CITY OF SHORELINE

Boeing Creek
Basin Plan

March 2013

Wind Ward environmental LLC

OSBORN CONSULTING INCORPORATED

THE WATERSHED COMPANY

Table of Contents

Tables

Figures

Acronyms

ADS®	Advanced Drainage System
BFE	base flood elevation
B-IBI	Benthic Indices of Biotic Integrity
Bravo	Bravo Environmental
CCTV	closed-circuit television
cfs	cubic feet per second
CIP	capital improvement project
CIPP	cured-in-place pipe
City	City of Shoreline
CMP	corrugated metal pipe
CPP	corrugated plastic pipe
CWA	Clean Water Act
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
ESA	Endangered Species Act
FC	fecal coliform
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	geographic information system
GMA	Growth Management Act
gpm	gallons per minute
HDPE	high-density polyethylene
HSPF	Hydrological Simulation Program – FORTRAN
IDDE	Illicit Discharge Detection and Elimination
LDW	large woody debris
LID	low-impact development
LOMA	letter of map amendment

LOMR	letter of map revision
MPRI	Maintenance Pipe Ratings Index
NASSCO	National Association of Sewer Service Companies
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant discharge Elimination System
OPRI	Overall Pipe Ratings Index
PCHB	Pollution Control Hearing Board
ROW	right-of-way
RPO	regional project officer
SAIC	Science Applications International Corporation
SEPA	State Environmental Policy Act
SPRI	Structural Pipe Ratings Index
SWMM	stormwater management model
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
Windward	Windward Environmental LLC
WQC	water quality criteria
WQI	water quality index
WRIA	water resource inventory area

Executive Summary

The Boeing Creek basin (Figure ES-1) has experienced ongoing surface water problems, including major erosion issues in Boeing Creek, since the 1970s. The purpose of this basin plan is to present a current, comprehensive representation of the natural and built infrastructure in the basin so that the City of Shoreline (City) can manage existing issues and minimize future problems using its stormwater management resources. The City's specific goals and objectives include:

1. A condition assessment video of all stormwater pipes more than 12 in. in diameter to evaluate maintenance, repair, and replacement needs in the basin.
2. A prioritized list of structural and programmatic strategies, including a repair and replacement schedule, to solve surface water and infrastructure problems in the basin (e.g., water quality, flooding, and habitat).

To develop this basin plan, the Windward Environmental LLC (Windward) team (including Osborn Consulting Inc. and The Watershed Company):

- Used existing information and documents for historical context and reference
- Field verified conditions in both the natural landscape and piped infrastructure
- Worked with the City and public to develop workable management strategies and feasible projects for managing stormwater in the Boeing Creek basin

The specific natural and built characteristics of the Boeing Creek basin, along with associated issues and potential solutions, are shown in Figure ES-2.

The primary stormwater-related issues in the Boeing Creek basin include:

- Lack of dispersed stormwater management facilities throughout the basin to mitigate runoff from developed areas
- Erosion in the Boeing Creek channel and adjacent hillslopes, and subsequent sedimentation in Hidden Lake
- Piped infrastructure in need of maintenance, repair, or replacement
- Poor water quality due to the presence of fecal coliform (FC) bacteria and nutrients

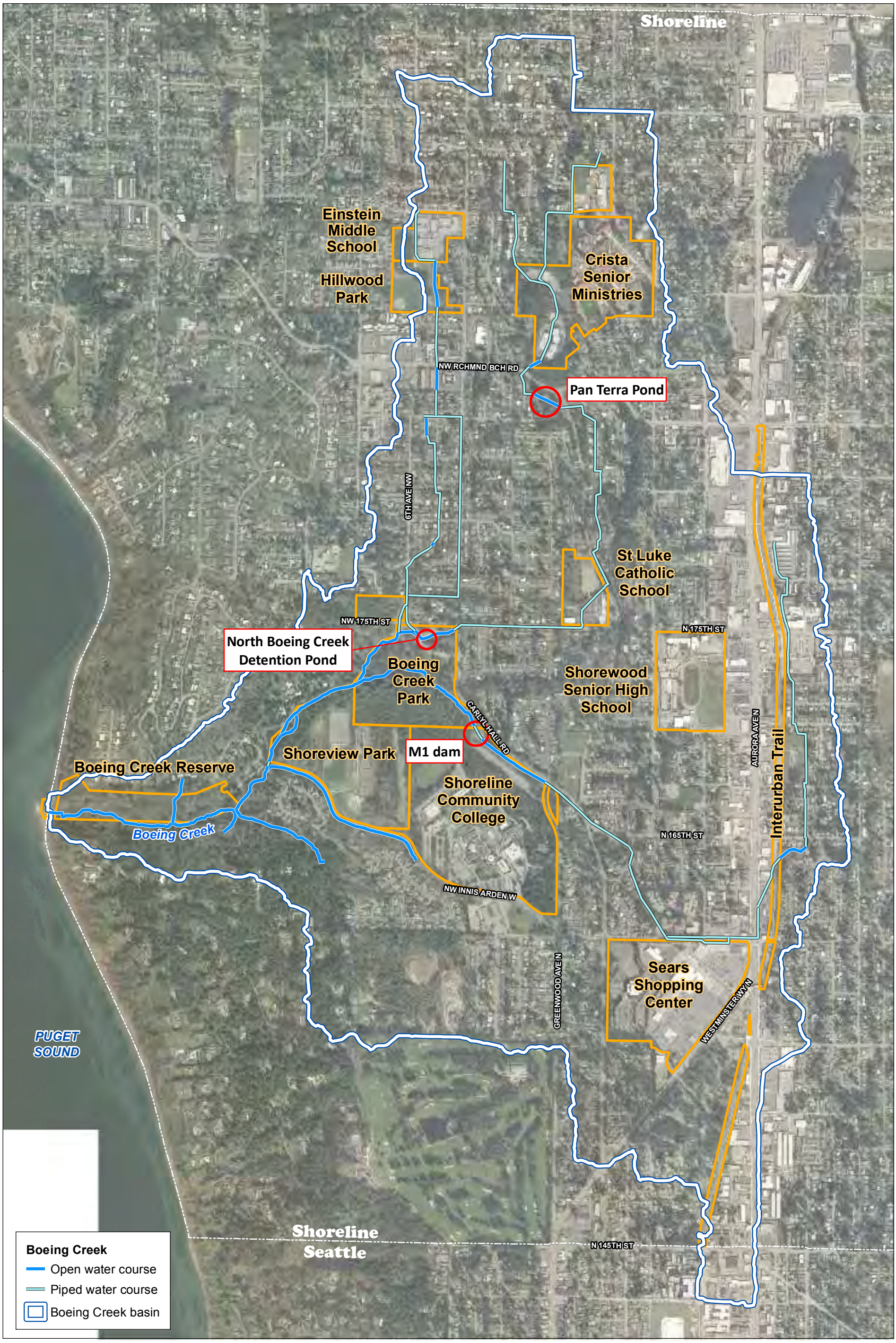
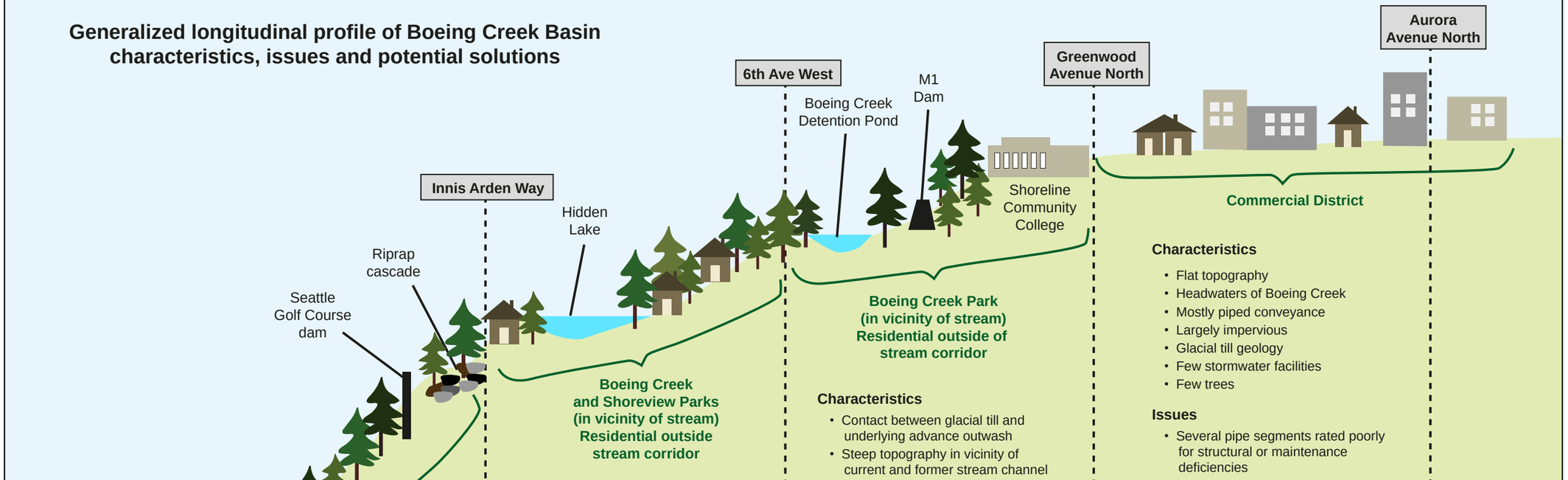


