	\$ 500.00
17	Concrete Curb and Gutter	LF	30	\$ 25.00	\$ 750.00
18	Re-Planting	LS	1	\$ 5,000.00	\$ 5,000.00
19	Irrigation	LS	1	\$ 5,000.00	\$ 5,000.00
20	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Construction Subtotal				\$ 73,347.43
	Design Preparation (10%)				\$ 7,334.74
	Construction Management (10%)				\$ 7,334.74
	WA State Sales Tax (8.6%)				\$ 6,307.88
	Subtotal				\$ 94,324.79
	Pre-Design Contingency (20%)				\$ 18,864.96
	Total				\$ 113,189.75
Notes: • Infiltration Facility includes excavation, grading, soil mix, and landscaping cover.					

Outfall NR05 Stormwater Retrofit Project - Alt 3 - Drywells				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
2	Project Temporary Traffic Control	LS	1	\$ 10,000.00	\$ 10,000.00
3	Removal of Structure and Obstruction	LS	1	\$ 8,000.00	\$ 8,000.00
4	Structure Excavation Class B Incl. Haul	CY	208.7	\$ 10.00	\$ 2,086.88
5	Crushed Surfacing Base Course	TON	150.8	\$ 20.00	\$ 3,016.67
6	Crushed Surfacing Top Course	TON	100.6	\$ 25.00	\$ 2,513.89
7	HMA Cl. 1/2-Inch PG 64-28	TON	138.8	\$ 80.00	\$ 11,101.33
8	Solid Wall PVC Storm Sewer Pipe 12 In. Diam.	LF	236.0	\$ 40.00	\$ 9,440.00
9	Precast Concrete Drywell	EA	4	\$ 6,000.00	\$ 24,000.00
10	Catch Basin Type 1	EA	2	\$ 1,000.00	\$ 2,000.00
11	Manhole 48 In. Diam. Type 3	EA	1	\$ 3,000.00	\$ 3,000.00
12	Sedimentation Manhole 48 In. Diam.	EA	2	\$ 3,500.00	\$ 7,000.00
13	Connection to Drainage Structure	EA	1	\$ 1,000.00	\$ 1,000.00
14	ESC Lead	DAY	2	\$ 100.00	\$ 200.00
15	Erosion and Water Pollution Control	FA	EST	\$ 2,000.00	\$ 2,000.00
16	Gravel Backfill for Pipe Zone Bedding	TON	91.8	\$ 25.00	\$ 2,294.44
17	Minor Change	FA	EST	\$ 5,000.00	\$ 5,000.00
	Construction Subtotal				\$ 102,653.22
	Design Preparation (10%)				\$ 10,265.32
	Construction Management (10%)				\$ 10,265.32
	WA State Sales Tax (8.6%)				\$ 8,828.18
	Subtotal				\$ 132,012.04
	Pre-Design Contingency (20%)				\$ 26,402.41
	Total				\$ 158,414.44

CITY OF RICHLAND

Stormwater LID Retrofit Project Pre-Design Report



City of Richland
Public Works Department
840 Northgate Drive
P.O. Box 190, MS-26
Richland, WA 99352

April 16, 2014

ACKNOWLEDGEMENTS

City of Richland

Stormwater LID Retrofit Project—Pre-Design Report

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City of Richland

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Attachment 2	Existing and Proposed Subbasin Maps
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Section I—Introduction

As a part of the 2013-2015 Biennial Municipal Stormwater Capacity Grant Program, the Washington State Department of Ecology (Ecology) has provided the City of Richland (City), a NPDES Phase II community, with funds to conduct project specific planning and design (pre-construction) activities for retrofit projects which address stormwater pollution runoff from existing development. As a condition for pre-construction activity funding, at least one of the projects must implement low impact development techniques in accordance with Ecology approved design manuals, primarily the Stormwater Management Manual for Eastern Washington (SWMMEW) and the Eastern Washington Low Impact Development Guidance Manual (E. WA LID Manual).

City staff selected two locations as the best candidate sites for incorporating stormwater retention best management practices (BMPs): 1) Swift Blvd.; and 2) Columbia Park Trail. These sites were evaluated for retrofits based on their proximity to an impaired waterbody (Columbia River), traffic volumes, size of drainage area, public visibility, and use.

In the fall of 2013, Ecology reviewed conceptual retrofit ideas for the sites and verified them as eligible to use planning and design grant funds. The retrofit project locations are shown in the vicinity map below and described in detail in Section 2.



Section I—Introduction

Continued

An overview of Richland’s climate is provided in the table below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	40.7	48.6	57.9	66.4	75.3	82.2	90.5	89.3	80.6	66.7	50.7	41.5	65.9
Average Min. Temperature (F)	26.4	30.2	35.1	40.8	48.1	54.7	59.7	58.7	50.8	41.2	33.7	28.2	42.3
Average Total Precipitation (in.)	0.99	0.70	0.61	0.49	0.59	0.54	0.20	0.23	0.28	0.54	0.93	1.05	7.15
Average Total Snowfall (in.)	2.6	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.2	7.1
Avg. Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Source: Western Region Climate Center (2014)

Both sites are located in climatic Region 2 (Central Basin) of eastern Washington and receive approximately 7.15 inches of mean annual precipitation, a portion of which falls as snow.

Section 2—Basin and Site Descriptions

2.1 Swift Blvd.

A portion of Swift Blvd. consists of a four-lane roadway with streetside parking and a 40-foot vegetated median. The median presents an excellent opportunity to allow localized street runoff to be retained, treated, and infiltrated rather than entering into the existing storm drain system, which conveys untreated runoff to a U.S. Army Corps of Engineers drainage system where it is subsequently pumped to the Columbia River.

2.1.1 Basin Description

Basin Delineation

An overall basin map for the Swift Blvd. stormwater drainage system is provided as Attachment 2-1. Fifteen subbasins have been identified for potential bioretention retrofits along the median of Swift Blvd. Drainage subbasin maps are provided as Attachments 4-1 through 4-4. The maps show the drainage basin boundaries and flow directions for existing and proposed conditions. Existing and proposed peak runoff rates and volume calculations are provided in Attachment 3.



Swift Blvd. Median Looking West

Basin Information

The existing land use consists primarily of residential homes with limited public and commercial areas. There are no expected future land use changes for the sites or overall basin.

Native soils are generally Hydrologic Class A, expected to have high to very high infiltration rates. The water table is expected to be well below the ground surface.

The overall Swift Blvd. basin is approximately 116.18 acres in size and consists of roughly 105.18 acres of impervious surfaces and 11.00 acres of pervious surfaces. The smaller subbasins range in size from 2,000 sq-ft to almost 1 acre and consists almost entirely of impervious surfaces.

Stormwater quality issues include those typically associated with moderate average daily traffic (ADT) urban minor arterial roadways, including sediments, hydrocarbons, vehicle fluids, metals, elevated temperature, and other pollutants.

Section 2—Project Descriptions

Continued

Based on review of Ecology's 2012 303(d) list of impaired receiving waters, the Columbia River is currently listed as impaired for temperature near the ultimate discharge point for the project area. There are currently no ongoing efforts to develop a total maximum daily load (TMDL) for this water quality impairment. Retention and infiltration is a suitable way to reduce temperature increases due to stormwater runoff from impervious surfaces during spring through fall thunderstorms.

2.1.2 Site Description

Existing Stormwater Controls

The overall Swift Blvd. basin, including the subbasins, drain to an existing stormwater conveyance system that ultimately discharges to the Columbia River (see Attachment 2-1). There are no existing stormwater quality or flow control BMPs in the basin (the Columbia River is exempt from flow control requirements).

Total Area, Impervious Area, Pervious Area

In total, the fifteen drainage subbasins are approximately 3.66 acres in size. Attachment 3-2 provides a breakdown of Total Area, Connected ISA, Disconnected ISA, and Pervious Area by subbasin. Refer to Attachment 4-1 through 4-4 for subbasin delineations.

Vegetation and Wetlands

Existing vegetation in the median includes: maintained turf grass, mature trees, and other shrubbery. No wetlands are present within the immediate project area.

Soils

According to the Benton County Soil Survey, surficial soils at the project site primarily consist of Burbank loamy fine sand, an excessively drained soil with an estimated saturated hydraulic conductivity in the 5.95 to 19.98 inches/hour range (see Attachment 1). Based on the experience of City staff on a recent stormwater infiltration design project, it is anticipated that each bioretention swale will require soil amendments to reduce the infiltration rate of the facility to meet the water quality design requirements as stated in the Stormwater Management Manual for Eastern Washington. Note that a detailed geotechnical investigation will be performed during the design stage.

Access

Access to the site is readily available through the existing City road infrastructure.

2.2 Columbia Park Trail

Columbia Park Trail is a 4-lane roadway located in southern Richland along the Columbia River. The City's 2013 Streetscape Master Plan proposes sidewalk and greenspace improvements along both sides of Columbia Park Trail, including parking lot improvements for Wye Park. The proposed greenspace presents an excellent opportunity to allow localized street and parking lot runoff to be retained, treated, and infiltrated within bioretention swales rather than entering into the existing storm drain system, which discharges directly to the Columbia River. As an alternative to grading the parking lot to drain to a bioretention swale, porous asphalt will be considered as the design process progresses. Due to project scope and funding limitations, this submittal focuses only on retrofitting LID BMPs on the north side of the roadway (with the exception of a bioretention facility on the south side of the roadway at the intersection of Columbia Center Blvd., near the City storm outfall SR08).

2.2.1 Basin Description

Basin Delineation

Existing and proposed subbasin maps are provided as a part of Attachments 4-9 through 4-12. The maps show the drainage basin boundaries and flow directions for existing and proposed conditions. Existing and proposed peak runoff rates and volume calculations are provided in Attachment 3.

Basin Information

The existing land use consists of commercial and industrial businesses, as well as open space. There are no expected future land use changes for the project area.



Columbia Park Trail Shoulder Looking East

Native soils are generally Hydrologic Class A, expected to have high to very high infiltration rates. The water table is expected to be below the ground surface at an elevation similar to the Columbia River.

In total, the twelve drainage subbasins evaluated for this project (SR08 and SR20a through SR20k) are approximately 5.34 acres in size and consist primarily of sloped to fairly flat impervious surfaces.

Stormwater quality issues include those typically associated with moderate ADT urban minor arterial roadways, including sediments, hydrocarbons, vehicle fluids, metals, and elevated temperature, and other pollutants.

Section 2—Project Descriptions

Continued

Based on review of Ecology's 2012 303(d) list of impaired receiving waters, the Columbia River is currently listed as impaired for temperature near the ultimate discharge point for the project area. There are currently no ongoing efforts to develop a total maximum daily load (TMDL) for this water quality impairment. Retention and infiltration is a suitable way to reduce temperature increases due to stormwater runoff from impervious surfaces during spring through fall thunderstorms.

2.2.2 Site Description

Existing Stormwater Controls

The intersection of Columbia Park Trail and Columbia Center Blvd. is drained by an existing stormwater conveyance system that discharges directly to the Columbia River (SR08). There are no existing stormwater quality or flow control BMPs in the subbasin (the Columbia River is exempt from flow control requirements). The remaining subbasins (SR20a through SR20k) discharge to a drainage swale behind a U.S. Army Corps of Engineers levee. The swale likely provides some water quality and flow control benefit for the Columbia River.

Total Area, Impervious Area, Pervious Area

In total, the twelve drainage subbasins are approximately 5.34 acres in size. Attachment 3-2 provides a breakdown of Total Area, Connected ISA, Disconnected ISA, and Pervious Area by subbasin. Refer to Attachment 4-9 and 4-12 for subbasin delineations.

Vegetation and Wetlands

Existing vegetation at the project site includes naturally vegetated roadway shoulders and maintained park landscaping. No wetlands are present within the immediate project area.

Soils

According to the Benton County Soil Survey, surficial soils at the project site consist of Burbank loamy fine sand, an excessively drained soil with an estimated saturated hydraulic conductivity in the 5.95 to 19.98 inches/hour range and Finley stony fine sandy loam, a well drained soil with an estimated saturated hydraulic conductivity in the 1.98 to 5.95 inches/hour range (see Attachment 1). Based on the experience of City staff on a recent stormwater infiltration design project, it is anticipated that each bioretention swale will require soil amendments to reduce the infiltration rate of the facility to meet the water quality design requirements as stated in the Stormwater Management Manual for Eastern Washington. Note that a detailed geotechnical investigation will be performed during the design stage.

Access

Access to the site is readily available through the existing City road infrastructure.

Section 3—Design Alternatives and Analysis

3.1 Alternatives Considered

City staff initially evaluated a number of sites for retrofit desirability based on proximity to a receiving water, public visibility and use, and planned City projects. This initial process resulted in the identification of three candidate sites including: 1) Swift Blvd.; 2) the Uptown Mall Parking Lot; and 3) Columbia Park Trail.

The Uptown Mall Parking Lot is owned by the City and presents an opportunity to improve stormwater quality and flow control through the use of LID BMPs (primarily bioretention). The conceptual design for the Uptown Mall parking lot (see Attachments 4-5 through 4-8) includes retrofitting bioretention facilities into the existing parking lot at strategic locations. Two conceptual alternatives were developed:

- Alternative 1.** Construct large bioretention facilities over the top of existing catch basins and modify the catch basins to serve as overflow structures into the existing storm system; or
- Alternative 2.** Construct small bioretention facilities at the ends of each row of parking and leave the existing storm system unmodified for overflow.

Hydrology and sizing calculations were performed for both alternatives at a select area within the parking lot. The City intends to begin talks with the mall tenants to determine which, if any, of these concepts will be preferred before utilizing template sizing calculations and completing design for the remainder of the parking lot. It is unlikely that the City will be able to complete a 90% design by the current July 31 grant deadline. As such, the City has decided to focus current grant funded design efforts on the Swift Blvd. and Columbia Park Trail retrofit sites.

Following the selection of the two preferred retrofit sites, a meeting and field review was conducted with City staff to refine the selection and location of LID BMPs at each site. The following issues were considered during the BMP selection and layout process:

- Climate/seasonal precipitation patterns.
- Expected traffic use levels.
- Available right-of-way and setback requirements.
- Ability to work with existing drainage patterns and infrastructure to degree possible.
- Review/avoidance of likely utility/existing infrastructure issues.
- Likely soil and groundwater properties/conditions.
- Avoidance of steep or unstable slopes, or other geologic hazard areas.
- Ability to help address receiving water concerns.
- Minimizing/avoiding work within exterior roads and sidewalks.
- Typical O&M requirements/level of effort/special equipment.

Section 3—Design Alternatives and Analysis

Continued

- Critical areas issues.
- Tree related issues such as the effects of roots and leaves on BMPs.
- Ability to safely drain overflow water to an appropriate location.
- Ability to prevent significant problems in the event that systems fail or periodically operate below the intended design level.
- City tree/shrub retention/replacement goals/requirements.
- Corridor beautification goals/standards.
- Aesthetic compatibility of BMPs with existing site structures and features.
- Consideration of future improvement projects.

Many of these considerations are also feasibility criteria recommended by the Eastern Washington LID and Stormwater Management Manuals.

3.2 Description of Final Alternatives

3.2.1 Design Storms

Water quality facilities (bioretention swales) will be designed to retain, treat, and infiltrate up to the 25-year, 24-hour SCS Type 1A storm event for the contributing areas. Each facility will be designed to completely drain down within at most 72-hours in order to meet the following objectives:

- Restore hydraulic capacity to receive runoff from a new storm;
- Maintain infiltration rates; and
- Aerate vegetation and soil to keep the vegetation healthy, prevent anoxic conditions in the treatment soils, and enhance the biodegradation of pollutants and organics.

All storm drain pipes and other conveyance facilities will be designed to convey the peak discharge from the 10-year, 3-hour short duration storm event.

3.2.2 Preliminary Infiltration Characteristics

As discussed in Section 2, based on published Soil Survey information, the saturated hydraulic conductivity of the native soil at each site is estimated at 5.95 to 19.98 inches/hour, which can also serve as an initial conservative estimate of the long-term infiltration rate for minimal ponding depth situations (gravity flow conditions). For purposes of this Pre-Design Report, it was assumed that soil amendments will be required to reduce the infiltration rate of each facility to 2.4 inches/hour in order to meet the water quality design requirements as stated in the Stormwater Management Manual for Eastern Washington.

Geotechnical testing will be conducted to verify soil properties.

3.2.3 Swift Blvd.

The Swift Blvd. retrofit project includes retrofitting bioretention facilities into existing landscaped median islands and adjacent shoulder landscaped areas. Preliminary hydrology and sizing calculations reveal that most bioretention facilities may be able to retain, treat, and infiltrate stormwater runoff up to the 25-year storm event from localized roadway subbasins. The concept of utilizing the median space to daylight the storm main and treat at least the water quality storm for the entire Swift Blvd. basin was deemed infeasible due to the size of the overall basin and large amount of stormwater runoff generated during the 6-month, 24-hour storm event.

Key aspects of the project include:

- Installing curb inlets along the median to allow localized street runoff to enter into proposed bioretention swales.
- In two locations, installing a bubble-up system to direct runoff from nearby catch basins into proposed median bioretention swales.
- In one location, installing a flow splitter to direct up to the 25-year, 24-hour peak flow to a proposed bioretention swale located in a relatively flat grassed portion of the George Prout Aquatic Complex (City owned) and constructing an emergency overflow for the bioretention swale.

Refer to the pre-design plan drawings included as Attachments 4-1 through 4-4 for additional information. These same attachments also include proposed subbasin maps as well as approximate utility locations. Peak runoff rates and volume calculations are provided in Attachments 3.

Water Quality Benefits

The proposed stormwater LID retrofits will reduce the volume of runoff from each outfall site as compared to the existing condition by retaining and infiltrating the 25-year, 24-hour SCS Type 1A storm event from the contributing areas. Water quality is also improved from the existing condition since the proposed BMPs will effectively retain and treat greater than 90% of the annual runoff volume from the retrofit areas including nearly all of the “first flush” storm events.

Preliminary Cost Estimate

The pre-design level construction cost estimate for the Swift Blvd. retrofit project is \$386,688.17, including a 50% pre-design contingency. See Attachment 5 for a complete breakdown of the pre-design level construction cost estimate.

Section 3—Design Alternatives and Analysis

Continued

3.2.4 Columbia Park Trail

The Columbia Park Trail retrofit project includes retrofitting bioretention facilities into existing roadway shoulder areas and either porous asphalt or bioretention into an existing public parking lot during a future roadway corridor improvement project. The goal of the retrofit projects is to improve stormwater quality for the runoff discharging to outfalls SR08 and SR20. The conceptual locations for bioretention facilities were taken from the City's Streetscape Master Plan (June 2013). Due to project scope and funding limitations, this submittal focuses only on retrofitting bioretention on the north side of the roadway (with the exception of a bioretention facility for SR08 on the south side of the roadway at the intersection of Columbia Center Blvd.). Preliminary hydrology and sizing calculations reveal that most bioretention facilities may be able to retain, treat, and infiltrate stormwater runoff up to the 25-year storm event from localized roadway subbasins.

Key aspects of the project include:

- Constructing new sidewalk along Columbia Park Trail with curb inlets to allow localized street runoff to enter into proposed bioretention swales along the backside of the sidewalk. The City is aware that sidewalk improvements are likely not grant eligible, and will have to fund them separately.
- Improving the existing park parking by:
 - Alternative 1: utilizing conventional asphalt to direct stormwater runoff towards a bioretention swale; or
 - Alternative 2: utilizing porous asphalt.

As the design progresses the City will decide which site improvement will be best.

Refer to the pre-design plan drawings included as Attachments 4-9 through 4-12 for additional information. These same attachments also include proposed subbasin maps as well as approximate utility locations. Peak runoff rates and volume calculations are provided in Attachment 3.

Water Quality Benefits

The proposed stormwater LID retrofits will reduce the volume of runoff from each outfall site as compared to the existing condition by retaining and infiltrating the 25-year, 24-hour SCS Type 1A storm event from the contributing areas. Water quality is also improved from the existing condition since the proposed BMPs will effectively retain and treat greater than 90% of the annual runoff volume from the retrofit areas including nearly all of the “first flush” storm events.

Section 3—Design Alternatives and Analysis

Continued

Preliminary Cost Estimate

The pre-design level construction cost estimate for Alternative 1 of the Columbia Park Trail retrofit project is \$473,224.25, including a 50% pre-design contingency. The pre-design level construction cost estimate for Alternative 2 of the Columbia Park Trail retrofit project is \$610,942.61, including a 50% pre-design contingency. See Attachment 5 for a complete breakdown of the pre-design level construction cost estimates.

Section 4—Implementation Considerations

4.1 Design and Operational Considerations to be Addressed Between the Pre-Design Report and 60% Design

The design submitted with this Pre-Design Report is at a preliminary level. Design and operational considerations to be addressed in the next phase of the design process are discussed below.

4.1.1 Existing Utilities

There are multiple water lines running through the median areas of Swift Blvd. It was assumed that the water lines are sufficiently deep and will not interfere with the bioretention facilities. During the design phase, the City will want to call for locates, perform potholing, and/or utilize as-built information to gain a better understanding of the exact location and depth to the existing water lines as well as any other utilities.

4.1.2 Swift Blvd. Median Bioretention Areas East of Long Avenue

The landscaped median east of Long Ave. on Swift Blvd. has approximately 20 feet of fall across its length. This will require a stair-stepped bioretention design that may be difficult to construct and potentially unattractive. We do not recommend pursuing bioretention placement within this median; however, if the City decides to move forward with design, Attachment 1 provides preliminary sizing calculations and Attachment 2-5 shows a possible layout. Based on recent communications (Asotin County), Ecology considers drywells to be equivalent to an approved LID approach; while not a visible and educational BMP for the public, they may be a good retrofit option for this steep sloped area.

4.1.3 Bioretention Footprints

The bioretention footprints shown in Attachment 2 are rectangular in shape for purposes of quickly calculating and displaying the estimated size of the facilities required to retain, treat, and infiltrate stormwater runoff up to the 25-year storm event. The actual design should be aesthetically pleasing with respect to shape, landscaping, cover, and vegetation selection. We also recommend, where feasible, that bioretention facilities adjacent to roadway curbing (i.e., no sidewalk) be setback from the roadway curbing at least 3 feet for vehicle safety and roadway integrity reasons. The use of shallow infiltration next to existing pavements should consider and address any structural stability concerns (this is generally not a significant concern unless fine textured subgrade soils are present).

