APPENDIX A

Stormwater Management Memorandum

Columbia River CROSSING

Memorandum

January 21, 2011

TO: Heather Wills

FROM: Roger Kitchin

SUBJECT: STORMWATER MANAGEMENT

COPY: Andrew Beagle; Jeff Heilman

This memorandum presents proposed stormwater management strategies for the Columbia River Crossing (CRC) project. Figure 1 shows the proposed footprint and location of Ruby Junction, the proposed site for the light rail vehicle (LRV) maintenance facility. The memo does not provide an evaluation of the potential impacts from the strategies; these are addressed in the Biological Assessment and Final Environmental Impact Statement (FEIS) Water Quality Technical Report.

Note that all figures are located at the end of this memorandum.

Introduction

Background

There are a number of federal, state and local agencies with direct jurisdiction over or significant input to the stormwater aspects of the CRC project. These include:

- National Oceanic & Atmospheric Administration (NOAA) Fisheries
- U.S. Environmental Protection Agency (EPA)
- Oregon Department of Environmental Quality (DEQ)
- Washington State Department of Ecology (Ecology)
- City of Portland
- City of Vancouver
- City of Gresham (Ruby Junction only)

The state and federal agencies listed above are signatories of the Interstate Collaborative Environmental Process (InterCEP) agreement with the exception of Gresham. The agreement defines a process for coordinating their involvement, and streamlining regulatory reviews and permits agencies and through this process, the team engages in an ongoing dialogue with the necessary state and federal agencies prior to making major decisions.

One result of this collaborative approach is the adoption of the Oregon Department of Transportation's (ODOT) recent technical memorandum on stormwater water quality [1] on a project-wide basis to provide a standard approach to determining types of water quality facilities that would provide adequate protection to listed species. The memorandum is the result of a collaborative venture by ODOT, the Federal Highway Administration (FHWA), and natural resource agencies (NOAA Fisheries, DEQ, U.S. Fish and Wildlife Service, EPA, and the Oregon Department of Fish and Wildlife). The decision to use this

[1] Stormwater Management Program, Geo-Environmental Bulletin GE09-02(B). Prepared by the Oregon Department of Transportation. January 27, 2009.

approach on the CRC project has been endorsed by the Washington State Department of Transportation (WSDOT) and Ecology.

The water management strategies presented in this report are based on the Option A full build presented in the FEIS. This option includes:

- Rebuilding and resurfaced approximately 6 miles of Interstate 5 (I-5) between Victory Boulevard interchange in Portland and the Main Street interchange in Vancouver.
- Rebuilding the Victory Boulevard, Marine Drive, Hayden Island, SR 14, Mill Plain, Fourth Plain and SR 500 interchanges.
- Replacing the existing highway bridges across the Columbia River by two 10-lane bridges. The structure will also accommodate light rail and bike-pedestrian facilities.
- Extending the existing MAX Yellow Line light rail transit (LRT) from the Portland Metropolitan Exposition Center (Expo) to Clark College in Vancouver.
- Improvements to bike-pedestrian facilities and local streets. Street improvements include an arterial connection across North Portland Harbor, between Hayden Island and the Marine Drive interchange area. The arterial lanes would be located on the LRT bridge.
- Expanding the maintenance facilities at the existing TriMet facility in the City of Gresham, the design of which is being performed by TriMet.

A discussion is also included for the anticipated differences should Option B or a phased approach be adopted. Option B does not have arterial lanes on the LRT bridge across North Portland Harbor, but instead provides direct access between Marine Drive and Hayden Island with collector-distributor lanes on two new bridges that would be built adjacent to I-5. A phased approach, which could be adopted for either option, would defer construction of part of the Victory Boulevard and Marine Drive interchanges, and most of the SR 500 interchange.

Should these assumptions change, the project team will revisit and revise strategies as necessary to meet project requirements.

Stormwater Management Goals

The CRC project is a bi-state initiative and it is important to note that the implementation of water management objectives differ significantly between Oregon and Washington. The primary differences involve how areas that require pollutant reduction are calculated. These differences, which are described in the following paragraphs, can have an impact of the sizes of water quality facility required, especially for projects like the CRC that involve significant areas of impervious pavement.

Oregon requires runoff from the entire contributing impervious area (CIA) be treated to reduce pollutants regardless of the degree to which the surfaces would contribute pollutants to runoff. Using this approach, runoff from highways would be required to be treated in the same manner as runoff from bike-pedestrian paths. In contrast, Washington focuses on requiring treatment for runoff from the pollutant-generating impervious surfaces (PGIS).

ODOT defines the CIA as consisting of all impervious surfaces within the strict project limits, plus impervious surface owned or operated by ODOT outside the project limits that drain to the project via direct flow or discrete conveyance.[2] NOAA Fisheries has expanded this definition to also include impervious areas that are not owned by ODOT but drain onto the project footprint.

WSDOT and Ecology define PGIS as surfaces that are considered a significant source of pollutants in stormwater runoff including:

- Highways, ramps and non-vegetated shoulders
- LRT guideway subject to vehicular traffic
- streets, alleys and driveways
- bus layover facilities, surface parking lots and the top floor of parking structures

---

[2] http://www.oregon.gov/ODOT/HWY/GEOENVIRONMENTAL/storm_management_program_cia.shtml

The following types of impervious area are considered non-PGIS:

- LRT guideway not subject to vehicular traffic except the occasional use by emergency or maintenance vehicles (referred to as an exclusive guideway)
- LRT stations
- bicycle and pedestrian paths

Exclusive LRT guideway is considered non-PGIS because light rail vehicles are electric, and that other potential sources of pollution such as bearings and gears are sealed to prevent the loss of lubricants. Light rail vehicle braking is almost exclusively accomplished via (power) regenerative braking, which avoids any friction or wear on the vehicle brake pads and, thus, very few pollutants are generated. In Washington, NOAA Fisheries and U.S. Fish and Wildlife concurred with Sound Transit's conclusion that this type of guideway was non-polluting and, as such, the runoff did not require treatment before being discharged to the receiving waterbody[3]. In Oregon, runoff from this area would require treatment before being released.

In addition, Washington differentiates between stormwater runoff treatment requirements for new and rebuilt[4] versus resurfaced[5] pavement while state and local jurisdictions in Oregon do not. In Washington, water quality treatment is only required for runoff from new and rebuilt PGIS while Oregon does not differentiate; requiring treatment for all impervious surfaces. However, this approach is not consistently applied within Oregon. For example, the Standard Local Operating Procedures for Endangered Species (SLOPES IV)[6], a programmatic biological opinion and incidental take statement by NOAA Fisheries for projects undertaken in Oregon by the U.S. Army Corps of Engineers states that "actions that merely resurface pavement by placing a new surface, or overlay, directly on top of existing pavement with no intervening base course and no change in the subgrade shoulder points, are not subject to these [pollution reduction and flow control] requirements". Regardless, NOAA Fisheries has determined that resurfaced pavement within a project cannot be handled differently from rebuilt pavement unless the resurfacing is conducted within a "hydrologically isolated basin"[7] even though the potential impediments to retrofitting water quality facilities for resurfaced pavement are the same whether the resurfacing is a stand-alone undertaking or within a larger project. These impediments include very limited or non-existent ability to change existing conveyance systems and possible lack of physical space to install a water quality facility.

Since the early stages of development, the overall permanent stormwater management objectives for the CRC project have been:

1) Provide flow control for new and replaced impervious areas in accordance with state and local requirements. Note that flow control is only required for stormwater discharges to Burnt Bridge Creek. Discharges to the Columbia Slough, North Portland Harbor, and Columbia River are exempt.
2) Select and provide water quality facilities for new and rebuilt existing PGIS in accordance with the most restrictive requirements of the agencies that have authority over the drainage area being considered.
3) Where practical and cost-effective, provide water quality facilities for resurfaced and existing PGIS.

Flow control is only required for stormwater discharges to Burnt Bridge and Fairview Creeks: discharges to the Columbia Slough, North Portland Harbor and Columbia River are exempt from flow control

---

[3] Central Link Light Rail transit Project, Sound Transit Biological Assessment. Prepared by Sound Transit. November 1999.

[4] Rebuilt impervious surfaces are existing impervious areas that are excavated to a depth at or below the top of the subgrade.

[5] Resurfaced impervious surfaces are those existing impervious surfaces where the asphalt or concrete is <u>not</u> removed down to or below the top of the subgrade.

[6] Revisions to Standard Local Operating Procedures for Endangered Species to Administer Maintenance or Improvement of Road, Culvert, Bridge and Utility Line Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in the Oregon (SLOPES IV Roads, Culverts, Bridges and Utility Lines). National Marine Fisheries Service, Northwest Region. August 13, 2008

[7] Email from Devin Simmons dated July 26, 2010.

requirements. Runoff to Burnt Bridge Creek must be reduced to pre-development (forested) conditions for peak discharges between 50 percent of the 2-year event and the 50-year event. For Fairview Creek, which is associated with the Ruby Junction facility and runoff to which would be under the jurisdiction of the City of Gresham, flow control is currently required only to the extent necessary to ensure that existing flows in the creek would not be increased. Gresham, however, is in the process of revising the Public Works Standards[8] to require runoff for storm events with a recurrence interval less than or equal to 25-years be reduced to what would have occurred prior to any development having taken place (for example, forested conditions).

For objectives 2) and 3), the project has agreed to adopt the requirements of NOAA Fisheries for water quality facilities even though, in our opinion, the additional measures are not expected to provide any measurable increase in the level of protection of listed species. These requirements are that the project treats runoff from the entire CIA in both Oregon and Washington regardless of whether it is considered pollutant-generating or whether it is new, rebuilt, resurfaced, or existing.

The sizing and detailed design of individual water quality facilities will be in accordance with the specific requirements of the state or local agency that has jurisdiction over that facility. For example, water quality facilities within the WSDOT right-of-way will be sized and designed in accordance with the WSDOT Highway Runoff Manual. In Oregon, single rainfall events are used to size water quality facilities. ODOT uses rainfall events that would result in about 85 percent of the cumulative runoff being treated while the City of Gresham's and the City of Portland's design rainfall would result in about 80 and 90 percent of the average annual runoff being treated, respectively. In Washington, the types of water quality facility being proposed would be sized to treat at least 91 percent of the runoff volume regardless of where the facility is located. Unlike Oregon, design flows and volumes for water quality facilities in Washington are estimated using continuous rainfall-runoff simulation models. It should be noted that many of the water quality facilities being proposed rely on infiltration as the primary mechanism for treatment and disposal. Depending on the infiltration rates available at a particular site, these facilities could result in an even higher percentage of runoff treatment.

Existing Conditions

Watersheds

Following is a brief description of watersheds within which the project is located and the waterbodies to which runoff would be discharged. From south to north, the waterbodies are Columbia Slough, Columbia River (including North Portland Harbor) and Burnt Bridge Creek. Fairview Creek, which receives runoff from the Ruby Junction facility, is located east of the project corridor. Figures 2 through 4 show the existing drainage systems, watershed boundaries and outfalls within the project corridor. Figure 5 shows the existing Ruby Junction LRT maintenance facility and Fairview Creek.

Table 1 shows the average monthly discharges for each watercourse based on data available from United States Geological Survey (USGS) gauging stations. See Figure 6 for locations (except Fairview Creek). The information provides an indication of the relative size of each waterbody. Note that discharges in Columbia Slough are influenced by backwater effects from the Willamette River to the extent that the recorded mean monthly discharge was actually negative three times in May (1997, 2006 and 2008) and once in June (1960).

Columbia Slough Watershed

Columbia Slough, located south of the CRC project, discharges to the Willamette River. Its watershed[9] is a 51-square-mile area that extends from Kelly Point to the west to Fairview Lake and Fairview Creek to the east, and comprises the former Columbia River floodplain and before the construction of a levee system and pump stations, would have been subjected to frequent inundation. In the vicinity of I-5, the original ground surface is below the ordinary high water (OHW) level for the Columbia River. There are two drainage districts within the project footprint: Peninsula Drainage Districts No.1 and No.2. I-5 is the boundary between the two districts with No.1 located to the west and No.2 to the east. Day-to-day operations of both districts are managed by the Multnomah County Drainage District (MCDD).

[8] Public Works Standards. Prepared by the Department of Environmental Services, City of Gresham, Oregon. January 1, 2006.

[9] *Draft 2005 Portland Watershed Management Plan.* Bureau of Environmental Services, City of Portland. October 2005.

Land west of I-5 generally has an Industrial zoning designation while land to the east is generally designated as Open Space. The latter area includes sports facilities such as baseball diamonds.

TABLE 1

Mean Monthly Discharge (in cubic feet per second)

Month	Fairview Creek at Glisan Street (USGS 14211814)	Columbia Slough at Portland (USGS 14211820)	Columbia River at Vancouver (USGS 14144700)	Burnt Bridge Creek near Mouth (USGS 14211902)
January	11	162	156,000	46
February	9.1	151	163,000	53
March	8.6	135	170,000	39
April	6.3	85	204,000	21
May	5.1	29	286,000	19
June	4.0	65	415,000	14
July	2.4	79	291,000	9.1
August	2.0	74	153,000	7.4
September	2.1	63	117,000	7.0
October	3.4	96	116,000	9.8
November	6.5	112	122,000	34
December	10	123	138,000	41

I-5, Marine Drive and Martin Luther King, Jr. (MLK) Boulevard are elevated on embankments or structures and the drainage systems that serve these and roads do not handle runoff from outside the right-of-way. These embankments are also part of the levee system. Surface runoff from the I-5 and roads within the project footprint is generally confined to the roadway surface by continuous concrete barriers or curbs, and is collected almost entirely by closed gravity drainage systems with inlets and stormwater pipes, The one notable exception is MLK Boulevard east of I-5 where runoff is shed off the south shoulder. As shown on Figure 7, runoff from the project area drains to a system of sloughs before being discharged to Columbia Slough via the Portland International Raceway (PIR), Schmeer Road or Pen 2 - NE 13th pump station. These pump stations, which are sized to handle the 1 in 100 year runoff, have installed capacities of 19,700, 40,000 and 32,000 gallons per minute, respectively. Note that Marine Drive west of I-5, while within the confines of the levee system, drains to outfalls on North Portland Harbor and is included in the Columbia River South Watershed.

Within the project CIA, there is approximately 42.8 and 1.6 acres of existing PGIS and non-PGIS, respectively. Runoff from about 3 acres (MLK Boulevard and Union Court) of existing PGIS is dispersed and infiltrated. There are no flow control measures for runoff within the project footprint beyond the regulation of discharges to Columbia Slough provided by pump station operation. In addition, there are no engineered water quality facilities except for a manhole sediment trap located at the Victory Boulevard interchange (see Figure 2) that treats runoff from approximately 6 acres of impervious surfaces at the interchange (not within the project footprint).

Columbia River South Watershed

For convenience, the areas draining to the Columbia River are divided into those within Oregon and those within Washington. The Columbia River South Watershed includes the portion of the project area south of North Portland Harbor (a side channel of the Columbia River) that drains to that waterbody, North Portland Harbor Bridge, Hayden Island and the Columbia River Bridges south of the state line (see Figure 2).

Like the Columbia Slough Watershed, the project footprint within this watershed is located in what was part of the Columbia River floodplain. The portion south of North Portland Harbor is protected against flooding by a levee system, while material dredged from the Columbia River has been used to raise the overall ground surface on Hayden Island east of the Burlington Northern Santa Fe Railway (BNSF) railroad tracks above the 1 in 100-year flood elevation.

Land either side of I-5 on Hayden Island is highly developed and comprises service-related businesses such as retail stores and restaurants, and their parking lots.

Similar to the Columbia Slough Watershed, I-5 is elevated on an embankment across Hayden Island. Surface runoff from the I-5 and local roads within the project footprint is generally confined to the roadway surface by continuous concrete barriers or curbs. Except for the North Portland Harbor and Columbia River Bridges, runoff is collected entirely by closed gravity drainage systems with inlets and stormwater pipes that discharge directly to North Portland Harbor or Columbia River. Runoff from the bridges is discharged through scuppers directly to the water surface below. The project CIA within this watershed contains approximately 59.4 and 3.0 acres of existing PGIS and non-PGIS, respectively. There are no flow control measures or engineered water quality facilities.

Columbia River North Watershed

This watershed comprises the project footprint from the state line in the south to the SR 500 interchange in the north. It comprises the current I-5 corridor as well as Vancouver city streets on which the LRT guideway will be located. Existing impervious surfaces in the CIA comprise about 120.7 and 12.2 acres of PGIS and non-PGIS. There are no flow control measures or engineered water quality facilities with the exception of approximately 3 acres of SR 14 from which runoff is dispersed and infiltrated.

Land west of I-5 comprises downtown Vancouver and residential neighborhoods to the north. The area east of I-5 and south of Fourth Plain Boulevard contains the Pearson Airpark and Fort Vancouver Historic Park, both of which are low density. North of Fourth Plain Boulevard, land east of the highway comprises residential development.

Surface runoff from I-5 and local streets is generally confined to the roadway by continuous curbs and concrete barriers, and is collected almost entirely by closed drainage systems. The only exceptions are the Columbia River Bridges and a few ditches adjacent to the highway. These closed systems discharge runoff directly to the Columbia River via outfalls in the vicinity of the existing highway bridges while runoff from the bridges themselves drains through scuppers to the river below. A pump station located southeast of the SR 14 interchange (see Figure 3) discharges runoff from lower lying portions of the interchange to the Columbia River during high river levels.