Figure ES-1. Boeing Creek basin

Prepared by craigh, 12/28/2012, W:\Projects\City of Shoreline Basin Plan\Data\GISMaps_and_Analysis\Boeing Crk Basin Plan\Fig ES-1 5140 Boeing Creek basin.mxd

Generalized longitudinal profile of Boeing Creek Basin characteristics, issues and potential solutions



Innis Arden Boeing Reserve and Highlands (forested ravine)

Characteristics

- Contact between advance glacial outwash and underlying transitional beds (clay deposits)
- Seepage at geologic contact
- Local landslides/slumps
- Sediment deposition zone in lower reaches (low gradient)
- Wide forested riparian area

Issues

- Blocked fish passage above dam and rip-rap cascade
- Pools filled with sediment
- Stormwater discharges onto erosive slopes

Potential Solutions

- Tightline discharges to stream channel
- Remove dam (determine use)

Boeing Creek and Shoreview Parks (in vicinity of stream) Residential outside stream corridor

Characteristics

- Glacial advance outwash geology
- Sediment deposition zone in Hidden Lake
- Local landslides along valley walls
- Forested in stream vicinity

Issues

- Maintenance dredging at Hidden Lake
- Blocked fish passage under Innis Arden Way and Hidden Lake dam and weirs in park

Potential Solutions

- Restoration of Boeing Creek and Hidden Lake to minimize maintenance and improve fish passage for resident fish

Boeing Creek Park (in vicinity of stream) Residential outside of stream corridor

Characteristics

- Contact between glacial till and underlying advance outwash
- Steep topography in vicinity of current and former stream channel
- Piped conveyance outfalls to open streams
- M1 dam, Boeing Creek Detention pond and Pan Terra pond stormwater facilities
- Forested in stream vicinity

Issues

- In-stream fish barriers (weirs)
- Localized erosion on hillslopes and trails
- Lack of stormwater quality treatment (fair water quality conditions)

Potential Solutions

- Restoration of trail and stream within park
- Public education and outreach for water quality issues in upstream neighborhoods

Commercial District

Characteristics

- Flat topography
- Headwaters of Boeing Creek
- Mostly piped conveyance
- Largely impervious
- Glacial till geology
- Few stormwater facilities
- Few trees

Issues

- Several pipe segments rated poorly for structural or maintenance deficiencies
- Localized flooding (many, if not all flooding issues have been resolved)
- Clogged catch basins and ditches
- Large areas of untreated flow (water quantity and quality)

Potential Solutions

- Retrofit large impervious areas as commercial areas get redeveloped
- Stream restoration/pipe daylighting opportunities, where appropriate (Hillwood Park, Interurban Trail)

Not to Scale

Wind Ward environmental LLC

Figure ES-2. Schematic of Boeing Creek basin characteristics, issues, and potential solutions

The existing stormwater-related issues are mostly related to urbanization that occurred following major development of the Aurora Avenue corridor. Many efforts have been implemented over the years to alleviate erosion in Boeing Creek, including large in-stream detention facilities. Whereas these efforts have likely resulted in attenuation of large flows, much of the basin still remains without flow control and water quality facilities. There are great opportunities for stormwater retrofit projects, particularly in consideration of the redevelopment of large private parcels such as Crista Ministries, Shoreline Community College, and the Sears Shopping Center. In addition to stormwater retrofit opportunities, the pipe condition assessment conducted as part of this basin plan identified many stormwater pipes in need of repair or replacement.

The full list of recommended projects and strategies is provided in Section 6. Table ES-1 lists the criteria and scoring used to prioritize projects.

Table ES-1. Criteria and scoring for project prioritization

Criteria	Rank Scores		
	High (5 Points)	Medium (3 Points)	Low (1 Point)
Likelihood of success	proven in other cases	mixed results	unproven
Number of issues addressed (water quality, habitat, erosion, flooding)	three	two	one
Protects infrastructure and public safety	both	one or the other	none
On public property	in ROW or existing easement	requires easement on other public property	private property
Cost	low (< $20,000)	medium ($20,000 to $50,000)	high (> $50,000)

ROW – right-of-way

The combined scores of individual criteria, ranked according to total points, are as follows:

- Low priority (13 points or fewer)
- Medium priority (13 to 18 points)
- High priority (19 points or more)

Out of 26 projects, 10 rank as high priority based on the above criteria, and an additional 5 projects rank on the high end of medium priority. These 15 projects are listed in Tables ES-2 and ES-3. The total estimated cost to implement the high-priority projects is approximately $1.6million. The estimated cost to implement the higher ranked medium-priority projects is approximately $908,000 (Table ES-3). The locations of the recommended projects are shown in Figure ES-3.

Table ES-2. Summary list of highest priority projects and estimated costs

Issue	Project Name	Type	Total Score and Priority	Estimated Cost
Conveyance pipe maintenance and structural deficiencies	(BC-CIP-3) remove utility crossings BY OTHERS		HIGH (21)	$8,000
	(BC-Main-2) pipe repairs to be handled by City operations and maintenance staff		HIGH (21)	$40,000
	(BC-CIP-1) open cut pipe replacement and modification of drainage structures		HIGH (19)	$508,000
	(BC-Mon-2) monitor pipes not recommended for immediate replacement		HIGH (19)	$15,750 every other year
	(BC-Main-1) pipe maintenance needed that was not accomplished during condition assessment		HIGH (19)	$118,000
	(BC-CIP-2) trenchless pipe repair		HIGH (19)	$447,000
Flooding	(BC-CIP-4) stormwater upgrades between Linden Avenue and Dayton		HIGH (19)	$386,380

Issue	Project Name	Type	Total Score and Priority	Estimated Cost
General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	(BC-Mon-4) monitor the functionality of deep stormwater injection wells at Shorewood Senior High School as a case study for similar stormwater management strategies in other parts of the basin and City.		HIGH (21)	$2,000 annually
	(BC-Ed-4) develop materials and tools to educate owners of large properties in the basin about stormwater retrofit opportunities. (Locations shown on map).		HIGH (21)	$15,000
	(BC-Study-1) conduct a study to evaluate the potential for City-owned and -operated regional facilities that assess capital facilities charges to redeveloping properties.		HIGH (21)	$50,000