Section 4—Implementation Considerations

Continued

4.1.4 Curb Inlets to Bioretention Facilities

The curb inlets into bioretention facilities should have the ability to capture sediment and debris prior to spilling runoff into the facility for treatment and infiltration. The example shown on the right is the preferred approach; it allows roadway runoff to enter into a sump where large sediment and debris will settle out, while the backside of the sump structure serves as a weir allowing runoff to spill into the bioretention facility. The sump structure should have an access lid for easy maintenance of the sump (i.e., removal of sediment and debris) that is large enough for use of the City's vactor truck hose. The weir elevation should be set 1 – 2 inches below the roadway gutter elevation to ensure adequate head. The grading design of the bioretention facilities should allow runoff to enter the facility, but when the facility is full of water that water surface elevation should be equal to that of the calculated water depth traveling in the roadway gutter at the inlet; this will not allow any additional water to enter the facility thereby eliminating the need for an overflow structure. Roadway runoff not able to enter a full bioretention facility should continue down the gutter to the nearest existing catch basin/inlet and into the City's existing storm system. Each bioretention facility should also be designed with some amount of freeboard to ensure that the facility does not overtop as the water surface elevation in the facility approaches that of the calculated maximum water depth traveling in the roadway gutter.

This preferred inlet also provides for a continuous curb, which will ultimately be safer for vehicles and not allow a vehicle tire to travel into the inlet as could potentially be the case for other inlet types, an example of which is shown in the photo on the right.

Also note that not all inlets are shown for the Columbia Park Trail retrofit sites. It is expected that some subbasins will need to be further broken up and inlets added as necessary to accommodate topographic changes along the roadway alignment.



Example photo of a preferred curb inlet with sump into a bioretention facility (likely oversized).



Example photo of a curb cut inlet into a bioretention facility (not the preferred approach.)

Section 4—Implementation Considerations

Continued

4.1.5 Swift Blvd. Bioretention Facilities Served by Bubble Ups

There are two opportunities along Swift Blvd. where stormwater runoff can be intercepted and allowed to bubble up into two separate median bioretention facilities (refer to Attachments 2-3 and 2-4). In both cases, the concept is to install a manhole along the storm lateral with a new storm pipe leading east to a bubble up structure placed at the bottom of a bioretention facility. Within the manhole there will be an overflow weir/structure to allow stormwater to overflow into the existing storm system once the bioretention swale is full. Preliminary elevations and calculations suggest that there will be enough head between the upstream catch basin and the downstream bubble up to allow at least the 10-year, 3-hour short duration peak flow to pass through the system and enter the bioretention swale.

4.1.6 Recommended Landscaping, Vegetation, and Irrigation

The character of the bioretention facilities may vary depending on the setting and goals of the City. Preliminary landscaping, vegetation, and irrigation recommendations for the Swift Blvd. and Columbia Park Trail retrofit locations are provided below:

- **Swift Blvd** — The bioretention facilities within the medians of Swift Blvd. should use more of a xeriscaped approach where the existing turf is replaced with low maintenance river rock, landscaping cobbles/boulders, and several low to moderate water use plants that perform well with minimal supplemental irrigation. See Attachment 4 for examples of this approach. Several plant species suitable for this condition are included in the table below.

Scientific/Common Name	Planting Zone ¹	Height/ Spread	Typical Spacing ²	Sun/Shade Preference	Irrigation Need
<i>Spiraea</i> species Spirea	1	2-4'/2-4'	8'	Full Sun to Part Shade	Mod
<i>Physocarpus</i> species Ninebark	1	6-8'/6-8'	16'	Full Sun to Part Shade	Mod
<i>Helictotrichon sempervirens</i> Blue Oat Grass	1	2-4'/2-3'	6'	Full Sun	Mod
<i>Lonicera tatarica</i> Honeysuckle	2	8-10'/8-10'	20'	Full Sun	Low
<i>Berberis</i> species Barberry	2	4-6'/4-6'	12'	Full Sun to Part Shade	Low
<i>Perovskia atriplicifolia</i> Russian Sage	2	3-5'/3-4'	8'	Full Sun	Low
<i>Festuca ovina glauca</i> Blue Fescue	2	10-12'/10-12'	24"	Full Sun to Part Shade	Low

¹ Planting Zone 1 includes bottom portion of bioretention facility subject to periodic inundation or saturation. Zone 2 includes side slopes with dry soils that are infrequently inundated or saturated.

² Typical spacing per plant defined as twice the mature plant spread. City may wish to increase/decrease spacing depending on desired planting density.

Section 4—Implementation Considerations

Continued

- Columbia Park Trail** — The bioretention facilities should incorporate roadside trees, turf grass, and other landscaping per the City's Streetscape Master Plan. Placing trees or other vegetation in or around the bioretention facilities should have minimal to no impact on the facilities ability to retain, treat, and infiltrate stormwater runoff; however, supplemental irrigation will be required. Since irrigation will be used it may be desirable to include more green vegetation including turf grass and flowering tree species. See Attachment 4 for examples of this approach. Several plant species suitable for this condition are included in the table below.

Scientific/Common Name	Planting Zone ¹	Height/Spread	Typical Spacing ²	Sun/Shade Preference	Irrigation Need
<i>Pyrus calleyana</i> 'Aristocrat' Aristocrat Callery Pear	1/2	20-30'/15-20'	40'	Full Sun	Mod
<i>Quercus robur</i> 'Crimschmidt' Crimson Spire Columnar Oak	1/2	35-45'/12-15'	40'	Full Sun	Mod
<i>Ginkgo biloba</i> 'Princeton' Princeton Sentry Maidenhair	1/2	50-65'/15-20'	40'	Full Sun	Mod
<i>Cornus florida</i> Dogwood (pink/white)	1/2	25'/25'	40'	Full Sun to Part Shade	Mod
<i>Festuca</i> species Tall Fescue Blend	1/2	N/A	N/A	Full Sun to Part Shade	Mod to High

¹ *Planting Zone 1 includes bottom portion of bioretention facility subject to periodic inundation or saturation. Zone 2 includes side slopes with dry soils that are infrequently inundated or saturated.*

² *Typical spacing per plant as provided in the City of Richland Streetscape Master Plan (2013).*

Additional design and operational considerations to be addressed in the next phase of the design process include:

- Call for utility locates (approximate utility locations are shown in Attachment 4).
- Collect detailed topographic and utilities survey data.
- Identify, avoid, or otherwise address any utility conflicts.
- Verify high groundwater levels and depth to bedrock.
- Test the soil conditions and infiltration characteristics and refine the BMP designs accordingly.
- Address potential irrigation requirements for bioretention swales (currently all proposed bioretention areas for Swift Blvd. have existing irrigation infrastructure).
- Prepare planting and irrigation plans for bioretention swales based on recommended plant species as described above.
- Specify mulching requirements to control weeds and any soil amendments necessary to meet required maximum infiltration rates and to help establish vegetation.

Section 4—Implementation Considerations

Continued

- Design flow entrances to provide for sediment control and erosion prevention as described above.
- Determine if conventional asphalt with a bioretention swale or porous asphalt is best suited for the parking lot at Wye Park.
- Verify construction accessibility and traffic control issues.
- Address O&M equipment accessibility and routes.
- Other considerations and limitations per the Eastern Washington LID Manual and the Stormwater Management Manual for Eastern Washington.

4.2 Additional Implementation Considerations

Based on City input, it is expected that permitting requirements include:

- Swift Blvd. – SEPA and City Construction Stormwater.
- Columbia Park Trail – SEPA, Shorelines, Critical Areas, City Construction Stormwater, and City Floodplain Development.
- State mandated cultural resources requirements.

Anticipated City Council involvement includes:

- Approval to submit grant application for construction funding.
- Approval for any contracts associated with project work.
- Approval to place LID projects on the City CIP list.

Section 5—Proposed Schedule

The City anticipates completing 60% design by mid-June, and 90% design by the end of July (to be submitted to Ecology for review and acceptance). The 90% design package will include:

- 90% design
- 90% bid schedule
- 90% bid specifications and special provisions
- Engineers estimate of probable project costs
- O&M Guide

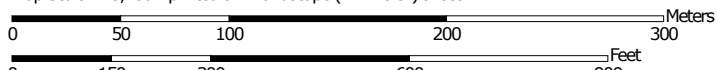
Following completion of the 90% design, the City will complete and submit an application to the competitive grant program scheduled for September 2014 in hopes of securing grant funding for construction activities.

ATTACHMENT 1 — PRELIMINARY GEOTECHNICAL INFORMATION

Soil Map—Benton County Area, Washington (Swift Blvd)



Map Scale: 1:3,480 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge ticks: UTM Zone 11N WGS84



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

3/27/2014
Page 1 of 3

Soil Map—Benton County Area, Washington
(Swift Blvd)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

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

Date(s) aerial images were photographed: Aug 6, 2010—Oct 17, 2010

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

Benton County Area, Washington (WA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BbA	Burbank loamy fine sand, 0 to 2 percent slopes	24.7	59.8%
PaA	Pasco fine sandy loam, 0 to 2 percent slopes	3.9	9.5%
QuA	Quincy loamy sand, 0 to 2 percent slopes	7.7	18.8%
QuD	Quincy loamy sand, 2 to 15 percent slopes	4.9	11.9%
Totals for Area of Interest		41.2	100.0%

Benton County Area, Washington

BbA—Burbank loamy fine sand, 0 to 2 percent slopes

Map Unit Setting

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Map Unit Composition

Burbank and similar soils: 90 percent

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly
and stony alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to
very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability classification (irrigated): 4s

Land capability (nonirrigated): 6e

Hydrologic Soil Group: A

Typical profile

0 to 5 inches: Loamy fine sand

5 to 16 inches: Loamy sand

16 to 30 inches: Very gravelly loamy sand

30 to 60 inches: Extremely gravelly sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

PaA—Pasco fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

Elevation: 250 to 700 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 52 to 55 degrees F

Frost-free period: 136 to 190 days

Map Unit Composition

Pasco and similar soils: 90 percent

Description of Pasco

Setting

Landform: Flood plains

Parent material: Alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: About 24 to 36 inches

Frequency of flooding: Occasional

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Maximum salinity: Very slightly saline to slightly saline (4.0 to 8.0
mmhos/cm)

Sodium adsorption ratio, maximum: 10.0

Available water capacity: High (about 9.9 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance

Land capability classification (irrigated): 3w

Land capability (nonirrigated): 6e

Hydrologic Soil Group: C

Typical profile

0 to 6 inches: Fine sandy loam

6 to 60 inches: Silt loam

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

QuA—Quincy loamy sand, 0 to 2 percent slopes

Map Unit Setting

Elevation: 200 to 4,500 feet

Mean annual precipitation: 6 to 12 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 200 days

Map Unit Composition

Quincy and similar soils: 90 percent

Description of Quincy

Setting

Landform: Terraces

Parent material: Eolian sands

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to
very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 3 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Moderate (about 6.1 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance

Land capability classification (irrigated): 3e

Land capability (nonirrigated): 3e

Hydrologic Soil Group: A

Typical profile

0 to 9 inches: Loamy sand

9 to 60 inches: Loamy fine sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

QuD—Quincy loamy sand, 2 to 15 percent slopes

Map Unit Setting

Elevation: 200 to 4,500 feet

Mean annual precipitation: 6 to 12 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 200 days

Map Unit Composition

Quincy and similar soils: 100 percent

Description of Quincy

Setting

Landform: Terraces

Parent material: Eolian sands

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to
very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 3 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Moderate (about 6.1 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance

Land capability classification (irrigated): 4e

Land capability (nonirrigated): 3e

Hydrologic Soil Group: A

Typical profile

0 to 9 inches: Loamy sand

9 to 60 inches: Loamy fine sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Soil Map—Benton County Area, Washington (Uptown Mall)



Soil Map—Benton County Area, Washington
(Uptown Mall)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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Coordinate System: Web Mercator (EPSG:3857)

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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

Benton County Area, Washington (WA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BbA	Burbank loamy fine sand, 0 to 2 percent slopes	0.1	0.1%
BIA	Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes	5.1	10.1%
BID	Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes	0.1	0.3%
FeA	Finley fine sandy loam, 0 to 2 percent slopes	14.7	29.4%
PaA	Pasco fine sandy loam, 0 to 2 percent slopes	30.1	60.2%
Totals for Area of Interest		50.0	100.0%

Benton County Area, Washington

BbA—Burbank loamy fine sand, 0 to 2 percent slopes

Map Unit Setting

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Map Unit Composition

Burbank and similar soils: 90 percent

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly
and stony alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to
very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability classification (irrigated): 4s

Land capability (nonirrigated): 6e

Hydrologic Soil Group: A

Typical profile

0 to 5 inches: Loamy fine sand

5 to 16 inches: Loamy sand

16 to 30 inches: Very gravelly loamy sand

30 to 60 inches: Extremely gravelly sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

BIA—Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes

Map Unit Setting

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Map Unit Composition

Burbank and similar soils: 90 percent

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability classification (irrigated): 4s

Land capability (nonirrigated): 6e

Hydrologic Soil Group: A

Typical profile

0 to 5 inches: Loamy fine sand

5 to 16 inches: Loamy sand

16 to 30 inches: Very gravelly loamy sand

30 to 60 inches: Extremely gravelly sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

BID—Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes

Map Unit Setting

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Map Unit Composition

Burbank and similar soils: 100 percent

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability classification (irrigated): 4e

Land capability (nonirrigated): 6s

Hydrologic Soil Group: A

Typical profile

0 to 5 inches: Loamy fine sand

5 to 16 inches: Loamy sand

16 to 30 inches: Very gravelly loamy sand

30 to 60 inches: Extremely gravelly sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

FeA—Finley fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

Elevation: 300 to 1,800 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 135 to 180 days

Map Unit Composition

Finley and similar soils: 90 percent

Description of Finley

Setting

Landform: Flood plains, terraces

Parent material: Alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 20 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Low (about 4.3 inches)

Interpretive groups

Farmland classification: Prime farmland if irrigated

Land capability classification (irrigated): 3e

Land capability (nonirrigated): 6e

Hydrologic Soil Group: A

Typical profile

0 to 3 inches: Fine sandy loam

3 to 13 inches: Fine sandy loam

13 to 28 inches: Very gravelly loam

28 to 60 inches: Extremely gravelly sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

PaA—Pasco fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

Elevation: 250 to 700 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 52 to 55 degrees F

Frost-free period: 136 to 190 days

Map Unit Composition

Pasco and similar soils: 90 percent

Description of Pasco

Setting

Landform: Flood plains

Parent material: Alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: About 24 to 36 inches

Frequency of flooding: Occasional

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Maximum salinity: Very slightly saline to slightly saline (4.0 to 8.0
mmhos/cm)

Sodium adsorption ratio, maximum: 10.0

Available water capacity: High (about 9.9 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance

Land capability classification (irrigated): 3w

Land capability (nonirrigated): 6e

Hydrologic Soil Group: C

Typical profile

0 to 6 inches: Fine sandy loam

6 to 60 inches: Silt loam

Data Source Information

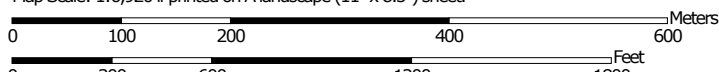
Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Soil Map—Benton County Area, Washington (Columbia Park Trail)



Map Scale: 1:6,920 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

3/27/2014
Page 1 of 3

Soil Map—Benton County Area, Washington
(Columbia Park Trail)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Benton County Area, Washington
Survey Area Data: Version 9, Dec 9, 2013

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

Date(s) aerial images were photographed: Aug 6, 2010—Oct 17, 2010

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

Benton County Area, Washington (WA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BIA	Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes	7.6	9.1%
BID	Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes	28.0	33.7%
FfE	Finley stony fine sandy loam, 0 to 30 percent slopes	25.5	30.7%
PaA	Pasco fine sandy loam, 0 to 2 percent slopes	13.0	15.7%
W	Water	9.0	10.8%
Totals for Area of Interest		83.1	100.0%

Benton County Area, Washington

BIA—Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes

Map Unit Setting

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Map Unit Composition

Burbank and similar soils: 90 percent

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability classification (irrigated): 4s

Land capability (nonirrigated): 6e

Hydrologic Soil Group: A

Typical profile

0 to 5 inches: Loamy fine sand

5 to 16 inches: Loamy sand

16 to 30 inches: Very gravelly loamy sand

30 to 60 inches: Extremely gravelly sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

BID—Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes

Map Unit Setting

Elevation: 300 to 1,300 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 160 to 220 days

Map Unit Composition

Burbank and similar soils: 100 percent

Description of Burbank

Setting

Landform: Terraces

Parent material: Mixed alluvium and/or eolian deposits over gravelly and stony alluvium

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability classification (irrigated): 4e

Land capability (nonirrigated): 6s

Hydrologic Soil Group: A

Typical profile

0 to 5 inches: Loamy fine sand

5 to 16 inches: Loamy sand

16 to 30 inches: Very gravelly loamy sand

30 to 60 inches: Extremely gravelly sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

FfE—Finley stony fine sandy loam, 0 to 30 percent slopes

Map Unit Setting

Elevation: 300 to 1,500 feet

Mean annual precipitation: 6 to 9 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 135 to 180 days

Map Unit Composition

Finley and similar soils: 90 percent

Description of Finley

Setting

Landform: Terraces, flood plains

Parent material: Alluvium

Properties and qualities

Slope: 0 to 30 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 20 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Low (about 4.2 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability classification (irrigated): 6e

Land capability (nonirrigated): 7s

Hydrologic Soil Group: A

Ecological site: SANDY 6-10 PZ (R007XY501WA)

Typical profile

0 to 3 inches: Stony fine sandy loam

3 to 13 inches: Fine sandy loam

13 to 28 inches: Very gravelly loam

28 to 60 inches: Extremely cobbly loamy sand

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

PaA—Pasco fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

Elevation: 250 to 700 feet

Mean annual precipitation: 6 to 10 inches

Mean annual air temperature: 52 to 55 degrees F

Frost-free period: 136 to 190 days

Map Unit Composition

Pasco and similar soils: 90 percent

Description of Pasco

Setting

Landform: Flood plains

Parent material: Alluvium

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: About 24 to 36 inches

Frequency of flooding: Occasional

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Maximum salinity: Very slightly saline to slightly saline (4.0 to 8.0
mmhos/cm)

Sodium adsorption ratio, maximum: 10.0

Available water capacity: High (about 9.9 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance

Land capability classification (irrigated): 3w

Land capability (nonirrigated): 6e

Hydrologic Soil Group: C

Typical profile

0 to 6 inches: Fine sandy loam

6 to 60 inches: Silt loam

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

Benton County Area, Washington

W—Water

Map Unit Composition

Water: 100 percent

Description of Water

Interpretive groups

Farmland classification: Not prime farmland

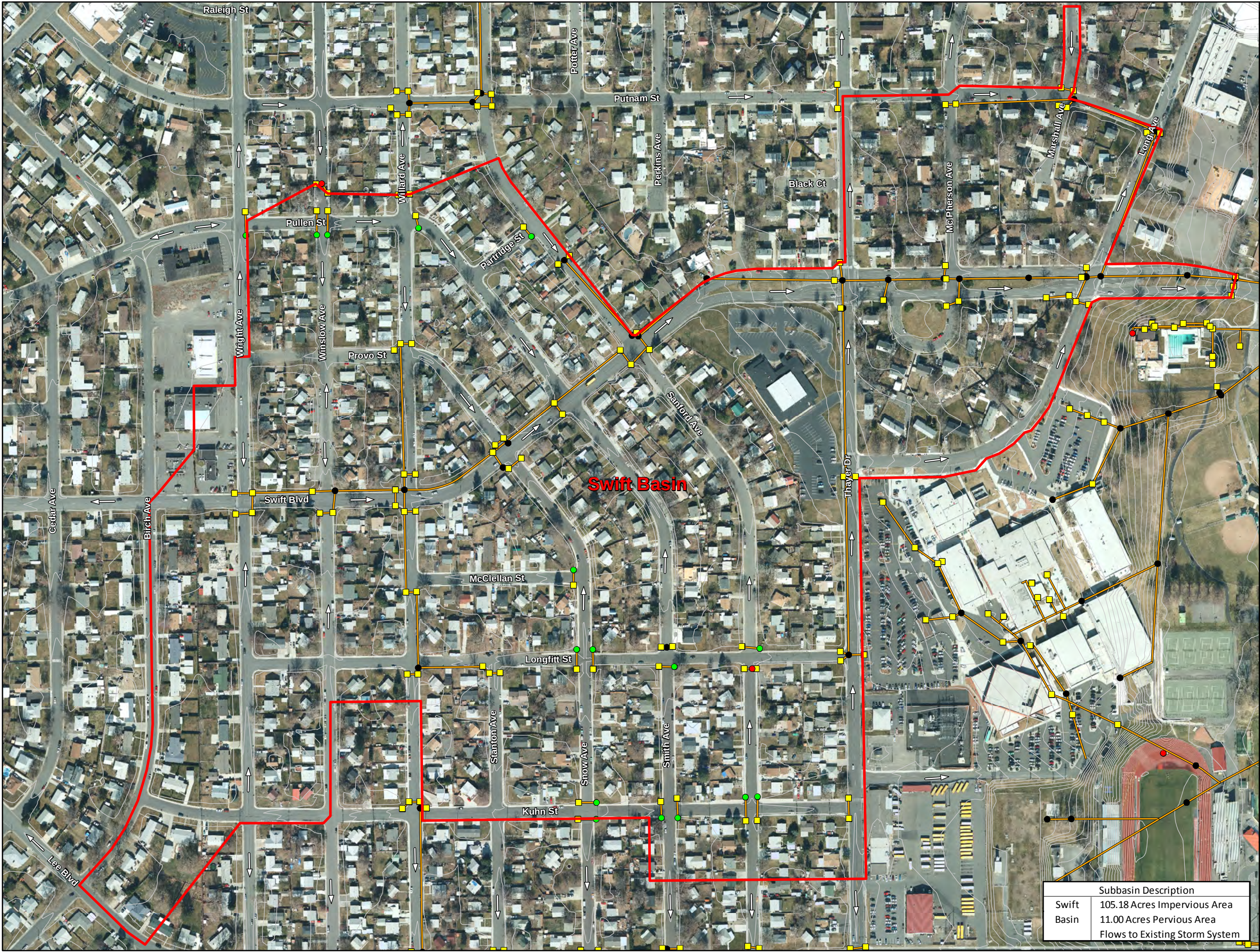
Land capability (nonirrigated): 8

Data Source Information

Soil Survey Area: Benton County Area, Washington

Survey Area Data: Version 9, Dec 9, 2013

ATTACHMENT 2 — EXISTING SUBBASIN MAPS



City of Richland Stormwater LID Retrofit Projects

Swift Blvd

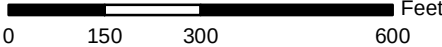
Existing Condition Subbasin Map

Legend

- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- 1999 Contours
- Subbasin
- Approx Flow Direction