The vertical grade of I-5 is generally below the surrounding areas and as a result, the drainage system serving the highway also handles runoff from built-up areas outside the highway right-of-way as shown on Figures 3 and 4. These areas, which are extensive, are estimated to comprise over 50 percent of the total drainage area served by this system, and their contribution to flows was an important consideration when developing the approach to stormwater management in this watershed.

Burnt Bridge Creek Watershed

The CIA within this watershed includes the SR 500 interchange and portions of I-5 to the north and SR 500 to the east. Within the project footprint, the CIA includes about 16.2 and 0.3 acres of existing PGIS and non-PGIS, respectively. Residential developments are located south of the SR 500 interchange and there is a school to the northwest of the SR 500 interchange and a park to the northeast.

Typical of an urban environment, surface runoff from the highways and local streets is generally confined to the roadway by continuous curbs and concrete barriers, and is collected almost entirely by closed drainage systems. In contrast to the other watersheds, runoff from the entire PGIS within the project footprint currently contains some form of treatment. Runoff from about 14.5 and 0.2 acres of PGIS and non-PGIS within the project footprint is conveyed to an infiltration pond at the Main Street interchange and the balance is conveyed to a wet pond north of SR 500 (see Figure 4 for both locations).

The infiltration pond would be considered to provide protection for Endangered Species Act (ESA)-listed species that might be found in Burnt Bridge Creek in terms of water quality (dissolved metals reduction) and flow reduction. The primary water quality function of the wet pond, however, is to reduce sediment and, as such, would not provide adequate protection for ESA species. For this reason, runoff from the area served by this pond is not included in this report as receiving water quality treatment.

Fairview Creek Watershed

The project CIA within this watershed comprises the Ruby Junction LRT operations and maintenance facility which would be expanded to meet the needs of the CRC and TriMet's Milwaukie project, both of which are expected to be constructed at about the same time. The expansion will extend the existing maintenance bays and constructing a new LRV storage yard.

Based on information provided by TriMet, runoff from about 1.5 acres comprising the parking area adjacent to the paint/body shop at the south end of the site (adjacent to Fairview Creek) is treated using proprietary cartridge filters before being conveyed to Fairview Creek. Elsewhere, runoff is infiltrated.

Surficial Soils

Figure 8 shows the approximate areal extent of the surficial soils in the vicinity of the project corridor (excluding Ruby Junction). The descriptions below are from the National Resources Conservation Service (NRCS) website.[10]

The Sauvie-Rafton-Urban land complex belongs to Hydrologic Soil Group D, the Pilchuck-Urban land complex belongs to Group A, and the Wind River and Lauren soils belong to Group B. A soil survey[11] indicates that water tables are at a depth of less than one foot for the Sauvie-Rafton-Urban land complex, and between two and four feet for the Pilchuck-Urban land complex. While the depths for the Sauvie-Rafton-Urban complex south of North Portland Harbor are confirmed by borehole logs available for the project area, they also indicate that the soils can be highly variable. For the Pilchuck-Urban soils on Hayden Island, available geotechnical data suggests that the water table is approximately 15 feet below ground level. It should also be noted that the phreatic surface is expected to respond to changes in river level given the highly permeable nature of these soils. While depths to water table are not provided for the Wind River and Lauren soils[12] north of the Columbia River, borehole logs for property in downtown Vancouver and the recently-constructed Land Bridge across SR 14 indicate that groundwater levels in that area are close to water levels in the Columbia River.

Soils at the Ruby Junction facility comprise the Multnomah-Urban land complex belonging to Hydrologic Group A. While the NRCS soil survey indicates a depth to groundwater in excess of 80 inches, TriMet personnel have advised that the water table is shallow at the south end of the site, adjacent to Fairview Creek.

The hydrologic properties of the three Groups referenced above are:

- Group A soils have a high infiltration rate and consist mainly of deep, well drained to excessively drained sands or gravelly sands.
- Group B soils have a moderate infiltration rate and consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture.
- Group D soils have a low infiltration rate and high runoff potential. They consist primarily of clay soils that have high swelling potential, a permanent high water table, or a clay layer at or near the surface, and shallow soils over nearly impervious material.

Based on available data, there are no Group C soils within the project area.

Given the predominance of poorly drained soils and high groundwater table south of North Portland Harbor, infiltration (the preferred method for stormwater management) is not currently recommended for this area. As noted above, soils are variable and future site investigations may reveal locations where infiltration might be feasible.

On Hayden Island, infiltration is not currently proposed even though the soils are classified as being in Hydrologic Group A. Considering the likely depth of any ponds, there may not be adequate separation

---

[10] http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

[11] Soil Survey of Multnomah County, Oregon. United States Department of Agriculture, Soil Conservation Service, in cooperation with Oregon Agricultural Experiment. August 1983.

[12] Soil Survey of Clark County, Washington. United States Department of Agriculture, Soil Conservation Service, in cooperation with the Washington Agricultural Experiment Station. November 1972.

between the pond invert and groundwater table for treating runoff. The EPA recommends a “significant separation distance (2 to 5 feet) between the bottom of an infiltration basin and seasonal high groundwater table.” Recently installed piezometers are being monitored to determine groundwater elevations and their response to changes in Columbia River water levels.

Pending the results of an ongoing investigation program to determine site-specific infiltration rates and groundwater levels at other proposed pond locations, infiltration is considered feasible for highway-related elements of the project north of the Columbia River. Again, underdrains could be provided should the assumed infiltration rate not be achievable and no options exist for expanding the pond. Infiltration, however, is not recommended for the LRT guideway and associated construction in downtown Vancouver because of the presence of building basements and lack of available sites.

Temporary Construction Activities

Without proper management, construction activities could create temporary adverse affects on water quality in nearby water bodies. Adverse impacts could result in the erosion of disturbed areas, and the accidental release of fuels and soluble or water-transportable construction materials.

As shown in Table 2, up to about 415 acres could be disturbed during construction. The table, which shows potential areas of disturbance on a watershed basis, includes all areas within the rights-of-way proposed for the project but does not include potential areas of construction in or over water or additional land that could be required outside the rights-of way for staging or laydown.

While Table 2 includes temporary construction easements and potential staging areas adjacent to the project footprint, it does not include potential casting/fabrication yards and staging areas identified further away from the project. These include two bridge casting/fabrication yard sites adjacent to the Columbia River, a 95-acre parcel at the Port of Vancouver and a 51-acre parcel north of the Portland-Troutdale Airport (Sundial Site), and a 52-acre staging area in the Port of Vancouver. Although these sites have been identified by the project team, construction contractors may elect to use other locations. In such circumstances, the contractor(s) would typically be required to obtain the necessary permits and comply with any conditions attached by regulatory agencies to those permits.

TABLE 2

Areas of Potential Disturbance during Construction

Watershed	Potential Area of Temporary Disturbance
Columbia Slough	105 acres
Columbia River - Oregon	70 acres
Columbia River – Washington	170 acres
Burnt Bridge Creek	55 acres
Fairview Creek	15 acres

National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Discharge Permits will regulate the discharge of stormwater from construction sites. These permits include discharge water quality standards, runoff monitoring requirements, and provision for preparing a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP contains all the elements of a Temporary Erosion and Sediment Plan and Spill Prevention Control and Countermeasures Plan.

The SWPPP and its adoption by construction personnel are essential for ensuring water quality standards are met during construction, and a single, comprehensive plan would ensure project-wide consistency. Contractors would be required to have a certified Erosion and Sediment Control Lead on staff to ensure proper implementation of the SWPPP. In addition, the agency or agencies responsible for providing construction oversight would also have one or more staff assigned to monitor SWPPP implementation.

An SWPPP typically contains the following elements:

1. Project information
2. Existing site conditions.

3. Potential erosion problem areas.
4. Descriptions and drawings of pollution-prevention measures and best management practices (BMP) for:
   - Preserving vegetation
   - Sequence of clearing operations, including limitations on areas cleared at the same time
   - Construction access, including wheel wash facilities
   - Flow control (where required)
   - Sediment control, including check dams, silt fences and sediment ponds
   - Soil stabilization, including temporary seeding
   - Slope protection
   - Existing drain inlet protection
   - Channel and outlet stabilization
   - Pollution control (including spill prevention)
   - Street cleaning
   - Dewatering control
   - BMP maintenance, inspection and monitoring
   - Construction phasing and implementation schedule for BMPs.
5. Compliance assurance procedures and corrective actions in case performance goals are not achieved.
6. Spill response procedures.
7. Engineering calculations.

Water quality standards, which include turbidity and pH, are usually monitored at the point(s) of discharge. There may also be special requirements in addition to turbidity and pH for discharges to since all receiving watercourses are 303(d) listed watercourses.

The selection of construction BMPs is dependent on the specific site layout and sequence of construction activities and, as such, is beyond the scope of this report.

Permanent Water Quality Facilities – Full Build

This section describes the proposed stormwater management plan for constructing Option A full build. There are alternatives still being considered including Option B and deferring construction of parts of the Victory Boulevard, Marine Drive and SR 500 interchanges to a later date (which could be applied to either option). The potential effect of these alternatives on stormwater management is discussed in a subsequent section.

The waterbodies to which runoff would be discharged are Columbia Slough (via the Peninsula Drainage District No.1 and No.2 surface water systems and associated pump stations), North Portland Harbor (a side channel of the Columbia River), Columbia River mainstem, Burnt Bridge Creek, and Fairview Creek. Columbia Slough, North Portland Harbor and the Columbia River contain species listed under the ESA, and all receiving watercourses are 303(d) listed. Note that although a watercourse may be 303(d) listed, the parameters listed may not necessarily have EPA-approved Total Maximum Daily Loads (TMDL).

To address ESA and TMDL issues, the overall approach to stormwater management from a water quality perspective is to treat runoff to reduce the following pollutants that are typically associated with transportation projects:

- Debris and litter
- Suspended solids such as sand, silt and particulate metals
- Oil and grease
- Dissolved metals

The last criterion, especially dissolved copper, is of particular concern to NOAA Fisheries. Dissolved copper is known to have a detrimental effect on the olfactory senses of young salmonids.

Based on the ODOT memorandum,[13] the following water quality BMPs are effective in reducing sediments, and particulate and dissolved metals; pollutants of concern for ESA-listed species observed in the waterbodies to which stormwater will be discharged:

- **Bioretention Ponds** are infiltration ponds that use an engineered (amended) soil mix to remove pollutants as runoff infiltrates through this zone to the underlying soils. The primary mechanisms for pollutant reduction are filtration, sorption, biological uptake and microbial activity. While this BMP is best-suited to sites with Hydrologic Group A and B soils, it may be used for Group C and D Hydrologic Group soils with the addition of an underdrain system to collect infiltration and convey it to a stormwater conveyance system. When estimating the size of these facilities, an infiltration rate of 1 inch per hour was assumed. If the soils cannot sustain this rate and there is insufficient space to increase the pond size to accommodate a lower value, underdrains would be installed.
- **Constructed Treatment Wetlands** are shallow, permanent, vegetated ponds that function like natural wetlands. They remove pollutants through sedimentation, sorption, biological uptake and microbial activity.
- Soil-amended **Biofiltration Swales** are trapezoidal channels with mild slopes and shallow depths of flow. The channels are dry between storm events and are typically grassed. They treat runoff by filtration and sorption as runoff flows through the vegetated surface and amended soils. Amended soils, especially compost-amended, is an excellent filtration medium. Compost-amended soils have a high cation exchange capacity that will bind and trap dissolved metals. Similar to bioretention ponds, an underdrain system is recommended for sites with Group C and D Hydrologic Group soils.
- Soil-amended **Filter Strips** are intended to treat sheet runoff from an adjacent roadway surface. In a confined urban setting such as the project corridor, opportunities to use this BMP are limited. Similar to grass swales, filter strips treat runoff by filtration and sorption as runoff flows through the vegetated surface and amended soils.
- Bioslopes, like filter strips, are intended to treat sheet runoff from an adjacent roadway surface. They comprise a vegetated filter strip, infiltration trench and underdrain, and reduce pollutants through sorption and filtration. Bioslopes are also known as Ecology Embankments. The percolating runoff flows through a special mixture of materials, including dolomite and gypsum, which promotes the adsorption of pollutants.

These BMPs would be constructed for the sole purpose of improving stormwater runoff quality and infiltration is the preferred method of runoff treatment. The location of such facilities in the proximity of well-travelled roads and transit systems combined with ongoing maintenance would discourage their use as habitat by wildlife.

Other water quality approaches, including Dispersal, Drywells and Proprietary Systems (such as cartridge filters), have been considered on a case-by-case basis where the BMPs listed above would not be practical or feasible.

Oil control pretreatment may be required at high-traffic intersections and park and ride facilities where high concentrations of oil and grease are expected in stormwater runoff. **Baffle Type Oil-Water Separators** and **Coalescing Plate Oil-Water Separators** are considered to be suitable types of treatment facility.

As the project design progresses, the team will continue to assess new technologies and whether they should be added to the suite of acceptable BMPs. For example, Ecology recently approved[14] Americast's Filterra® system for reducing, among other pollutants, dissolved metals. This system uses engineered bioretention filtration incorporated into a planter box to treat runoff.

---

[13] Stormwater Management Program, Geo-Environmental Bulletin GE09-02(B). Prepared by the Oregon Department of Transportation. January 27, 2009.

[14] General Use Level Designation for Basic (TSS), Enhanced, & Oil Treatment & Conditional Use Level Designation for Phosphorus Treatment for Americast's Filterra®. Washington State Department of Ecology. November 2006 (Revised December 2009).

Proposed water management strategies are presented for runoff to outfalls on a watershed basis. As described previously, the strategies present one set of approaches to water management; approaches that might change as design work progresses. They demonstrate the level of stormwater quality improvements that the project would achieve. As design work progresses, the project will identify and evaluate options for low impact development and the use of more localized water quality facilities that treat runoff closer to its source, thereby reducing the size of the stormwater management facilities currently proposed.

The strategies presented rely in part on “as built” information provided by ODOT, WSDOT, and the cities of Portland and Vancouver. While this information has been accepted on an as-is basis, the data is in the process of independently verified through field measurements.

Columbia Slough Watershed

The project footprint in this watershed comprises highway, local street and LRT improvements south of North Portland Harbor. Overall, the project will increase the total CIA in this watershed by approximately 13.6 acres. The increase may be attributed to new local streets and the addition of runoff from new and existing bridges across the North Portland Harbor.

The project will create approximately 51.6 acres of new, rebuilt and resurfaced PGIS and about 4.3 acres of new sidewalk and bike-pedestrian paths. The remaining 2.1 acres comprises the existing bridge over North Portland Harbor: runoff currently drains via scuppers to the water below. While I-5 will generally follow its current alignment and grade, the Marine Drive interchange will be completely rebuilt and will differ significantly from its existing layout.

Table 3 summarizes the impact of the project on CIA and the areas from which runoff will be treated, and the paragraphs following the table describe the individual water quality facilities, the locations of which are shown on Figure 9. Note that the areas shown on the table do not include a potential staging area in the Expo parking lot since construction contractors may elect to use other locations for temporary staging. Regardless, it is likely that this area will be returned to parking after construction.

TABLE 3

Contributing Impervious Areas[a] for Columbia Slough Watershed

Outfall	Water Quality Facility	Impervious Area Draining to Outfall (acres)					
		PGIS			Non-PGIS		Total CIA
		New/Rebuilt	Resurfaced	Existing	New/Rebuilt	Existing	
CS-01	CS-A	0.9					0.9
	Total area treated	0.9					0.9
	Total area untreated						
	Total CIA	0.9					0.9
CS-02	N/A						
	Total area treated						
	Total area untreated	3.4	3.7				7.1
	Total CIA	3.4	3.7				7.1
CS-03	CS-B	5.2					5.2
	Total area treated	5.2					5.2
	Total area untreated						
	Total CIA	5.2					5.2

Outfall	Water Quality Facility	Impervious Area Draining to Outfall (acres)					
		PGIS			Non-PGIS		
		New/Rebuilt	Resurfaced	Existing	New/Rebuilt	Existing	Total CIA
CS-04	CS-C	1.2					1.2
	CS-D	3.1					3.1
	Total area treated	4.3					4.3
	Total area untreated						
	Total CIA	4.3					4.3
CS-05	CS-E	11.7	4.6	1.9		0.2	18.4
	Total area treated	11.7	4.6	1.9		0.2	18.4
	Total area untreated						
	Total CIA	11.7	4.6	1.9		0.2	18.4
CS-06	CS-F	1.6					1.6
	Total area treated	1.6					1.6
	Total area untreated						
	Total CIA	1.6					1.6
CS-07	CS-G	1.4			0.6		2.0
	Total area treated	1.4			0.6		2.0
	Total area untreated						
	Total CIA	1.4			0.6		2.0
Other		14.8			3.7		18.5
	Total area treated	14.8			3.7		18.5
	Total area untreated						
	Total CIA	14.8			3.7		18.5
TOTAL AREA		**43.3**	**8.3**	**1.9**	**4.3**	**0.2**	**58.0**

a Includes the area of impervious surfaces under bridges. Such duplicate areas would not be included when sizing water quality facilities.