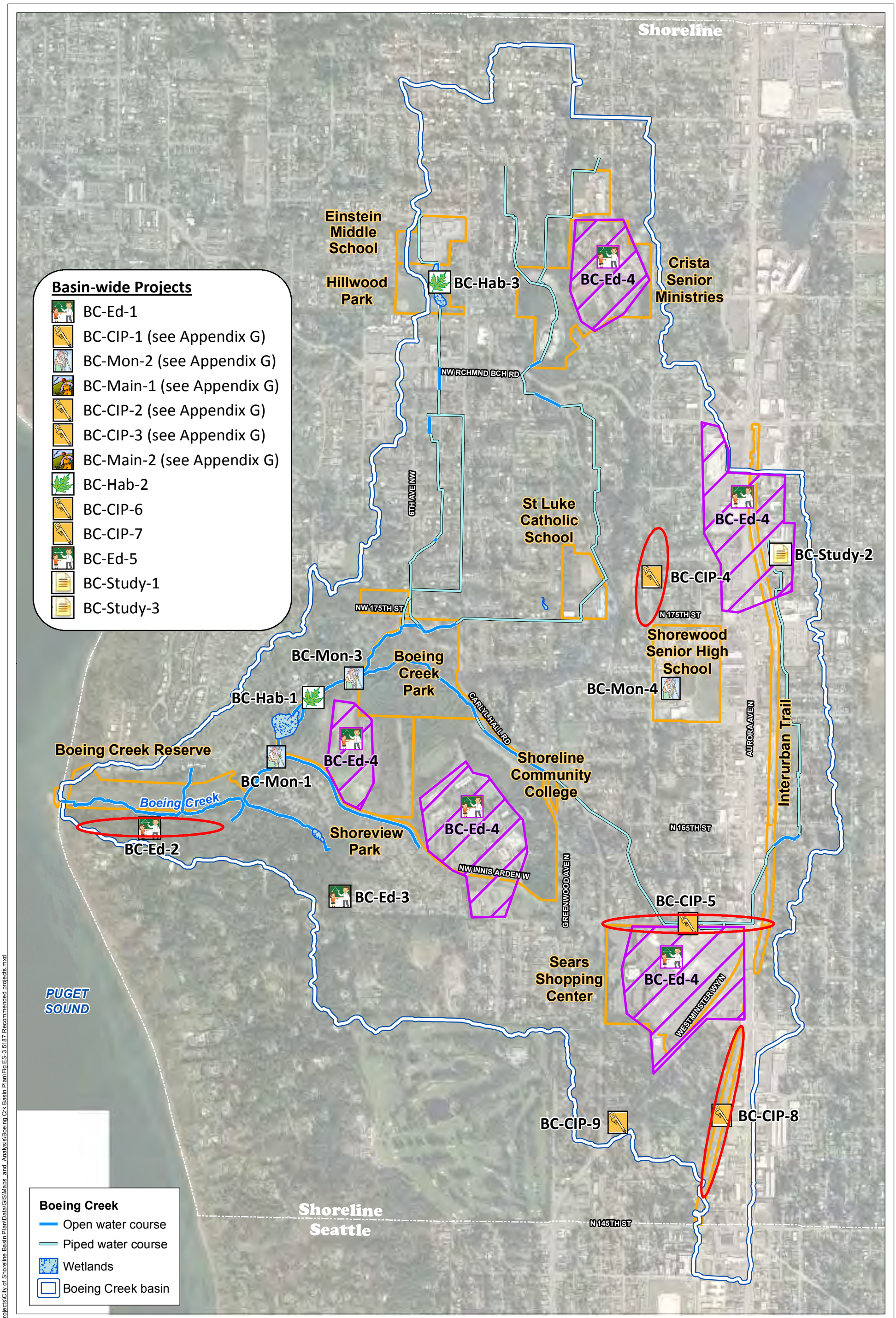
City – City of Shoreline

Table ES-3. Summary list of highest-ranked medium priority projects and estimated costs

Issue	Project Name	Type	Total Score and Priority	Estimated Cost
Habitat and fish passage	(BC-Hab-1) develop feasibility study to determine the best course of action for long-term maintenance and restoration of Hidden Lake and Boeing Creek within Boeing Creek and Shoreview Parks.		MEDIUM (17)	$100,000
	(BC-Mon-3) partner with Shoreline Community College to continue conducting geomorphic cross section monitoring in Boeing Creek.		MEDIUM (17)	$2,200 annually

Issue	Project Name	Type	Total Score and Priority	Estimated Cost
General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	(BC-CIP-8) City light interurban trail bio-infiltration swales		MEDIUM (17)	$745,416
	(BC-Ed-5) facilitate a focus group with owners of large properties in the basin to discuss stormwater retrofit options for their redevelopment projects.		MEDIUM (17)	$20,000
	(BC-Study-2) develop an infrastructure plan for Shoreline Town Center that incorporates goals of the adopted Subarea Plan (City of Shoreline 2011d) and sets forth implementation and financing options.		MEDIUM (17)	$40,000

City – City of Shoreline



Wind Ward LLC environmental

Figure ES-3. Locations of recommended projects

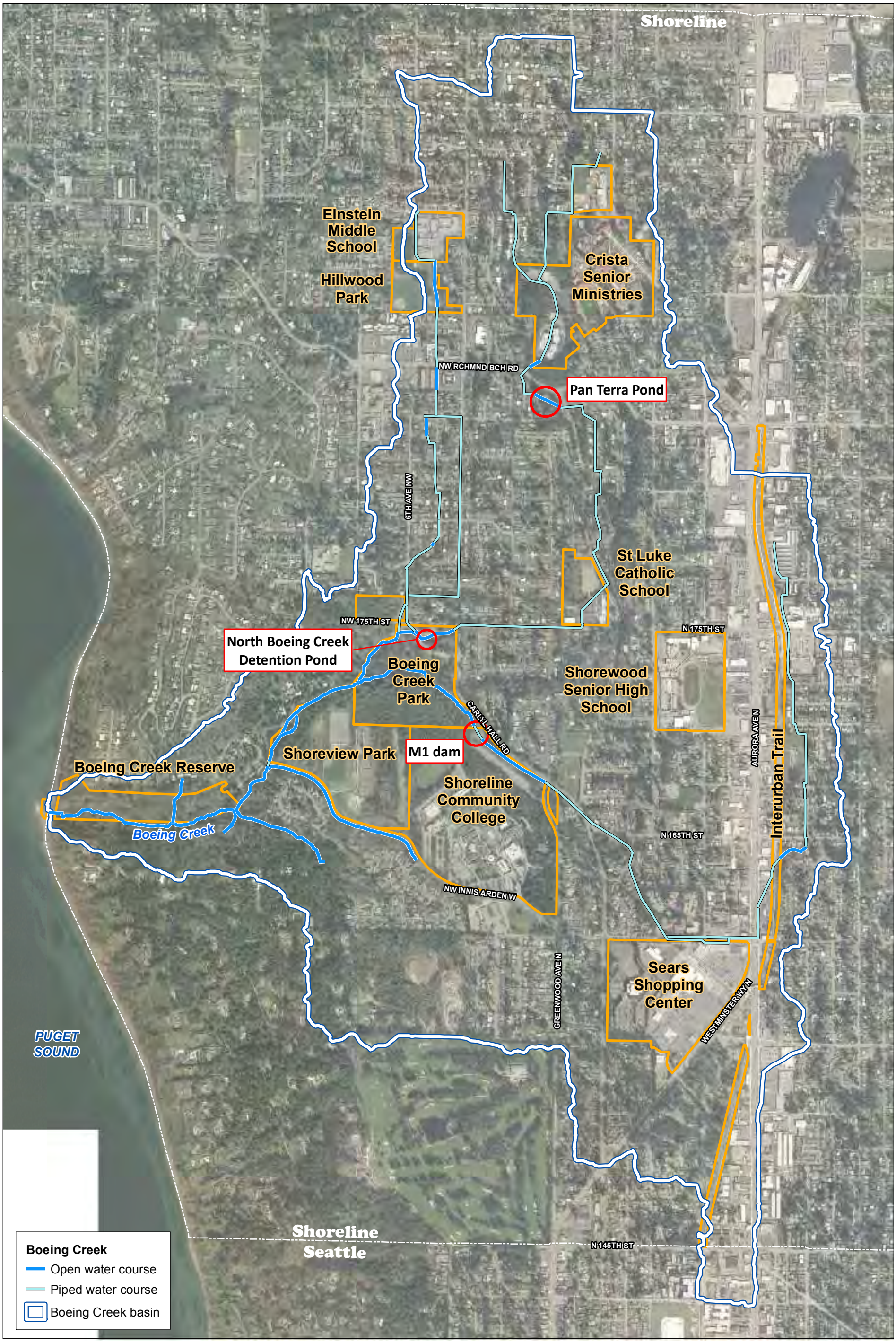
Prepared by craigh, 12/28/2012: W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig ES-3 5187 Recommended projects.mxd

1 Introduction

The Boeing Creek basin (Figure 1) is the largest drainage basin entirely within the City of Shoreline (City), spanning the commercial center on Aurora Avenue North and including the forested Boeing Creek Park and Reserve. The majority of Boeing Creek is contained within a forested ravine that has fairly good riparian conditions, especially compared to other urban stream corridors in the Seattle metropolitan area. Nonetheless, development along the Aurora Avenue Corridor in the 1960s and 1970s and subsequent years has contributed to major erosion and flooding issues in Boeing Creek. In 1983, these problems resulted in the installation of a large dam (M1 dam) to control flow to the stream corridor; another large stormwater management facility (North Boeing Creek detention pond) was installed in 1992 and, following a slope failure associated with a broken stormwater pipe and large precipitation event, reconstructed first in 1997 and again in 2008 as part of the Boeing Park Improvement project. Other stormwater-related issues, including deteriorating conveyance infrastructure and less than optimal aquatic habitat and water quality conditions, are concerns in the Boeing Creek basin. The purpose of this basin plan is to present a comprehensive representation of the natural and built infrastructure in the basin so that the City can direct its stormwater management resources to manage existing issues and minimize future problems. The City's specific goals and objectives include completion of the following:

1. A condition assessment video of all stormwater pipes more than 12 in. in diameter to evaluate maintenance, repair, and replacement needs in the basin.
2. A prioritized list of structural and programmatic strategies, including a repair and replacement schedule to solve surface water and infrastructure problems in the basin (e.g., water quality, flooding, and habitat).

To develop this basin plan, the Windward Environmental LLC (Windward) team (including Osborn Consulting Inc. and The Watershed Company) used existing information and documents for historical context and reference, field verified conditions in both the natural landscape and piped infrastructure, and worked with the City and public to develop workable management strategies and feasible projects for managing stormwater in the Boeing Creek basin.



Prepared by craigh, 12/27/2012; W:\Projects\City of Shoreline Basin Plan\Data\GISMaps_and_Analysis\Boeing Crk Basin Plan\Fig 01 5140 Boeing Creek basin.mxd

Wind Ward LLC environmental

N

0 250 500 Yards

0 200 400 Meters

Figure 1. Boeing Creek basin

2 Previous Studies

A number of studies, both City wide and Boeing Creek basin specific, were reviewed prior to evaluation and analysis of issues and potential solutions in the Boeing Creek basin. These studies, including source, date, and relevance to Boeing Creek basin, are listed in Table 1. Specific findings are discussed in the sections that follow.