2012 Aerial Imagery

Attachment 2-1



Date Created: March 28, 2014

Subbasin Description	
Swift Basin	105.18 Acres Impervious Area
	11.00 Acres Pervious Area
	Flows to Existing Storm System

ATTACHMENT 3 — DESIGN CALCULATIONS

Hydrologic Calculations - Time of Concentration

Stormwater Management Manual for Eastern Washington

Calculated By: E. Pruneda

Date: 3/28/2014

Project: Richland

Checked By: J. Knutson

Date: 3/31/2014

Project No: 33764414

Attachment 3-1

Sheet No: 1 of 1

	Sheet Flow					Shallow Concentrated Flow				Open Channel Flow				Time of Concentration
	$T_t = 0.42 * (n_s * L)^{0.8} / ((P_{2yr2hr})^{0.5} * (s_0)^{0.4})$					$T_t = L / (60 * (k * (s_0)^{0.5}))$				$T_t = L / (60 * (k_c * (s_0)^{0.5}))$				$T_c = T_{t1} + T_{t2} + ... T_{tm}$
Subbasin ID	n_s	L (ft)	P_{2yr2hr} (in)	s_0 (ft/ft)	T_t (min)	L (ft)	k	s_0 (ft/ft)	T_t (min)	L (ft)	k_c	s_0 (ft/ft)	T_t (min)	T_c (min)
Swift Basin	0.011	20	0.4	0.0200	0.95	913	27	0.0044	8.52	3521	42	0.0125	12.50	21.96
Swift1a	0.011	100	0.4	0.0100	4.52	183	27	0.0218	0.76					5.29
Swift1b	0.011	94	0.4	0.0211	3.19	280	27	0.0215	1.18					5.00
Swift1c	0.011	20	0.4	0.0246	0.87	172	27	0.0146	0.88					5.00
Swift2a	0.011	100	0.4	0.0150	3.85	180	27	0.0110	1.06					5.00
Swift2b	0.011	81	0.4	0.0123	3.52	238	27	0.0094	1.52					5.03
Swift2c	0.011	20	0.4	0.0200	0.95	588	27	0.0120	3.31					5.00
Swift2c Disconnected	0.15	61	0.4	0.0247	17.15	25	27	0.0119	0.14					17.29
Swift3a	0.011	24	0.4	0.0200	1.09	308	27	0.0065	2.36					5.00
Swift3b	0.011	52	0.4	0.0200	2.03	124	27	0.0162	0.60					5.00
Swift4a	0.011	100	0.4	0.0025	7.87	188	27	0.0050	1.64					9.51
Swift4b	0.011	100	0.4	0.0025	7.87	179	27	0.0040	1.75					9.62
Swift4c	0.011	100	0.4	0.0200	3.43	386	27	0.0039	3.82					7.25
Swift4c Disconnected	0.15	100	0.4	0.0250	25.35	349	27	0.0039	3.45					28.80
Swift5a	0.011	50	0.4	0.0200	1.97	433	27	0.0554	1.14					5.00
Swift5b	0.011	82	0.4	0.0212	2.86	157	27	0.0463	0.45					5.00
Swift5c	0.011	18	0.4	0.0550	0.58	74	27	0.0671	0.18					5.00
Swift5d	0.011	20	0.4	0.0497	0.66	90	27	0.0669	0.21					5.00
Uptown-Alt1	0.011	32	0.4	0.0200	1.38	231	27	0.0073	1.67					5.00
Uptown1-Alt2	0.011	66	0.4	0.0170	2.62									5.00
Uptown2-Alt2	0.011	78	0.4	0.0200	2.81									5.00
Uptown3-Alt2	0.011	66	0.4	0.0170	2.62									5.00
Uptown4-Alt2	0.011	55	0.4	0.0200	2.12									5.00
Uptown5-Alt2	0.011	74	0.4	0.0170	2.87									5.00
Uptown6-Alt2	0.011	47	0.4	0.0100	2.47									5.00
SR08	0.011	100	0.4	0.0019	8.87	561	27	0.0053	4.76					13.63

Notes:

- (1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.
Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.
- (2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.
- (3) All subbasins are considered "Connected ISA" unless otherwise shown.
- (4) Time of Concentration values less than 5 minutes were rounded up to 5 minutes.
- (5) Time of Concentration values for Columbia Park Trail (SR20a through SR20k) were assumed to be 5 minutes.

							24-Hour Type 1A Storm Event		24-Hour Type 1A Storm Event		24-Hour Type 1A Storm Event		24-Hour Type 1A Storm Event		3-Hour Short Duration Storm Event	
							6-Month (0.53 in)		2-Year (0.80 in)		10-Year (1.30 in)		25-Year (1.60 in)		10-Year (0.69 in)	
Subbasin ID	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T _c (min)	Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)	Volume (cf)	Peak Flow (cfs)	Volume (cf)
Swift Basin	116.18	11.00	0.91	98	49	21.96	7.06	131,089	12.68	228,440	23.20	413,694	29.47	526,382	65.06	188,569
Swift1a	0.07	0.00	1.00	98	49	5.29	0.01	92	0.01	160	0.02	290	0.03	369	0.09	132
Swift1b	0.41	0.00	1.00	98	49	5.00	0.04	513	0.06	894	0.12	1,619	0.15	2,060	0.50	738
Swift1c	0.08	0.00	1.00	98	49	5.00	0.01	106	0.01	184	0.02	333	0.03	424	0.10	152
Swift2a	0.08	0.00	1.00	98	49	5.00	0.01	94	0.01	163	0.02	295	0.03	376	0.09	135
Swift2b	0.19	0.00	1.00	98	49	5.03	0.02	243	0.03	424	0.05	767	0.07	976	0.24	350
Swift2c	0.35	0.00	1.00	98	49	5.00	0.03	438	0.05	764	0.10	1,383	0.13	1,760	0.43	631
Swift2c Disconnected	0.10	0.10	0.00	98	63.7	17.29	#N/A	#N/A	0.00	0	0.00	2	0.00	13	0.00	0
Swift2c Total							#N/A	#N/A	0.05	764	0.10	1,385	0.13	1,773	0.43	631
Swift3a	0.08	0.00	1.00	98	49	5.00	0.01	105	0.01	182	0.02	330	0.03	420	0.10	151
Swift3b	0.15	0.00	1.00	98	49	5.00	0.01	187	0.02	326	0.04	590	0.05	751	0.18	269
Swift4a	0.09	0.00	1.00	98	49	9.51	0.01	115	0.01	200	0.02	362	0.03	460	0.09	165
Swift4b	0.09	0.00	1.00	98	49	9.62	0.01	108	0.01	189	0.02	342	0.03	436	0.08	156
Swift4c	0.39	0.00	1.00	98	49	7.25	0.03	476	0.06	842	0.10	1,502	0.13	1,912	0.42	685
Swift4c Disconnected	0.97	0.97	0.00	98	63.7	28.80	#N/A	#N/A	0.00	0	0.00	15	0.00	121	0.00	0
Swift4c Total							#N/A	#N/A	0.06	842	0.10	1,518	0.13	2,032	0.42	685
Swift5a	0.24	0.00	1.00	98	49	5.00	0.02	300	0.04	523	0.07	948	0.09	1,206	0.29	432
Swift5b	0.25	0.00	1.00	98	49	5.00	0.02	307	0.04	535	0.07	968	0.09	1,232	0.30	441
Swift5c	0.05	0.00	1.00	98	49	5.00	0.00	59	0.01	104	0.01	188	0.02	239	0.06	86
Swift5d	0.07	0.00	1.00	98	49	5.00	0.01	82	0.01	143	0.02	260	0.02	330	0.08	118
Uptown-Alt1	1.54	0.11	0.93	98	79	5.00	0.12	1,793	0.22	3,135	0.40	5,726	0.51	7,319	1.75	2,583
Uptown1-Alt2	0.07	0.00	1.00	98	79	5.00	0.01	91	0.01	158	0.02	286	0.03	364	0.09	130
Uptown2-Alt2	0.13	0.02	0.88	98	79	5.00	0.01	137	0.02	240	0.03	441	0.04	566	0.13	197
Uptown3-Alt2	0.07	0.00	1.00	98	79	5.00	0.01	91	0.01	158	0.02	287	0.03	365	0.09	131
Uptown4-Alt2	0.08	0.01	0.88	98	79	5.00	0.01	91	0.01	160	0.02	294	0.03	378	0.09	132
Uptown5-Alt2	0.11	0.00	1.00	98	79	5.00	0.01	137	0.02	239	0.03	433	0.04	551	0.13	197
Uptown6-Alt2	0.14	0.04	0.71	98	79	5.00	0.01	122	0.02	216	0.03	411	0.04	536	0.12	177
SR08	1.32	0.00	1.00	98	49	13.63	0.10	1,643	0.18	2,863	0.33	5,185	0.42	6,598	1.07	2,364
SR20a	0.18	0.00	1.00	98	49	5.00	0.02	219	0.03	381	0.05	690	0.06	878	0.21	315
SR20b	0.68	0.00	1.00	98	49	5.00	0.06	849	0.10	1,480	0.19	2,680	0.24	3,410	0.83	1,222
SR20c	0.53	0.00	1.00	98	49	5.00	0.05	666	0.08	1,161	0.15	2,102	0.19	2,674	0.65	958
SR20d	0.40	0.00	1.00	98	49	5.00	0.03	499	0.06	869	0.11	1,574	0.14	2,002	0.49	717
SR20e	0.89	0.00	1.00	98	49	5.00	0.08	1,109	0.14	1,932	0.25	3,499	0.32	4,452	1.08	1,595
SR20f	0.25	0.00	1.00	98	49	5.00	0.02	317	0.04	552	0.07	999	0.09	1,271	0.31	455
SR20g	0.37	0.00	1.00	98	49	5.00	0.03	464	0.06	808	0.10	1,464	0.13	1,863	0.45	667
SR20h	0.19	0.00	1.00	98	49	5.00	0.02	231	0.03	403	0.05	730	0.07	929	0.23	333
SR20i	0.21	0.00	1.00	98	49	5.00	0.02	261	0.03	454	0.06	822	0.07	1,046	0.25	375
SR20j	0.13	0.00	1.00	98	49	5.00	0.01	156	0.02	273	0.04	494	0.04	628	0.15	225
SR20k	0.20	0.00	1.00	98	49	5.00	0.02	248	0.03	431	0.06	781	0.07	994	0.24	356

Notes:

(1) Connected ISA = Impervious streets, driveways, parking lots, etc. directly connected to the drainage system (via curb & gutter, catchbasins, downspouts connected to curbs, etc.). Runoff from these areas directly enters the drainage system.

Pervious and Disconnected ISA = Pervious areas + Impervious rooftops, etc. where runoff must flow through pervious areas prior to entering the drainage system.

(2) Connected ISA and Pervious and Disconnected ISA areas were modeled separately, each with their own Time of Concentration value.

(3) All subbasins are considered "Connected ISA" unless otherwise shown.

(4) It is assumed that Pervious and Disconnected ISA areas do not contribute runoff during the 6-Month, 24-Hour Type 1A Storm Event.

(5) 10-Year, 3-Hour Short Duration peak flows are provided for high-flow bypass conveyance sizing.

Bioretention Swale Calculations	Calculated By: E. Pruneda	Date: 3/28/2014	Project: Richland
	Checked By: J. Knutson	Date: 3/31/2014	Project No: 33764414
	Attachment 3-3		Sheet No: 1 of 1

Bioretention ID (Subbasin ID)	Available Storage Volume					Predicted Infiltration Rate (cfs)	24-Hour Type 1A Storm Event		24-Hour Type 1A Storm Event		24-Hour Type 1A Storm Event		24-Hour Type 1A Storm Event	
							6-Month (0.53 in)		2-Year (0.80 in)		10-Year (1.30 in)		25-Year (1.60 in)	
	Top Area (sq-ft)	Bottom Area (sq-ft)	Side Slope (H:V)	Depth (ft)	Volume (cf)		Volume (cf)	Max Volume in Swale During Event (cf)	Volume (cf)	Max Volume in Swale During Event (cf)	Volume (cf)	Max Volume in Swale During Event (cf)	Volume (cf)	Max Volume in Swale During Event (cf)
Swift1a	1513	528	2:1	0.5	510	0.029	92	0	160	0	290	0	369	0
Swift1b	1660	731	2:1	0.5	598	0.041	513	0	894	32	1619	158	2060	268
Swift1c	825	290	2:1	0.5	279	0.016	106	0	184	0	333	10	424	22
Swift2a	501	319	2:1	0.5	205	0.018	94	0	163	0	295	3	376	12
Swift2b	501	319	2:1	0.5	205	0.018	243	0	424	19	767	83	976	140
Swift2c	1565	1142	2:1	0.5	677	0.063	438	0	764	0	1385	49	1773	103
Swift3a	728	486	2:1	0.5	303	0.027	105	0	182	0	330	0	420	3
Swift3b	1251	965	2:1	0.5	554	0.054	187	0	326	0	590	0	751	0
Swift4a	1073	727	2:1	0.5	450	0.040	115	0	200	0	362	0	460	0
Swift4b	997	649	2:1	0.5	412	0.036	108	0	189	0	342	0	436	0
Swift4c	1788	1438	2:1	0.5	806	0.080	476	0	842	0	1518	28	2032	79
Swift5a	1553	1081	2:1	0.5	658	0.060	300	0	523	0	948	7	1206	34
Swift5b	543	316	2:1	0.5	215	0.018	307	4	535	36	968	140	1232	239
Swift5c	399	102	2:1	0.5	125	0.006	59	0	104	2	188	15	239	25
Swift5d	156	50	2:1	0.5	52	0.003	82	5	143	19	260	72	330	123
Uptown-Alt1	2352	1730	3:1	0.5	1021	0.096	1793	31	3135	234	5726	888	7319	1546
Uptown1-Alt2	550	264	3:1	0.5	203	0.015	91	0	158	0	286	7	364	17
Uptown2-Alt2	550	264	3:1	0.5	203	0.015	137	0	240	2	441	28	566	50
Uptown3-Alt2	550	264	3:1	0.5	203	0.015	91	0	158	0	287	8	365	17
Uptown4-Alt2	550	264	3:1	0.5	203	0.015	91	0	160	0	294	8	378	18
Uptown5-Alt2	550	264	3:1	0.5	203	0.015	137	0	239	2	433	28	551	49
Uptown6-Alt2	550	264	3:1	0.5	203	0.015	122	0	216	0	411	21	536	40
SR08	1167	381	2:1	0.5	387	0.021	1643	360	2863	1303	5185	3500	6598	4877
SR20a	559	392	2:1	0.5	238	0.022	219	0	381	6	690	50	878	86
SR20b	3112	1847	2:1	0.5	1240	0.103	849	0	1480	1	2680	142	3410	261
SR20c	5351	4267	2:1	0.5	2404	0.237	666	0	1161	0	2102	0	2674	0
SR20d	2148	708	2:1	0.5	714	0.039	499	0	869	32	1574	154	2002	262
SR20e	5644	1869	2:1	0.5	1878	0.104	1109	0	1932	40	3499	275	4452	470
SR20f	1296	424	2:1	0.5	430	0.024	317	0	552	23	999	105	1271	178
SR20g	2322	766	2:1	0.5	772	0.043	464	0	808	18	1464	118	1863	202
SR20h	1038	337	2:1	0.5	344	0.019	231	0	403	14	730	69	929	118
SR20i	1209	394	2:1	0.5	401	0.022	261	0	454	14	822	74	1046	127
SR20j	837	271	2:1	0.5	277	0.015	156	0	273	5	494	38	628	64
SR20k	1091	356	2:1	0.5	362	0.020	248	0	431	15	781	75	994	128

- Notes:
- (1) Uptown-Alt1: Top Area represents bioretention swale at the overflow elevation. Recommend a minimum of 6" freeboard between overflow elevation and curb cuts (true Top Area as shown in figure = 2690 sq ft assuming a 3:1 side slope).
 - (2) An assumed max infiltration rate of 2.4 in/hr was applied to each bioretention swale. If geotechnical investigations determine the infiltration rate to be lower for any of the facilities, hydrology calculations should be rerun to verify adequate storage volume.
 - (3) Red text denotes insufficient storage volume.
 - (4) Bioretention swales (subbasins) SR20b through SR20h will need to be designed with longitudinal slope in mind. Actual storage volumes will be less than those shown above.

Bubble Up Calculations Energy Equation and Darcy Weisbach	Calculated By: E. Pruneda	Date: 3/26/2014	Project: Richland
	Checked By: J. Knutson	Date: 3/31/2014	Project No: 33764414
	Attachment 3-4		Sheet No: 1 of 2

Location: Swift2c

Catchbasin Rim Elevation =	395.00 ft	
Catchbasin Water Elevation =	394.50 ft	<i>Assumed to be 0.5 ft below rim of catchbasin</i>
Existing Ground Elevation at BMP =	393.75 ft	
Bubble Up Rim Elevation =	392.75 ft	<i>Assumed to be 1.0 ft below ground elevation to allow room for 0.5 ft depth of runoff storage and 0.5 ft depth of freeboard</i>
Max Water Surface Elev in BMP =	393.25 ft	

10-Year, 3-Hour Peak Flow, $Q = 0.43$ cfs

Pipe Material =	Conc	<i>Equivalent Roughness, ϵ (ft) = 40.0×10^{-4}</i>
Pipe Diameter, $d =$	0.67 ft	<i>8" Pipe</i>
Pipe Length, $L =$	100 ft	

Head Loss, $h_{loss} = 1.25$ ft *Application of the Energy Equation assuming two reservoirs
Catchbasin Water Elevation - Max Water Surface Elevation in BMP*

$$\text{Friction Loss, } h_f = \frac{fL}{d} \frac{Q^2}{\left[\left(\frac{\pi}{4}\right)d^2\right]^2 2g} = \frac{fLQ^2}{39.68d^5} \quad \text{in FPS units}$$

$$\text{Minor Losses, } h_m = K \frac{Q^2}{\left[\left(\frac{\pi}{4}\right)d^2\right]^2 2g} = \frac{KQ^2}{39.68d^4} \quad \text{in FPS units}$$

where $K =$	Entrance Loss	0.5
	Exit Loss	1.0
	90° Bend	0.9
	Total	2.4

$$h_{loss} = h_f + h_m$$

$$1.25 = \frac{fLQ^2}{39.68d^5} + \frac{KQ^2}{39.68d^4}$$

Assuming trial $f = 0.03$, solve for Q and recalculate f :

$$\begin{aligned} Q &= 1.21 \text{ cfs} \\ A &= 0.3491 \text{ sf} \\ V &= 3.45 \text{ ft/s} \\ \text{Re} = \frac{Vd}{\nu} &= \frac{Vd}{1.217 \times 10^{-5}} = 1.89 \text{E}+05 \end{aligned}$$

$$\begin{aligned} \epsilon/d &= 0.006 \\ f &= 0.0323 \quad \text{from the Moody Diagram} \end{aligned}$$

$f = 0.0323$, solve for Q and recalculate f :

$$\begin{aligned} Q &= 1.18 \text{ cfs} \\ A &= 0.3491 \text{ sf} \\ V &= 3.37 \text{ ft/s} \\ \text{Re} = \frac{Vd}{\nu} &= \frac{Vd}{1.217 \times 10^{-5}} = 1.85 \text{E}+05 \end{aligned}$$

$$\begin{aligned} \epsilon/d &= 0.006 \\ f &= 0.0323 \quad \text{from the Moody Diagram} \end{aligned}$$

Since f stabilizes, $Q = 1.18$ cfs
Bubble up will function for flows up to 1.18 cfs.

Bubble Up Calculations Energy Equation and Darcy Weisbach	Calculated By: E. Pruneda	Date: 3/26/2014	Project: Richland
	Checked By: J. Knutson	Date: 3/31/2014	Project No: 33764414
	Attachment 3-4		Sheet No: 2 of 2

Location: Swift4c

Catchbasin Rim Elevation =	392.75 ft	
Catchbasin Water Elevation =	392.25 ft	Assumed to be 0.5 ft below rim of catchbasin
Existing Ground Elevation at BMP =	391.75 ft	
Bubble Up Rim Elevation =	390.75 ft	Assumed to be 1.0 ft below ground elevation to allow room for 0.5 ft depth of runoff storage and 0.5 ft depth of freeboard
Max Water Surface Elev in BMP =	391.25 ft	

10-Year, 3-Hour Peak Flow, $Q = 0.42$ cfs

Pipe Material =	Conc	Equivalent Roughness, ϵ (ft) = 40.0×10^{-4}
Pipe Diameter, $d =$	0.67 ft	8" Pipe
Pipe Length, $L =$	120 ft	

Head Loss, $h_{loss} = 1.00$ ft Application of the Energy Equation assuming two reservoirs
Catchbasin Water Elevation - Max Water Surface Elevation in BMP

$$\text{Friction Loss, } h_f = \frac{fL}{d} \frac{Q^2}{\left[\left(\frac{\pi}{4}\right)d^2\right]^2 2g} = \frac{fLQ^2}{39.68d^5} \text{ in FPS units}$$

$$\text{Minor Losses, } h_m = K \frac{Q^2}{\left[\left(\frac{\pi}{4}\right)d^2\right]^2 2g} = \frac{KQ^2}{39.68d^4} \text{ in FPS units}$$

where $K =$	Entrance Loss	0.5
	Exit Loss	1.0
	90° Bend	0.9
	Total	2.4

$$h_{loss} = h_f + h_m$$

$$1.00 = \frac{fLQ^2}{39.68d^5} + \frac{KQ^2}{39.68d^4}$$

Assuming trial $f = 0.03$, solve for Q and recalculate f :

$$\begin{aligned} Q &= 1.01 \text{ cfs} \\ A &= 0.3491 \text{ sf} \\ V &= 2.90 \text{ ft/s} \\ \text{Re} = \frac{Vd}{\nu} &= \frac{Vd}{1.217 \times 10^{-5}} = 1.59 \times 10^5 \end{aligned}$$

$$\begin{aligned} \epsilon/d &= 0.006 \\ f &= 0.0325 \quad \text{from the Moody Diagram} \end{aligned}$$

$f = 0.0325$, solve for Q and recalculate f :

$$\begin{aligned} Q &= 0.99 \text{ cfs} \\ A &= 0.3491 \text{ sf} \\ V &= 2.82 \text{ ft/s} \\ \text{Re} = \frac{Vd}{\nu} &= \frac{Vd}{1.217 \times 10^{-5}} = 1.55 \times 10^5 \end{aligned}$$

$$\begin{aligned} \epsilon/d &= 0.006 \\ f &= 0.0325 \quad \text{from the Moody Diagram} \end{aligned}$$

Since f stabilizes, $Q = 0.99$ cfs
Bubble up will function for flows up to 0.99 cfs.