As shown in Table 3, no options have been identified to treat runoff from about 7.1 acres of new and resurfaced I-5 pavement immediately north of Victory Boulevard (see Outfall CS-02). The primary issue is that the proximity of the outfall CS-02 to the highway embankment does not leave adequate room to construct a water quality facility such as a bioretention pond or swale, and the acquisition of additional property at this location would introduce 4f issues. It would also be extremely difficult modify the existing stormwater conveyance system and direct runoff to another location where a water quality facility could be constructed. It should be noted that some runoff treatment would take place as runoff flows through Schmeer Slough before being discharged to Columbia Slough via the Schmeer Road Pump Station. The project team will, however, continue to develop and evaluate options to treat runoff from this area.

Flow control is not required for runoff discharged to Columbia Slough and no new outfalls are proposed. The stormwater management plan for this watershed reflects a request by the MCDD to minimize runoff from the project to the Peninsula Drainage District No.2 surface water system to provide greater flexibility for handling increased runoff from a potential redevelopment of the Hayden Meadows race track.

As described earlier, soils in this area are generally poorly drained and, for this reason, the primary BMP proposed for water quality facilities in this watershed is a constructed treatment wetland. However, boreholes in the area show that the soils can be quite variable and, as the project design advances, site-specific geotechnical investigations may prove that one or more of the locations proposed for water quality facilities may be suitable for infiltration.

A new conveyance system, constructed as part of the CRC project, will enable some of the runoff that currently flows to the outlet CS-04 to be re-routed to CS-05; most of the runoff being re-routed would be from the I-5 mainline. The primary reasons for this strategy are:

1. The west side of the proposed interchange provides the largest uninterrupted open area for water quality facilities.
2. MCDD has requested CRC minimize runoff from the project to the Peninsula Drainage District No.2 surface water system to provide greater flexibility for handling increased runoff from potential redevelopment of the Hayden Meadows race track.

A ballasted LRT track is proposed between the existing Expo station and south end of the combined LRT-arterial bridge across North Portland Harbor. Since the track is pervious, it is not included in Table 3. Perforated underdrains serving existing ballasted track at the Expo station would be extended to collect runoff from the new guideway: the existing track underdrain system discharges to the channel located immediately south of the Expo Center.

Following is a description of the water quality facilities listed in Table 3.

Water Quality Facility CS-A

CS-A would be sized to handle runoff from the south end of the ramp from Marine Drive to southbound I-5. It is a biofiltration swale located south of Victory Boulevard and west of I-5 and outflows would be discharged to Schmeer Slough at outfall CS-01 via an existing or new stormwater pipe located on Victory Boulevard.

Water Quality Facility CS-B

CS-B is a constructed wetland located within the existing loop ramp from MLK Boulevard to Union Court: the ramp will be removed as part of the project. The pond will serve a portion of the realigned MLK Boulevard east of I-5 and south end of the ramp from westbound MLK to northbound I-5. Outflows will be released via an existing City of Portland stormwater pipe to Walker Slough at outfall CS-03.

Water Quality Facility CS-C

The grades are such that it would be difficult to convey about 1.2 acres of the ramp from northbound I-5 to westbound Marine Drive to the water quality facility CS-D described below. A biofiltration swale, CS-C, is proposed to treat runoff from this area, the flows from which would be released to Walker Slough via Outfall CS-04.

Water Quality Facility CS-D

A constructed treatment wetland CS-D is proposed to treat runoff from about 3.1 acres comprising most of the ramp from MLK Boulevard to northbound I-5. Outflows would be discharged to the upstream end of Walker Slough at outfall CS-02.

Water Quality Facility CS-E

This is the largest water quality facility proposed in the Columbia Slough watershed and takes advantage of the relatively open area in the southwest quadrant of the Marine Drive interchange. It would be a constructed wetland sized to treat runoff from approximately 18.4 acres of impervious surface. This area comprises I-5, including approximately 2.1 acres of the existing North Portland Harbor bridges, and ramps on the west side of the highway.

Outflows from the wetland would be released to the drainage channel located immediately south of Expo at outlet CS-03. The channel and associated pump station may need to be enlarged to handle the additional flows: alternatively, the wetland could be enlarged to provide detention storage and reduce peak outflows provided the water balance would still be conducive to the long-term survival of wetland plants.

Water Quality Facility CS-F

The project would construct new connections between MLK Boulevard and Vancouver Way. Runoff from about 1.6 acres of new and resurfaced pavement would be treated at a biofiltration swale, water quality facility CS-F, adjacent to the connection between MLK and Vancouver Way. Flows from the swale areas would drain to the existing City of Portland stormwater conveyance system under Vancouver Way at outlet CS-06. Additional water quality improvements are expected as runoff flows through over 7,000 feet of open channel before being pumped to Columbia Slough via the Pen 2 – NE 13th Pump Station (see Figure 7).

Water Quality Facility CS-G

Runoff from 2.0 acres of impervious surface comprising MLK, the new connection to Union Court and associated sidewalks would be discharged to constructed wetland, CS-E, located between the two roadways. Flows from the wetland would be released to an existing City of Portland conveyance system on Union Court at outlet CS-07 and would be ultimately be pumped to Columbia Slough via the Schmeer Road Pump Station.

Alternatively, the project may elect to shed runoff (or at least part of the runoff) across the each shoulder, as currently happens, where it would infiltrate and/or evaporate.

Other Water Quality Facilities

Following is a summary of the proposed water quality facilities that comprise this category on Table 3:

- Runoff from the new merge lane south of Victory Boulevard (about 0.5 acre) for the ramp from Marine Drive to southbound I-5 would be conveyed to a water quality swale constructed as part of the I-5 Delta Park project. This swale has adequate capacity to handle the additional runoff.
- Runoff from approximately 16.9 acres of proposed new, rebuilt and existing local streets and contiguous sidewalks within the CIA would be treated using a mix of semi-continuous biofiltration swales and proprietary systems such as cartridge filters.
- Runoff from about 1.1 acres of the bike-pedestrian pathway that is physically separated from the street network will likely be shed to adjacent landscaped areas where it will infiltrate and/or evaporate.

Columbia River South Watershed

The project-related part of the Columbia River watershed in Oregon is comprises Hayden Island and Marine Drive west of I-5. Although this part of Marine Drive is located within the level system protecting the Delta Park area, runoff is discharged to North Portland Harbor via stormwater pipes located under the levee and floodwall.

The existing impervious area within watershed would be increased by approximately 0.2 acre. On Hayden Island, I-5 will start to deviate from its current alignment and profile immediately north of the existing North Portland Harbor bridges, which will be retained. The Hayden Island interchange would be completely rebuilt, local streets will be reconfigured and the LRT guideway will be extended across the island to the proposed new southbound highway bridge across the Columbia River.

Table 4 summarizes the areas from which runoff will be treated, and the paragraphs following the table describe the individual water quality facilities, the locations of which are shown on Figure 9. This watershed includes existing surface parking that may or may not remain after the project has been completed. While it is uncertain at this time how land use in the vicinity of the Hayden Island interchange might change after completion of the CRC project, it has been assumed that land on the west side of the proposed interchange and transit guideway that might be purchased for staging during construction would be converted into transit-oriented development. This land comprises an area of about 10.0 acres west of the project and bounded by the transit guideway, Center Avenue, Hayden Island Drive and Jantzen Drive. Any redevelopment would need to meet ODOT or City of Portland stormwater requirements and, as such, runoff would either be infiltrated or treated before being released to the Columbia River or North Portland Harbor: Table 4 assumes the latter. This is considered to be a reasonable approach as the areas immediately east of I-5 are currently identified as potential sites for water quality facilities.

TABLE 4

Contributing Impervious Areas[a] for Columbia River South Watershed

Outfall	Water Quality Facility	Impervious Area Draining to Outfall (acres)					
		PGIS			Non-PGIS		Total CIA
		New/Rebuilt	Resurfaced	Existing	New/Rebuilt	Existing	
NPH-01	NPH-A	2.5			0.1		2.6
	NPH-B	1.5			1.2		2.7
	Total area treated	4.0			1.3		5.3
	Total area untreated						
	Total CIA	4.0			1.3		5.3
CR-01/02	CR-A	17.5			0.1		17.6
	CR-B	10.4		2.2	1.1	0.2	13.9
	CR-C	2.5			2.4		4.9
	Total area treated	30.4		2.2	3.6	0.2	36.4
	Total area untreated						
	Total CIA	30.4		2.2	3.6	0.2	36.4
Other		18.4			2.5		20.9
	Total area treated	18.4			2.5		20.9
	Total area untreated						
	Total CIA	18.4			2.5		20.9
TOTAL AREA		**52.8**		**2.2**	**7.4**	**0.2**	**62.6**

a Includes the area of impervious surfaces under bridges. Such duplicate areas would not be included when sizing water quality facilities.

Flow control is not required for runoff discharged to North Portland Harbor or Columbia River and no new outfalls are proposed. Although soils in this area belong to Hydrologic Group A, the primary BMP proposed for water quality facilities in this watershed is a constructed treatment wetland due to the assumed lack of separation between the bottom of proposed water quality facilities and groundwater table. This assumption will be revisited as more groundwater data becomes available.

Note that between structures, the LRT guideway will be on pervious ballast and, as such, those areas are not included in Table 4.

Following is a description of the water quality facilities listed in Table 4.

Water Quality Facility NPH-A

The grades are such that it would be difficult to convey runoff from Marine Drive west of the proposed bridge over LRT guideway extension to the constructed treatment wetland CS-E (see previous section). It is proposed to convey runoff from 2.6 acres of new pavement and sidewalk to a biofiltration swale, NPH-A, located immediately north of Marine Drive. Outflows from the swale would be released to North Portland Harbor at outlet NPH-01 via an existing City of Portland stormwater system.

Water Quality Facility NPH-B

Water quality facility NPH-B, a constructed wetland, is proposed at the south end of the proposed LRT-arterial bridge across North Portland Harbor. It would be sized to handle runoff from approximately 2.0 acres of impervious surface on the bridge, including 1.2 acres of transit guideway, sidewalk and bike path, and about 0.7 acres comprising a local street immediately west of the south end of the bridge: runoff from the street will drain towards the proposed constructed wetland.

Outflows from the wetland would be conveyed to North Portland Harbor at outlet NPH-01 via an existing City of Portland stormwater pipe under Marine Drive.

Water Quality Facility CR-A

Runoff from about 17.5 acres of new I-5 mainline between Tomahawk Island Drive extension and the high point across the Columbia River, and a portion of Hayden Island Drive east of I-5 would be conveyed to a constructed treatment wetland located along the east side of the interchange. Outflows from the facility would be released to the Columbia River via one of the two existing ODOT outfalls CS-01 or CS-02, both of which are located under the south end of the existing bridges over the Columbia River.

Water Quality Facility CR-B

This water quality facility would be a constructed wetland located east of I-5 and south of the Tomahawk Island Drive extension. It would be sized to handle about 13.9 acres of new ramps and I-5 pavement between North Portland Harbor and Tomahawk Island Drive extension under I-5, the Tomahawk Island Drive extension, and a portion of the realigned Jantzen Drive under I-5. It would also handle runoff from the north half of the existing North Portland Harbor bridges. Proposed grades are such that drainage from Tomahawk Island Drive and Jantzen Drive would need to be pumped to the wetland.

Outflows from the facility would likely be released to the Columbia River via outfall CS-01 or CS-02.

Water Quality Facility CR-C

Runoff from approximately 4.9 acres of impervious pavement, including 1.2 acres each of transit-only structure and bike-pedestrian path, would be conveyed to a constructed wetland located west of I-5 and immediately south of Hayden Island Drive. Outflows from the facility would likely be released to the Columbia River via outfalls CS-01 or CS-02.

Other Water Quality Facilities

Following is a summary of the proposed water quality facilities that comprise this category on Table 4:

- Runoff from approximately 10.5 acres of proposed new, rebuilt and existing local streets and contiguous sidewalks within the CIA would be treated using a mix of semi-continuous biofiltration swales and proprietary systems such as cartridge filters.
- Approximately 10.0 acres of future transit-oriented development has been assumed on the west side of I-5. Runoff would be treated to either ODOT or City of Portland standards.
- Runoff from about 0.4 acres of the bike-pedestrian pathway west of the south end of the transit-arterial bridge over North Portland Harbor will likely be shed to adjacent landscaped areas where it will infiltrate and/or evaporate. This path is physically separated from the street network.

Columbia River North Watershed

This is the largest watershed from the project perspective and comprises the project footprint from the state line in the south to the SR 500 interchange in the north. It includes the current I-5 corridor as well as Vancouver city streets on which the LRT guideway would be located.

From about 6th Street, I-5 will generally follow its existing alignment and grade. The SR 14 and Mill Plain interchanges would be reconfigured and while the Fourth Plain interchanges would be rebuilt, the footprint will be similar to what currently exists. New streets would be constructed at the SR 14 interchange to improve local connections, and the LRT guideway would be constructed primarily along existing streets. In addition, three park and ride structures would be built to serve the extended LRT system. With the exception of the above-grade guideway between 6th Street and new southbound Columbia River Bridge, the LRT track could be subject to use by buses and would not be considered non-polluting. This is a conservative determination, and one that could change should buses be excluded from the guideway.

The project would increase the impervious area within this watershed by approximately 21.1 acres. The total project CIA would be about 154.0 acres of which approximately 112.8 acres would be new, rebuilt and resurfaced PGIS and about 13.3 acres would be new sidewalk and bike-pedestrian paths. The 27.9-acre balance comprises existing impervious areas, mostly city streets, from which runoff would flow onto the project footprint.

Table 5 summarizes the impact of the project on CIA and the areas from which runoff will be treated, and the paragraphs following the table describe the individual water quality facilities, the locations of which are shown on Figures 10 and 11.

TABLE 5

Contributing Impervious Areas[a] for Columbia River North Watershed

Outfall	Water Quality Facility	Impervious Area Draining to Outfall (acres)					
		PGIS			Non-PGIS		Total CIA
		New/Rebuilt	Resurfaced	Existing	New/Rebuilt	Existing	
CR-03	CR-C	16.1	1.6		0.2		17.9
	CR-D	16.5	2.0		0.2		18.7
	CR-E (2)	2.6			0.6		3.2
	CR-G (2)	16.7	3.9	4.1	0.1	0.6	25.4
	CR-H	0.8					0.8
	CR-I	5.3			0.9		6.2
	CR-J	2.9			1.0		3.9
	CR-K	5.3	5.6		0.3		11.2
	CR-L	3.6		9.0	0.4	1.3	14.3
	CR-M	1.7		0.8	0.1		2.6
	Total area treated	71.5	13.1	13.9	3.8	1.9	104.2
	Total area untreated						
	Total CIA	71.5	13.1	13.9	3.8	1.9	104.2
CR-05	CR-F	3.0	0.9				3.9
	Total area treated	3.0	0.9				3.9
	Total area untreated		1.0				1.0
	Total CIA	3.0	1.9				4.9
Other		23.3		9.0	9.5	3.1	44.9
	Total area treated	23.3	-	9.0	9.5	3.1	44.9
	Total area untreated						
	Total CIA	23.3	-	9.0	9.5	3.1	44.9
TOTAL AREA		**97.8**	**15.0**	**22.9**	**13.3**	**5.0**	**154.0**

a Includes the area of impervious surfaces under bridges. Such duplicate areas would not be included when sizing water quality facilities.

Table 5 demonstrates that the project proposes to treat runoff from the entire CIA with exception of about 1.0 acre comprising the eastbound lanes of SR 14. Existing and proposed highway super-elevation at this location will result in runoff draining to catch basins located adjacent to the center median. Since this portion of SR 14 is only being resurfaced, there are very limited opportunities, if any, to reconfigure the conveyance system. In addition, there are no opportunities to construct a biofiltration swale or media drain at the median and no room to provide either a cartridge vault or an end-of-pipe water quality facility: the outfall CR-05 discharges directly into the Columbia River, and the limited distance between the highway and river is occupied by the BNSF railroad embankment and Columbia Way.

New stormwater conveyance systems are proposed for I-5 and associated interchanges. The existing stormwater trunk main serving I-5 also receives runoff from urban areas to the west, none of which is currently treated. The new conveyance systems will allow runoff from the highway and ramps to collected and treated before being released to the stormwater trunk main.

Flow control is not required for runoff discharged to the Columbia River and no new outfalls are proposed. Soils in this area belong to Hydrologic Group B, which are considered suitable for infiltration; an assessment that is confirmed by soils data recently obtained by the project. Therefore, the primary BMP assumed for water quality facilities in this watershed is a biofiltration pond. This assumption may need to be revisited for facilities in the SR 14 interchange area due to the potential presence of a shallow groundwater table. Regardless of infiltration rates, constructed treatment wetlands would not be considered south of Fourth Plain Boulevard because of the proximity to Pearson Airfield. Such facilities would be regarded as hazardous wildlife attractants and could pose a threat to the safety of planes landing or departing from the airfield.[15]

Following is a description of the water quality facilities listed in Table 5.