Table 1. Reference material used in this basin plan

Reference	Author(s)	Date	Relevance
GIS coverages	City	unknown	GIS coverages were used in many of the analyses described in Section 4.
Service requests	City	2000 – 2011	Stormwater-related calls; information is summarized in Section 3.6.2 and Appendix B.
Geomap Northwest Documents	various authors	various dates	Site-specific geologic information is summarized in Section 3.3 and Figures 4 and 5.
Ecology-recorded water rights website	Ecology (2012)	various dates	Site-specific water rights information is summarized in Section 3.5.2 and Table 6.
City of Shoreline stream and wetland inventory and assessment: Appendices	Tetra Tech/KCM Inc. (2004a)	2004	Relevant information is presented in Section 3.
City of Shoreline Boeing Creek Basin Characterization Report	Tetra Tech/KCM Inc. (2004a)	2004	Relevant information is presented in Section 4.
City of Shoreline comprehensive plan	City (2011c)	2004	Relevant information is presented in Section 5.
North Boeing Creek Improvement Projects Final Design Report	Otak (2008)	2008	Relevant information is presented in Section 3.6.
2007 Bioassessment report: biological and habitat assessment of Shoreline streams	The Watershed Company (2009)	2009	Information from this report, including data from macroinvertebrate sampling, was used in the water quality analysis in Section 4.8.
2009 freshwater assessment report: state of the water quality in Shoreline streams, lakes and wetlands	City – Jessica Williams (2010)	2010	Information from this report, including water quality monitoring data, was used in the water quality analysis in Section 4.8.
Shoreline inventory and characterization	ESA Adolfson (2010)	2010	Information on shoreline functions, characteristics, and opportunities are discussed in Section 3.

Reference	Author(s)	Date	Relevance
Surface water master plan update, City of Shoreline	SAIC and SvR Design (2011)	2011	Relevant recommended projects are discussed in Section 5.
2011–2017 parks, recreation and open space plan	City (2011a)	2011	There are several public and private parks located in Boeing Creek basin, including Innis Arden's Boeing Reserve, Shoreview Park, Boeing Creek Park, and Hillwood Park.
2011 transportation master plan	City (2011b)	2011	Recommended transportation improvements include re-channelization on North 160th, sidewalk projects, and major roadway preservation projects.
2011 Town Center Subarea Plan	City (2011d)	2011	Relevant goals and policies related to stormwater runoff in City's planned Town Center.
Shoreline Community College master development plan	Shoreline Community College (2011)	2011	Relevant stormwater management related to the college's overall master development plans.
Underground injection control well plan- Shorewood Senior High School	Bassetti Architects	2011	Location of deep infiltration wells and design plans.
Greenworks Prioritization Criteria Matrix	SvR Design (2012)	2012	Recommended low-impact development projects in Boeing Creek basin.

City – City of Shoreline
Ecology – Washington State Department of Ecology
GIS – geographic information system
SAIC – Science Applications International Corporation

3 Basin Characteristics

There are certain characteristics of individual drainage basins that influence the flow, pathways, and pollutants of surface water and stormwater which, in turn, can affect the natural and built environments in positive and negative ways. The characteristics of the Boeing Creek basin in the context of surface water and stormwater flow are discussed in this section.

3.1 BUILT LANDSCAPE

The Boeing Creek basin is approximately 1,740 acres in size. Land use is predominantly low-density residential (~ 47 %), with a high-density commercial corridor along Aurora Avenue North (Figure 2). Table 2 lists the percentage of the basin that falls within each type of zoning. The currently "underdeveloped" areas with the potential for additional residential development through short-platting or subdivision are listed in Table 2. The underdeveloped parcels were determined by comparing the numbers of existing to potential dwelling units per acre for the low-density (R-4, R-6, and R-8) zoning classes. For instance, if an individual parcel is currently zoned R-4 (i.e., four units per acre), but is effectively R-1 (i.e., one unit per acre), that parcel would be considered underdeveloped. It would be possible, by subdividing the lot, to build three additional homes on that property. High-density residential and commercial properties were not considered in this analysis, as there are frequently multiple tax parcels that make up apartment complexes and higher-density residential settings, and it was assumed that commercially zoned properties are already developed to their full potential.

How does the built landscape affect stormwater runoff?

The type and density of development affect the quantity of hard surfaces present to create runoff, as well as the types of pollutants that could be transported from different surface types.

Currently, the basin is approximately 67% impervious surfaces (i.e., City and private roads, houses, and parking lots). Approximately 88 acres of undeveloped open space is present in the basin, including:

- Boeing Creek Park (owned by the City) ~ 36 acres
- Boeing Reserve (owned by Innis Arden) ~ 20 acres
- Boeing Creek Open Space (owned by the City) ~ 4.4 acres
- The Highlands Open Space adjacent to lower Boeing Creek (owned by the Highlands) ~28 acres

Additionally, there are other small to large parks and institutional campuses in the Boeing Creek basin that have some open space. They are:

- Shoreview Park (owned by the City) ~ 47 acres

- A portion of Hillwood Park (owned by the City) ~ 5 of a total of 10 acres
- Interurban Trail (owned by Seattle City Light, and maintained by the City) ~ 21.2 acres
- Park at Town Center (owned by the City and Seattle City Light) ~ 6.7 acres
- Richmond Highlands Park (owned by the City) ~ 4.2 acres
- Crista Senior Ministries ~ 48.5 acres
- Shoreline Community College ~ 78.5 acres
- Shorewood Senior High School ~ 23 acres
- St. Luke's Catholic School ~ 11 acres
- Einstein Middle School ~ 10 acres
- Highland Terrace Elementary School ~ 9.5 acres
- Washington State Department of Transportation campus ~ 15 acres
- Herzel Memorial Park cemetery ~ 5 acres

Shoreline

Einstein Middle School

Hillwood Park

Crista Senior Ministries

NW RCHMND BCH RD

6TH AVE NW

St Luke Catholic School

NW 175TH ST

N 175TH ST

Boeing Creek Park

Shorewood Senior High School

CARYL HALL RD

AURORA AVE N

Interurban Trail

Shoreview Park

Boeing Creek Reserve

Shoreline Community College

Boeing Creek

N 165TH ST

NW INNIS ARDEN W

GREENWOOD AVE N

Sears Shopping Center

WEST MINSTER WY N

Shoreline

Seattle

N 145TH ST

Comprehensive plan

- Town center district
- Low density residential
- Medium density residential
- High density residential
- Mixed use
- Community business
- Public facilities
- Campus
- Special study area
- Private open space
- Public open space

Boeing Creek

- Open water course
- Piped water course
- Wetlands
- Tax parcel
- Boeing Creek basin

Prepared by craigh, 12/27/2012; W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 02 5142 Land use.mxd

Wind Ward environmental LLC

N

0 250 500 Yards

0 200 400 Meters

Figure 2. Comprehensive plan land use in the Boeing Creek basin

Table 2. Land use statistics within Boeing Creek Basin

Land Use Classification	Area of Basin Within Classification (acres)	% of Basin Within Classification	% of Parcels Within Classification Currently Underdeveloped	Acres of Underdeveloped Parcels
Community business	57.75	3.29	not evaluated	na
Campus/institution	134.67	7.68	not evaluated	na
High-density residential	20.82	1.19	not evaluated	na
Medium-density residential	18.77	1.07	not evaluated	na
Low-density residential (R-4, R-6 and R-8)	821.42	46.85	57	~ 474
Mixed use	43.65	2.49	not evaluated	na
Public facilities	79.10	4.51	not evaluated	na
Private open space	51.15	2.92	na	na
Public open space	99.63	5.68	na	na
Special study area	39.16	2.23	na	na
Town center district	100.42	5.73	na	na
City ROW[a]	287.6	16.4	45	129
Total	**1753**	**100**	**34**	**603**

[a] Underdeveloped ROW is the ROW that is not currently paved.

na – not applicable

ROW – right-of-way

3.1.1 Timeline of development

The Boeing Creek basin has an interesting history that was strongly influenced by Mr. Bill Boeing, founder of the Boeing Airplane Company. Figure 3 depicts the general timeline of development in the Boeing Creek basin, including a brief history of surface water issues and construction of stormwater management facilities. Mr. Boeing settled in the Highlands in 1913, using the surrounding forest as hunting grounds and Hidden Lake as a private fishing pond.

Why does the age of development matter?

Current stormwater practices were not in place when a large part of the Boeing Creek basin was constructed (prior to 1980), resulting in few stormwater treatment facilities to help manage flow control and provide water quality treatment for large areas of impervious surface.