ATTACHMENT 4 — PLANS AND DETAILS

City of Richland
Stormwater LID
Retrofit Projects

Swift Blvd

Proposed Condition
Subbasin Map

Legend

- Existing Inlet/Catch Basin
 - Existing Manhole
 - Existing Bubble Up
 - Existing Outlet
 - Existing UIC Facility
 - Existing Culvert
 - Existing Storm Pipe
 - Existing Open Channel
 - Existing Perforated Pipe
 - Existing Sewer System
 - Existing Water System
 - 1999 Contours
 - Curb Inlet
 - Bubble Up
 - Bypass Structure
 - Manhole
 - Overflow Structure
 - Curb and Gutter
 - Standing Curb
 - Storm Pipe
 - Bioretention Swale
 - Asphalt Parking Lot
 - Sidewalk
 - Subbasin
 - Approx Flow Direction
- 2012 Aerial Imagery

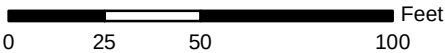
Sheet Notes

1	Curb Inlet to Bioretention Swale (Typical)
2	Bioretention Swale (Swift 1a) Approx Top Area: 1,513 SQ FT Approx Bottom Area: 528 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 510 CU FT
3	Bioretention Swale (Swift 1b) Approx Top Area: 1,660 SQ FT Approx Bottom Area: 731 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 598 CU FT
4	Bioretention Swale (Swift 1c) Inlets Set at Same Elevation Approx Top Area: 825 SQ FT Approx Bottom Area: 290 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 279 CU FT

Subbasin Description

Swift 1a	3,210 SQ FT Impervious Area Flows to Bioretention Swale
Swift 1b	17,927 SQ FT Impervious Area Flows to Bioretention Swale
Swift 1c	3,691 SQ FT Impervious Area Flows to Bioretention Swale

Attachment 4-1

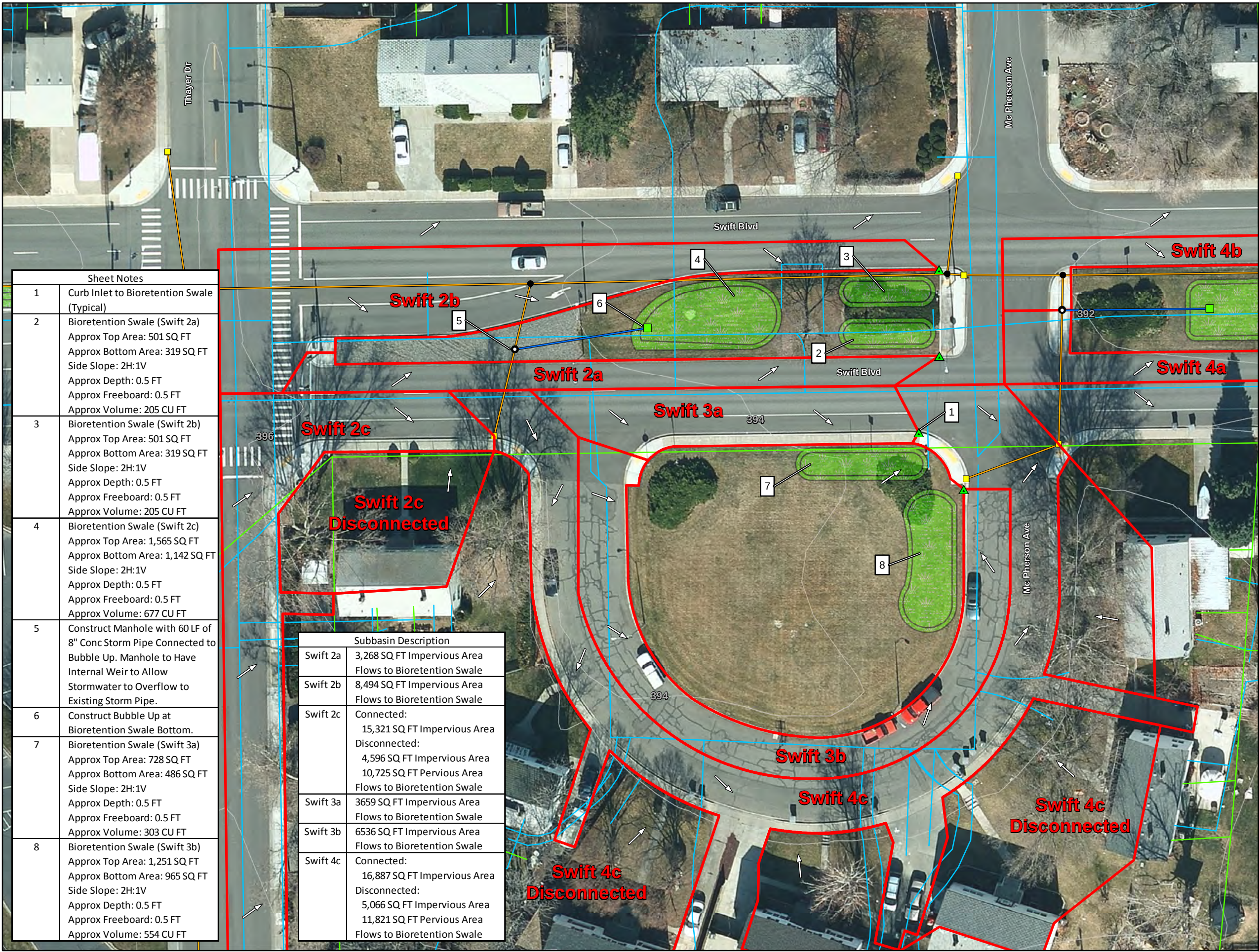


Date Created: April 10, 2014

City of Richland
Stormwater LID
Retrofit Projects

Swift Blvd

Proposed Condition
Subbasin Map

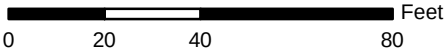


Legend

- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- Existing Sewer System
- Existing Water System
- 1999 Contours
- Curb Inlet
- Bubble Up
- Bypass Structure
- Manhole
- Overflow Structure
- Curb and Gutter
- Standing Curb
- Storm Pipe
- Bioretention Swale
- Asphalt Parking Lot
- Sidewalk
- Subbasin
- Approx Flow Direction

2012 Aerial Imagery

Attachment 4-2

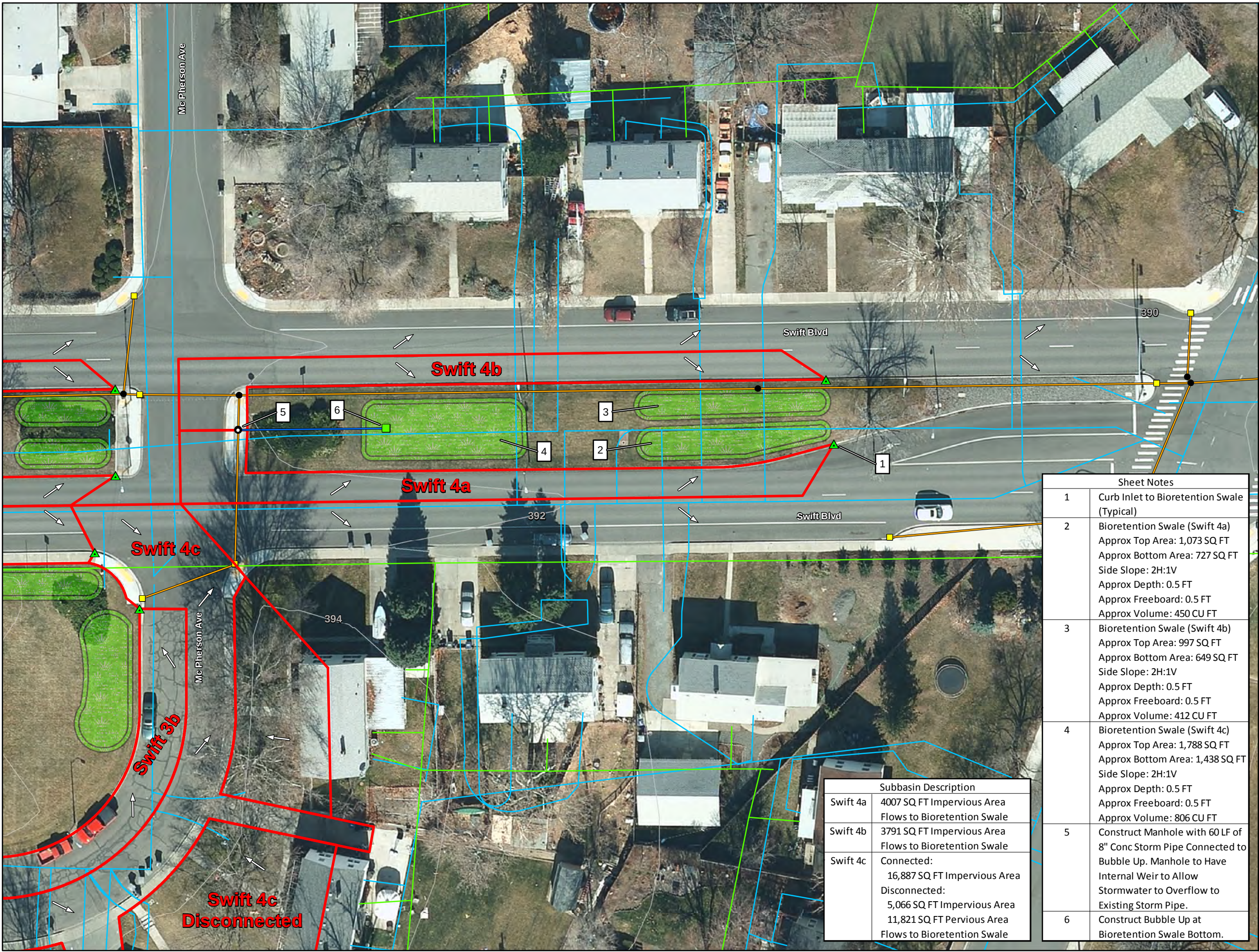


Date Created: March 28, 2014

City of Richland
Stormwater LID
Retrofit Projects

Swift Blvd

Proposed Condition
Subbasin Map



Legend

- Existing Inlet/Catch Basin
 - Existing Manhole
 - Existing Bubble Up
 - Existing Outlet
 - Existing UIC Facility
 - Existing Culvert
 - Existing Storm Pipe
 - Existing Open Channel
 - Existing Perforated Pipe
 - Existing Sewer System
 - Existing Water System
 - 1999 Contours
 - Curb Inlet
 - Bubble Up
 - Bypass Structure
 - Manhole
 - Overflow Structure
 - Curb and Gutter
 - Standing Curb
 - Storm Pipe
 - Bioretention Swale
 - Asphalt Parking Lot
 - Sidewalk
 - Subbasin
 - Approx Flow Direction
- 2012 Aerial Imagery

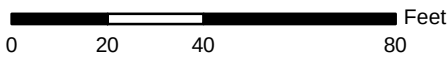
Sheet Notes

1	Curb Inlet to Bioretention Swale (Typical)
2	Bioretention Swale (Swift 4a) Approx Top Area: 1,073 SQ FT Approx Bottom Area: 727 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 450 CU FT
3	Bioretention Swale (Swift 4b) Approx Top Area: 997 SQ FT Approx Bottom Area: 649 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 412 CU FT
4	Bioretention Swale (Swift 4c) Approx Top Area: 1,788 SQ FT Approx Bottom Area: 1,438 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 806 CU FT
5	Construct Manhole with 60 LF of 8" Conc Storm Pipe Connected to Bubble Up. Manhole to Have Internal Weir to Allow Stormwater to Overflow to Existing Storm Pipe.
6	Construct Bubble Up at Bioretention Swale Bottom.

Subbasin Description

Swift 4a	4007 SQ FT Impervious Area Flows to Bioretention Swale
Swift 4b	3791 SQ FT Impervious Area Flows to Bioretention Swale
Swift 4c	Connected: 16,887 SQ FT Impervious Area Disconnected: 5,066 SQ FT Impervious Area 11,821 SQ FT Pervious Area Flows to Bioretention Swale

Attachment 4-3

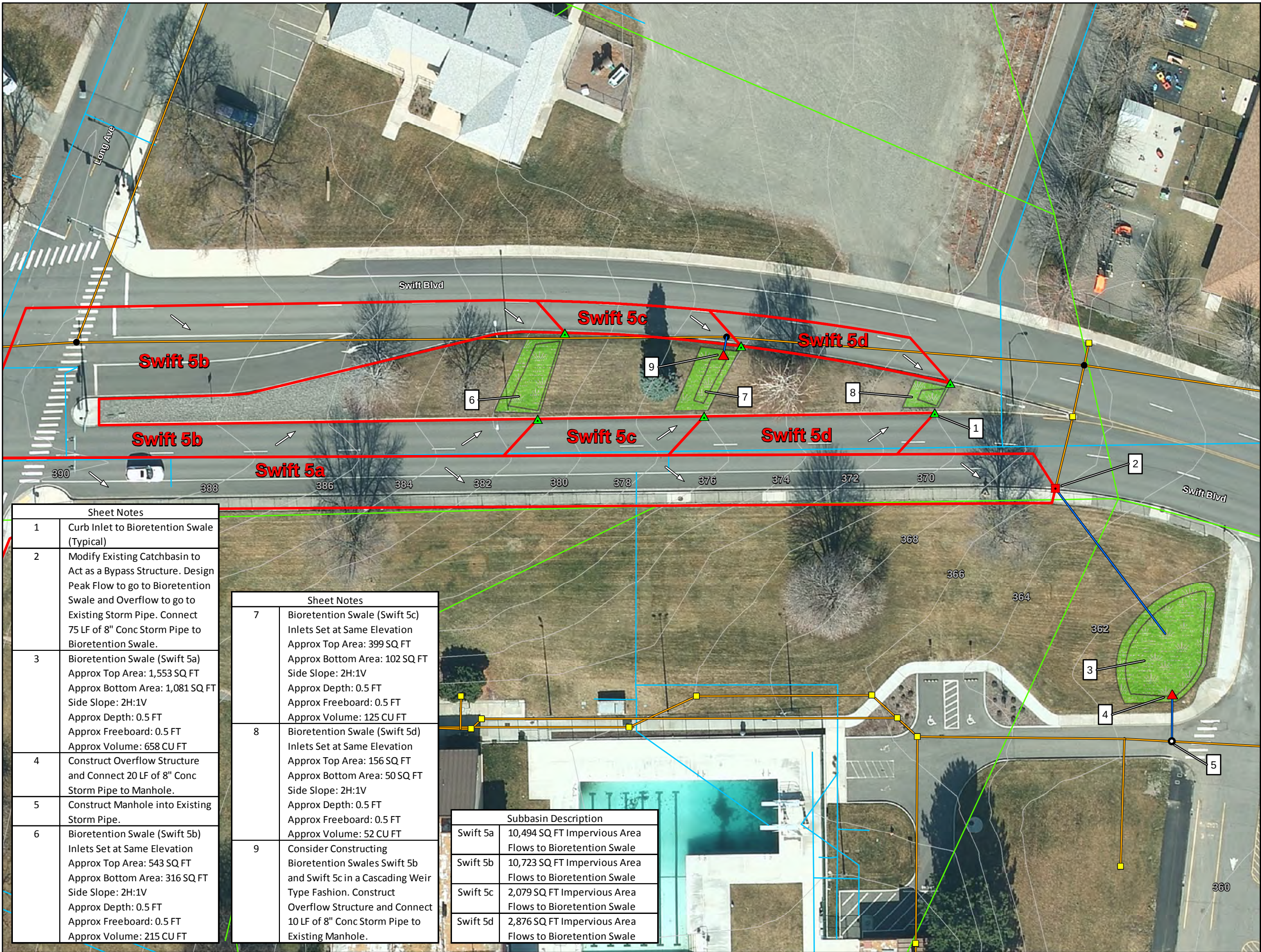


Date Created: March 28, 2014

City of Richland
Stormwater LID
Retrofit Projects

Swift Blvd

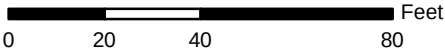
Proposed Condition
Subbasin Map



Legend

- Existing Inlet/Catch Basin
 - Existing Manhole
 - Existing Bubble Up
 - Existing Outlet
 - Existing UIC Facility
 - Existing Culvert
 - Existing Storm Pipe
 - Existing Open Channel
 - Existing Perforated Pipe
 - Existing Sewer System
 - Existing Water System
 - 1999 Contours
 - Curb Inlet
 - Bubble Up
 - Bypass Structure
 - Manhole
 - Overflow Structure
 - Curb and Gutter
 - Standing Curb
 - Storm Pipe
 - Bioretention Swale
 - Asphalt Parking Lot
 - Sidewalk
 - Subbasin
 - Approx Flow Direction
- 2012 Aerial Imagery

Attachment 4-4



Date Created: March 28, 2014

Sheet Notes	
1	Curb Inlet to Bioretention Swale (Typical)
2	Modify Existing Catchbasin to Act as a Bypass Structure. Design Peak Flow to go to Bioretention Swale and Overflow to go to Existing Storm Pipe. Connect 75 LF of 8" Conc Storm Pipe to Bioretention Swale.
3	Bioretention Swale (Swift 5a) Approx Top Area: 1,553 SQ FT Approx Bottom Area: 1,081 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 125 CU FT
4	Construct Overflow Structure and Connect 20 LF of 8" Conc Storm Pipe to Manhole.
5	Construct Manhole into Existing Storm Pipe.
6	Bioretention Swale (Swift 5b) Inlets Set at Same Elevation Approx Top Area: 543 SQ FT Approx Bottom Area: 316 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 215 CU FT

Sheet Notes	
7	Bioretention Swale (Swift 5c) Inlets Set at Same Elevation Approx Top Area: 399 SQ FT Approx Bottom Area: 102 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 125 CU FT
8	Bioretention Swale (Swift 5d) Inlets Set at Same Elevation Approx Top Area: 156 SQ FT Approx Bottom Area: 50 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 52 CU FT
9	Consider Constructing Bioretention Swales Swift 5b and Swift 5c in a Cascading Weir Type Fashion. Construct Overflow Structure and Connect 10 LF of 8" Conc Storm Pipe to Existing Manhole.