Water Quality Facility CR-C

- Runoff from about 17.9 acres of southbound I-5 (including 1.6 acres of resurfaced pavement), ramps on the west side of the interchange, and west side of the Evergreen Boulevard bridge over I-5 would be conveyed to this bioretention pond located on the west side of the SR 14 interchange and east of the Main Street extension.

Any overflow from bioretention pond would be released to the Columbia River at outfall CR-03 via the existing stormwater conveyance system.

Water Quality Facility CR-D

- The water quality facility is located within the loop ramps on the east side of the SR 14 interchange. It would be sized to handle runoff from approximately 18.7 acres of northbound I-5 (including 2.0 acres of resurfaced pavement), ramps on the east side of the interchange, and east side of the Evergreen Boulevard bridge over I-5.

Again, any overflow from the bioretention pond would be released to the Columbia River at outfall CR-03 via the existing stormwater conveyance system.

Water Quality Facility CR-E

Runoff from about 3.2 acres of new impervious area on SR 14 and Main Street would be directed to one or two biofiltration swales located adjacent to the intersection of Main Street and SR 14. Outflows would be released to the Columbia River at outfall CR-03 via the existing stormwater conveyance system.

Water Quality Facility CR-F

Runoff from approximate 3.9 acres comprising the new, rebuilt and resurfaced westbound lanes of SR 14 east of the SR 14 interchange would be conveyed to a biofiltration swale located on the north side of the highway, Alternatively, runoff from the resurfaced westbound lanes may be shed to the shoulder where it would be infiltrated, similar to what currently occurs. Outflows from the swale would be conveyed to outfall CS-05 on the Columbia River via an existing 6-foot by 6-foot culvert.

As mentioned in the preamble to this section, project staff have not yet identified any options for treating runoff from the eastbound lanes.

Water Quality Facility CR-G

CR-G comprises two biofiltration ponds proposed in the northeast and southeast quadrants of the reconfigured Mill Plain interchanges. They will be sized to handle runoff from approximately 25.4 acres of new ramps, new, replaced and resurfaced highway, new collector-distributor road to the north, and Mill Plain Blvd to the east would be conveyed to two bioretention ponds located within the interchange footprint.

The contributing area includes about 3.9 acres of resurfaced highway and approximately 4.7 acres of existing pavement and sidewalk on Mill Plain Boulevard east of the project footprint. Runoff from the latter would drain towards the project. Any overflow from the ponds would be conveyed to outfall CR-03 via the existing stormwater conveyance system under I-5.

Water Quality Facility CR-H

Runoff from approximately 0.8 acre of the ramp from southbound I-5 to Mill Plain Boulevard would be directed to a biofiltration swale west of the ramp. Discharge from the swale would be discharged to outfall CR-03 via the existing stormwater trunk main under I-5.

---

[15] *Hazardous Wildlife Attractants on or near Airports, Advisory Circular 150/5200-33A*. U.S. Department of Transportation, Federal Aviation Administration. July 27, 2004

Water Quality Facility CR-I

Proposed street grade for Mill Plain Boulevard under I-5 is too low to permit runoff from about 6.2 acres to be conveyed to either of the CR-G bioretention ponds. Instead, runoff would be conveyed to proprietary cartridge filter vault and, if necessary, an oil-water separator pre-treatment facility. Based on available data, there appears to be adequate vertical distance between the low point on Mill Plain Boulevard and invert of the existing stormwater conveyance system under I-5 to install this type of facility. Discharge from the vault would be discharged to outfall CR-03 via the existing stormwater trunk main under I-5.

Water Quality Facility CR-J

- Drainage from the top surface of the Clark College Park and Ride and associated paths (about 3.9 acres) would be conveyed to a biofiltration swale located on the east side of the structure. An oil-water separator would pretreat runoff from the park and ride. Outflow from the swale would be conveyed to outfall CR-03 via the existing stormwater conveyance system under I-5.

Water Quality Facility CR-K

- Runoff from about 11.2 acres of I-5 mainline and access road to the Clark College Park and ride (including 5.6 acres of resurfaced highway) would be conveyed to a bioretention pond located in the southeast interchange area. Any overflows from the pond would be conveyed to outfall CR-03 via the existing stormwater conveyance system under I-5.

Water Quality Facility CR-L

- A bioretention pond proposed in the northwest quadrant of the Fourth Plain interchange would be sized to handle runoff from an impervious area of approximately 14.3 acres. This area includes approximately 4.0 acres of new and rebuilt pavement and sidewalk as well as about 10.3 acres of existing streets and sidewalk in the Shumway neighborhood to the northwest of the interchange. Again, any overflows from the pond would be conveyed to outfall CR-03 via the existing stormwater conveyance system under I-5.

Water Quality Facility CR-M

- Runoff from approximately 1.8 acres of new and rebuilt pavement and sidewalk on Fourth Plain Boulevard east of I-5 and about 0.8 acres of existing impervious area further east would be conveyed to a biofiltration swale south of Fourth Plain Boulevard and east of the collector-distributor road. Outflow from the swale would be conveyed to outfall CR-03 via the existing stormwater conveyance system under I-5.

Other Water Quality Facilities

Following is a summary of the proposed water quality facilities that comprise this category on Table 5:

- Runoff from approximately 41.9 acres of proposed LRT guideway, new, rebuilt and existing local streets, and contiguous sidewalks within the CIA would be treated using a mix of semi-continuous biofiltration swales and proprietary systems such as cartridge filters.
- Runoff from about 2.1 acres comprising the top floors of the Columbia Street and Mill District Park and Ride structures will be conveyed to existing City of Vancouver stormwater conveyance systems via proprietary cartridge filter vaults. Pretreatment would be provided using oil-water separators.
- Runoff from about 0.9 acre of the bike-pedestrian pathway that is physically separated from the street network will likely be shed to adjacent landscaped areas where it will infiltrate and/or evaporate.

Burnt Bridge Creek Watershed

The full-build scenario would provide full connectivity between I-5 and SR 500 through the construction of a new ramp from southbound I-5 to eastbound SR 500 and tunnel from westbound SR 500 to northbound I-5. Available information indicated that it would be feasible to redirect runoff from about 2.2 acres of the existing highway south of 39th Street from the existing infiltration pond at the Main Street interchange (BBC-C) to a new biofiltration pond proposed as part of the CRC project (BBC-B). There are no transit-related facilities proposed in this watershed.

The project would increase the impervious area by approximately 6.6 acres. The total project CIA would be about 23.1 acres of which approximately 20.5 acres would be new, rebuilt and resurfaced PGIS and about 0.7 acre would be new sidewalk and bike-pedestrian paths. The balance comprises an existing portion of SR 500.

Table 6 summarizes the impact of the project on CIA and the areas from which runoff will be treated, and the paragraphs following the table describe the individual water quality facilities, the locations of which are shown on Figure 11. The table demonstrates that the project proposes to treat runoff from the entire CIA.

TABLE 6

Contributing Impervious Areas[a] for Burnt Bridge Creek Watershed

Outfall	Water Quality Facility	Impervious Area Draining to Outfall (acres)					
		PGIS			Non-PGIS		Total CIA
		New/Rebuilt	Resurfaced	Existing	New/Rebuilt	Existing	
BBC-01	BBC-A	2.2	1.2	1.9	0.2		5.5
	BBC-B	2.5	2.3				4.8
	Total area treated	4.7	3.5	1.9	0.2		10.3
	Total area untreated						
	Total CIA	4.7	3.5	1.9	0.2		10.3
BBC-02	BBC-C	5.6	6.7		0.5		12.8
	Total area treated	5.6	6.7		0.5		12.8
	Total area untreated						
	Total CIA	5.6	6.7		0.5		12.8
TOTAL AREA		**10.3**	**10.2**	**1.9**	**0.7**		**23.1**

a Includes the area of impervious surfaces under bridges. Such duplicate areas would not be included when sizing water quality facilities.

As stated above, flow control is required for runoff discharged to Burnt Bridge Creek. No new outfalls are proposed. Soils in this area belong to Hydrologic Group B, which are considered suitable for infiltration; an assessment that is confirmed by soils data recently obtained by the project. Therefore, the primary BMP assumed for water quality facilities in this watershed is a biofiltration pond.

Following is a description of the water quality facilities listed in Table 6.

Water Quality Facility BBC-A

Runoff from approximately 3.6 acres of new, rebuilt eastbound lanes of SR 500 and 39th Street, and 1.9 acres of existing westbound lanes that would not be affected by the project would be conveyed to a bioretention pond south of the highway. Overflows from the pond would be conveyed to an existing outfall, BBC-01.

Water Quality Facility BBC-B

Runoff from about 2.5 acres of rebuilt and new pavement and approximately 2.3 acres of resurfaced pavement would be conveyed to a bioretention pond, BBC-B, located immediately east of I-5 and south of 39th Street. Most of the impervious area comprises I-5 that currently drains to the existing infiltration pond (BBC-C) at the Main Street interchange. Overflows from the pond would be conveyed to an existing outfall, BBC-01.

Water Quality Facility BBC-C

BBC-C is the existing infiltration pond at the Main Street interchange. We do not propose to modify this pond since this type of facility is considered to provide an adequate runoff treatment. Although approximately 12.8 acres of new, rebuilt and resurfaced project pavement would be conveyed to this pond, the total impervious area served by it would be decreased by about 2.2 acres as stated above.

Overflows from the pond are released to Burnt Bridge Creek at outfall BBC-02.

Fairview Creek Watershed

TriMet's Ruby Junction operations and maintenance facility, which is located in this watershed, would be expanded to meet the needs of both the CRC and Milwaukie projects. The expansion would comprise extending the existing maintenance bays and constructing a new storage yard. To facilitate construction, property west and south of the existing facility would be acquired and the south end of NW Eleven Mile Avenue would be vacated. The expansion would result in a net reduction in impervious of about 0.5 acre.

The design of the Ruby Junction expansion is being undertaken independently of the CRC. Based on information provided by TriMet, runoff from existing and proposed impervious areas would be infiltrated; there would be no provision for overflow to Fairview Creek, even in the case of an extreme storm event.Although infiltration has been assumed, it should be noted that other methods of water quality treatment may be selected by TriMet. Regardless, the facility will need to comply with the City of Gresham's water quality requirements[16]. Since the receiving watercourse, Fairview Creek, is 303(d) listed and has TMDLs, these requirements would result in a suite of acceptable stormwater BMPs that would be similar to those proposed elsewhere for the CRC project.

Permanent Flow Control Management Strategies

As stated elsewhere, flow control is only required for discharges to Burnt Bridge Creek. Based on the current project layout, additional flow control measures would not be required for the existing infiltration pond at the Main Street interchange since the total impervious area draining to this facility would be reduced by the project. Preliminary sizing for the proposed new biofiltration ponds is based on ensuring that inflows up to the 1 in 100-year event or greater would be infiltrated.

Facility Maintenance and Inspection

Continued inspection and maintenance of the permanent water quality and flow control facilities is vital to the long-term protection of receiving water bodies. While detailed procedures will be developed as part of final design and associated design reports, appendices at the back of this memorandum contain general inspection and maintenance requirements contained in the ODOT Hydraulics Manual[17] and WSDOT Highway Runoff Manual.[18]

SUMMARY

OPTION A – FULL-BUILD

Overall, the project will increase the total impervious area by approximately 38 acres. Not including the Fairview Creek watershed, the current full build design would result in approximately 225 acres of new and rebuilt impervious surface, and 39 acres of resurfaced pavement. The total CIA of 298 acres also includes about 34 acres of existing pavement and sidewalk that will not be affected by the project. The existing impervious surfaces within the CIA include the North Portland Harbor bridges and Vancouver streets not affected by the project, but from which runoff would drain to proposed water quality facilities.

At this time, the project team has not determined approaches to treat runoff from approximately 8 acres, or about 3 percent of the CIA. This area comprises approximately 7 acres of I-5 pavement immediately north of Victory Boulevard and 1 acre of the eastbound lanes on SR 14. As mentioned elsewhere in this document, project staff are continuing to investigate options to collect and treat runoff from these areas.

PROJECT OPTIONS AND PHASING

This section describes the differences should project or phasing be implemented. Project options being considered and elements that could be constructed at a later date and the overall changes in stormwater-related impacts are:

---

[16] Water Quality Manual. Prepared by the Stormwater Division, Department of Environmental Services, City of Gresham. Summer 2003.

[17] Hydraulics Manual, Chapter 14 (Draft). Prepared by the Oregon Department of Transportation, Highway Division. 2007.

[18] Highway Runoff Manual. Prepared by Washington State Department of Transportation. Publication M31-16.01. June 2008.

1) Option B – Full Build

   Under this scenario, the proposed arterial connection over North Portland Harbor would be eliminated and the vehicle movements accommodated by highway ramps. The changes would result in nominal increases of 0.3 acre and 0.4 acre in the Columbia Slough Watershed and Columbia River Watershed – Oregon, respectively.

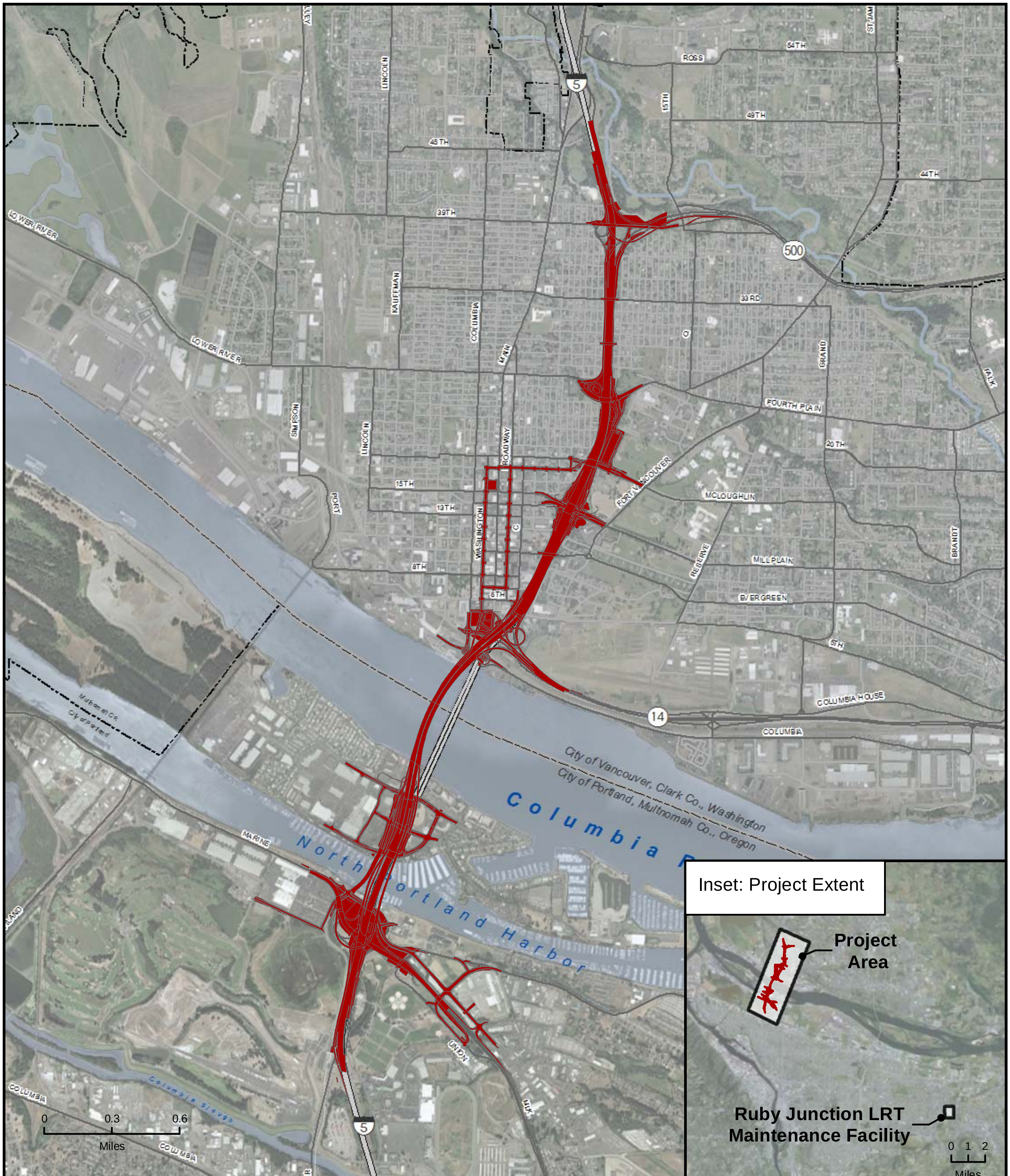
2) Options A and B – with Highway Phasing

   The braided ramp between Marine Drive and southbound I-5 would be replaced by a shorter ramp merging onto southbound I-5 north of Victory Boulevard and construction of the ramp from eastbound Marine Drive to northbound I-5 would be deferred. In the full-build scenarios, the braided ramp would join I-5 south of Victory Boulevard. This would result in a net reduction in CIA within the Columbia Slough watershed of approximately 5.5 acres, all of which would be PGIS. The 0.9 acre of new impervious surface draining to the proposed biofiltration swale CS-A would be eliminated as would the 0.5 acre merge south of Victory Boulevard (the latter would be conveyed to a swale constructed as part of the Delta Park project). In addition, the new impervious areas draining to constructed wetlands CS-B, CS-D and CS-E would be reduced by 0.8, 0.2, and 3.1 acres, respectively.