General Timeline of Development and Surface Water-Related Issues in the Boeing Creek Basin

Years

1900s

- **Highlands** water system built (1910)

1910s

- Bill Boeing builds mansion in the **Highlands** (1913)

1920s

- **Hidden Lake** enlarged for Boeing fishing pond (1920s)

1930s

- Bill Boeing logs 400 acres north of Boeing Creek and sells to developers (later becomes **Innis Arden** neighborhood)(1930s)

1940s

1950s

1960s

- **Highlands** Sewer District formed (1968)
- **Shoreline Community College** – opened in 1964
- **Sears shopping center** developed, wetlands filled, stormwater discharged to unprotected channel at Greenwood Avenue North and North Carlyle Hall Road (1964)

1970s

- **Highlands** water system abandoned (1976)
- **Hidden Lake** dam fails (1970), Highlands Beach Drive washed out
- Bill Boeing donates and clears land south of Hidden Lake for new Shoreview high school- this area becomes **Shoreview Park** (1979) when school funding falls through

1980s

- **M1** dam constructed on mainstem of Boeing Creek (1983)
- **Crista ministries and Pan Terra** upstream regional ponds constructed (1980 -1988)

1990s

- **BNSF culvert** improved for fish passage (1995)
- **North Boeing Detention Pond** constructed (1991)
- Storm sewer system installed in **Happy Valley**, downstream of Pan Terra (1992)

1995 - Shoreline Incorporates

- **Hidden Lake** reconstructed (1996) and filled with sediment (1997) following N. 175th wash-out
- **North 175th Street washed out** (1997)—Pond reconstructed

2000s

- **Highlands** Sewer District adds stormwater services to 1/3 of customers (2005)
- **Third Avenue** drainage improvements (2006)
- **Pan Terra** pond improvement and pump station installed (2009)
- **Midvale Avenue N.** drainage (2009)
- **Darnell Park** neighborhood drainage (2009)

2010s

- **Hidden Lake** maintained through annual and bi-annual dredging (on-going)
- **North Boeing Detention Pond** improved (2010)

Highlands
Puget Sound

Innis Arden/Hidden Lake
Shoreline Community College

Uplands

General Position in Basin

Wind Ward environmental LLC

Figure 3. General timeline of development in the Boeing Creek basin

Over the years, Mr. Boeing either sold or donated large portions of his property. These properties were subsequently developed into the Innis Arden neighborhood (1950s and 1960s) and Shoreview Park (1979). Mr. Boeing also created wooded reserves, including the Boeing Reserve, effectively protecting the riparian areas adjacent to Boeing Creek. At the same time that Innis Arden was developing, Aurora Square (also known as the Sears shopping center) was being constructed; Shoreline Community College opened around 1964. The commercial area adjacent to Aurora Avenue North followed suit, and surface water runoff from these areas was contained in pipes and directed downstream to open channel portions of Boeing Creek. Although stormwater management facilities to control flow or provide water quality treatment were not required until the late 1980s and early 1990s, several large facilities were constructed during and prior to this timeframe to alleviate problems in Boeing Creek that had resulted from much earlier basin development. The first facility constructed was M1 dam, built on Boeing Creek in 1983. Additional regional ponds upstream of the Happy Valley neighborhood were constructed between 1980 and 1988 in an attempt to solve local flooding problems in that neighborhood. The North Boeing Detention Pond was first constructed in 1991, and was later reconstructed and improved in 1997 and again in 2008. Other stormwater improvements have been completed in recent years, as transportation improvement projects have been implemented along the Aurora Avenue corridor. These projects, including Midvale Avenue North and Darnell Park drainage improvements (SAIC 2011), have minimized local flooding problems.

Despite the stormwater facilities and improvements mentioned above, more than 90% of the residential properties in the Boeing Creek basin were constructed prior to current stormwater management strategies, and have not been retrofit for stormwater flow control or water quality treatment. Figure 4 shows the age of housing stock in the basin, illustrating the history of residential development.

3.1.2 Potential future development

The opportunities and potential for redevelopment, particularly commercial and institutional facilities, are significant. Shoreline Community College, Crista Ministries, and the City itself have long-range plans for redevelopment and modernization. Elements from these plans that relate to this document and could affect Boeing Creek are described below.

3.1.2.1 Shoreline Community College master development plan

Shoreline Community College was built in the 1960s and is interested in modernizing its campus and upgrading buildings and facilities (SCC 2011). Long-range development priority plans related to stormwater and opportunities for improvements include:

- Respecting the character of the existing campus by preserving tress and other significant landscape elements

- Implementing Shoreline Community College's commitment to an environmentally sustainable campus

Specifically, the master development plan describes planned stormwater improvements that include:

- A new wetpond in the greenwood parking lot. This wetpond would be used for pretreatment and water quality treatment of stormwater before the release of that water to an adjacent pond for infiltration.
- Trees and plantings in campus parking lots. These plants would be used to reduce the urban heat island effect and contribute to a stormwater management system that detains and filters surface runoff, protecting the ecosystem of the Boeing Creek drainage basin.

The master development plan describes other opportunities for stormwater improvements, such as the use of low-impact development (LID), to the extent practical, when replacing buildings and improving the drainage system. The following excerpts from the plan illustrate the potential surface water management strategies that may be incorporated into the redevelopment of Shoreline Community College:

> The landscape plan should incorporate sustainable landscape strategies, such as retention of existing vegetation to the extent practical, transplanting significant trees and plants if likely to be disturbed by new construction, reuse of materials, and use of native and drought-tolerant plants."
>
> To avoid and reduce stormwater impacts, the design of proposed parking areas will integrate LID features, such as permeable paving and bioretention, to the extent feasible on soils. Runoff will be conveyed to new treatment and infiltration ponds in Greenwood parking lot.

3.1.2.2 Crista Ministries Redevelopment

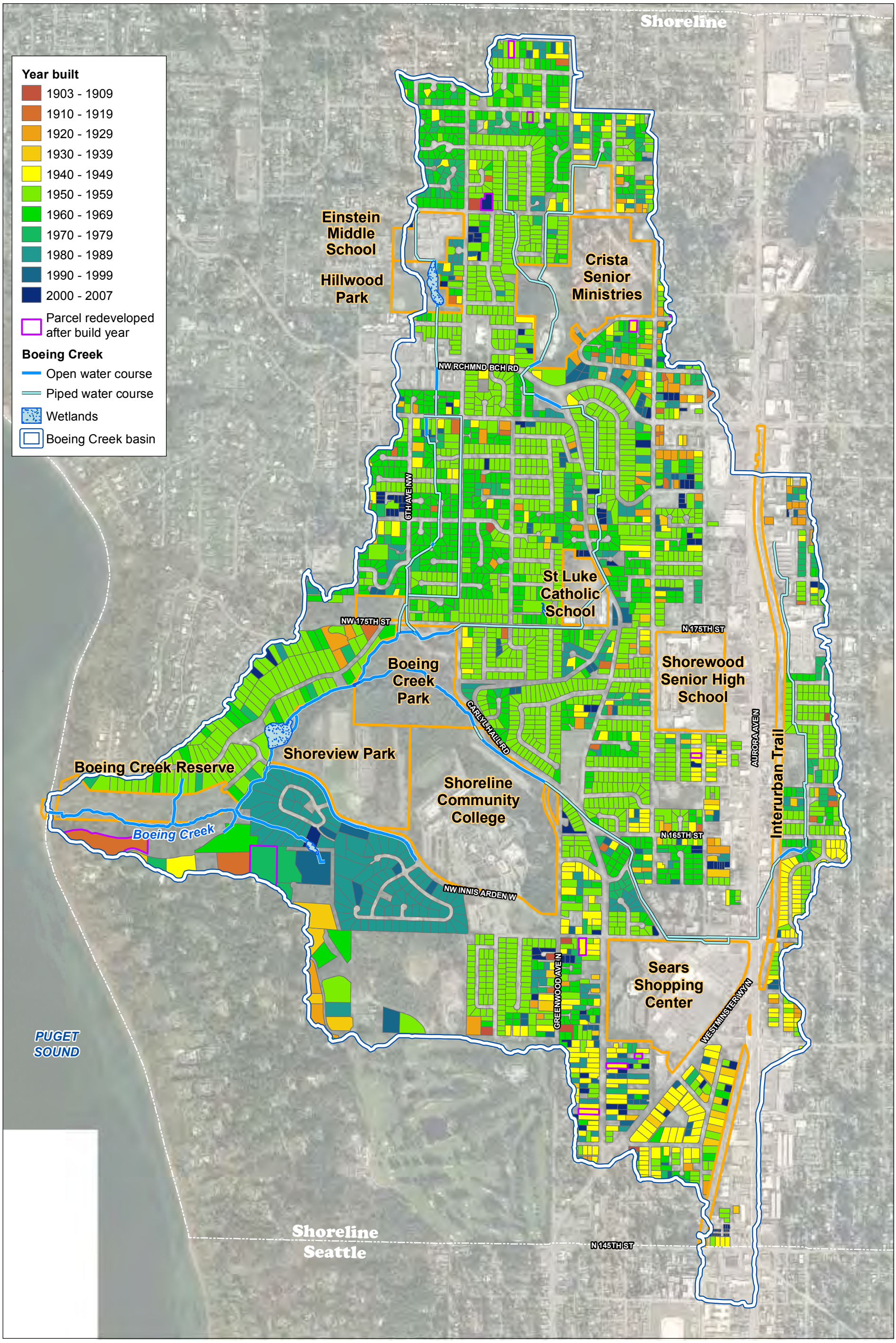
Crista Ministries also has a master development plan, which includes new residential senior living facilities and classroom buildings for King's Schools (Kilburn Architects and Triad Associates 2010). The redevelopment is planned to be phased over a 10- to 15-year period. In addition to new buildings, the plan also includes improvements to adjacent roads for pedestrians and traffic. Potential stormwater facilities are not outlined in the master development plan, but there are opportunities for stormwater improvements that would accompany the redevelopment.