Subbasin Description	
Swift 5a	10,494 SQ FT Impervious Area Flows to Bioretention Swale
Swift 5b	10,723 SQ FT Impervious Area Flows to Bioretention Swale
Swift 5c	2,079 SQ FT Impervious Area Flows to Bioretention Swale
Swift 5d	2,876 SQ FT Impervious Area Flows to Bioretention Swale



**City of Richland
Stormwater LID
Retrofit Projects**

Uptown Mall

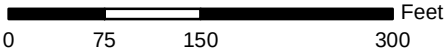
Proposed Condition
Alternative 1

Legend

- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- 1999 Contours
- Bioretention Swale

2012 Aerial Imagery

Attachment 4-5



Date Created: March 28, 2014



**City of Richland
Stormwater LID
Retrofit Projects**

Uptown Mall

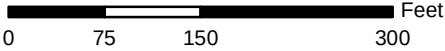
Proposed Condition
Alternative 2

Legend

- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- 1999 Contours
- Bioretention Swale

2012 Aerial Imagery

Attachment 4-6



Date Created: March 28, 2014

City of Richland
Stormwater LID
Retrofit Projects

Uptown Mall

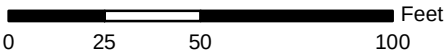
Proposed Condition
Subbasin Map Alt 1

Legend

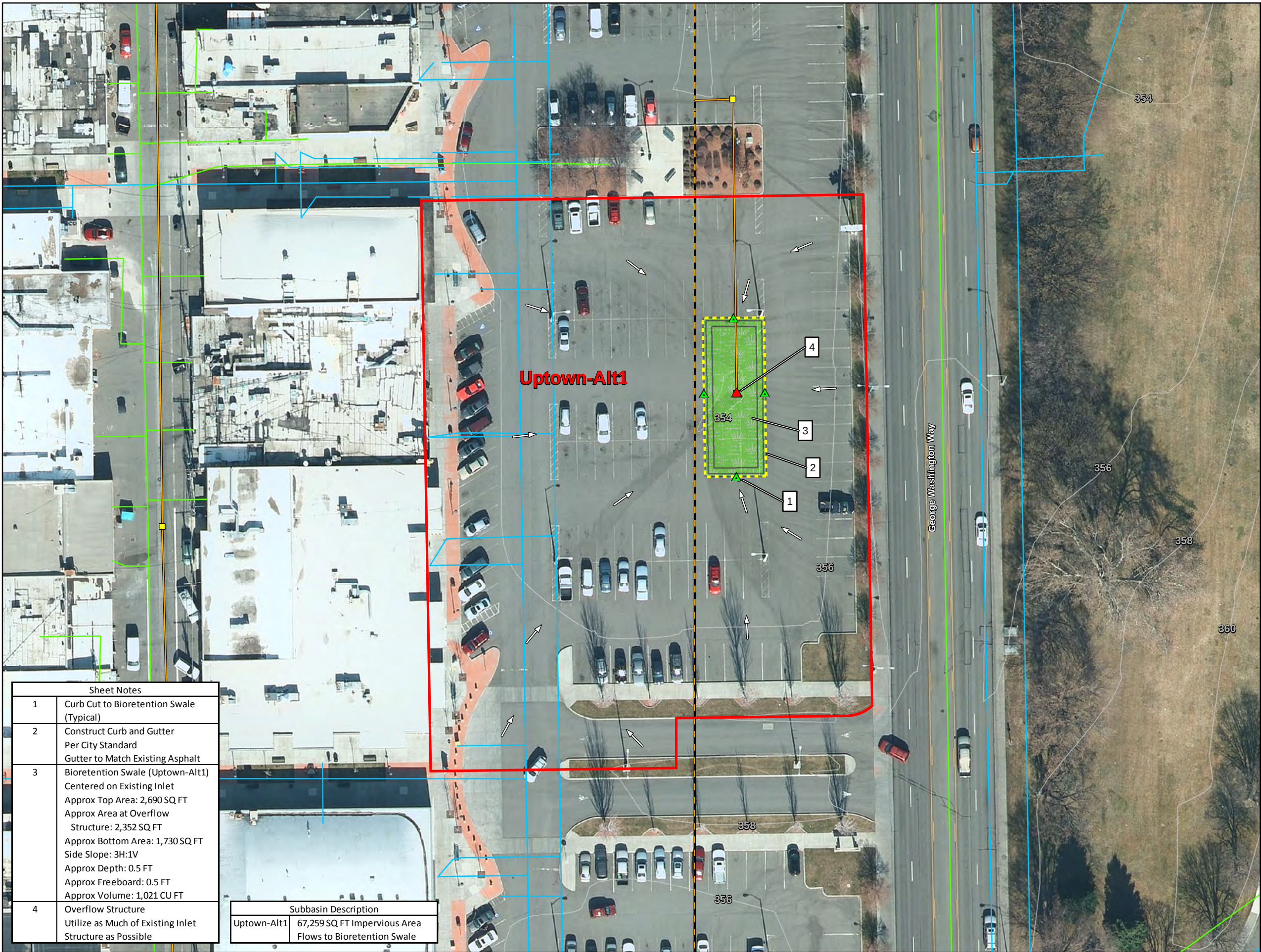
- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- Existing Sewer System
- Existing Water System
- 1999 Contours
- Curb Inlet
- Bubble Up
- Bypass Structure
- Manhole
- Overflow Structure
- Curb and Gutter
- Standing Curb
- Storm Pipe
- Bioretention Swale
- Asphalt Parking Lot
- Sidewalk
- Subbasin
- Approx Flow Direction

2012 Aerial Imagery

Attachment 4-7



Date Created: March 28, 2014



Sheet Notes

1	Curb Cut to Bioretention Swale (Typical)
2	Construct Curb and Gutter Per City Standard Gutter to Match Existing Asphalt
3	Bioretention Swale (Uptown-Alt1) Centered on Existing Inlet Approx Top Area: 2,690 SQ FT Approx Area at Overflow Structure: 2,352 SQ FT Approx Bottom Area: 1,730 SQ FT Side Slope: 3H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 1,021 CU FT
4	Overflow Structure Utilize as Much of Existing Inlet Structure as Possible

Subbasin Description

Uptown-Alt1	67,259 SQ FT Impervious Area Flows to Bioretention Swale
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City of Richland
Stormwater LID
Retrofit Projects

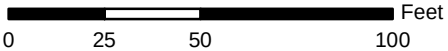
Uptown Mall

Proposed Condition
Subbasin Map Alt 2

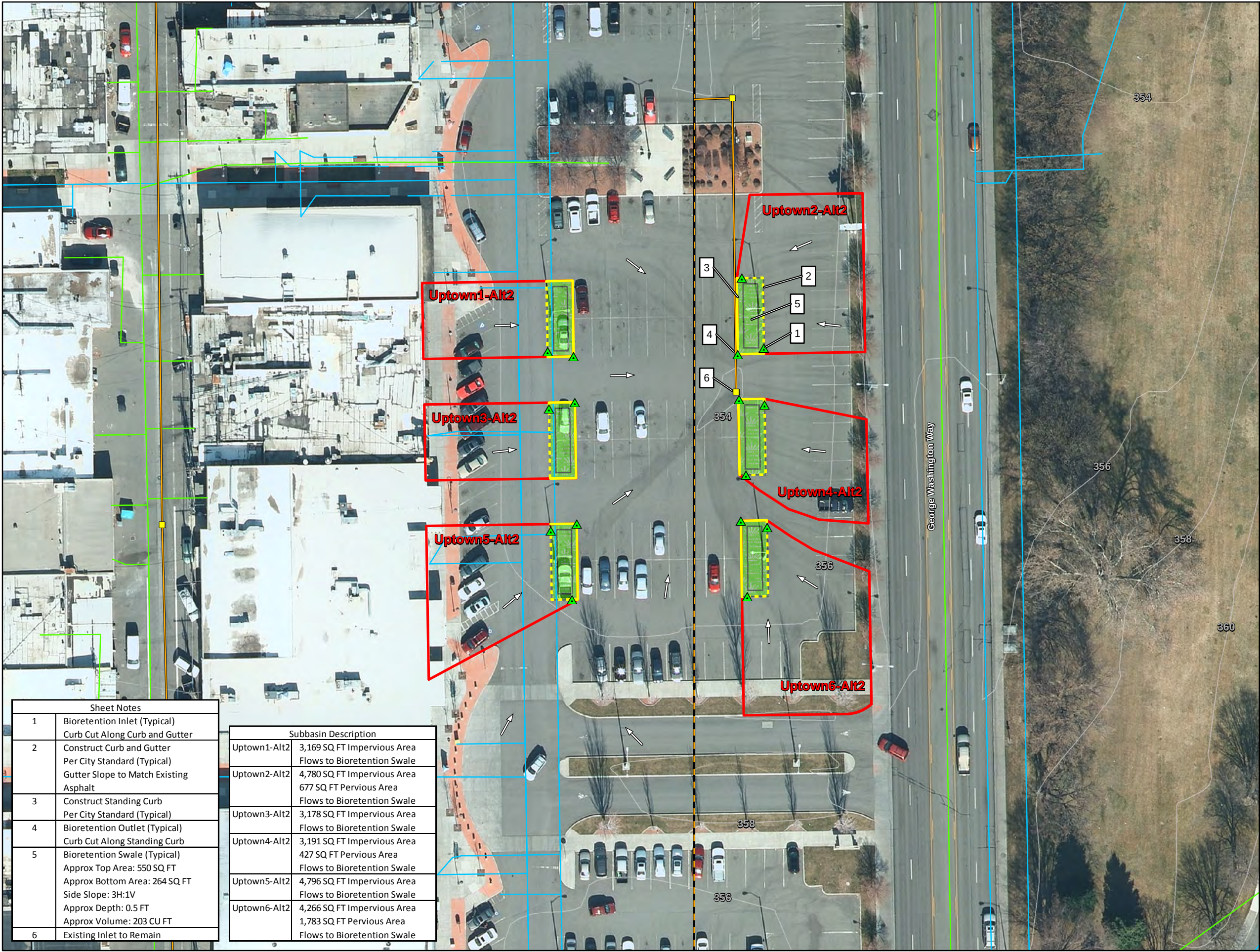
Legend

- Existing Inlet/Catch Basin
 - Existing Manhole
 - Existing Bubble Up
 - Existing Outlet
 - Existing UIC Facility
 - Existing Culvert
 - Existing Storm Pipe
 - Existing Open Channel
 - Existing Perforated Pipe
 - Existing Sewer System
 - Existing Water System
 - 1999 Contours
 - Curb Inlet
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 - Bioretention Swale
 - Asphalt Parking Lot
 - Sidewalk
 - Subbasin
 - Approx Flow Direction
- 2012 Aerial Imagery

Attachment 4-8



Date Created: March 28, 2014

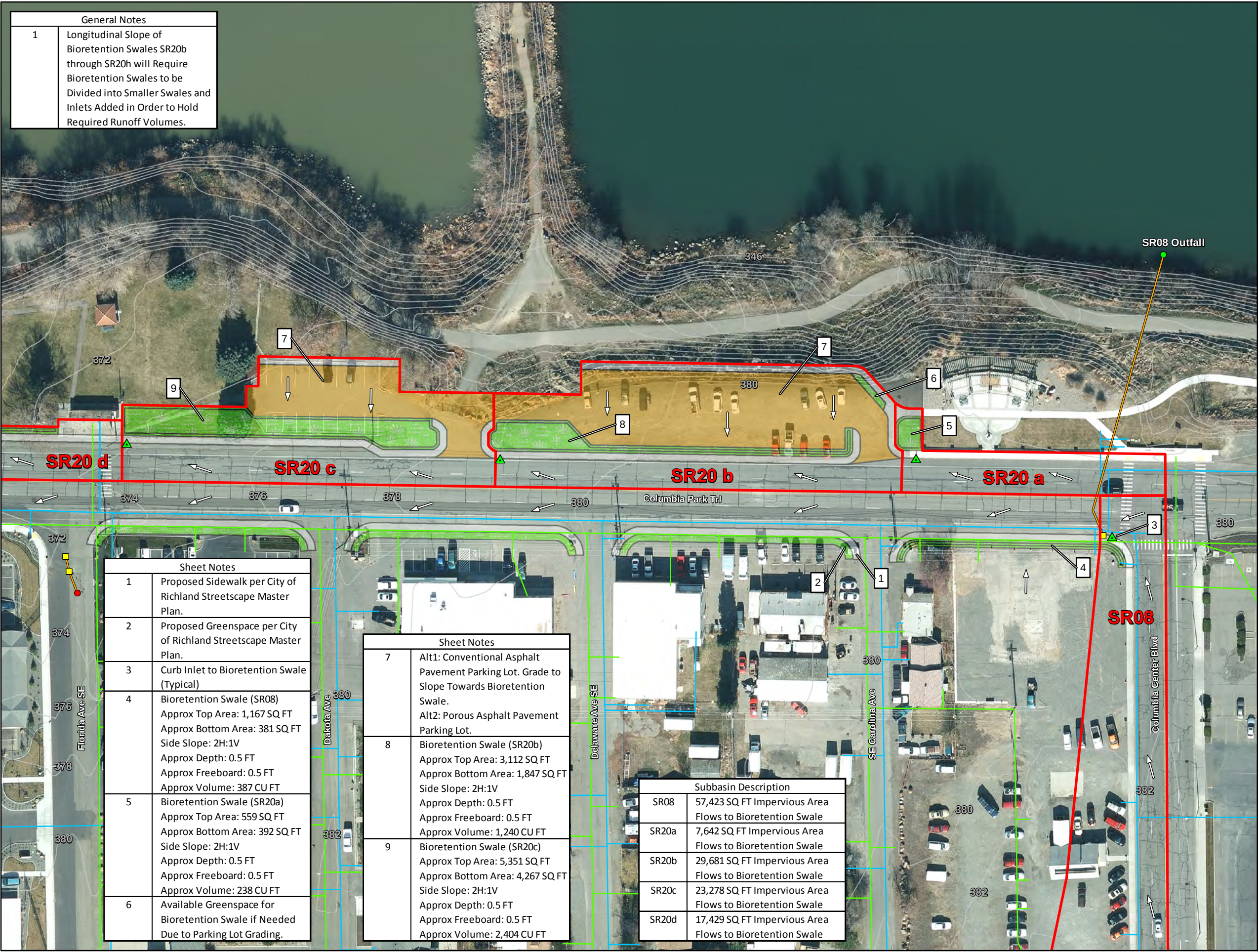


Sheet Notes

1	Bioretention Inlet (Typical) Curb Cut Along Curb and Gutter
2	Construct Curb and Gutter Per City Standard (Typical) Gutter Slope to Match Existing Asphalt
3	Construct Standing Curb Per City Standard (Typical)
4	Bioretention Outlet (Typical) Curb Cut Along Standing Curb
5	Bioretention Swale (Typical) Approx Top Area: 550 SQ FT Approx Bottom Area: 264 SQ FT Side Slope: 3H:1V Approx Depth: 0.5 FT Approx Volume: 203 CU FT
6	Existing Inlet to Remain

Subbasin Description

Uptown1-Alt2	3,169 SQ FT Impervious Area Flows to Bioretention Swale
Uptown2-Alt2	4,780 SQ FT Impervious Area 677 SQ FT Pervious Area Flows to Bioretention Swale
Uptown3-Alt2	3,178 SQ FT Impervious Area Flows to Bioretention Swale
Uptown4-Alt2	3,191 SQ FT Impervious Area 427 SQ FT Pervious Area Flows to Bioretention Swale
Uptown5-Alt2	4,796 SQ FT Impervious Area Flows to Bioretention Swale
Uptown6-Alt2	4,266 SQ FT Impervious Area 1,783 SQ FT Pervious Area Flows to Bioretention Swale



City of Richland
Stormwater LID
Retrofit Projects

Columbia Park Trail

Proposed Condition
Subbasin Map

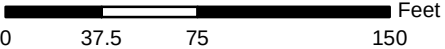
Legend

- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- Existing Sewer System
- Existing Water System
- 1999 Contours
- Curb Inlet
- Bubble Up
- Bypass Structure
- Manhole
- Overflow Structure
- Curb and Gutter
- Standing Curb
- Storm Pipe
- Bioretention Swale
- Asphalt Parking Lot
- Sidewalk
- Subbasin
- Approx Flow Direction

2012 Aerial Imagery

Attachment 4-9





0 37.5 75 150 Feet

Date Created: April 10, 2014

General Notes

1 Longitudinal Slope of Bioretention Swales SR20b through SR20h will Require Bioretention Swales to be Divided into Smaller Swales and Inlets Added in Order to Hold Required Runoff Volumes.

Sheet Notes	
1	Proposed Sidewalk per City of Richland Streetscape Master Plan.
2	Proposed Greenspace per City of Richland Streetscape Master Plan.
3	Curb Inlet to Bioretention Swale (Typical)
4	Bioretention Swale (SR08) Approx Top Area: 1,167 SQ FT Approx Bottom Area: 381 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 387 CU FT
5	Bioretention Swale (SR20a) Approx Top Area: 559 SQ FT Approx Bottom Area: 392 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 238 CU FT
6	Available Greenspace for Bioretention Swale if Needed Due to Parking Lot Grading.

Sheet Notes	
7	Alt1: Conventional Asphalt Pavement Parking Lot. Grade to Slope Towards Bioretention Swale. Alt2: Porous Asphalt Pavement Parking Lot.
8	Bioretention Swale (SR20b) Approx Top Area: 3,112 SQ FT Approx Bottom Area: 1,847 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 1,240 CU FT
9	Bioretention Swale (SR20c) Approx Top Area: 5,351 SQ FT Approx Bottom Area: 4,267 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 2,404 CU FT

Subbasin Description	
SR08	57,423 SQ FT Impervious Area Flows to Bioretention Swale
SR20a	7,642 SQ FT Impervious Area Flows to Bioretention Swale
SR20b	29,681 SQ FT Impervious Area Flows to Bioretention Swale
SR20c	23,278 SQ FT Impervious Area Flows to Bioretention Swale
SR20d	17,429 SQ FT Impervious Area Flows to Bioretention Swale

City of Richland
Stormwater LID
Retrofit Projects

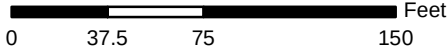
Columbia Park Trail

Proposed Condition
Subbasin Map

Legend

- Existing Inlet/Catch Basin
 - Existing Manhole
 - Existing Bubble Up
 - Existing Outlet
 - Existing UIC Facility
 - Existing Culvert
 - Existing Storm Pipe
 - Existing Open Channel
 - Existing Perforated Pipe
 - Existing Sewer System
 - Existing Water System
 - 1999 Contours
 - Curb Inlet
 - Bubble Up
 - Bypass Structure
 - Manhole
 - Overflow Structure
 - Curb and Gutter
 - Standing Curb
 - Storm Pipe
 - Bioretention Swale
 - Asphalt Parking Lot
 - Sidewalk
 - Subbasin
 - Approx Flow Direction
- 2012 Aerial Imagery

Attachment 4-10



Date Created: March 28, 2014



Sheet Notes

1	Proposed Sidewalk per City of Richland Streetscape Master Plan.
2	Proposed Greenspace per City of Richland Streetscape Master Plan.
3	Curb Inlet to Bioretention Swale (Typical)
4	Bioretention Swale (SR20d) Approx Top Area: 2,148 SQ FT Approx Bottom Area: 708 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 714 CU FT
5	Bioretention Swale (SR20e) Approx Top Area: 5,644 SQ FT Approx Bottom Area: 1,869 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 1,878 CU FT

General Notes

1	Longitudinal Slope of Bioretention Swales SR20b through SR20h will Require Bioretention Swales to be Divided into Smaller Swales and Inlets Added in Order to Hold Required Runoff Volumes.
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Subbasin Description

SR20d	17,429 SQ FT Impervious Area Flows to Bioretention Swale
SR20e	38,749 SQ FT Impervious Area Flows to Bioretention Swale

City of Richland
Stormwater LID
Retrofit Projects

Columbia Park Trail

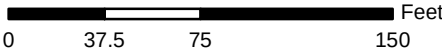
Proposed Condition
Subbasin Map

Legend

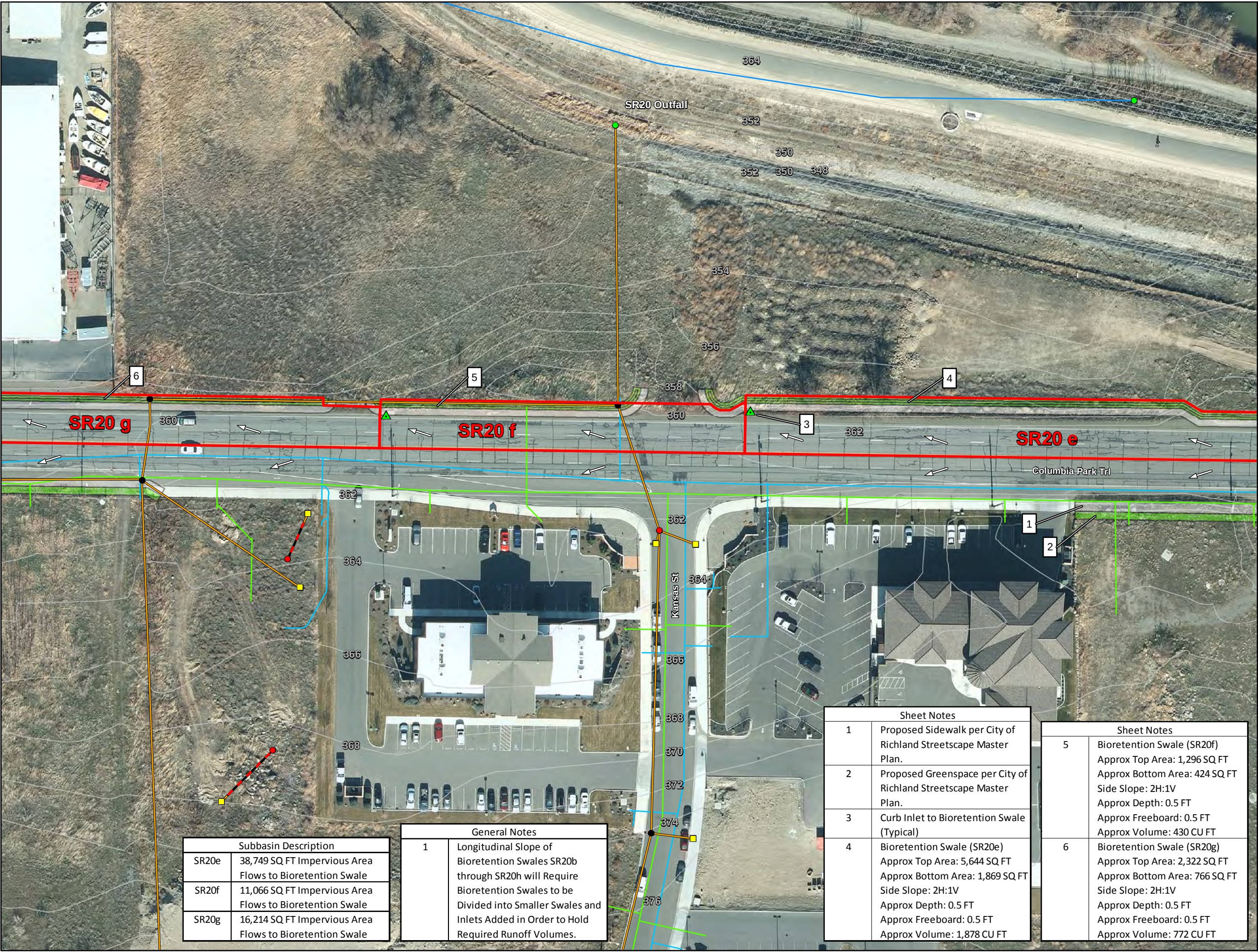
- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- Existing Sewer System
- Existing Water System
- 1999 Contours
- Curb Inlet
- Bubble Up
- Bypass Structure
- Manhole
- Overflow Structure
- Curb and Gutter
- Standing Curb
- Storm Pipe
- Bioretention Swale
- Asphalt Parking Lot
- Sidewalk
- Subbasin
- Approx Flow Direction

2012 Aerial Imagery

Attachment 4-11



Date Created: March 28, 2014



Subbasin Description	
SR20e	38,749 SQ FT Impervious Area Flows to Bioretention Swale
SR20f	11,066 SQ FT Impervious Area Flows to Bioretention Swale
SR20g	16,214 SQ FT Impervious Area Flows to Bioretention Swale

General Notes	
1	Longitudinal Slope of Bioretention Swales SR20b through SR20h will Require Bioretention Swales to be Divided into Smaller Swales and Inlets Added in Order to Hold Required Runoff Volumes.