   The ramps from southbound I-5 to eastbound SR 500 and from westbound SR 500 to northbound I-5 would be deferred. Phasing this construction would result in a reduction in impervious area of approximately 5 acres, all of which is in the Burnt Bridge Creek watershed, and eliminate the need for water quality facility BBC-A. The CIA draining to water quality facility BBC-B would be reduced by 0.9 acre, all of which is resurfaced pavement on I-5, and the CIA draining to the existing infiltration pond BBC-C would be reduced by 1.3 rather than 2.3 acres.

These alternatives would only affect the impervious area from which runoff would be treated: the untreated area of about 8 acres would remain unchanged.

FIGURES



N
W
E
S

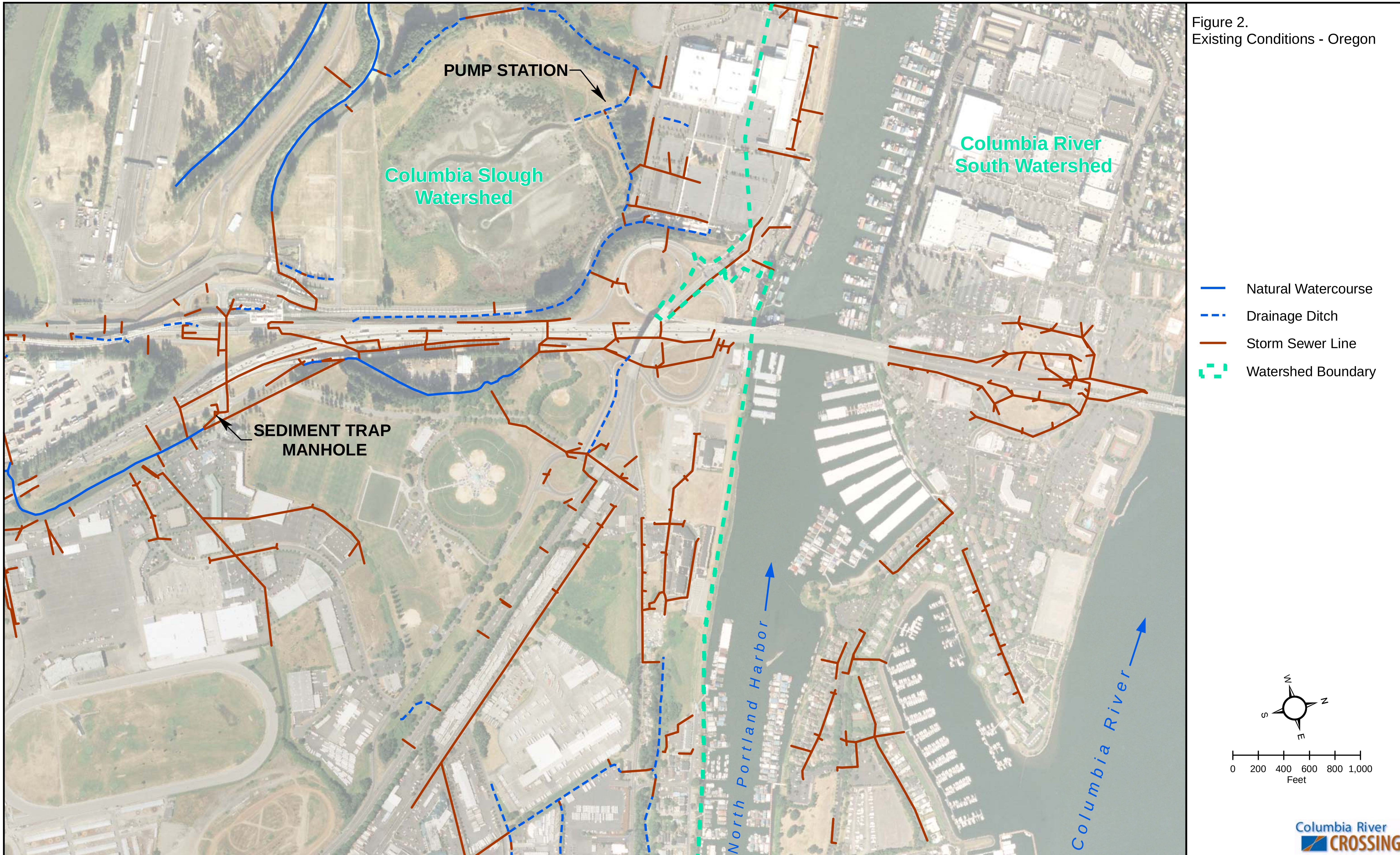
Project Footprint

Figure 1. Proposed Project Footprint

Columbia River CROSSING

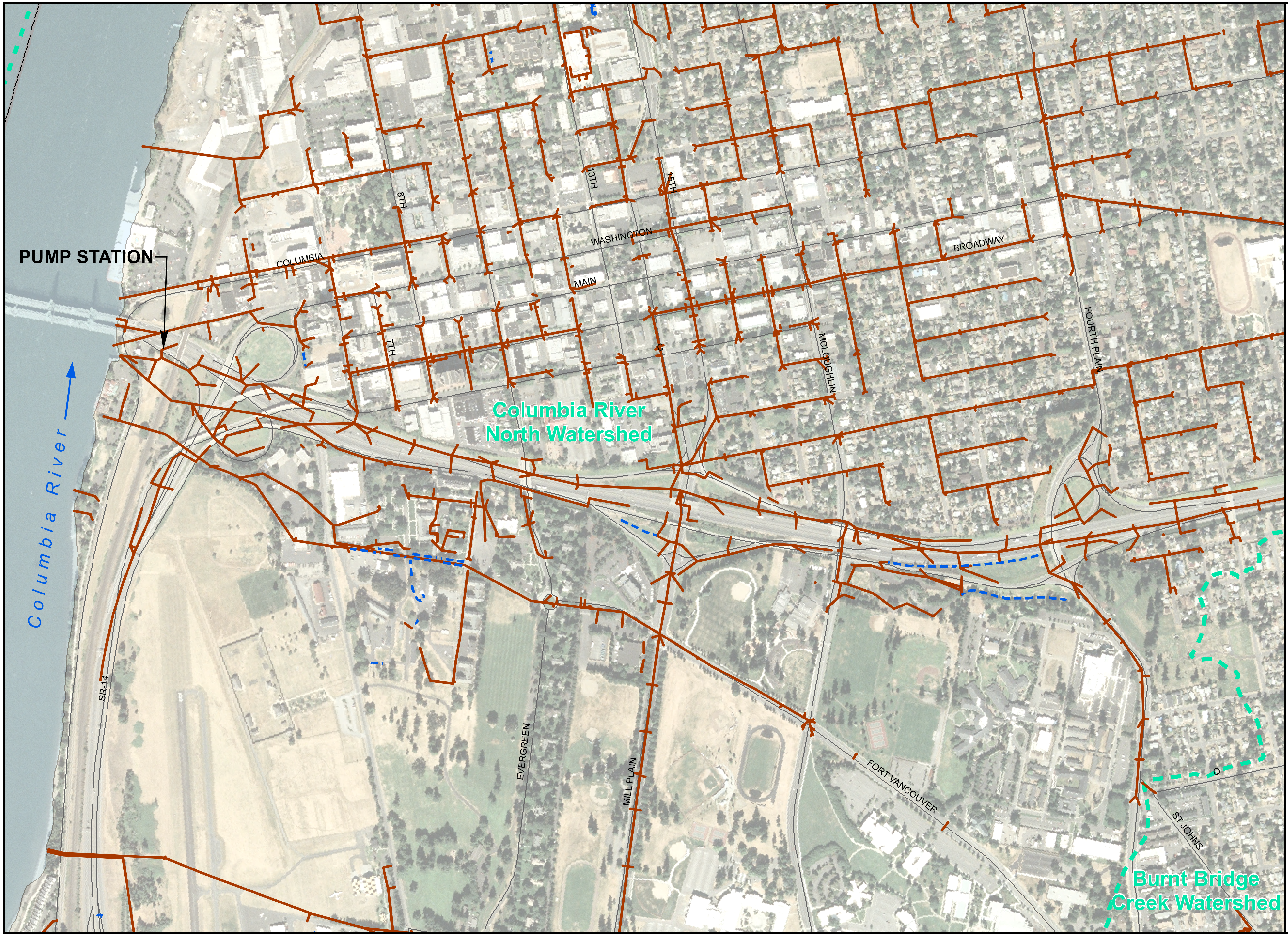
Analysis by J. Koloszar; Analysis Date: Dec. 28, 2010; File Name: Ex1_1_StormwaterProjArea.mxd

Figure 2.
Existing Conditions - Oregon



Analysis by J. Koloszar; Analysis Date: Oct. 21, 2010; File Name: Ex3_13-1Stormwater_RK251.mxd

Figure 3.
Existing Conditions - Washington State (Sheet 1 of 2)



- Natural Watercourse
- Drainage Ditch
- Storm Sewer Line
- Watershed Boundary

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Feb. 12, 2010; File Name: Ex3_13-2Stormwater_RK251.mxd

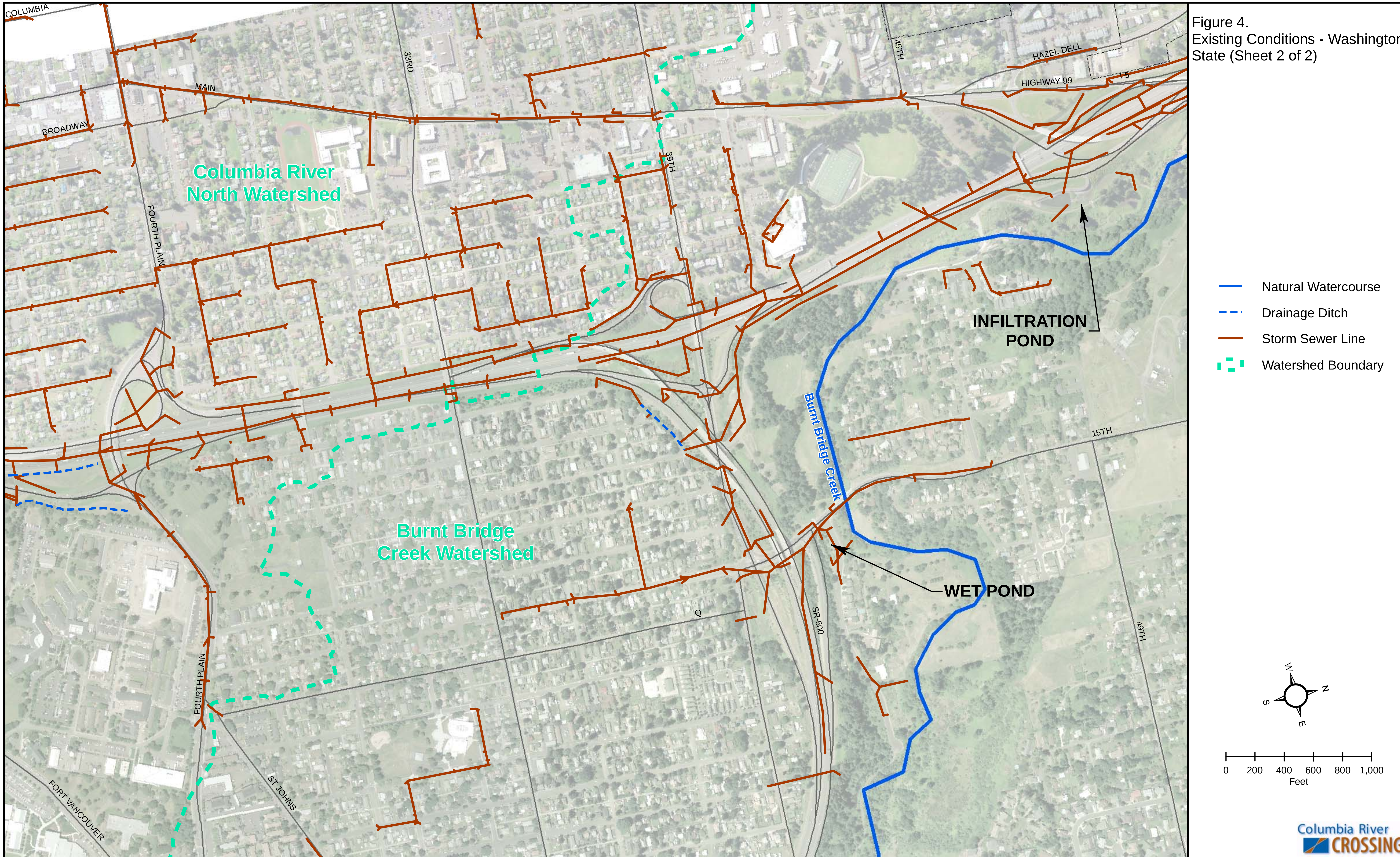


Figure 4.
Existing Conditions - Washington State (Sheet 2 of 2)

Analysis by J. Koloszar; Analysis Date: Feb. 03, 2010; File Name: Ex3_13-3Stormwater_RK251.mxd

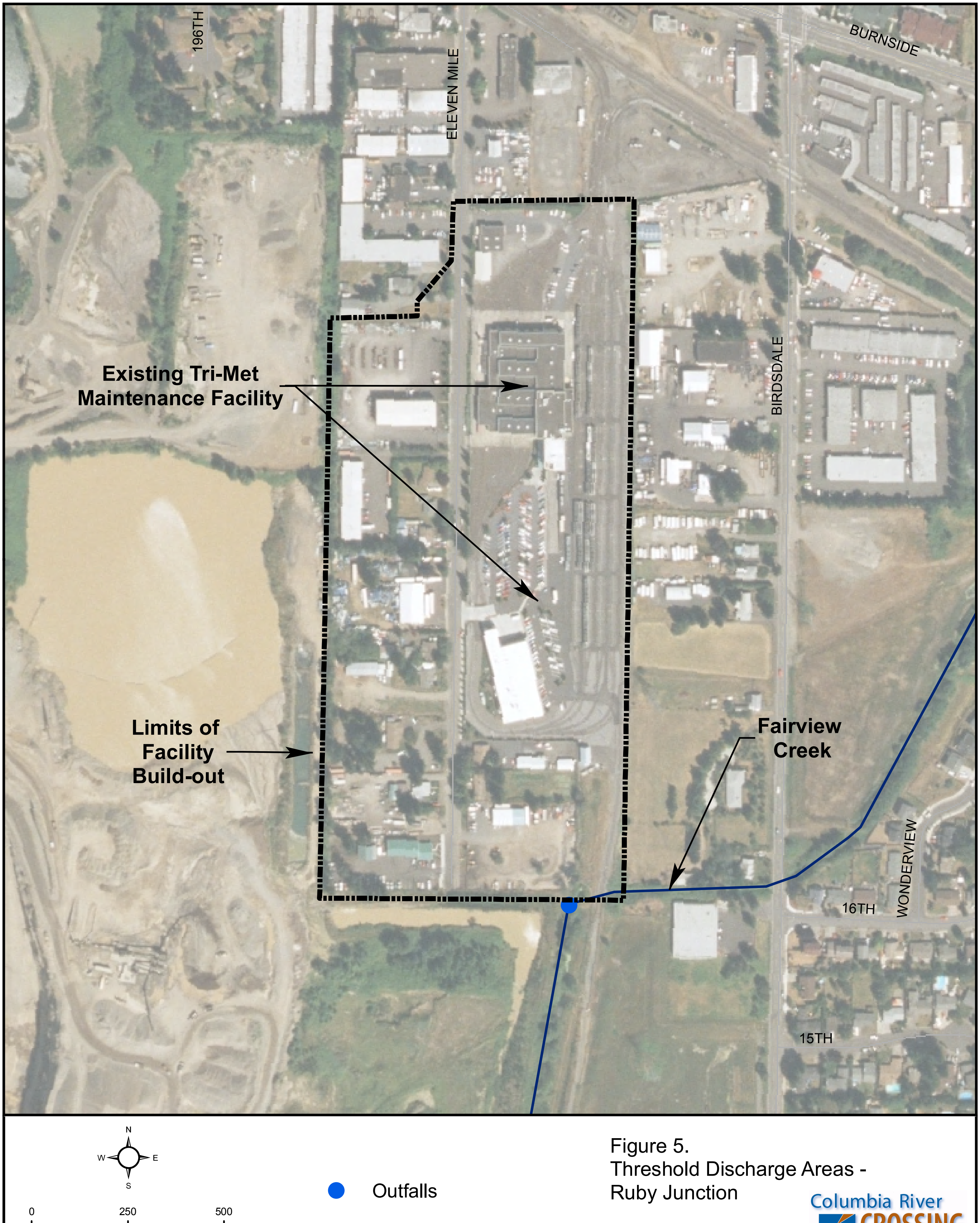
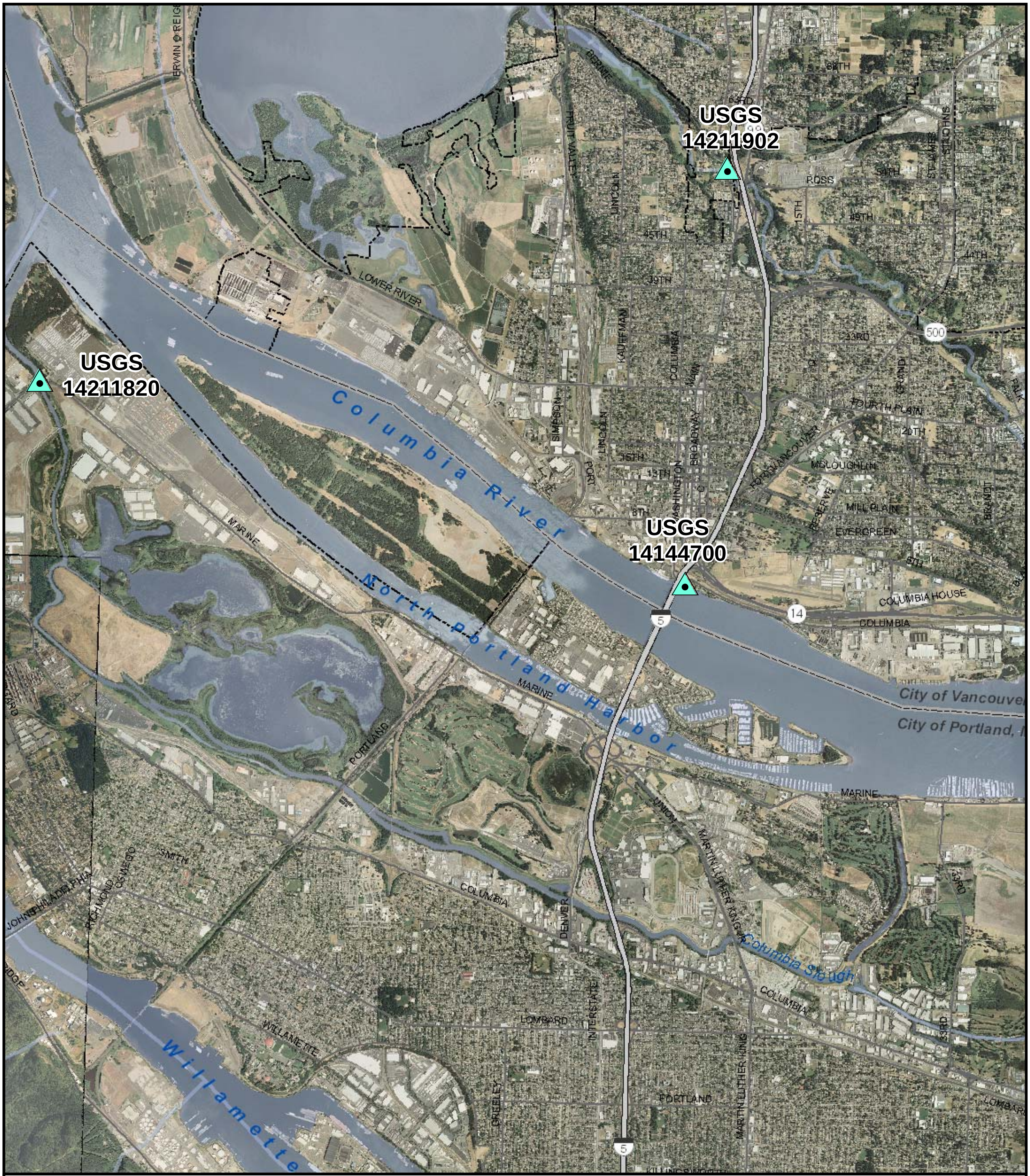