3.2.1.3 Shoreline Town Center

The City's plan for a Town Center in the vicinity of City Hall is committed to successfully integrating values of environmental quality, economic vitality, and social equity to achieve a sustainable development (City of Shoreline 2011d). Specifically, the *Town Center Subarea Plan* describes how the "…Town Center's tree canopy and native vegetation are all part of a strategic system for capturing and treating stormwater on site and protecting and enhancing overall environmental quality."

The following stormwater and Boeing Creek basin-related policies are provided in the *Town Center Subarea Plan* (City of Shoreline 2011d):

- Policy TC-4: Publicize innovative "green infrastructure," including City Hall, Shorewood High School, and Aurora Boulevard, as models for private projects in Town Center.
- Policy TC-8: Enhance the sustainability of adjacent residential neighborhoods through targeted investments in green street links to Town Center, and focused programs to enhance energy conservation and carbon neutrality.
- Policy TC-18: Recognize the environmental and aesthetic value of existing stands of prominent trees and promote a green built environment.



Prepared by craigh, 12/27/2012: W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 04 5145 Age of housing stock.mxd

Wind Ward environmental LLC

N

0 250 500 Yards

0 200 400 Meters

Figure 4. Age of housing stock in the Boeing Creek basin

3.2 TOPOGRAPHY

Boeing Creek basin ranges in elevation from about 500 ft above mean sea level (near 8th Avenue Northwest on the northeastern edge of the basin) to sea level (at the mouth of Boeing Creek in Puget Sound). Figure 5 uses bare-earth shading to illustrate the topographic features of the Boeing Creek basin. The lighter shades indicate higher elevations, whereas the darker shades indicate lower elevations. As shown in Figure 5, the primary topographic feature of the basin is a southwest trending valley bisecting a much higher elevation plateau. Historically, the Boeing Creek stream flowed in an open channel in this valley from the northern end of the basin near Crista Ministries to Puget Sound. Today, the stream channel is piped to Boeing Creek Park, where the pipes coming from the north feed into the North Boeing detention pond. Similarly, a smaller, less pronounced topographic valley contains piped flow from the Sears shopping center to an open channel adjacent to Shoreline Community College and Carlyle Hall road above M1 dam. The topography and geology (discussed in Section 3.3) of Boeing Creek basin influence how surface water moves through the basin. In the upper, flatter parts of the basin, water does not easily flow off the ground surface, especially where wetlands have been filled and replaced with pavement. Surface water in these areas is generally piped or conveyed in ditches that have been deepened to facilitate positive drainage. In the steeper parts of the basin, water flows readily, and such locations are typically where erosion problems start to occur, particularly at the point where piped flow enters the stream channel system.

Einstein Middle School

Hillwood Park

Crista Senior Ministries

St Luke Catholic School

Boeing Creek Park

Shorewood Senior High School

Shoreview Park

Boeing Creek Reserve

Shoreline Community College

Boeing Creek

Interurban Trail

Sears Shopping Center

Elevation
High
Low

Boeing Creek
Open water course
Piped water course
Wetlands
Boeing Creek basin

Wind Ward LLC environmental

N

0 250 500 Yards

0 200 400 Meters

Figure 5. Topographic features indicated by bare-earth shading

Prepared by craigh, 12/27/2012; W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 05 5315 Topographic features.mxd

3.3 GEOLOGY AND GEOMORPHOLOGY

Geologic conditions in the Boeing Creek basin are typical of the Puget Sound lowlands, consisting of glacially deposited sediments. The surface geology in more than 79% of the basin is mapped as Quaternary Vashon-age glacial till (Figure 6). This till is present in the topographic high points located in the north and east parts of the basin, and is characterized by poorly drained and consolidated sand, silt, and gravel, with interspersed layers of silt. The other predominant surface geology present in this basin is Vashon-age advance outwash (~ 17%). The outwash is present in the ravines surrounding Boeing Creek and consists of very well-drained and unconsolidated sand and gravel. As the creek drops in elevation on its course to Puget Sound, pre-Vashon-age transitional bed (clay) deposits are present in the stream channel. Seeps are often present at the points of contact between overlying sandy deposits (outwash materials) and underlying clay deposits (transitional beds); such seeps are present in the Boeing Reserve (Photo 1). Figure 6 shows the general geology and locations of geologic cross sections. The general locations of the photos provided in this basin plan are shown in Figure 7.

What is the impact of geology on surface water runoff?

Geologic conditions affect how much water runs off the landscape naturally, how much is infiltrated, and how easily stream channels and hillslopes are eroded. The geologic conditions in the open channel portions of Boeing Creek are particularly susceptible to erosion, which can be exacerbated by surface water runoff.