Sheet Notes	
1	Proposed Sidewalk per City of Richland Streetscape Master Plan.
2	Proposed Greenspace per City of Richland Streetscape Master Plan.
3	Curb Inlet to Bioretention Swale (Typical)
4	Bioretention Swale (SR20e) Approx Top Area: 5,644 SQ FT Approx Bottom Area: 1,869 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 1,878 CU FT

Sheet Notes	
5	Bioretention Swale (SR20f) Approx Top Area: 1,296 SQ FT Approx Bottom Area: 424 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 430 CU FT
6	Bioretention Swale (SR20g) Approx Top Area: 2,322 SQ FT Approx Bottom Area: 766 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 772 CU FT

City of Richland
Stormwater LID
Retrofit Projects

Columbia Park Trail

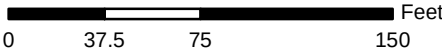
Proposed Condition
Subbasin Map

Legend

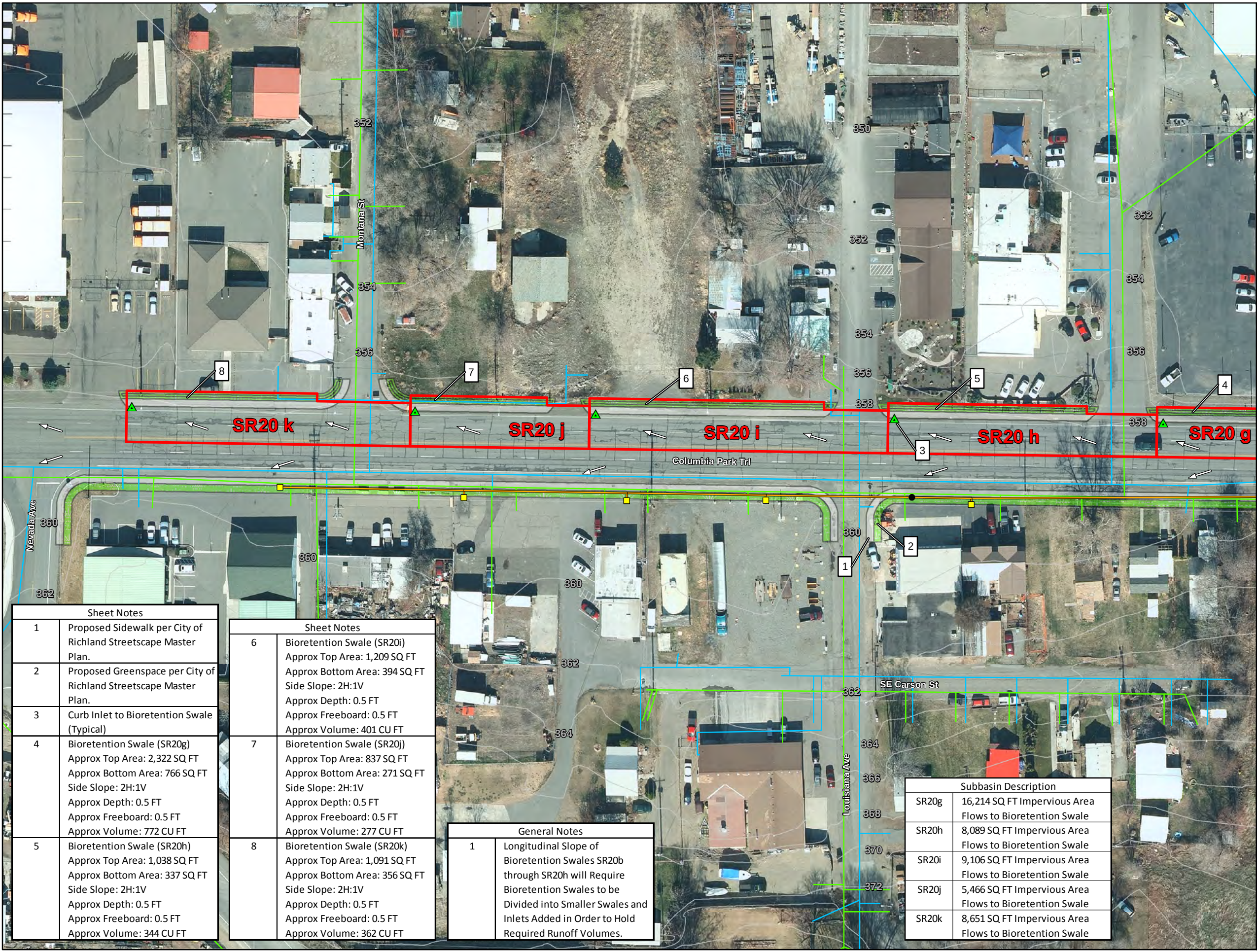
- Existing Inlet/Catch Basin
- Existing Manhole
- Existing Bubble Up
- Existing Outlet
- Existing UIC Facility
- Existing Culvert
- Existing Storm Pipe
- Existing Open Channel
- Existing Perforated Pipe
- Existing Sewer System
- Existing Water System
- 1999 Contours
- Curb Inlet
- Bubble Up
- Bypass Structure
- Manhole
- Overflow Structure
- Curb and Gutter
- Standing Curb
- Storm Pipe
- Bioretention Swale
- Asphalt Parking Lot
- Sidewalk
- Subbasin
- Approx Flow Direction

2012 Aerial Imagery

Attachment 4-12



Date Created: March 28, 2014



Sheet Notes	
1	Proposed Sidewalk per City of Richland Streetscape Master Plan.
2	Proposed Greenspace per City of Richland Streetscape Master Plan.
3	Curb Inlet to Bioretention Swale (Typical)
4	Bioretention Swale (SR20g) Approx Top Area: 2,322 SQ FT Approx Bottom Area: 766 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 772 CU FT
5	Bioretention Swale (SR20h) Approx Top Area: 1,038 SQ FT Approx Bottom Area: 337 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 344 CU FT

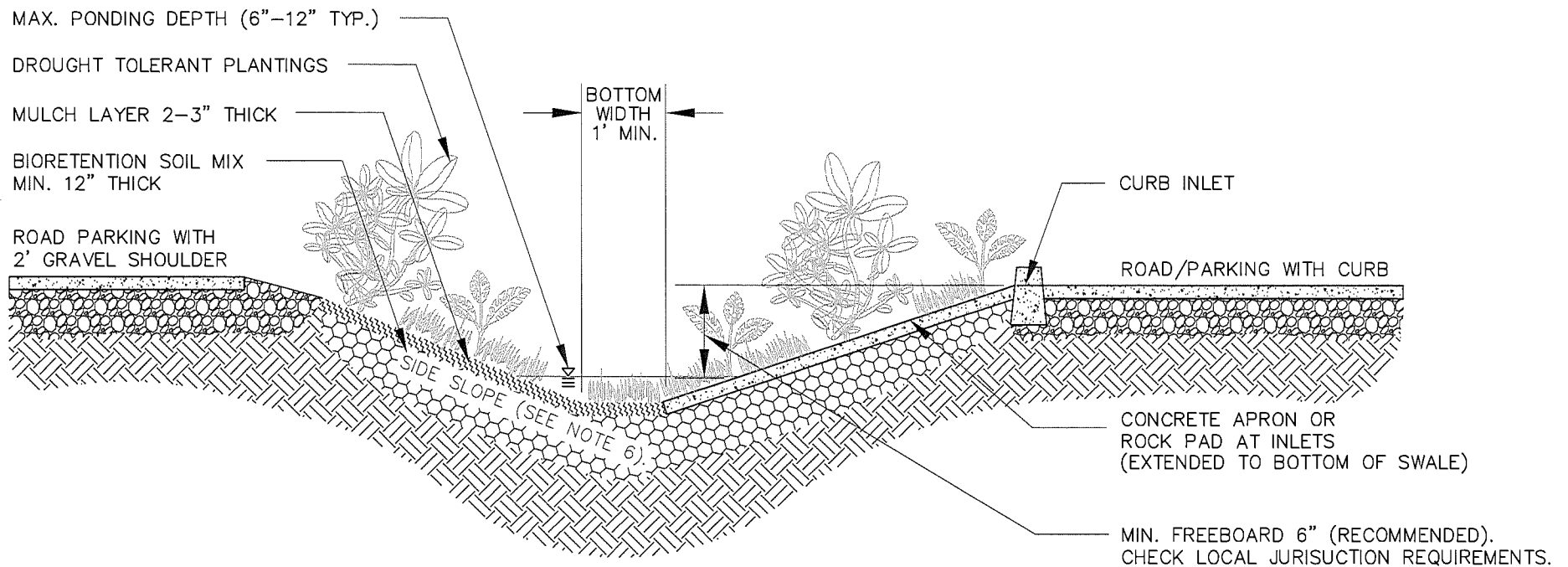
Sheet Notes	
6	Bioretention Swale (SR20i) Approx Top Area: 1,209 SQ FT Approx Bottom Area: 394 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 401 CU FT
7	Bioretention Swale (SR20j) Approx Top Area: 837 SQ FT Approx Bottom Area: 271 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 277 CU FT
8	Bioretention Swale (SR20k) Approx Top Area: 1,091 SQ FT Approx Bottom Area: 356 SQ FT Side Slope: 2H:1V Approx Depth: 0.5 FT Approx Freeboard: 0.5 FT Approx Volume: 362 CU FT

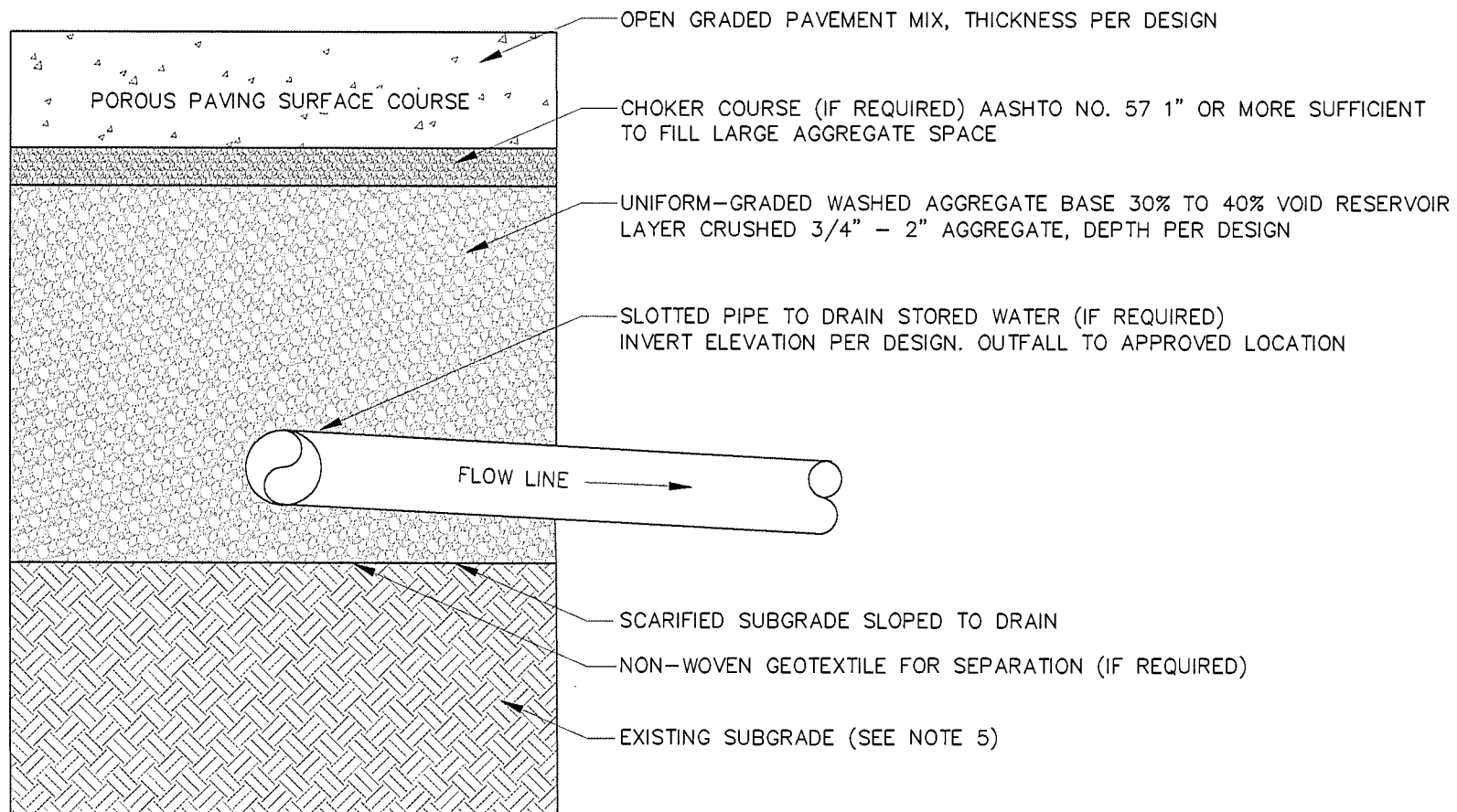
General Notes	
1	Longitudinal Slope of Bioretention Swales SR20b through SR20h will Require Bioretention Swales to be Divided into Smaller Swales and Inlets Added in Order to Hold Required Runoff Volumes.

Subbasin Description	
SR20g	16,214 SQ FT Impervious Area Flows to Bioretention Swale
SR20h	8,089 SQ FT Impervious Area Flows to Bioretention Swale
SR20i	9,106 SQ FT Impervious Area Flows to Bioretention Swale
SR20j	5,466 SQ FT Impervious Area Flows to Bioretention Swale
SR20k	8,651 SQ FT Impervious Area Flows to Bioretention Swale

NOTES:

1. SIZE AND DEPTH PER SWMMEW BMP T5.30 (BIO-INFILTRATION SWALES) OR LOCAL EQUIVALENT.
2. PROVIDE OVERFLOW STRUCTURE PER LOCAL JURISDICTION REQUIREMENTS.
3. THE VOLUME CONTAINED BY THE SWALE MUST BE SUFFICIENT TO TREAT THE WATER QUALITY VOLUME PRIOR TO OVERFLOWING.
4. DESIGN FACILITY TO DRAIN COMPLETELY WITHIN 72 HOURS.
5. TREES OR DEEP ROOTED VEGETATION ARE NOT RECOMMENDED OVER UTILITIES.
6. SIDE SLOPE 2.5H:1V MAX. (RECOMMENDED). SEE LOCAL JURISDICTION REQUIREMENTS.





NOTES:

1. NOT INTENDED FOR PUBLIC RIGHT OF WAY WITHOUT PRIOR APPROVAL. ENGINEERING DESIGN REQUIRED FOR STORMWATER AND STRUCTURE FUNCTIONS.
2. PAVEMENT SURFACE WITH SIGNIFICANT PERMEABILITY (>8" PER HR).
3. PROVIDE SLOTTED PIPE MANIFOLD IN RESERVOIR LAYER FOR CONVEYANCE, IF REQUIRED SUBGRADE INFILTRATION RATES LESS THAN 2"/HOUR.
4. NOT RECOMMENDED FOR TRAFFIC SURFACES WITH SLOPE >5%.
5. DO NOT COMPACT EXISTING SUBGRADE.
6. SUBGRADE SLOPED TO SLOTTED PIPE (IF REQUIRED) FOR DRAINAGE.
7. CONSULT WITH QUALIFIED GEOTECHNICAL ENGINEER IF HIGH GROUNDWATER IS SUSPECTED.
8. SIGNAGE IDENTIFYING POROUS PAVEMENT REQUIRED.

ATTACHMENT 5 — PRE-DESIGN LEVEL CONSTRUCTION COST ESTIMATES

Swift Blvd. LID Retrofit Project				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 15,000.00	\$ 15,000.00
2	Traffic Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Clearing and Grubbing	LS	1	\$ 10,000.00	\$ 10,000.00
4	Removal of Structures and Obstructions	LS	1	\$ 3,000.00	\$ 3,000.00
5	Sawcutting	LF	154.0	\$ 5.00	\$ 770.00
6	Structure Excavation Class B Incl. Haul	CY	92.5	\$ 10.00	\$ 924.59
7	Amended Treatment Soil Mix	CY	836.2	\$ 20.00	\$ 16,724.44
8	HMA Patch	LS	1	\$ 500.00	\$ 500.00
9	8-inch Diameter Storm Drain Pipe, in Place	LF	215.0	\$ 20.00	\$ 4,300.00
10	Pipe Zone Backfill	CY	50.4	\$ 40.00	\$ 2,017.28
11	Gravel Backfill for Pipe Zone Bedding	CY	42.0	\$ 50.00	\$ 2,101.34
12	Catch Basin Type 1 as Bubble-Up	EA	2	\$ 1,500.00	\$ 3,000.00
13	Curb Inlet	EA	16	\$ 1,500.00	\$ 24,000.00
14	Bypass Structure Manhole 48 In. Diam.	EA	3	\$ 2,500.00	\$ 7,500.00
15	Manhole 48 In. Diam. w/ Overflow Grate	EA	1	\$ 8,500.00	\$ 8,500.00
16	Connect to Drainage Structure	EA	6	\$ 500.00	\$ 3,000.00
17	Quarry Spalls	CY	3.6	\$ 35.50	\$ 126.22
18	Bioretention Swales	LS	1	\$ 75,000.00	\$ 75,000.00
19	Animal Guard, 8-Inch Diameter	EA	1	\$ 400.00	\$ 400.00
20	ESC Lead	DAY	7	\$ 150.00	\$ 1,050.00
21	Erosion Control	FA	EST	\$ 5,000.00	\$ 5,000.00
22	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Construction Subtotal				\$ 217,913.88
	Construction Management (10%)				\$ 21,791.39
	WA State Sales Tax (8.3%)				\$ 18,086.85
	Subtotal				\$ 257,792.12
	Pre-Design Contingency (50%)				\$ 128,896.06
	Total				\$ 386,688.17
Notes: • Curb Inlet includes sump structure, access lid, and concrete gutter restoration. • Bioretention Swale includes excavation, grading, soil mix, mulch, planting, and irrigation.					

Columbia Park Trail LID Retrofit Project - Alt 1				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 35,000.00	\$ 35,000.00
2	Traffic Control	LS	1	\$ 40,000.00	\$ 40,000.00
3	Clearing and Grubbing	LS	1	\$ 10,000.00	\$ 10,000.00
4	Amended Treatment Soil Mix	CY	1,431.8	\$ 20.00	\$ 28,636.67
5	Crushed Surfacing Top Course	TON	636.7	\$ 22.00	\$ 14,006.67
6	HMA Cl. 1/2-Inch PG 64-28	TON	439.3	\$ 90.00	\$ 39,537.00
7	Curb Inlet	EA	12	\$ 1,500.00	\$ 18,000.00
8	Bioretention Swales	LS	1	\$ 60,000.00	\$ 60,000.00
9	ESC Lead	DAY	10	\$ 150.00	\$ 1,500.00
10	Erosion Control	FA	EST	\$ 10,000.00	\$ 10,000.00
11	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Construction Subtotal				\$ 266,680.33
	Construction Management (10%)				\$ 26,668.03
	WA State Sales Tax (8.3%)				\$ 22,134.47
	Subtotal				\$ 315,482.83
	Pre-Design Contingency (50%)				\$ 157,741.42
	Total				\$ 473,224.25
Notes: • Curb Inlet includes sump structure, access lid, and concrete gutter restoration. • Bioretention Swale includes excavation, grading, soil mix, mulch, planting, and irrigation.					

Columbia Park Trail LID Retrofit Project - Alt 2				Pre-Design Estimate	
ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENDED AMOUNT
1	Mobilization	LS	1	\$ 35,000.00	\$ 35,000.00
2	Traffic Control	LS	1	\$ 40,000.00	\$ 40,000.00
3	Clearing and Grubbing	LS	1	\$ 10,000.00	\$ 10,000.00
4	Unclassified Excavation Incl. Haul	CY	848.9	\$ 10.00	\$ 8,488.89
5	Amended Treatment Soil Mix	CY	1,431.8	\$ 20.00	\$ 28,636.67
6	Aggregate Base for Porous HMA	CY	848.9	\$ 50.00	\$ 42,444.44
7	Porous HMA	SF	22,920	\$ 3.50	\$ 80,220.00
8	Curb Inlet	EA	12	\$ 1,500.00	\$ 18,000.00
9	Bioretention Swales	LS	1	\$ 60,000.00	\$ 60,000.00
10	ESC Lead	DAY	10	\$ 150.00	\$ 1,500.00
11	Erosion Control	FA	EST	\$ 10,000.00	\$ 10,000.00
12	Minor Change	FA	EST	\$ 10,000.00	\$ 10,000.00
	Construction Subtotal				\$ 344,290.00
	Construction Management (10%)				\$ 34,429.00
	WA State Sales Tax (8.3%)				\$ 28,576.07
	Subtotal				\$ 407,295.07
	Pre-Design Contingency (50%)				\$ 203,647.54
	Total				\$ 610,942.61
Notes: • Curb Inlet includes sump structure, access lid, and concrete gutter restoration. • Bioretention Swale includes excavation, grading, soil mix, mulch, planting, and irrigation.					

ATTACHMENT 6 — EXAMPLE LID BMP PHOTOS

Parking Lot Bioretention Swale Examples



Example xeriscaped parking lot bioretention swales.



Note: URS recommends having a clear space between parking stalls and bioretention curbing to avoid tripping hazards.



Example non-xeriscaped parking lot bioretention swale.

Non-xeriscaped Roadside Bioretention Examples



Example bioretention swale with roadside and parking lot runoff inputs.

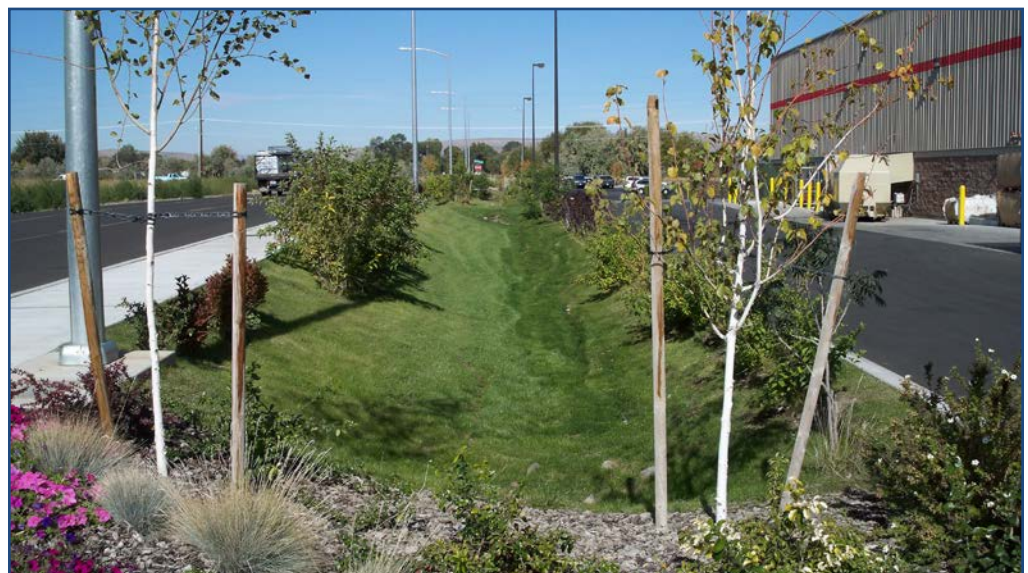
Example bioretention swale with roadside and parking lot runoff inputs. Note the berm separating the roadside swale from the parking lot swale.