Figure 5.
Threshold Discharge Areas -
Ruby Junction

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Oct. 05. 2010; File Name: Fig5_RubyJun_Stormwater_RK251.mxd



N
W E
S

0 0.5 1
Miles

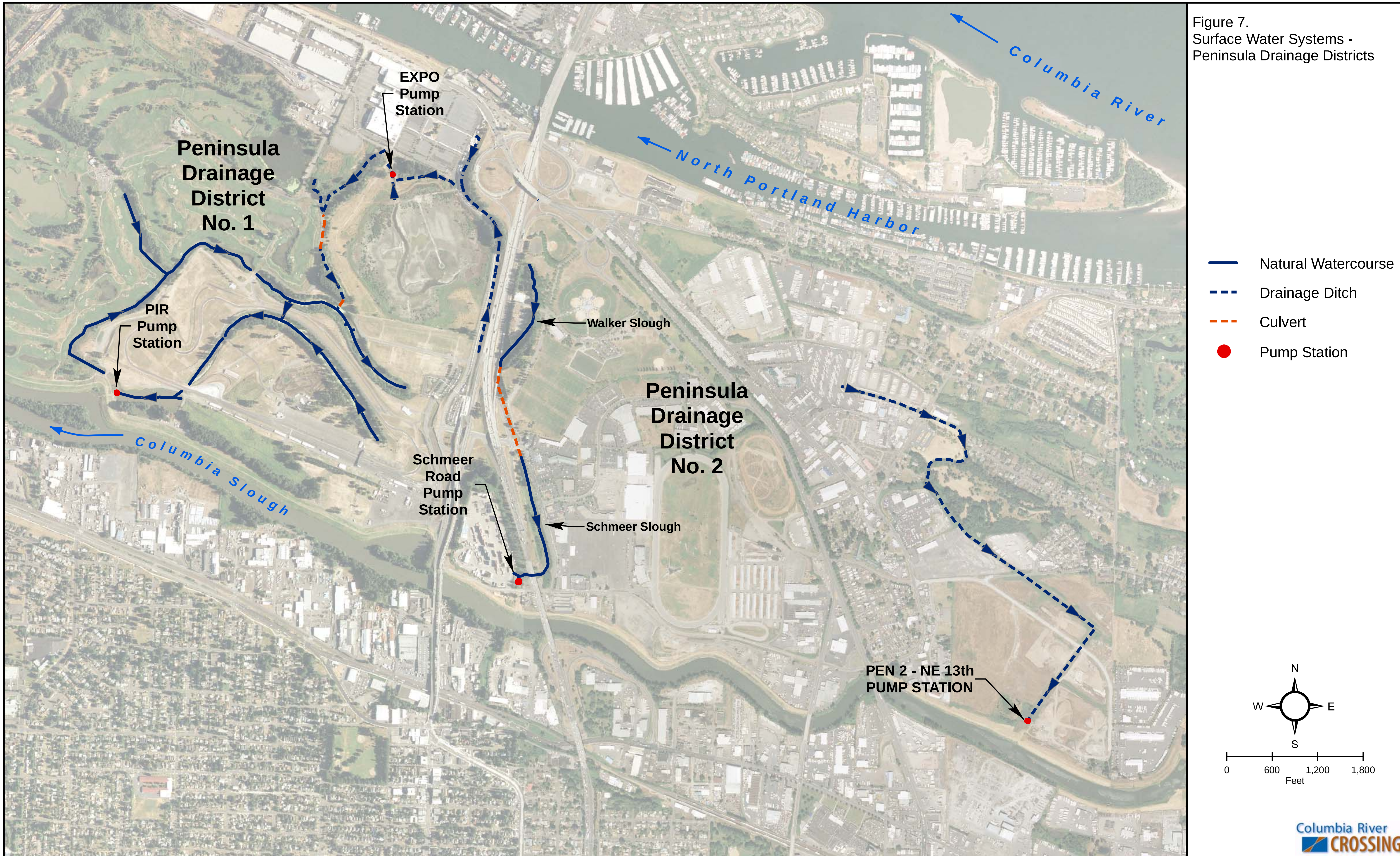
USGS Surface Water Gauging Station

Figure 6.
USGS Gauging Station Locations

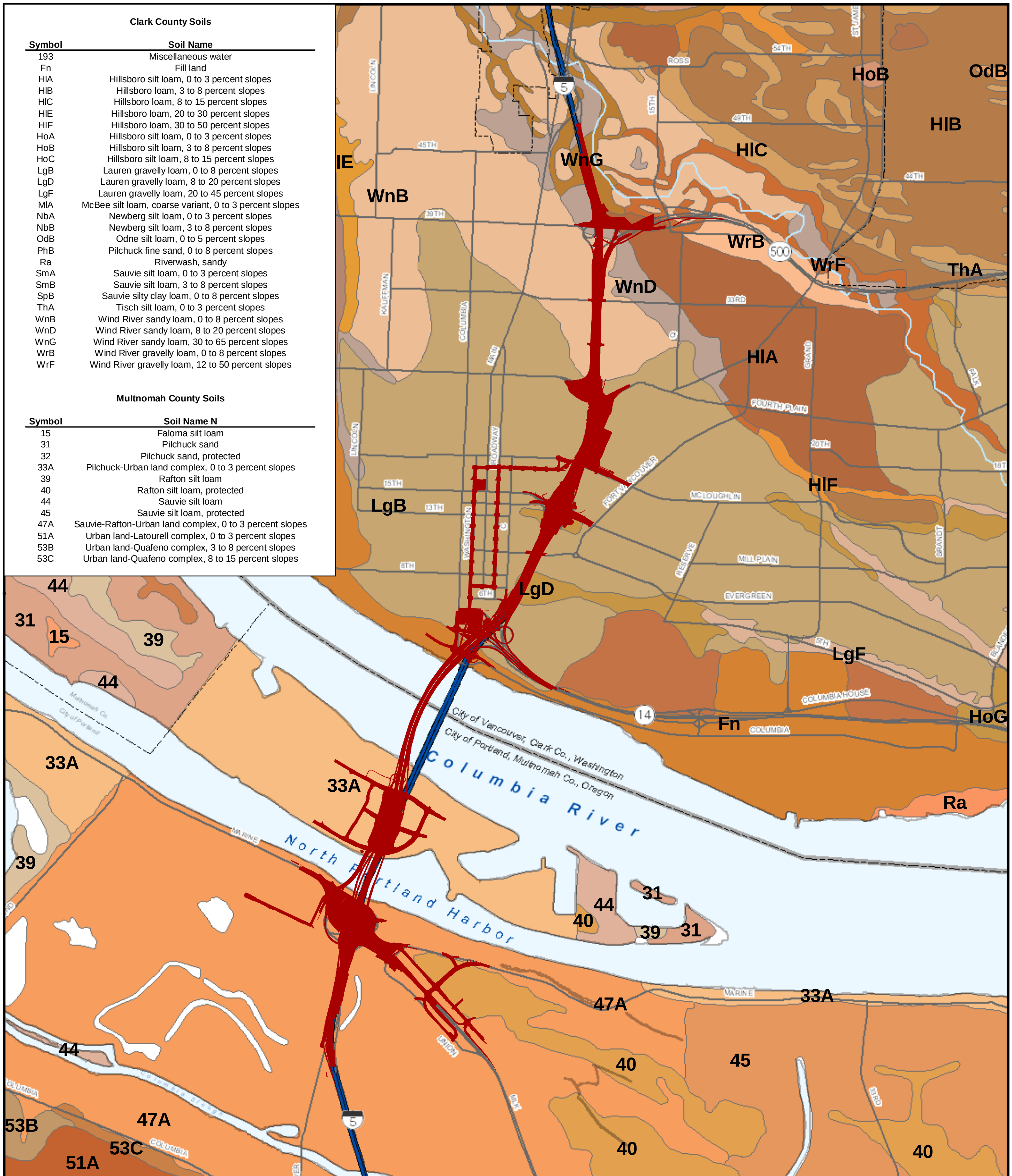
Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Dec. 22, 2010; File Name: Ex_13-4Stormwater_RK251.mxd

Figure 7.
Surface Water Systems -
Peninsula Drainage Districts



Analysis by J. Koloszar; Analysis Date: Feb. 12, 2010; File Name: Ex3_13-5Stormwater_RK251.mxd



Clark County Soils

Symbol	Soil Name
193	Miscellaneous water
Fn	Fill land
HlA	Hillsboro silt loam, 0 to 3 percent slopes
HlB	Hillsboro loam, 3 to 8 percent slopes
HlC	Hillsboro loam, 8 to 15 percent slopes
HlE	Hillsboro loam, 20 to 30 percent slopes
HlF	Hillsboro loam, 30 to 50 percent slopes
HoA	Hillsboro silt loam, 0 to 3 percent slopes
HoB	Hillsboro silt loam, 3 to 8 percent slopes
HoC	Hillsboro silt loam, 8 to 15 percent slopes
LgB	Lauren gravelly loam, 0 to 8 percent slopes
LgD	Lauren gravelly loam, 8 to 20 percent slopes
LgF	Lauren gravelly loam, 20 to 45 percent slopes
MlA	McBee silt loam, coarse variant, 0 to 3 percent slopes
NbA	Newberg silt loam, 0 to 3 percent slopes
NbB	Newberg silt loam, 3 to 8 percent slopes
OdB	Odne silt loam, 0 to 5 percent slopes
PhB	Pilchuck fine sand, 0 to 8 percent slopes
Ra	Riverwash, sandy
SmA	Sauvie silt loam, 0 to 3 percent slopes
SmB	Sauvie silt loam, 3 to 8 percent slopes
SpB	Sauvie silty clay loam, 0 to 8 percent slopes
ThA	Tisch silt loam, 0 to 3 percent slopes
WnB	Wind River sandy loam, 0 to 8 percent slopes
WnD	Wind River sandy loam, 8 to 20 percent slopes
WnG	Wind River sandy loam, 30 to 65 percent slopes
WrB	Wind River gravelly loam, 0 to 8 percent slopes
WrF	Wind River gravelly loam, 12 to 50 percent slopes

Multnomah County Soils

Symbol	Soil Name N
15	Faloma silt loam
31	Pilchuck sand
32	Pilchuck sand, protected
33A	Pilchuck-Urban land complex, 0 to 3 percent slopes
39	Rafton silt loam
40	Rafton silt loam, protected
44	Sauvie silt loam
45	Sauvie silt loam, protected
47A	Sauvie-Rafton-Urban land complex, 0 to 3 percent slopes
51A	Urban land-Latourell complex, 0 to 3 percent slopes
53B	Urban land-Quafeno complex, 3 to 8 percent slopes
53C	Urban land-Quafeno complex, 8 to 15 percent slopes

N
W E
S

0 0.4 0.8
Miles

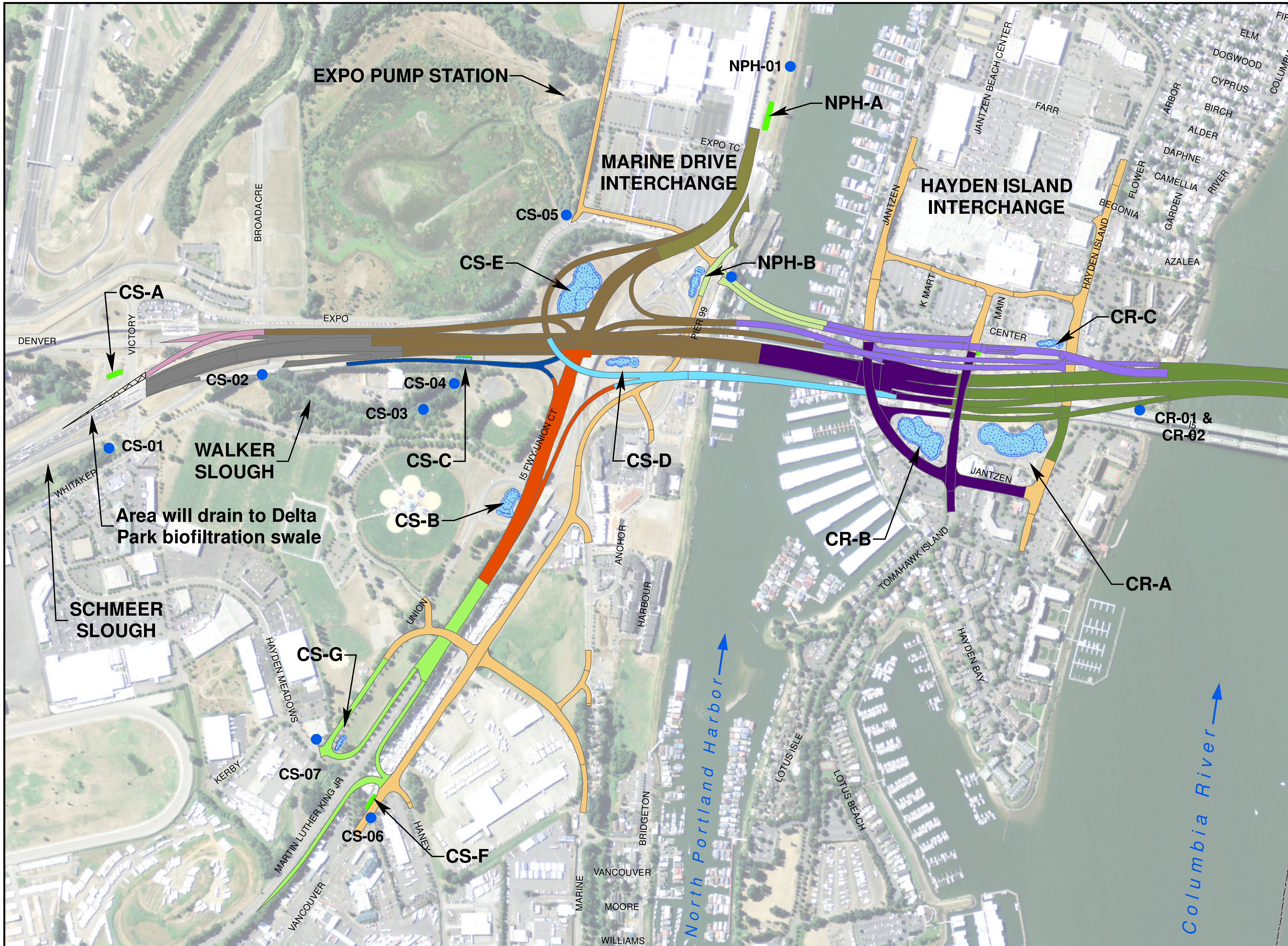
Project Footprint

Figure 8.
Surficial Soils

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Dec. 20. 2010; File Name: Fig8_RK080_100510.mxd