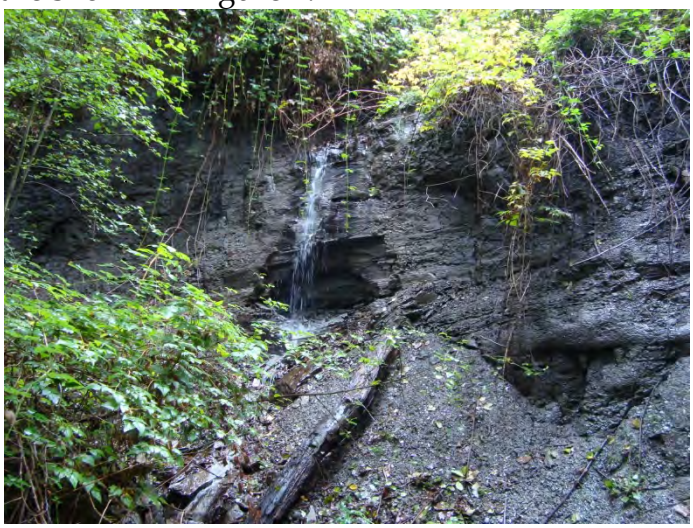
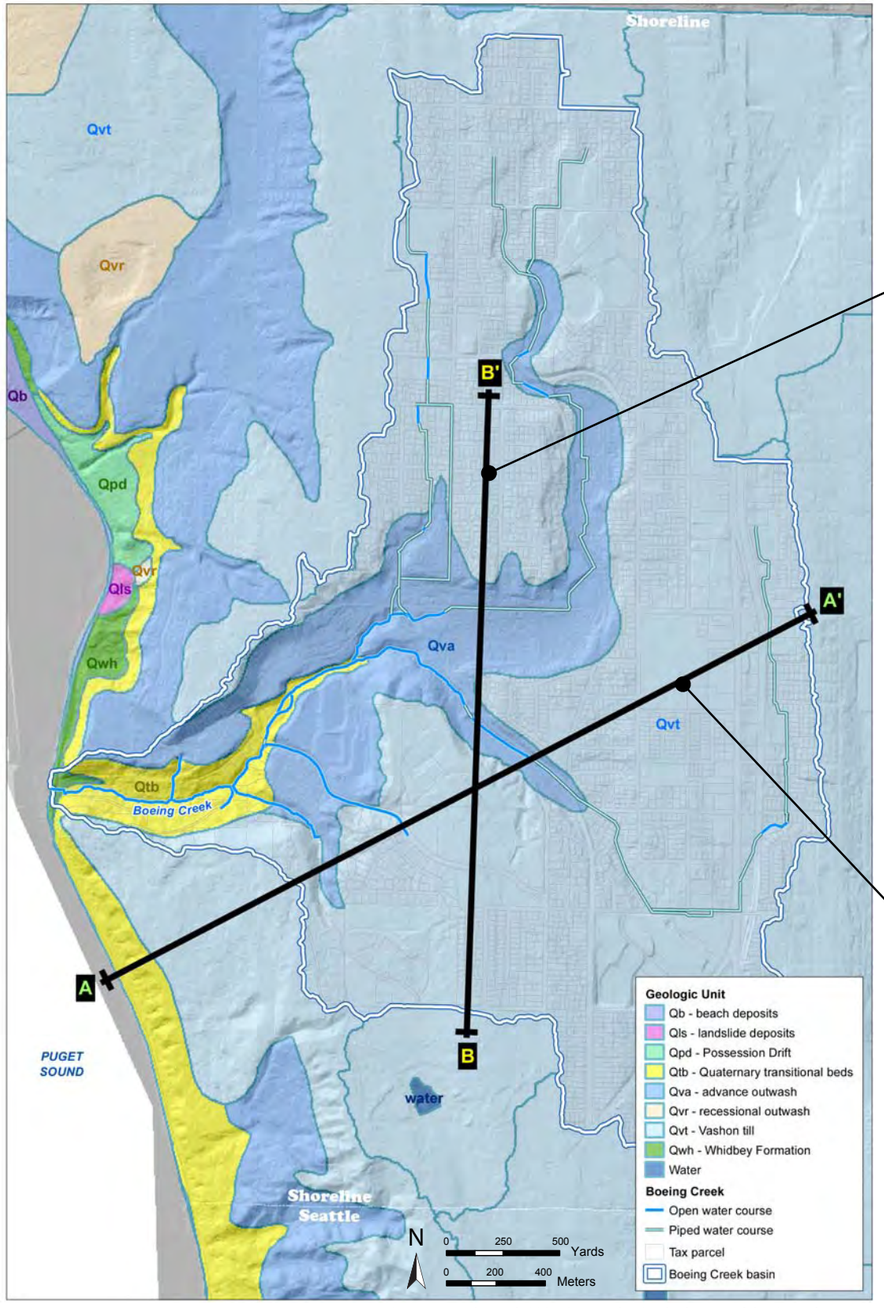
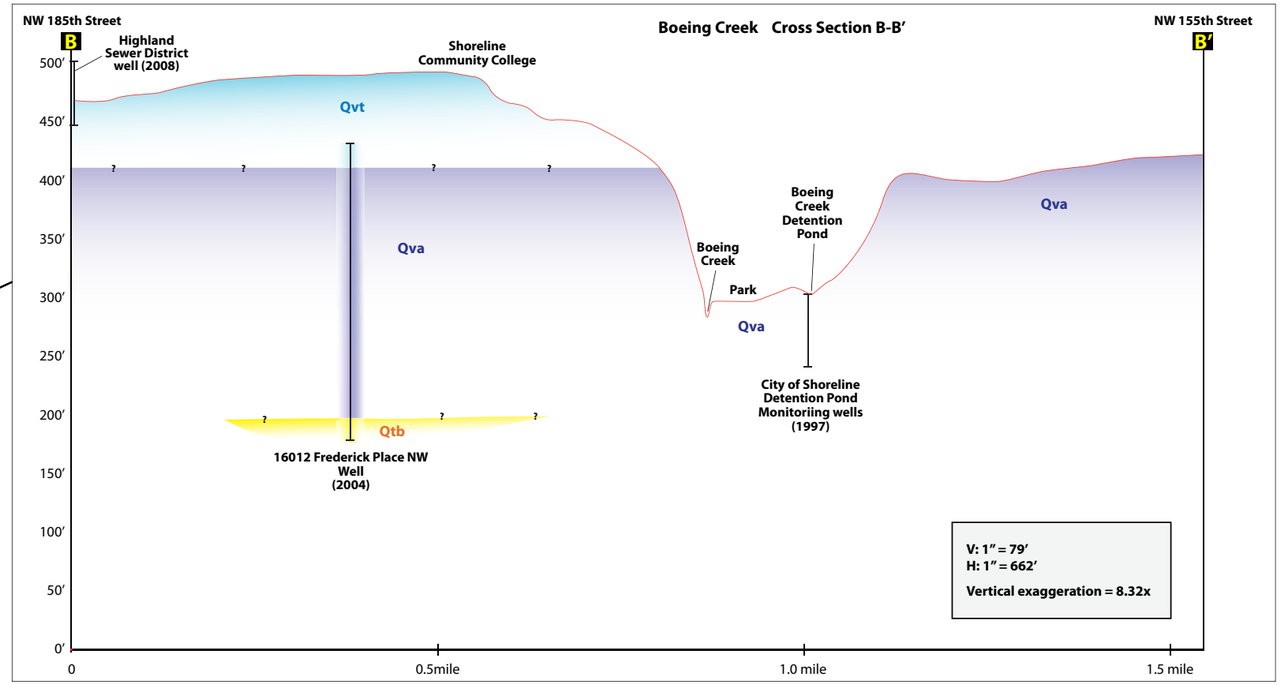
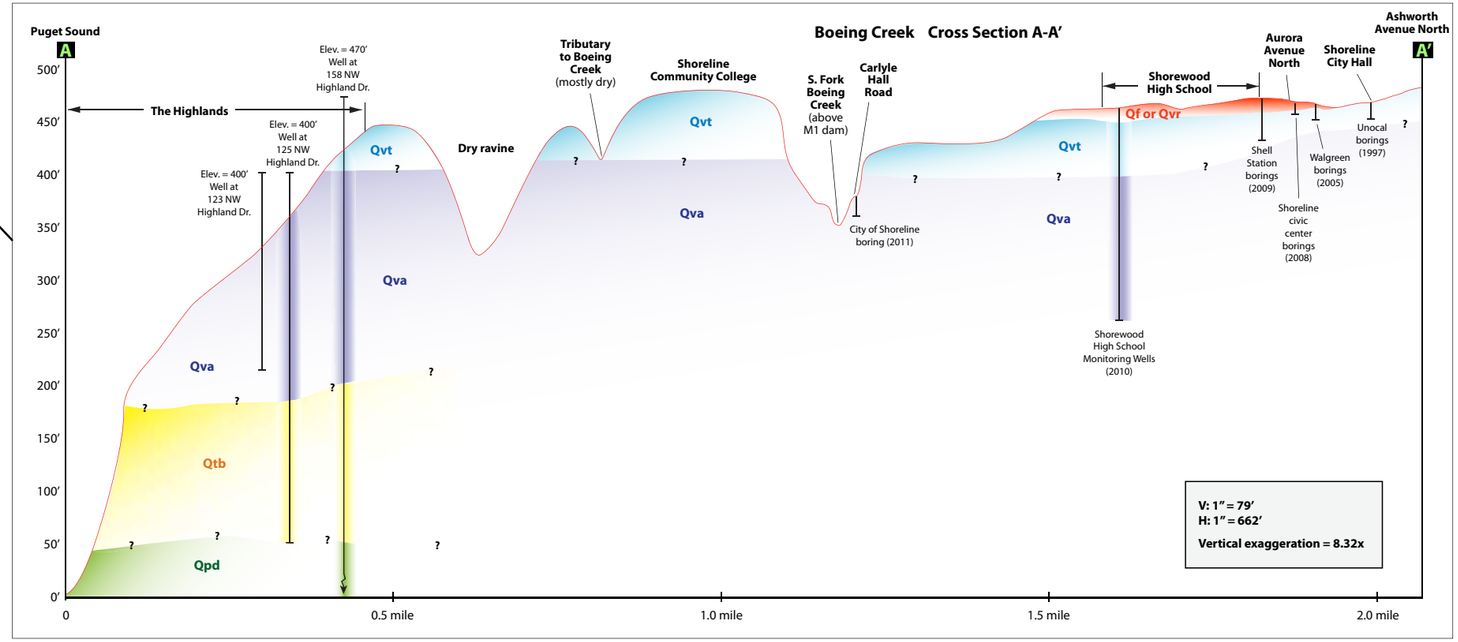


Photo 1. Example of seepage at the interface between transitional bed clay unit and overlying advance outwash



Source: Booth, et al. 2004 Composite Geologic Map of the Sno-King area.





Wind Ward environmental LLC

Figure 6. Boeing Creek geologic cross sections

Shoreline

Einstein Middle School

Hillwood Park

Crista Senior Ministries

NW RCHMND BCH RD

6TH AVE NW

St Luke Catholic School

North Fork Reach

Hidden Lake and Shoreview Park Reach

NW 175TH ST

N 175TH ST

Shorewood Senior High School

9
20
8
10
7, 18
6
Boeing Creek Park

M1 Reach

Hidden Lake

M1 dam

19

Innis Arden Reach

17
16
15
1
5, 14
13
Shoreview Park

11

CARLYL HALL RD

AURORA AVE N

Interurban Trail

Boeing Creek Reserve

South Fork Reach

12
2
4
3
Boeing Creek

Seattle Golf and County Club dam

Shoreline Community College

N 165TH ST

NW INNIS ARDEN W

Lower Reach

GREENWOOD AVE N

Sears Shopping Center

WESTMINSTER WY N

PUGET SOUND

Shoreline

Seattle

N 145TH ST

1 Approximate photo location

Boeing Creek

Open water course

Piped water course

Wetlands

Tax parcel

Boeing Creek basin

Wind Ward environmental LLC

N

0 250 500 Yards

0 200 400 Meters

Figure 7. Boeing Creek reaches and approximate locations of photos

Prepared by craigh, 12/27/2012: W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 07 5332 Reaches and photo locations.mxd

Windward reviewed geologic boring logs and test pit data available through Geomap Northwest (Booth et al. 2004) to correlate surface geologic conditions to subsurface conditions, and to get an understanding of the thicknesses of the materials mapped. The cross sections in Figure 6 show the potential thicknesses of geologic materials in the basin. This information is important in order to identify potential stormwater management options, including shallow- and deep-infiltration stormwater management alternatives.

3.3.2 Geomorphology

During field reconnaissance in October and December 2011, the Windward team walked the open channel portions of Boeing Creek and observed the geomorphic conditions of the channel and hillslopes.