Non-xeriscaped Roadside Bioretention Examples



Example of cascading bioretention swales.



Example bioretention swale. Lower zone comprised of turf grass and upper zone comprised of select grasses, shrubs, and trees.

Xeriscaped Roadside Bioretention Examples



Example bioretention swale with a xeriscaped approach. Lower zone comprised of river rock and upper zone comprised of select grasses, shrubs, and trees.



Example bioretention swale with a xeriscaped approach. Lower zone comprised of river rock and upper zone comprised of select grasses, shrubs, and trees.

Xeriscaped Roadside Bioretention Examples



***Example bioretention swale
with a xeriscaped approach.
Lower zone comprised of
pea gravel and upper zone
comprised of select grasses,
shrubs, and trees.***

CERTIFIED MAIL – RETURN RECEIPT REQUESTED



**DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
201 NORTH THIRD AVENUE
WALLA WALLA, WA 99362-1876**

RECEIVED MAR 3 2015

February 23, 2015

Real Estate Division

Mr. Pete Rogalsky, Public Works Director
City of Richland
PO Box 190, MS-26
Richland, WA 99352

Dear Mr. Rogalsky:

We received the storm water runoff facilities (facilities) easement application packages from the city of Richland (the City) earlier this month. We understand that the applications for easements will support construction, operation, and maintenance of facilities in and adjoining Leslie Groves Park (the park) and City outfall drainage basins numbered NR03, NR04, and NR05. The park is an area of United States property managed by the US Army Corps of Engineers and leased to the City under Department of the Army Public Park and Recreational Lease number W912EF-1-04-14.

We discussed the concept of locating the facilities in the park at our November 4, 2014, pre-project scoping meeting held with your staff in Walla Walla. The discussion lead to a preliminary analysis that the proposed uses do not appear to present health, safety, or environmental concerns.

Although we reached the above conclusion at the November meeting, the conclusion carried the caveat that it was made with limited information and that upon review of additional and more detailed information, alternative conclusions could be reached. With the receipt of the application package, we will be able to move into the formal first phase of our review which is the determination as to whether or not the property requested for use by the City for the facilities is available for that use.

However, as you are aware, it is the policy of the US Army to have the beneficiary of transactions involving Army managed real estate pay the Army's expenses commensurate with allowing the use. The costs associated with the November meeting totaled \$675.00, and Phase 1 of our review process requires a non-refundable payment from the city of \$1,500.00. Please have a check or money order made payable to F&AO, USAED WALLA WALLA, in the amount

of **\$2,175.00**. Please include on the payment document our tracking number for this transaction which is **230154**. Send the payment to the above address, attention Real Estate Division.

Processing of funds takes 6-8 weeks and we cannot start on Phase 1 of the review until processing is complete. In addition to determining whether or not the US property desired for use by the City is available for the facilities, we will also estimate the approximate cost of the reviews necessary under Phase 2 of our process. After receiving and processing the payment for Phase 2, we will look closely at the proposal as it relates to the National Environmental Policy Act, Endangered Species Act, the National Historic Preservation Act, and other environmental laws as outlined in the enclosure titled "OUTGRANT REQUIREMENTS."

Once we begin Phase 1, we will work on your project as judiciously and efficiently as possible. However, due to coordination with outside agencies and tribal entities, existing workload, backlog, processing time, and the overall complexity of the City's proposal, you should allow us a minimum of 180 days to complete the processing of your request.

If there are questions, please contact Mr. Paul Shampine, Realty Specialist, at 509-527-7324. You can also reach him by e-mail at Paul.S.Shampine@usace.army.mil.

Sincerely,



Rodney C. Huffman
Real Estate Contracting Officer
District Chief of Real Estate

Enclosure



PLANNING COMMISSION AGENDA ITEM COVERSHEET

Meeting Date: 03/25/2015

Agenda Category: New Business – Public Hearing

Prepared By: Rick Simon, Development Services Manager

Subject:

Consideration of Zoning for Proposed Whitfield Annexation

Request:

Key 3 - Economic Vitality

Recommended Motion:

Recommend R1-I0 Single Family Residential zoning for the proposed Whitfield annexation (File No. Z2015-203).

Summary:

This is a public hearing for the Commission to consider the appropriate zoning designation(s) for the proposed Whitfield annexation. Edith Whitfield is the owner of a 26 acre parcel located south of Shockley Road, north of the KID irrigation canal and west of Riesling Avenue. City Council has authorized the Commission to consider the appropriate zoning for this annexation through the adoption of Resolution No. 54-15.

Attachments:

1. Staff Report
2. Resolution No. 54-15
3. Residential Zoning Regulations
4. Maps

STAFF REPORT

TO: PLANNING COMMISSION
FILE NO.: Z2015-103

PREPARED BY: RICK SIMON
MEETING DATE: MARCH 25, 2015

GENERAL INFORMATION:

APPLICANT: CITY OF RICHLAND (Z2015-103)

REQUEST: CONSIDERATION OF APPROPRIATE ZONING FOR A PROPOSED ANNEXATION.

LOCATION: LAND LOCATED SOUTH OF SHOCKLEY ROAD, NORTH OF KID IRRIGATION CANAL, WEST OF RIESLING.

REASON FOR REQUEST:

The City is currently considering the annexation of a 26 acre parcel located just south of Shockley Road that is part of an unincorporated island. City Council authorized the annexation process to begin through the adoption of Resolution #54-15, which directed the Planning Commission to consider what zoning would be appropriate for this site.

FINDINGS AND CONCLUSIONS

Staff has completed its review of the request for zoning assignment (Z2015-103) and submits that:

1. The site is within the City of Richland's Urban Growth Area boundary as those boundaries were established with the adoption of the Benton County Comprehensive Plan in 1998;
2. The City's comprehensive plan designates the site as suitable for low density residential land uses;
3. The site is currently developed with a commercial orchard;
4. Lands to the to the east, south and southwest of the subject parcel have been subdivided and are developed with a single family residences; lands to the northwest and north are large lot single family homes;
5. Lands to the northwest are located outside of city boundaries, while lands to the east, south and southwest are located within the City and zoned R1-10 Single Family Residential; lands to the north are zoned a combination of R1-12 Single Family Residential, AG – Agricultural and the adjacent

property along the northeast boundary of the site is zoned SAG – Suburban Agriculture;

6. Application of R-1-10 Single Family Residential zoning is appropriate for a site that is designated as low density residential under the current comprehensive plan designation;
7. Based on the above findings and conclusions, assignment of R-1-10 Single Family Residential zoning would be in the best interest of the community of Richland.

RECOMMENDATION

Staff recommends the Planning Commission concur with the findings and conclusions set forth in Staff Report (Z2015-103) and recommend to the City Council assignment of R-1-10 Single Family Residential zoning.

EXHIBITS

- A. Supplemental Information
- B. Resolution #54-15
- C. Chapter 23.18 of the Richland Municipal Code – Residential Zones
- D. Aerial Photo
- E. Land Use Plan Map
- F. Zoning Map

SUPPLEMENTAL INFORMATION

BACKGROUND

The City is evaluating a proposal to annex approximately 26 acres of land located in South Richland, south of Shockley Road, which is part of an unincorporated island. The property owner, Edith Whitfield has requested annexation.

The City Council passed a resolution on 54-15 authorizing the annexation proceedings to begin. The next steps include filing an application with the Benton County Boundary Review Board and for the Commission to consider what zoning designation(s) would be appropriate if the property were to be annexed.

SITE DATA

Size: Approximately 26 acres.

Ownership: This single parcel is under the ownership of Edith Whitfield.

Current Use: The site is developed as a commercial cherry orchard.

Comprehensive Plan: The site is within the City of Richland's adopted Urban Growth Area (UGA) boundary and is designated as suitable for low density residential development.

Utilities: City water and sewer mains are located immediately adjacent to the site along the Shockley Road corridor.

Existing County Zoning: Urban Growth Area Residential.

SURROUNDING LAND USES

North: Property north of Shockley Road includes an irrigation pond, undeveloped property and a large lot single family home.

South: The site borders the KID irrigation canal. Beyond the canal is the Westcliffe subdivision, a single family residential neighborhood.

East: The site borders one large lot single family residence and the Vineyards subdivision, a single family residential neighborhood.

West: The site borders two large lot single family residences that are located within the unincorporated island.

PROPOSED ZONING

There are two single family zoning designations that could be applied to the property that would implement the low density residential comprehensive plan designation: the R-1-10 and R-1-12 zones. A copy of the residential zoning codes is attached.

ANALYSIS

Both the R1-10 and R1-12 zones would be consistent with the comprehensive plan designation of Low Density Residential. However, the majority of the properties abutting the site are zoned R1-10 Single Family Residential and appears to be the most logical choice for the site.

SUMMARY

Application of the R-1-10 zoning represents the most appropriate zoning designation for the proposed annexation area.

RESOLUTION NO. 54-15

A RESOLUTION of the City of Richland, accepting a request for annexation of approximately 26 acres located South of Shockley Road, North of the Kennewick Irrigation District canal and West of Riesling Street in Section 27, Township 9 North, Range 28 East W.M., Benton County, Washington (Whitfield).

WHEREAS, Edith Whitfield, the owner of a 26-acre tract has submitted a letter to the City requesting annexation; and

WHEREAS, on March 3, 2015, the City Council was presented with the request for annexation and passed Resolution No. 41-15, establishing March 17, 2015 as the date for the Council to meet with the proponents of the annexation; and

WHEREAS, City Council met with the annexation proponents on March 17, 2015 and has reviewed the proposed annexation, as required by RCW 35.13.125.

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Richland, Washington, as follows:

Section 1. The City of Richland hereby accepts the request for annexation subject to the following conditions:

1. That the annexation be accepted as proposed.
2. That simultaneous adoption of the City's Comprehensive Plan for the proposed annexation is required.
3. That the City requires the assumption of an appropriate share of all existing City indebtedness by the area to be annexed.

Section 2. Staff is hereby authorized and directed to submit an application to the Benton County Boundary Review Board.

Section 3. The Richland Planning Commission is hereby directed to review the proposal and forward a recommendation to City Council as to the most appropriate zoning designation(s) for the area proposed for annexation.

BE IT FURTHER RESOLVED that this resolution shall take effect immediately.

PASSED by the City Council of the City of Richland at a regular meeting on the 17th day of March, 2015.

DAVID W. ROSE
Mayor

ATTEST:

APPROVED AS TO FORM:

MARCIA HOPKINS
City Clerk

HEATHER KINTZLEY
City Attorney

Chapter 23.18 – Residential Zoning Districts

Sections:

23.18.010 Purpose of Residential Use Districts

23.18.020 Residential Performance Standards and Special Requirements

23.18.030 Residential Use Districts Permitted Land Uses

23.18.040 Site Requirements for Residential Use Districts

23.18.050 Parking Standards for Residential Use Districts

23.18.010 Purpose of Residential Use Districts

Five residential zone classifications permit a variety of housing and population densities without conflict. Protection is provided against hazards, objectionable influences, traffic, building congestion and lack of light, air and privacy. Certain essential and compatible public service installations are permitted in residential use districts.

- A. The single family residential – 12,000 (R-1-12) is a residential zone classification requiring the lowest density of population within the City, providing protection against hazards, objectionable influences, building congestion and lack of light, air and privacy. Certain essential and compatible public service facilities and institutions are permitted in this district. This zoning classification is intended to be applied to some portions of the City that are designated Low Density Residential (0 – 5 Dwellings/Acre) under the City of Richland Comprehensive Plan
- B. The single family residential – 10,000 (R-1-10) is a residential zone classification requiring a low density of population, providing protection against hazards, objectionable influences, building congestion, and lack of light, air, and privacy. Certain essential and compatible public service facilities and institutions are permitted in this district. This zoning classification is intended to be applied to some portions of the City that are designated Low Density Residential (0 – 5 Dwellings/Acre) under the City of Richland Comprehensive Plan.
- C. The medium density residential (R-2) is a residential zone classification permitting a higher density of population including the establishment of duplex dwellings and providing for these single-and two-family residences a high degree of protection from hazards, objectionable influences, building congestion and lack of light, air and privacy. Certain essential and compatible public service facilities and institutions are permitted in this district. This zoning classification is intended to be applied to some portions of the City that are designated Medium Density Residential (5.1- 10 Dwellings/Acre) under the City of Richland Comprehensive Plan
- D. The medium density residential small lot (R-2S) is a residential zone classification permitting a higher density of population, encouraging small lot development conducive to energy conservation and to other factors contributing to the production of affordable housing, and including the establishment of duplex dwellings and providing for these one- and two-family residences a high degree of protection from hazards, objectionable influences, building congestion and lack of light, air and privacy. Certain essential and compatible public service facilities and institutions are permitted in this district. This zoning classification is intended to be applied to some portions of the City that are designated Medium Density Residential (5.1- 10 Dwellings/Acre) under the City of Richland Comprehensive Plan
- E. The multiple-family residential use district (R-3) is a residential zone classification allowing for the location of multiple-family dwellings, duplexes and attached and detached one-family dwellings and providing a high degree of protection for such uses and adjacent low density residential development. This classification shall be designed to give protection from hazards, objectionable influences, building

congestion, and lack of light, air, and privacy. Certain essential and compatible public service facilities and installations are permitted in this district. This zoning classification is intended to be applied to some portions of the City that are designated High Density Residential (10.1+ Dwellings/Acre) under the City of Richland Comprehensive Plan.

23.18.020 Residential Performance Standards and Special Requirements

- A. **High Density Residential Small Lot Special Requirements:** In order to assure consistency with the purpose of the R-2S district, as stated in Section 23.18.010(D), and further to avoid potential negative and undesirable effects that may result from the higher density of development afforded in an R-2S zone, the following special requirements and provisions shall apply:
1. Any application for reclassification of land to R-2S shall be accompanied by an application for preliminary plat approval submitted in accordance with RMC 24.12.010. In addition, the following information shall be submitted with the application for preliminary plat:
 - a) A street landscaping plan showing the location and type of landscaping proposed;
 - b) Information showing the location, dimensions and character of recreational facilities and/or open space, including paths and trails; and
 - c) Utilization of curvilinear, cul-de-sac and/or loop streets or other appropriate design solutions to assist in modulating the interface of the residential buildings with the streets.
 2. The Planning Commission and City Council may, in keeping with the intent of this section, impose requirements and conditions on the approval of the preliminary plat or zoning reclassification as deemed appropriate. These conditions may include, but are not limited to architectural design parameters, screening and buffering treatments, and supplemental open space and/or recreational facility requirements. Compliance with these conditions shall be demonstrated precedent to final plat and/or building permit approval as appropriate.
 3. A combined front yard setback configuration and street-facing residential architectural elevation may be repeated continuously on no more than five (5) lots before a different combination must be utilized. Regardless of the street facing architectural elevation, a front yard setback configuration may be repeated no more than ten (10) lots before a different setback configuration must be utilized. The Administrative Official may approve variations to this requirement, which, in his judgment, accomplish the intent of avoiding a monotonous interface of the residential buildings with the streets, or are necessary due to constraints or unique characteristics of the site. This requirement shall be satisfied at the time of building permit application.
- B. **Multiple Family Residential Use District Special Requirements:** In any multi-family residential (R-3) zoning district that directly abuts a single family zoning district, the following buffer, setback and building height regulations shall apply to all multi-family residential structures:
1. Buildings shall maintain at least a thirty-five foot (35') setback from any property that is zoned for single-family residential use. Single family residential zones include R-1-12 Single Family Residential, R-1-10 – Single Family Residential, R-2 – Medium Density Residential, R2-S – Medium Density Residential Small Lot or any residential Planned Unit Development that is comprised of single-family detached dwellings.

2. Buildings that are within fifty feet of any property that is zoned for single-family residential use (as defined in item 1 above) shall not exceed thirty feet (30') in height. Beyond the area fifty (50) feet from any property that is zoned for single family residential use, building height may be increased at the rate of one foot in building height for each additional one foot of setback from property that is zoned for single family residential use to the maximum building height allowed in the multi-family zoning district.
3. A six (6) foot high fence that provides a visual screen shall be constructed adjacent to any property line that adjoins property that is zoned for single-family residential use. Additionally, a ten (10) foot landscape strip shall be provided adjacent to the fence. This landscape strip may be used to satisfy the landscaping requirements established for the landscaping of parking facilities as identified in Section 23.54.140.
4. Recreational Vehicle Parks are permitted in the Multi-Family Residential District (R-3) subject to the issuance of a special use permit meeting the requirements of Sections 23.42.220 and 23.42.240. Further, applicants must demonstrate that their proposed Recreational Vehicle Parks are immediately adjacent to a state highway and that appropriate provisions are put in place to protect adjacent land uses.

23.18.025 Single Family Residential Design Standards

Any one family attached dwelling, one family detached dwelling or designated manufactured home shall meet the following minimum requirements:

- A. All dwellings shall be placed on permanent foundations.
- B. At the time of construction, all new single family dwellings shall be new, not having been previously titled to a retail purchaser and not meeting the definition of a "used mobile home" as defined in RCW 82.45.032(2).

23.18.030 Residential Use Districts Permitted Land Uses

In the following chart, land use classifications are listed on the vertical axis. Zoning districts are listed on the horizontal axis.

- A. If the symbol "P" appears in the box at the intersection of the column and row, the use is permitted, subject to the general requirements and performance standards required in that zoning district.
- B. If the symbol "S" appears in the box at the intersection of the column and row, the use is permitted subject to the Special Use Permit provisions contained in Chapter 23.46 of this title.
- C. If the symbol "A" appears in the box at the intersection of the column and the row, the use is permitted as an accessory use, subject to the general requirements and performance standards required in the zoning district.
- D. If a number appears in the box at the intersection of the column and the row, the use is subject to the general conditions and special provisions indicated in the corresponding note.
- E. If no symbol appears in the box at the intersection of the column and the row, the use is prohibited in that zoning district.

Land Use	R1-12	R1-10	R-2	R-2S	R-3
Residential Uses					
Accessory Apartments	A ¹	A ¹	A ¹	A ¹	A ¹
Accessory Buildings ¹⁴	A	A	A	A	A

Land Use	R1-12	R1-10	R-2	R-2S	R-3
Adult Family Home	P	P	P	P	P
Apartment/Condominium (3 or more units)					P
Assisted Living Facility					P
Bed and Breakfast	S ²	S ²	S ²	S ²	P
Day Care Center	S ³	S ³	S ³	S ³	P ³
Designated Manufactured Home	P ⁴	P ⁴	P ⁴	P ⁴	P ⁴
Dormitories, Fraternities and Sororities					P
Dwelling, One Family Attached			P ⁴	P ⁴	P ⁴
Dwelling, One Family Detached	P ⁴	P ⁴	P ⁴	P ⁴	P ⁴
Dwelling, Two Family Detached			P	P	P
Home Occupations	A ⁵	A ⁵	A ⁵	A ⁵	A ⁵
Family Day Care Home	A ³	A ³	A ³	A ³	A ³
Manufactured Home Park			S ⁶	S ⁶	S ⁶
Playground developed in conjunction with school, park or community clubhouse	P	P	P	P	P
Nursing or Rest Home					P
Rental of Rooms to not more than four persons other than the family occupying the single family dwelling	A	A	A	A	A
Private Swimming Pools	A ⁷	A ⁷	A ⁷	A ⁷	A ⁷
Recreational Club	P ⁸	P ⁸	P ⁸	P ⁸	P ⁸
Senior Housing					P
Public/Quasi Public Uses					
Churches	P ⁹	P ⁹	P ⁹	P ⁹	P ⁹
Clubs or Fraternal Societies	P ⁹	P ⁹	P ⁹	P ⁹	P ⁹
Cultural Institutions	P ⁹	P ⁹	P ⁹	P ⁹	P ⁹
General Park Operations & Maintenance Activities	P	P	P	P	P
Golf Courses	P	P	P	P	P
Power Transmission & Irrigation Wasteway Easements & Utility Uses	P ¹⁰	P ¹⁰	P ¹⁰	P ¹⁰	P ¹⁰
Public Agency Buildings	P ¹⁰	P ¹⁰	P ¹⁰	P ¹⁰	P ¹⁰
Public Agency Facilities	P ¹⁰	P ¹⁰	P ¹⁰	P ¹⁰	P ¹⁰
Public Parks	P	P	P	P	P
Schools	P ¹¹	P ¹¹	P ¹¹	P ¹¹	P ¹¹
Special Events including concerts, tournaments and competitions, fairs, festivals and similar public gatherings	P	P	P	P	P
Trail Head Facilities	P	P	P	P	P
Miscellaneous Uses					
Micro and Macro Antennas	P	P	P	P	P
Parking Lots	P	P	P	P	P

Land Use	R1-12	R1-10	R-2	R-2S	R-3
Raising Crops, Trees, Vineyards	P	P	P	P	P
Recreational Vehicle Parks					S ^{12,13}

1 Section 23.42.020

2 Section 23.42.045

3 Section 23.42.080

4 Section 23.18.025

5 Section 23.42.090

6 Section 23.42.140

7 Section 23.42.300

8 Section 23.42.210

9 Section 23.42.050

10 Section 23.42.200

11 Section 23.42.250

12 Section 23.42.220

13 Section 23.18.020(B)(4)

14 Accessory buildings and structures are subject to RMC 23.38.020 – 23.38.070

(Ord. 04-09)

23.18.040 Site Requirements for Residential Use Districts

In the following chart, development standards are listed on the vertical axis. Zoning districts are listed on the horizontal axis. If a number appears in the box at the intersection of the column and row, that number represents the dimensional standard that applies to that zoning district.