Figure 9.
Proposed Water Management Facilities - Oregon



Areas Draining to Water Quality Facilities

- CR-A
- CR-B
- CR-C
- CS-A
- CS-B
- CS-C
- CS-D
- CS-E
- CS-G
- CS-F
- NPH-A
- NPH-B
- Semi-Continuous Biofiltration Swales or Proprietary Systems
- Not Treated

Stormwater Facility Type

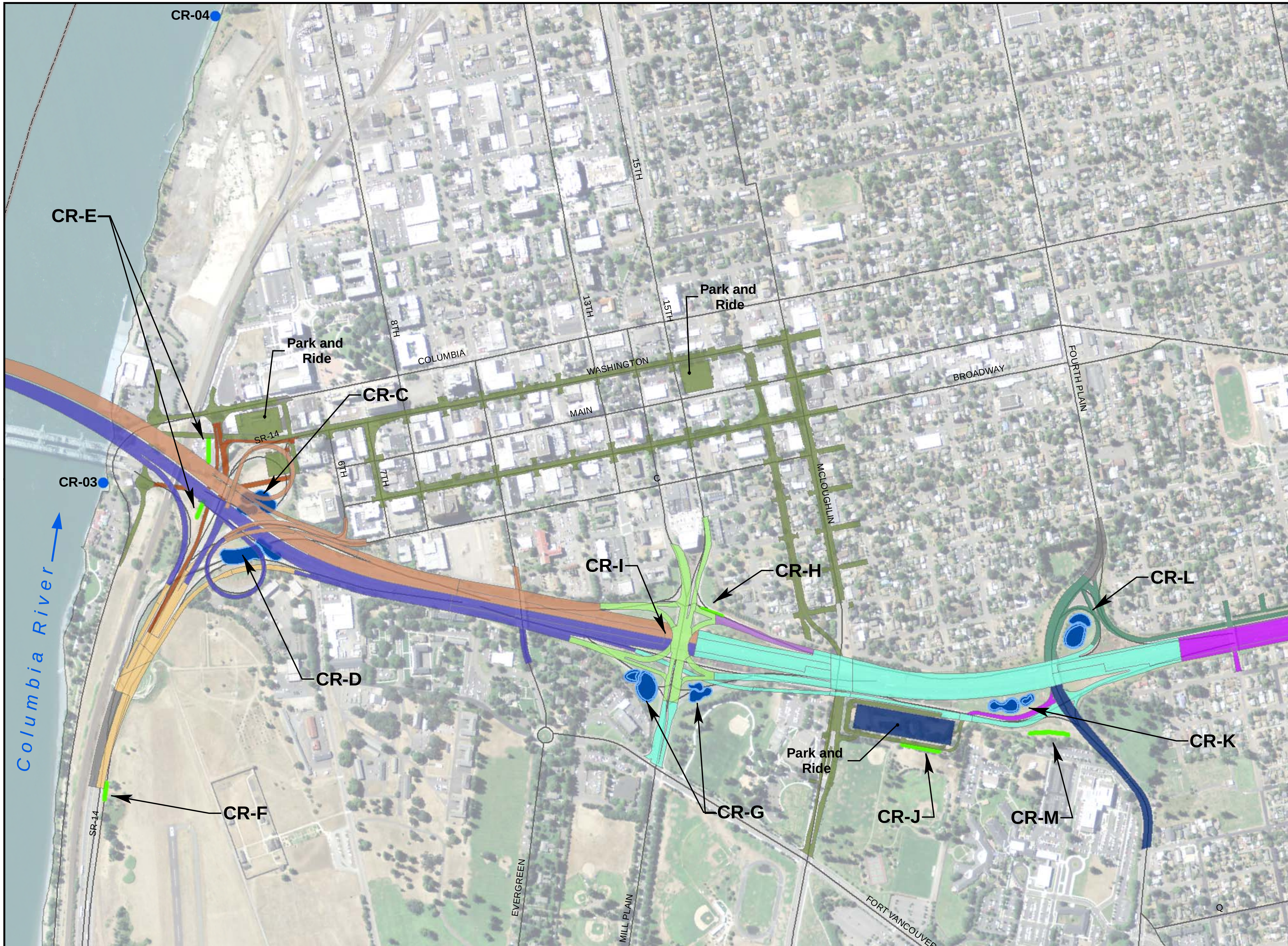
- Biofiltration Swale
- Constructed Wetland
- Outfalls

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Dec. 21, 2010; File Name: Ex3_13-9Stormwater_RK251.mxd

Figure 10.
Proposed Water Management Facilities - Washington State
(1 of 2)



Areas Draining to Water Quality Facilities

- CR-C
- CR-D
- CR-E
- CR-F
- CR-G
- CR-H
- CR-I
- CR-J & CR-M
- CR-K
- CR-L
- Semi-Continuous Biofiltration Swales or Proprietary Systems
- Not Treated

Stormwater Facility Type

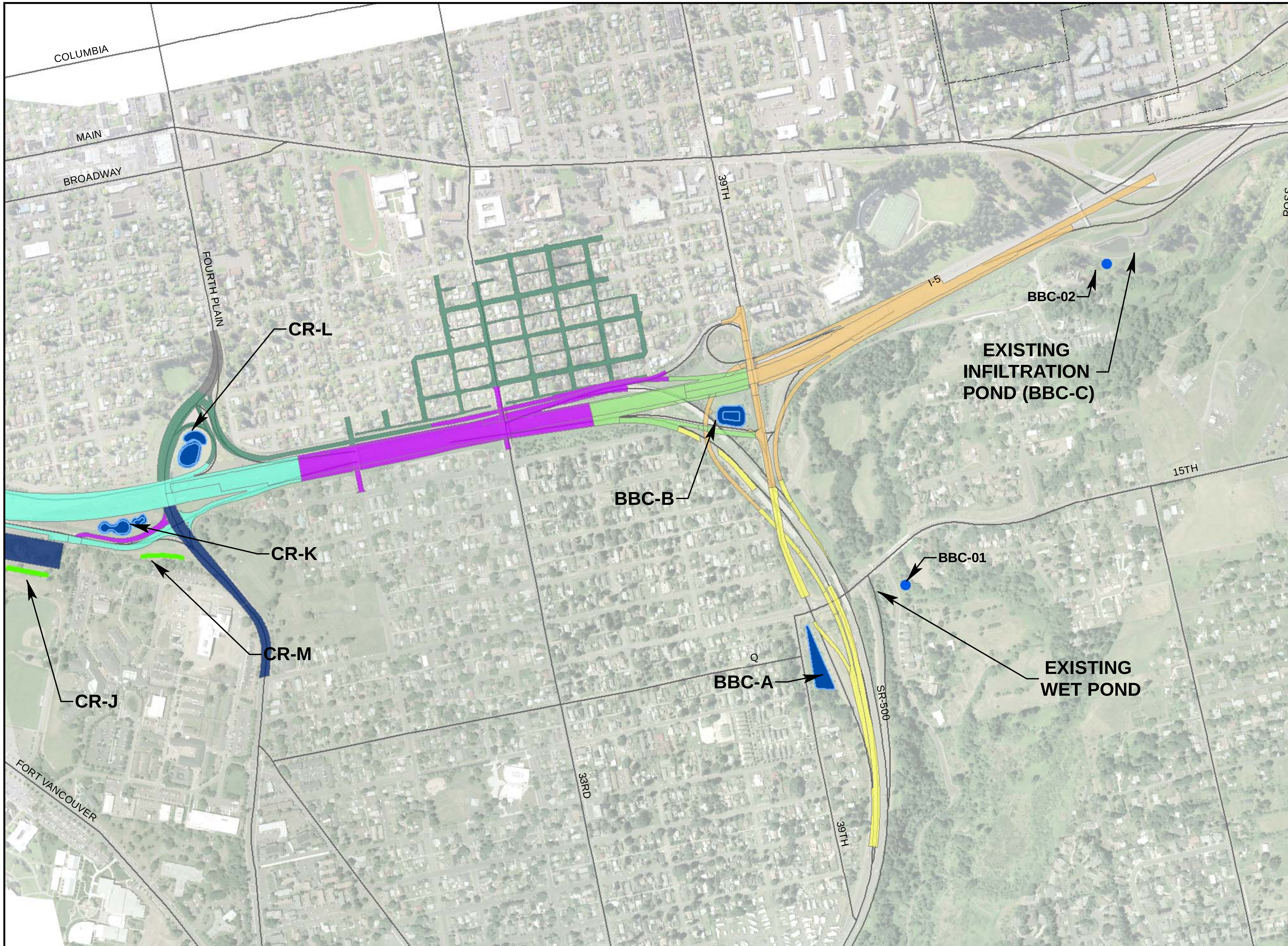
- Biofiltration Swale
- Bioretention Pond
- Outfall

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Dec. 21, 2010; File Name: Ex3_13-10Stormwater_RK251.mxd

Figure 11.
Proposed Water Management Facilities - Washington State
(2 of 2)



Areas Draining to Water Quality Facilities

- BBC-A
- BBC-B
- CR-G
- CR-J & CR-M
- CR-K
- CR-L
- Existing Infiltration Pond
- Not Treated

Stormwater Facility Type

- Biofiltration Swale
- Bioretention Pond
- Outfall

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Dec. 21, 2010; File Name: Ex3_13-11Stormwater_RK251.mxd

WSDOT MAINTENANCE STANDARDS

5-5 Operation and Maintenance

Inadequate maintenance is a common cause of failure for stormwater control facilities. All stormwater facilities require routine inspection and maintenance and thus must be designed so that these functions can be easily conducted.

5-5.1 Typical BMP Maintenance Standards

The facility-specific maintenance standards contained in this section (see Tables 5.5.1 through 5.5.13) are intended to be used for determining when maintenance actions are required for conditions identified through inspection. They are not intended to be measures of a facility's required condition at all times between inspections. In other words, exceeding these conditions at any time between inspections or maintenance does not automatically constitute a need for immediate maintenance. Based upon inspection observations, however, the inspection and maintenance schedules must be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

5-5.2 Natural and Landscaped Areas Designated as Stormwater Management Facilities

Maintenance of natural and landscaped areas designated as stormwater management facilities requires special attention. Generally, maintenance in these areas should be performed with light equipment. Heavy machinery and vehicles with large treads or tires can compact the ground surface, decreasing the effectiveness of the BMPs.

Table 5.5.1. Maintenance standards for detention ponds.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	Accumulations exceed 5 cubic feet (about equal to the amount of trash needed to fill one standard-size garbage can) per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold, all trash and debris will be removed as part of the next scheduled maintenance.	Trash and debris are cleared from site.
	Poisonous vegetation and noxious weeds	Poisonous or nuisance vegetation may constitute a hazard to maintenance personnel or the public. Noxious weeds as defined by state or local regulations are evident. (Apply requirements of adopted integrated pest management [IPM] policies for the use of herbicides).	No danger is posed by poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department.) Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies is required.
	Contaminants and pollution	Oil, gasoline, contaminants, or other pollutants are evident. (Coordinate removal/cleanup with local water quality response agency.)	No contaminants or pollutants are present.
	Rodent holes	For facilities acting as a dam or berm: rodent holes are evident or there is evidence of water piping through dam or berm via rodent holes.	Rodents are destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies.)
	Insects	Insects such as wasps and hornets interfere with maintenance activities.	Insects are destroyed or removed from site. Insecticides are applied in compliance with adopted IPM policies.
	Tree growth and hazard trees	Tree growth does not allow maintenance access or interferes with maintenance activity (slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove. Dead, diseased, or dying trees are observed. (Use a certified arborist to determine health of tree or removal requirements.)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (such as alders for firewood). Hazard trees are removed.
Side slopes of pond	Erosion	Eroded damage is over 2 inches deep and cause of damage is still present, or there is potential for continued erosion. Erosion is observed on a compacted berm embankment.	Slopes are stabilized using appropriate erosion control measures (such as rock reinforcement, planting of grass, and compaction). If erosion is occurring on compacted berms, a licensed civil engineer should be consulted to resolve source of erosion.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage area	Sediment	Accumulated sediment exceeds 10% of the designed pond depth, unless otherwise specified, or affects inletting or outletting condition of the facility.	Sediment is cleaned out to designed pond shape and depth. Pond is reseeded if necessary to control erosion.
	Liner (if applicable)	Liner is visible and has more than three ¼-inch holes in it.	Liner is repaired or replaced. Liner is fully covered.
Pond berms (dikes)	Settlements	Any part of berm has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Water flow is discernible through pond berm. Ongoing erosion is observed, with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping is eliminated. Erosion potential is resolved.
Emergency overflow/ spillway and berms over 4 feet high	Tree growth	Tree growth on emergency spillways reduces spillway conveyance capacity and may cause erosion elsewhere on the pond perimeter due to uncontrolled overtopping. Tree growth on berms over 4 feet high may lead to piping through the berm, which could lead to failure of the berm and related erosion or flood damage.	Trees should be removed. If root system is small (base less than 4 inches), the root system may be left in place; otherwise, the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Water flow is discernible through pond berm. Ongoing erosion is observed, with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping is eliminated. Erosion potential is resolved.
Emergency overflow/ spillway	Spillway lining insufficient	Only one layer of rock exists above native soil in area 5 square feet or larger, or native soil is exposed at the top of outflow path of spillway. (Riprap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.

Table 5.5.2. Maintenance standards for bioinfiltration ponds/infiltration trenches/basins.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
	Poisonous/noxious vegetation	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
	Contaminants and pollution	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
	Rodent holes	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
Storage area	Sediment	Water ponds in infiltration pond after rainfall ceases and appropriate time has been allowed for infiltration. (A percolation test pit or test of facility indicates facility is working at only 90% of its designed capabilities. If 2 inches or more of sediment present, remove sediment).	Sediment is removed or facility is cleaned so that infiltration system works according to design.
Rock filters	Sediment and debris	By visual inspection, little or no water flows through filter during heavy rainstorms.	Gravel in rock filter is replaced.
Side slopes of pond	Erosion	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
Emergency overflow/spillway and berms over 4 feet high	Tree growth	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
	Piping	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
Emergency overflow/spillway	Rock missing	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
	Erosion	See Table 5.5.1 (wet ponds).	See Table 5.5.1 (wet ponds).
Presettling ponds and vaults	Facility or sump filled with sediment or debris	Sediment/debris exceeds 6 inches or designed sediment trap depth.	Sediment is removed.

Table 5.5.3. Maintenance standards for closed treatment systems (tanks/vaults).

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage area	Plugged air vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents are open and functioning.
	Debris and sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for ½ length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank requires cleaning when sediment reaches depth of 7 inches for more than ½ the length of the tank.)	All sediment and debris are removed from storage area.
	Joints between tank/pipe section	Openings or voids allow material to be transported into facility. (Will require engineering analysis to determine structural stability.)	All joints between tank/pipe sections are sealed.
	Tank/pipe bent out of shape	Any part of tank/pipe is bent out of shape for more than 10% of its design shape. (Review required by engineer to determine structural stability.)	Tank/pipe is repaired or replaced to design specifications.
	Vault structure: includes cracks in walls or bottom, damage to frame or top slab	Cracks are wider than ½ inch and there is evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault is replaced or repaired to design specifications and is structurally sound.
		Cracks are wider than ½ inch at the joint of any inlet/outlet pipe, or there is evidence of soil particles entering the vault through the walls.	No cracks are more than ¼-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover not in place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than ½ inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure. *Intent: To prevent cover from sealing off access to maintenance.*	Cover can be removed and reinstalled by one maintenance person.
	Ladder unsafe	Ladder is unsafe due to missing rungs, misalignment, insecure attachment to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch basins	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).

Table 5.5.4. Maintenance standards for control structure/flow restrictor.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris (includes sediment)	Accumulation exceeds 25% of sump depth or is within 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris are removed.
	Structural damage	Structure is not securely attached to manhole wall.	Structure is securely attached to wall and outlet pipe.
		Structure is not in upright position; allow up to 10% from plumb.	Structure is in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are watertight; structure is repaired or replaced and works as designed.
		Holes other than designed holes are observed in the structure.	Structure has no holes other than designed holes.
Cleanout gate	Damaged or missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice plate	Damaged or missing	Control device is not working properly due to missing, out-of-place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Trash, debris, sediment, or vegetation blocks the plate.	Plate is free of all obstructions and works as designed.
Overflow pipe	Obstructions	Trash or debris blocks (or has the potential to block) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See Table 5.5.3 (closed treatment systems).	See Table 5.5.3 (closed treatment systems).	See Table 5.5.3 (closed treatment systems).
Catch basin	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).