Standard	R1-12	R1-10	R-2	R-2S	R-3
Minimum Lot Area Requirement – One Family Detached Dwelling	10,000 ¹	8,000	6,000	4,000	6,000
Minimum Lot Area Requirement – Two Family Detached Dwelling	N/A	N/A	10,000	7,000	10,000
Minimum Lot Area Requirement One-Family Attached Dwellings	N/A	N/A	N/A	3,000	3,000
Maximum Density – Multi Family Dwellings (units/square foot).	N/A	N/A	N/A	N/A	1:3,000
Minimum Lot Width – One Family Detached Dwelling	90	70	50	42	50
Minimum Lot Width – Two Family Detached Dwelling	N/A	N/A	70	64	70
Minimum Lot Width – One Family Attached Dwellings	N/A	N/A	N/A	30	30
Average Lot Size Requirement ²	12,000	10,000	None	None	None
Minimum Front Yard Setback ³	20	20	20	15/18 ⁴	20
Minimum Side Yard Setback	10	10	6	6 ⁵	Note 6, 10
Minimum Rear Yard Setback	25	25	25	20/3 ⁷	25 ¹⁰
Maximum Lot Coverage ⁸	40	40	40	50	33/45 ^{9,10}
Maximum Building Height - Main Building	30	30	30	30	40 ¹⁰
Maximum Building Height - Accessory Buildings ¹¹	18	18	18	18	18

¹ The minimum lot size in existing residential neighborhoods shall be based on the mean average lot size of existing platted R-1-12 lots within a radius of 500 feet (500') of the property proposed for subdivision. However, in no case shall the minimum lot requirement exceed 12,000 square feet, nor be less than 10,000 square feet.

² Minimum average lot area per subdivision, exclusive of the area of streets and lots designated for nonresidential uses. In calculating average lot size, at least 35% of all lots shall be larger than the average lot size requirement.

³ Front yard setbacks are required from all street rights-of-way adjoining a lot as shown in the table above, except as follows:

- A. In single-family residence districts and in R-2 and R-3 districts where more than fifty percent of the normal or average-size lots in a block fronting on one side of the street are developed with existing buildings, other than accessory buildings, with front-yard setbacks less than that required for the district, a new single-family or duplex dwelling shall adopt a minimum front yard setback dimension which is the average of the setbacks of the buildings on the two adjoining lots, existing prior to July 22, 1960, but in no case shall this dimension be less than fifteen feet nor need it exceed thirty feet.
- B. Residential Districts. In any "R" district, or any combination therewith, on any corner lot where there is provided a side yard along the interior side lot line at least equal in width to the minimum depth of the rear yard required for the district, the main building may encroach upon the required rear yard up to a line where the remaining rear yard is no less in depth than the minimum width of the side yard required for the district. No accessory buildings may be located in said side yard, except a patio shelter enclosed on no more than two sides by walls or other enclosures and in conformity with the other provisions of this title.

⁴ Front yards shall not be less than fifteen (15) feet in front of living areas, up to a maximum of fifty-five (55) percent of the front lot line and not less than eighteen (18) feet in front of all other areas.

⁵ Detached one family or detached two-family dwelling shall have two (2) side yards with each side yard having a width of not less than six (6) feet. Each lot upon which an attached one-family dwelling is constructed shall have one (1) side yard of zero (0) feet, the other side yard shall be not less than six (6) feet.

⁶ For Multiple-family dwellings. Side yards shall be equal to one foot of side yard for each three feet or portion thereof of building height. Attached one-family dwellings shall have side yards of zero feet except as required for corner lots; and further provided that there shall be a minimum separation of twenty feet between building clusters/complexes or a side yard of ten feet to the parcel boundary adjoining the end of a building cluster/complex.

⁷ Rear yards shall be not less than twenty (20) feet in back of living areas and three (3) feet in back of garages or carports up to a maximum of sixty (60) percent of the rear lot line for the garage or carport portion of the rear yard.

⁸ Lot coverage includes all buildings, including accessory buildings or structures on any lot in a residential district, exclusive of patios without roof coverings or patios with only open lattice or similar type roof construction.

⁹ Buildings in an R-3 district shall cover not more than thirty-three percent of the area of the lot except one-family attached dwellings which may cover up to forty-five per cent of the area of the lot.

¹⁰ Setbacks, building heights, and lot coverage requirements for one-family detached and two-family dwellings in the R-3 zoning district shall be the same as those set forth for development in the R-2 zoning district.

¹¹ Detached accessory structures built pursuant to the setback provisions of RMC Section 23.38.020 are limited to one story.
(Ord. 04-09)

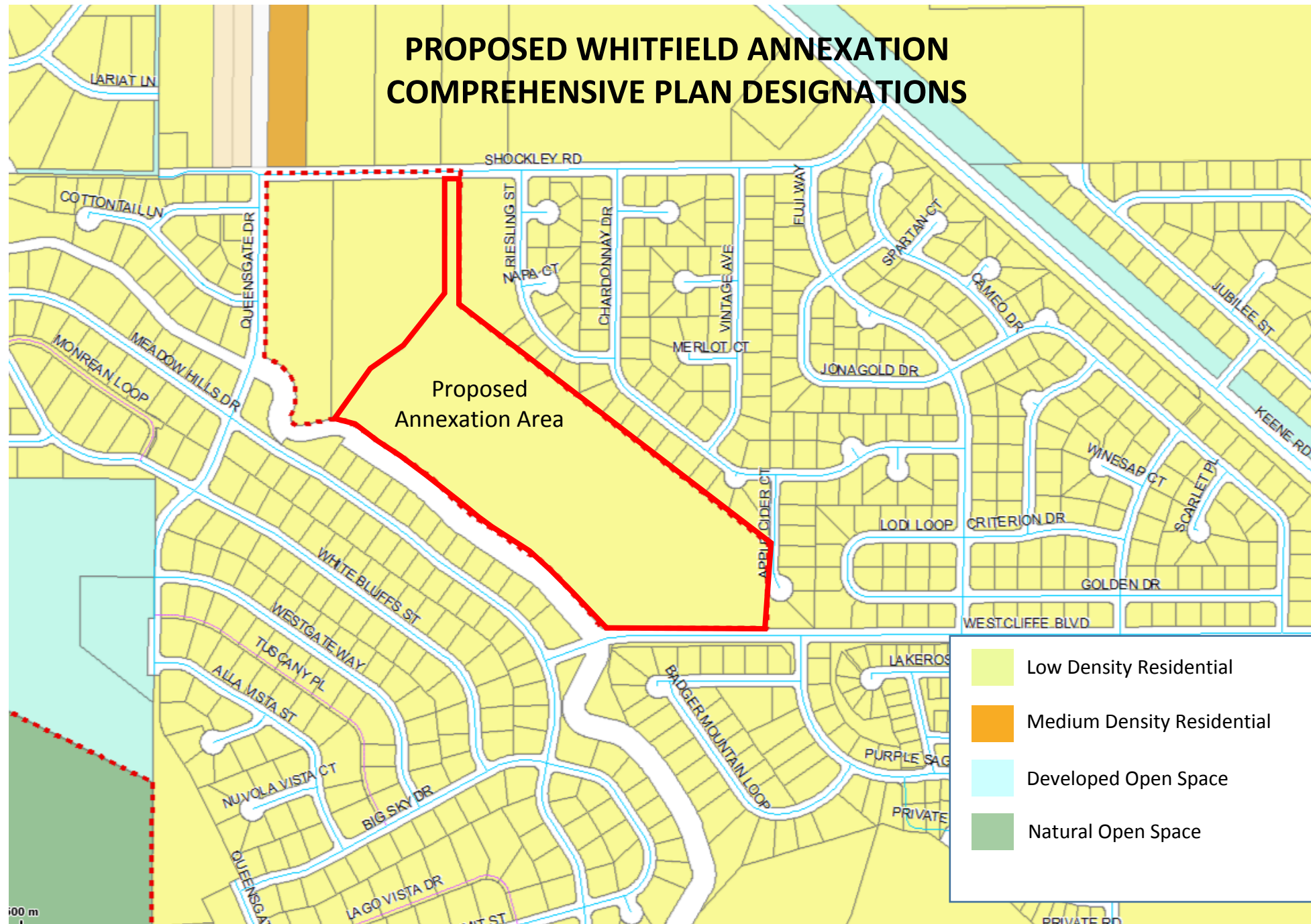
23.18.050 Parking Standards for Residential Use Districts

Off street parking space shall be provided in all residential zones in compliance with the requirements of Chapter 23.54 of this title.

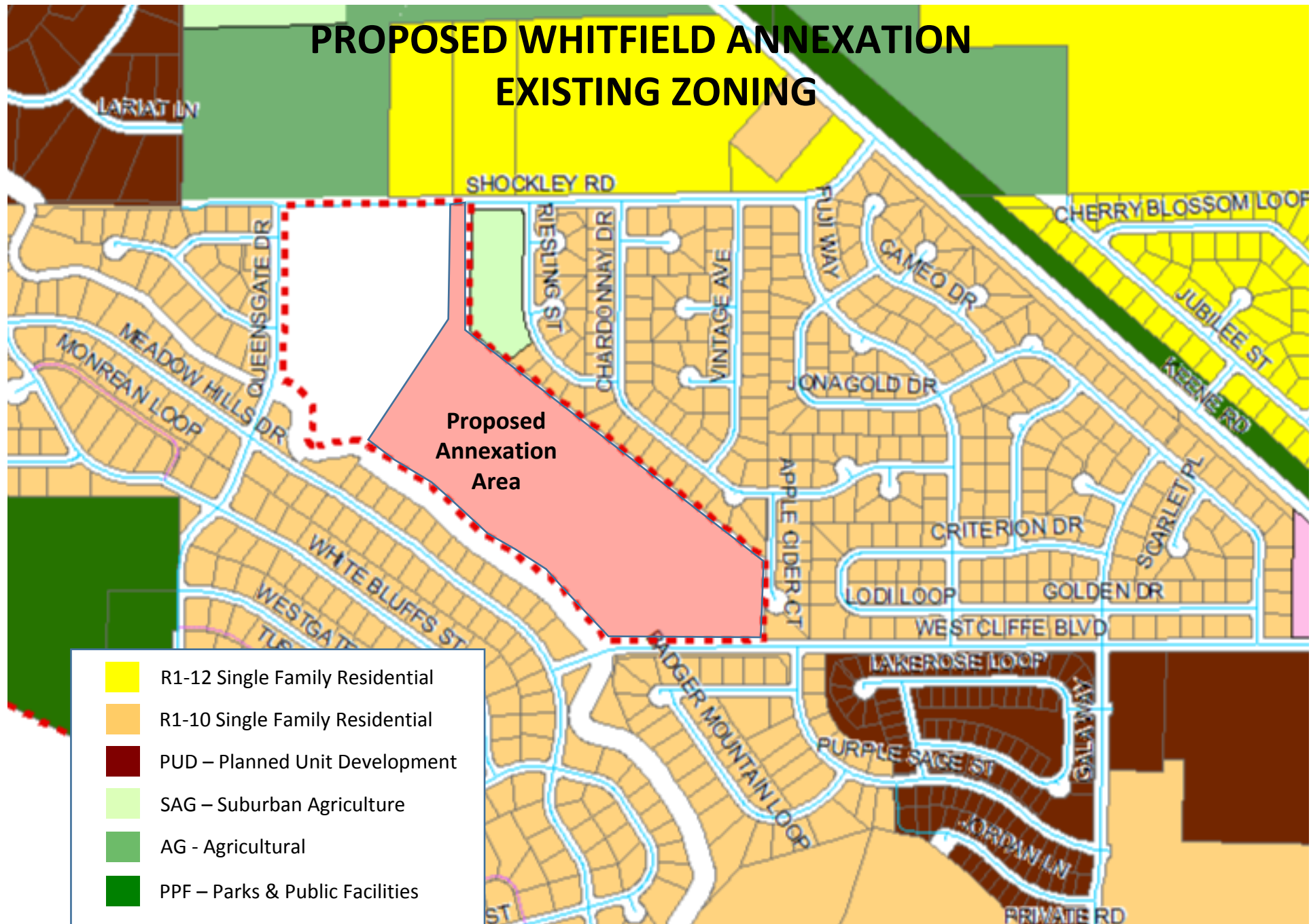
PROPOSED WHITFIELD ANNEXATION VICINITY MAP



PROPOSED WHITFIELD ANNEXATION COMPREHENSIVE PLAN DESIGNATIONS



PROPOSED WHITFIELD ANNEXATION EXISTING ZONING





PLANNING COMMISSION AGENDA ITEM COVERSHEET

Meeting Date: 03/25/2015

Agenda Category: New Business – Public Hearing

Prepared By: Rick Simon, Development Services Manager

Subject:

Consideration of Amendments to RMC Section 23.42.300 Concerning Swimming Pools on Residential Lots

Request:

Key 7 - Neighborhoods & Community Safety

Recommended Motion:

Recommend approval of the proposed amendment to RMC Section 23.42.300 pertaining to swimming pools on residential lots.

Summary:

Currently, the City has zoning regulations (RMC 23.42.300) that generally require swimming pools to be placed in the back yard, behind the residence. While this is a logical requirement, it eliminates homeowners from placing a pool on their property if they have a double frontage lot. The proposed code amendment would provide an opportunity for those homeowners to place a pool on their properties without having to go through the variance process.

Attachments:

1. Staff Report

STAFF REPORT

TO: PLANNING COMMISSION
FILE NO.: Z2015-104

PREPARED BY: RICK SIMON
MEETING DATE: MARCH 25, 2015

GENERAL INFORMATION:

APPLICANT: CITY OF RICHLAND Z2015-104

REQUEST: TEXT AMENDMENTS TO SECTION 23.42.300 OF THE
MUNICIPAL CODE CONCERNING SWIMMING POOLS ON
RESIDENTIAL LOTS

LOCATION: CITYWIDE

REASON FOR REQUEST:

The current provisions in the City code concerning the placement of swimming pools do not address double frontage lots.

FINDINGS AND CONCLUSIONS

Staff has completed its review of the proposed amendments to the city's development regulations and submits that:

1. The existing City code, under Section 23.42.300 mandates that private swimming pools be located in the rear yard, the back half of the lot or be setback a minimum of 75 feet from a public street. The effect of this regulation is to preclude a double frontage lot from having a swimming pool;
2. The proposed code amendments to RMC Section 23.42.300 would provide an option to land owners who wish to install private swimming pools on a double frontage lot;
3. The proposed code amendments would relax the standards by requiring that pools be setback a minimum of 20 feet from a public or private street when a lot is bordered on two or more sides by public and/or private streets;
4. Based upon the above findings and conclusions, the adoption of the City's amendments to Section 23.42.300 of the Richland Municipal Code – Swimming Pools is in the best interest of the community of Richland.

RECOMMENDATION

Staff recommends the Planning Commission concur with the findings and conclusions set forth in Staff Report (Z2015-104) and recommend to the City Council adoption of the proposed amendments to Section 23.42.300 of the Richland Municipal Code – Swimming Pools.

ATTACHMENTS

A. Supplemental Information

SUPPLEMENTAL INFORMATION

EXISTING CODE

The current City code provides for swimming pools in residential zones. Section 23.42.300 reads as follows:

All private swimming pools located in an AG, SAG, R-1-12, R-1-10, R-2, R-2S and R-3 zone capable of holding 24 inches or more of water shall be located in the back half or rear yard of the lot, or shall be located a minimum of 75 feet from a street right-of-way; except that this provision shall not apply to hot tubs as defined in RMC 23.06.500. Public and semi-public pools shall meet the provisions of RMC 23.42.210, Recreational clubs.

In order to better understand how to interpret this code language, the following definition of terms from the city code is provided:

23.06.975 Yard.

“Yard” means an open space of uniform width or depth on the same lot with a building or a group of buildings, which open space lies between the building or group of buildings and the nearest lot line and is unoccupied and unobstructed from the ground upward, except for the certain exceptions specified in this title. In measuring a yard, as hereinafter provided, the “line of a building” shall be deemed to mean a line parallel to or concentric with the nearest lot line drawn through the point of a building or the point of a group of buildings nearest to such a lot line, exclusive of the exceptions referenced above, and the measurements shall be taken from the line of the building to the nearest lot line.

23.06.980 Yard, front.

“Yard, front” means a yard extending the full width of the site and measured as to depth at the least horizontal distance between the street right-of-way line and the exterior wall.

23.06.575 Lot line, front.

“Lot line, front” means, in the case of an interior lot, a line separating the lot from the street; in the case of a corner lot, a line separating the narrowest street frontage of the lot from the street; except in those cases in a C-1 district where a lot has two or more street frontages of equal length or nearly equal length, the front lot line shall be considered to be the line adjoining the street which the comprehensive plan shows is intended to carry the heaviest traffic flow.

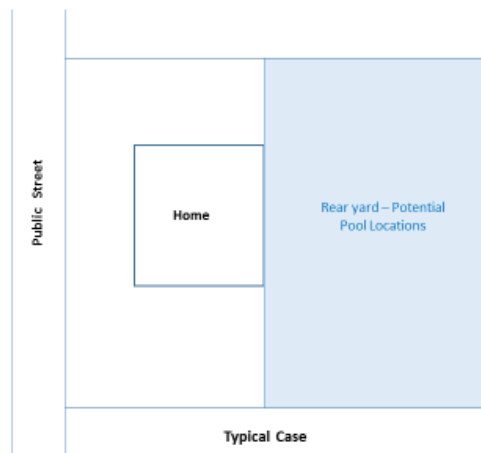
23.06.983 Yard, rear.

“Yard, rear” means a yard which extends the full width of the site and is measured as to depth at the least horizontal distance between the rear lot line and the exterior wall.

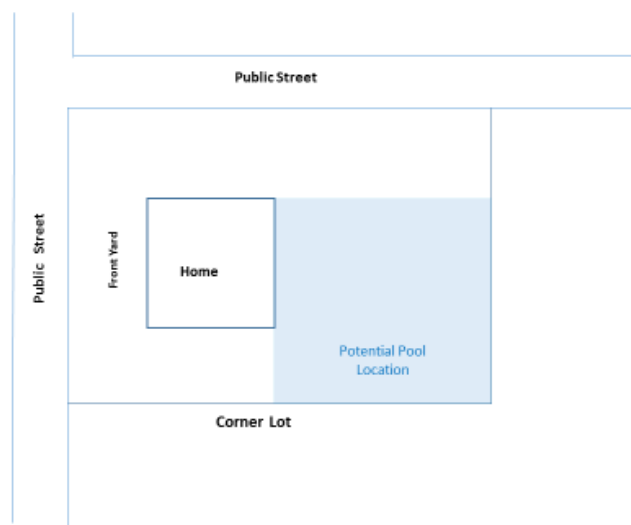
23.06.577 Lot line, rear.

“Lot line, rear” means the lot line which is generally opposite the front lot line. If the rear lot line is less than 10 feet in length, or if the lot comes to a point at the rear, the rear lot line shall be deemed to be a line parallel to the front lot line, not less than 10 feet long, lying wholly within the lot and farthest from the front lot line.

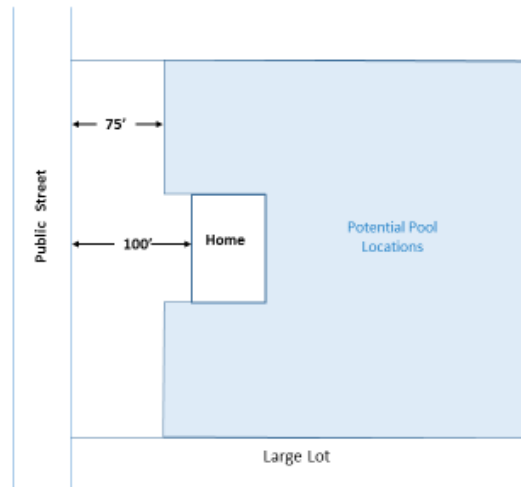
In the most common case, a pool would be located on a lot in this manner:



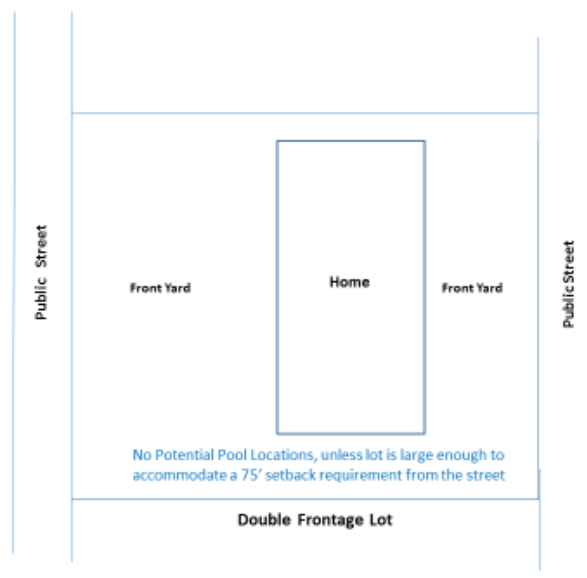
On a corner lot, pool placement would be as follows:



On a very large lot, pool could even be placed on the lot so that the pool is closer to the street than the residence.



In the case of a double frontage lot, because the term front yard is defined as being adjacent to a street, there are no options for the placement of a pool:



PROPOSED AMENDMENTS

23.42.300 Swimming pools. *All private swimming pools located in an AG, SAG, R-1-12, R-1-10, R-2, R-2S and R-3 zone capable of holding 24 inches or more of water shall*

be located in the back half or rear yard of the lot, or shall be located a minimum of 75 feet from a street right-of-way; except that pools may be located a minimum of 20 feet from a street right-of-way or private street on any lot that is bordered on two or more sides by a public right-of-way or is accessed via a private access drive and also abuts a public street. ‡This provision shall not apply to hot tubs as defined in RMC 23.06.500. Public and semi-public pools shall meet the provisions of RMC 23.42.210, Recreational clubs.

ANALYSIS

The proposed code amendments would make provisions for lot owners to place a pool on a lot that has two, opposite street frontages. While such double frontage lots are not as common as corner lots, there are quite a number scattered throughout the City. They are typically created when lots that are adjacent to collector or arterial streets are provided access from a local street. They are also somewhat common in the newer hillside subdivisions in South Richland. For this limited circumstance, the proposed amendment would benefit those lot owners whose only option under the existing code is to apply for a variance.

SUMMARY

The proposed amendments to the City's regulations pertaining to private swimming pools are desirable in providing more flexibility to land owners who wish to install this common accessory structure.