Table 5.5.5. Maintenance standards for catch basins.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	Trash or debris is immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris is immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) exceeds 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case is clearance less than 6 inches from the debris surface to the invert of the lowest pipe.	No trash or debris is in the catch basin.
		Trash or debris in any inlet or outlet pipe blocks more than ⅓ of its height.	Inlet and outlet pipes are free of trash or debris.
		Dead animals or vegetation could generate odors that might cause complaints or dangerous gases (such as methane).	No vegetation or dead animals are present within the catch basin.
	Sediment	Sediment (in the basin) exceeds 60% of the sump depth as measured from the bottom of the basin to invert of the lowest pipe into or out of the basin, but in no case is clearance less than 6 inches from the sediment surface to the invert of the lowest pipe.	No sediment is in the catch basin.
	Structure damage to frame and/or top slab	Top slab has holes larger than 2 square inches or cracks wider than ¼ inch. *Intent: To make sure no material is running into basin.*	Top slab is free of holes and cracks.
		Frame is not sitting flush on top slab (separation of more than ¾ inch of the frame from the top slab). Frame is not securely attached.	Frame is sitting flush on the riser rings or top slab and is firmly attached.
	Fractures or cracks in basin walls/bottom	Maintenance person judges that structure is unsound.	Basin is replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe, or there is evidence that soil particles have entered catch basin through cracks.	Pipe is regrouted and secure at the basin wall.
	Settlement/ misalignment	Failure of basin has created a safety, function, or design problem.	Basin is replaced or repaired to design standards.
	Vegetation	Vegetation is growing across and blocking more than 10% of the basin opening.	No vegetation blocks the opening to the basin.
		Vegetation growing in inlet/outlet pipe joints is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth is present.
	Contamination and pollution	Oil, gasoline, contaminants, or other pollutants are evident. (Coordinate removal/cleanup with local water quality response agency.)	No pollution is present.
Catch basin cover	Cover not in place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than ½ inch of thread.	Mechanism opens with proper tools.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Catch basin cover (continued)	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure. *Intent: To prevent cover from sealing off access to maintenance*.	Cover can be removed by one maintenance person.
Ladder	Ladder unsafe	Ladder is unsafe due to missing rungs, insecure attachment to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance staff safe access.
Metal grates (if applicable)	Grate opening unsafe	Grate opening is wider than ⅞ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris block more than 20% of grate surface inletting capacity.	Grate is free of trash and debris.
	Damaged or missing	Grate is missing or components of the grate are broken.	Grate is in place and meets design standards.

Table 5.5.6. Maintenance standards for debris barriers (such as trash racks).

Maintenance Components	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	Trash or debris plugs more than 20% of the openings in the barrier.	Barrier is cleared to design flow capacity.
Metal	Damaged/missing bars	Bars are bent out of shape more than 3 inches.	Bars are in place with no bends more than ¾ inch.
		Bars are missing or entire barrier is missing.	Bars are in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier is replaced or repaired to design standards.
	Inlet/outlet pipe	Debris barrier is missing or not attached to pipe.	Barrier is firmly attached to pipe.

Table 5.5.7. Maintenance standards for energy dissipaters.

Maintenance Components	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock pad	Missing or moved rock	Only one layer of rock exists above native soil in area 5 square feet or larger, or native soil is exposed.	Rock pad is replaced to design standards.
	Erosion	Soil erosion is evident in or adjacent to rock pad.	Rock pad is replaced to design standards.
Dispersion trench	Pipe plugged with sediment	Accumulated sediment exceeds 20% of the design depth.	Pipe is cleaned/flushed so that it matches design.
	Not discharging water properly	There is visual evidence of water discharging at concentrated points along trench—normal condition is a “sheet flow” of water along trench. *Intent: To prevent erosion damage*.	Trench is redesigned or rebuilt to standards.
	Perforations plugged	Over ½ of perforations in pipe are plugged with debris and sediment.	Perforated pipe is cleaned or replaced.
	Water flows out top of “distributor” catch basin	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm, or water is causing (or appears likely to cause) damage.	Facility is rebuilt or redesigned to standards.
	Receiving area over-saturated	Water in receiving area is causing (or has potential of causing) landslide problems.	There is no danger of landslides.
Internal:			
Manhole/chamber	Worn or damaged post, baffles, side of chamber	Structure dissipating flow deteriorates to ½ of original size or any concentrated worn spot exceeds 1 square foot, which would make structure unsound.	Structure is replaced to design standards.
	Other defects	See entire contents of Table 5.5.5 (catch basins).	See entire contents of Table 5.5.5 (catch basins).

Table 5.5.8. Maintenance standards for biofiltration swale.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing water	Water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages; improve grade from head to foot of swale; remove clogged check dams; add underdrains; or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant baseflow	Small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea gravel drain the length of the swale, or bypass the baseflow around the swale.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Replant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals; or reseed into loosened, fertile soil.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches. Mowing is not required for wet biofiltration swales. However, fall harvesting of very dense vegetation after plant die-back is recommended.
	Excessive shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/outlet	Inlet/outlet areas are clogged with sediment/debris.	Remove material so there is no clogging or blockage in the inlet and outlet area.
	Trash and debris	Trash and debris have accumulated in the swale.	Remove trash and debris from bioswale.
	Erosion/scouring	Swale bottom has eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large (generally greater than 12 inches wide), the swale should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Table 5.5.9. Maintenance standards for vegetated filter strip.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height between 3 and 4 inches.
	Trash and debris	Trash and debris have accumulated on the vegetated filter strip.	Remove trash and debris from filter.
	Erosion/scouring	Areas have eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table 5.5.10. Maintenance standards for <u>media filter drain</u>.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation zone/flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean so that flows are spread evenly over entire embankment width.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the <u>grass</u> strip surface area.	Consult with roadside vegetation specialists to determine why grass growth is poor and correct the offending condition. Replant with plugs of grass from the upper slope or reseed into loosened, fertile soil or compost.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of <u>6</u> inches.
	<u>Media filter drain mix</u> replacement	Water is seen on the surface of the <u>media filter drain mix</u> from storms that are less than a 6-month, 24-hour precipitation event. Maintenance also needed on a 10-year cycle and during a preservation project.	Excavate and replace all of the <u>media filter drain mix</u> contained within the <u>media filter drain</u>.
	Excessive shading	Grass growth is poor because sunlight does not reach embankment.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Trash and debris	Trash and debris have accumulated on embankment.	Remove trash and debris from embankment.

Table 5.5.11. Maintenance standards for permeable pavement.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation	Collection of sediment is too coarse to pass through pavement.	Remove sediment deposits with high-pressure vacuum sweeper.
	Accumulation of leaves, needles, and other foliage	Accumulation on top of pavement is observed.	Remove with a leaf blower or high-pressure vacuum sweeper.
	Trash and debris	Trash and debris have accumulated on the pavement.	Remove by hand or with a high-pressure vacuum sweeper.
	Oil accumulation	Oil collection is observed on top of pavement.	Immediately remove with a vacuum and follow up by a pressure wash or other appropriate rinse procedure.
Visual facility identification	Not aware of permeable pavement location	Facility markers are missing or not readable.	Replace facility identification where needed.
Annual minimum maintenance			Remove potential void-clogging debris with a biannual or annual high-pressure vacuum sweeping.

Table 5.5.12. Maintenance standards for dispersion areas (natural and engineered).

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on dispersion area	Sediment depth exceeds 2 inches.	Remove sediment deposits while minimizing compaction of soils in dispersion area Relevel so slope is even and flows pass evenly over/through dispersion area. Handwork is recommended rather than use of heavy machinery.
	Vegetation	Vegetation is sparse or dying; significant areas are without ground cover.	Control nuisance vegetation. Add vegetation, preferably native ground cover, bushes, and trees (where consistent with safety standards) to bare areas or areas where the initial plantings have died.
	Trash and debris	Trash and debris have accumulated on the dispersion area.	Remove trash and debris from filter. Handwork is recommended rather than use of heavy machinery.
	Erosion/scouring	Eroded or scoured areas due to flow channelization, or high flows are observed.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel/compost mix (see Section 5-4.3.2 for the compost specifications). The grass will creep in over the rock mix in time. If bare areas are large (generally greater than 12 inches wide), the dispersion area should be reseeded. For smaller bare areas, overseed when bare spots are evident. Look for opportunities to locate flow spreaders, such as dispersion trenches and rock pads.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table 5.5.13. Maintenance standards for wet ponds.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Water level	First cell is empty, doesn't hold water	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and debris	Accumulations exceed 1 cubic foot per 1000 square feet of pond area.	Remove trash and debris from pond.
	Inlet/outlet pipe	Inlet/outlet pipe is clogged with sediment or debris material.	Unclog and unblock inlet and outlet piping.
	Sediment accumulation in pond bottom	Sediment accumulations in pond bottom exceed the depth of sediment zone plus 6 inches, usually in the first cell.	Remove sediment from pond bottom.
	Oil sheen on water	Oil sheen is prevalent and visible.	Remove oil from water using oil-absorbent pads or Vactor truck. Locate and correct source of oil. If chronic low levels of oil persist, plant wetland species such as *Juncus effusus* (soft rush), which can uptake small concentrations of oil.
	Erosion	Pond side slopes or bottom show evidence of erosion or scouring in excess of 6 inches and the potential for continued erosion is evident.	Stabilize slopes using proper erosion control measures and repair methods.
	Settlement of pond dike/berm	Any part of the pond dike/berm has settled 4 inches or lower than the design elevation, or the inspector determines dike/berm is unsound.	Repair dike/berm to specifications.
	Internal berm	Berm dividing cells are not level.	Level berm surface so that water flows evenly over entire length of berm.
	Overflow/spillway	Rock is missing and soil exposed at top of spillway or outside slope.	Replace rocks to specifications.

ODOT MAINTENANCE STANDARDS

10.11 Operation and Maintenance

The proper operation, performance, structural integrity, and aesthetics of a stormwater treatment facility are dependent on routine inspection and adequate maintenance. Facility inspection schedule and maintenance guidelines are summarized in an Operation and Maintenance Manual prepared to assist personnel who maintain the facility.

General requirements include:

- All facilities must have an operation and maintenance manual prepared and a copy must be distributed to the appropriate district maintenance office and Geo-Environmental's Senior Hydraulics Engineer.
- All stormwater treatment facility structures should be accessible by foot and vactor truck for inspection and maintenance.
- Outline an inspection schedule. Inspection schedule guidelines are summarized in Table 6. Include schedule in the facility's Operation and Maintenance Manual.
- Outline maintenance requirements depending on the type of facility and its facility components. General maintenance requirements for extended dry ponds, biofiltration swales, filter strips, and bioslopes are provided in Tables 7 through 10. General maintenance requirements for proprietary structures should be obtained from the appropriate manufacturers. Include any additional requirements needed to maintain proper operation and performance. Include maintenance requirements in the facility's Operation and Maintenance Manual.

Table 6 Inspection Schedule to Determine and Perform Maintenance

Type of Treatment Facility	Additional Inspection	Annual Inspection
Extended Detention Dry Pond	As needed	Required
Bioretention Pond	As needed	Required
Biofiltration Swale	As needed	Required
Filter Strip	As needed	Required
Bioslopes	As needed	Required
Proprietary Structures	See manufacturer's literature	See manufacturer's literature

Table 7 Maintenance Requirements for Stormwater Ponds

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	Trash and debris has accumulated in the pond.	Trash and debris are removed from site.
	Contaminants and pollution	Oil, gasoline, contaminants, or other pollutants are evident following any hazmat spill event. (Additional information is provided in the waste material handling section of the operation and maintenance manual).	No contaminants or pollutants are present.
	Rodent holes	For facilities acting as a dam or berm: rodent holes are evident or there is evidence of water piping through dam or berm via rodent holes.	Rodents are removed from site.
	Beaver dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate regulatory agencies).
	Insects	Insects such as wasps and hornets interfere with maintenance activities.	Insects are removed from site.
	Vegetation growth	Excessive growth does not allow maintenance access, interferes with maintenance activity, or weeds are out of control.	Side slopes are mowed so that vegetation growth does not hinder maintenance activities. Noxious weeds are removed following state or local policies. Herbicides should not be used to control vegetation.
	Tree growth and hazard trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove. Dead, diseased, or dying trees are observed. (Use a certified arborist to determine health of tree or removal requirements).	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard trees.
	Conveyance piping	Conveyance piping is clogged with sediment or debris material.	Conveyance piping are not clogged or blocked.
	Sediment accumulation in pond bottom,	Sediment accumulations exceed the depth of 12 inches.	Sediment is removed.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	manhole, catch basin or other structure		
	Erosion	Pond side slopes or bottom show evidence of erosion in excess of 4 inches and the potential for continued erosion is evident.	Slopes are stabilized using proper erosion control measures and repair methods.
	Bioretention mix failure	Ponding for (7) consecutive days or longer from May through October. Contact a Region Hydraulics Engineer to evaluate condition of bioretention pond.	The bioretention mix is excavated and replaced with new mix that meets design standard.
Pond berms	Settlement	Any part of the pond dike/berm has settled 4 inches or lower than the design elevation.	Berm is repaired to design standards.
	Piping	Water flow is apparent through pond berm. Ongoing erosion is observed, with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping is eliminated. Erosion potential is resolved.
Split flow Manhole, Outlet Control Structure, and Auxiliary Outlet	Orifice assembly/Riser pipe damage or missing	Assembly is not working properly due to not securely attached, bent or other apparent damage.	Assembly is repaired or replaced to design standards.
	Obstruction	Trash, debris, sediment, or vegetation is clogging the assembly.	Assembly is free of all obstructions and design function is restored.
	Auxiliary outlet spillway lining insufficient	Minimal layer of spillway rip rap exists or native soil is exposed.	Rip rap depth is restored to design standards
Outfall	Bank armoring insufficient	Minimal layer of rip rap exists or native soil is exposed.	Rip rap depth is restored to design standards

Modified from reference 19.

Table 8 Maintenance Requirements for Biofiltration Swales

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation along bottom of swale	Sediment depth exceeds 2 inches.	Sediment deposits removed along bottom of swale. Swale slope and geometry restored to design standards. Areas with minimal grass cover reseeded. There should be no areas of standing water once inflow has ceased.
	Ponding water	Ponding water in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages; improve grade from head to foot of swale; or add an under drain
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed through entire swale width.	Spreader is re-leveled and cleaned to restore sheet flow conditions along the swale.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches occur in more than 10 percent of the swale bottom.	Poor grass growth is corrected and bare areas reseeded.
	Vegetation growth	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Vegetation is mowed and nuisance vegetation removed so that flow is not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings. Noxious weeds are removed following state or local policies. Herbicides should not be used to control vegetation.
	Excessive shading	Grass growth is poor because the lack of sunlight.	Overhanging limbs are trimmed. Brushy vegetation on adjacent slopes is removed.
	Inlet/outlet conveyance piping and structures	Inlet/outlet areas are clogged with sediment and/or debris.	Material removed so there is no clogging or blockage in the inlet and outlet area.
	Trash and debris	Trash and debris have accumulated in the swale.	Trash and debris removed from swale.
	Erosion	Swale bottom has eroded due to flow channelization or high flows.	Bare areas are regarded and reseeded.

Modified from reference 19.

Table 9 Maintenance Requirements for Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation along filter strip	Sediment depth exceeds 2 inches.	Sediment deposits removed, uneven areas are regarded and bare areas are reseeded.
	Vegetation growth	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Vegetation is mowed and nuisance vegetation removed so that flow is not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings. Noxious weeds are removed following state or local policies. Herbicides should not be used to control vegetation.
	Excessive shading	Grass growth is poor because the lack of sunlight.	Overhanging limbs are trimmed. Brushy vegetation on adjacent slopes is removed.
	Trash and debris	Trash and debris have accumulated on the vegetated filter strip.	Trash and debris removed along filter strip.
	Erosion	Areas have eroded or scoured due to flow channelization or high flows.	Bare areas are re-garded and reseeded.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Spreader is re-leveled and cleaned so that flows are spread evenly over entire filter width.

Modified from reference 19.

Table 10 Maintenance Requirements for Bioslopes

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation	Sediment depth exceeds 2 inches	Sediment deposits removed, uneven areas are regarded and bare areas are reseeded.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the vegetated filter strip surface area.	Poor grass growth is corrected and bare areas reseeded.
	Vegetation growth	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Vegetation is mowed and nuisance vegetation removed so that flow is not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings. Noxious weeds are removed following state or local policies. Herbicides should not be used to control vegetation.
	Ecology mix failure	Low and medium flows are seen bypassing the bioslope. Contact a Region Hydraulics Engineer to evaluate condition of bioslope.	The ecology mix is excavated and replaced with new mix that meets design standard.
	Excessive shading	Grass growth is poor because the lack of sunlight.	Overhanging limbs are trimmed. Brushy vegetation on adjacent slopes is removed.
	Trash and debris	Trash and debris have accumulated along the bioslope.	Trash and debris removed from the bioslope.

Modified from reference 19.