Boeing Creek can be logically divided into reaches that are separated by structural modifications or natural channel variability (Figure 7). The reaches described below correspond with habitat reaches identified by Tetra Tech in the Boeing Creek Characterization Report (Tetra Tech/KCM 2004b). The reach names used by Tetra Tech are shown in parentheses.

- Lower reach (Boeing Creek Reach 1) – from the mouth of Boeing Creek to the steel-pile dam owned by the Seattle Golf and Country Club
- Innis Arden Reach (Boeing Creek Reach 2) – between the steel-pile dam and Innis Arden Way
- Hidden Lake and Shoreview Park (Boeing Creek Reach 6) – between Innis Arden Way and the confluence of the north and south forks
- North Fork (Boeing Creek Reach 7) – from the confluence to the North Boeing Creek detention pond dam
- South Fork (Boeing Creek Reach 8) – from the confluence to M1 dam
- M1 Reach (Boeing Creek Reach 9) – above M1 dam

In general, the Boeing Creek channel conditions observed during the field reconnaissance were similar to those noted by Tetra Tech, with only a few differences despite the major road embankment and berm failure adjacent to the North Boeing Creek detention pond in early 1997. This event mobilized many cubic yards of sediment and water downstream in the north fork and mainstem of Boeing Creek and into Hidden Lake. Cross sections were set up throughout the reach and monitored over a period of several months. In less than 2 years, the channel had established an equilibrium that remained relatively unchanged even with the next season's rainfall (Henshaw and Booth 2000).

3.3.2.1 Lower reach

The lower reach of Boeing Creek within Boeing Reserve is relatively low gradient and includes a depositional zone. Active erosion is occurring along the stream channel banks at the interface between clay deposits and overlying sandy outwash, contributing sand to the channel (Photo 2). Several stormwater outfall pipes were observed to discharge south of Boeing Creek onto the adjacent hillslopes. As a result, gullies have formed at the discharge points and along Beach Drive (Photo 3), and active erosion is occurring, contributing additional sediment to the channel. This reach also has an abundance of large woody debris (Photo 4) in the channel up to a steel-pile dam owned by the Seattle Golf and Country Club. Several old concrete structures, remnants of fences and log bridges, and rusted drums were observed in and adjacent to the channel. These are likely from historical activities, including timber harvest and historical water systems.

Photo 2. Example of sand deposits in lower Boeing Creek.

Photo 3. Erosion along Beach Drive in lower reach

Photo 4. Large woody debris in lower Boeing Creek.

3.3.2.2 Innis Arden reach

The Innis Arden reach begins at the Seattle Golf and Country Club steel-pile dam and extends to Innis Arden Way. It is a short reach characterized by a cascade formed by

large rock that has been added to the channel (Photo 5), likely for the purpose of stabilizing the stream channel banks and bed next to adjoining residential properties. Channel incision and weirs noted in the Tetra Tech study (Tetra Tech/KCM 2004b) were not observed during Windward's field reconnaissance. The channel behind the dam was completely filled with sediment, and it is possible that the weirs had been buried.

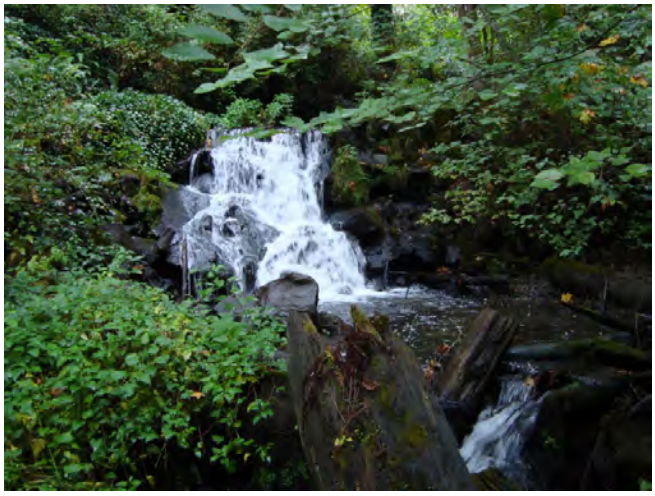


Photo 5. Cascade in Innis Arden reach below Innis Arden Way

The dam no longer supplies water for the Seattle Golf and Country Club, so sediment flushing behind the dam no longer occurs. This could account for differences in field observations between 2004 and 2011.

3.3.2.3 Hidden Lake/Boeing Creek Park reach

The Hidden Lake/Boeing Creek Park reach includes Hidden Lake, a dammed section of the creek upstream of Innis Arden Way. Hidden Lake is another depositional zone within Boeing Creek. In order to keep the lake as an open-water feature, the City maintains it by removing sediment on an annual or biannual basis. Approximately 9,000 cubic yards of sediment have been removed from Hidden Lake since 2002 (Table 3).The lake was reconstructed in 1996 (Figure 3) and has been maintained as an open-water feature since that time. In order to facilitate sediment removal, King County designed the reconstructed Hidden Lake to have two concrete weirs that function as bed control and allow for diversion of low flows during sediment removal. An access road exists on the north side of the lake to allow for maintenance. On the west side of the lake is an embankment with a 96-in.diameter control structure with two 30-in.-diameter pipes capable of passing the 100-year flow event. The control structure keeps water surface elevations at a constant 188 ft above mean sea level. The control structure also includes a 12-in.-diameter pipe outlet, and a 24-in.-diameter pipe inlet that is used to bypass flows for pond maintenance. The embankment is designed to function as an emergency spillway.

Table 3. Summary of sediment volume removed from Hidden Lake (2002–2011)

Year	Sediment Volume Removed (cubic yards)
2011	1,500
2009	500
2008	5,100 (total under 3 contracts)
2006	500
2005	500
2004	350
2002	726
Total	**9,176**

On November 19, 2012, a large precipitation event (approximately 2.6 in. of rain over the course of 24 hours) caused bank and hillslope failures upstream of Hidden Lake, resulting in the deposition of several thousand cubic yards of sediment. Photo 6, taken on December 14, 2012, shows the new delta that formed in Hidden Lake; Photo 7 depicts conditions in October 2011, following lake dredging.

A concrete structure is still present in the channel just upstream of Hidden Lake that, historically, was used for fish rearing by Mr. Boeing (Photo 8). Upstream of the lake, Boeing Creek is characterized by riffle pool sequences; there is very little channel structure excepting what has been placed historically as part of restoration and channel stabilization efforts. Several large log weirs span the channel's width, creating pools on the downstream sides (Photo 9).

Photo 6. Sedimentation in Hidden Lake (December 14, 2012)

Photo 7. Hidden Lake October 2011, post-dredging

Photo 8. Concrete weir above Hidden Lake

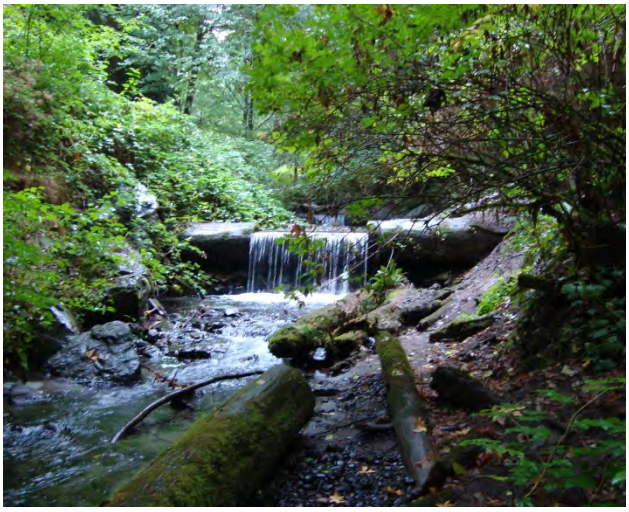


Photo 9. Example of typical log weir through Hidden Lake and Boeing Creek Park and North Fork reaches

3.3.2.4 North Fork reach

The North Fork of Boeing Creek extends from the confluence of the two forks to the North Boeing Creek detention pond dam at the location of the 1997 washout on North 175th Street. There is still evidence of this event in the stream channel. A low terrace of sediment deposited during the washout is present (Photo 10), as are slope stability mitigation structures consisting of large rocks on the north side of the channel (Photo 11). Large log weirs are also present through this reach.

Photo 10. Sediment terrace remaining from 1997 washout

Photo 11. Stabilizing wall adjacent to right bank of North Fork Boeing Creek

3.3.2.5 South Fork reach

The South Fork reach extends from the confluence to M1 dam. This reach is relatively low gradient on the downstream end, is sinuous in pattern, and contains some large wood (mostly above the active channel area, and therefore not contributing to hydraulic diversity and pool formation). Seeps were observed on the right bank (north side of the channel) in several locations, as were high-density polyethylene (HDPE) corrugated pipes discharging stormwater to the stream channel. The left bank is very steep through this reach, and consists of many small landslides on the order of 20 ft wide by 30 ft high. As the gradient increases toward M1 dam, there is significant evidence of previous attempts to stabilize this channel section, including large concrete blocks, riprap of various sizes, and asphalt pavement chunks (Photo 12). Much of the flow through this section is subsurface.

Photo 12. Concrete debris and oxidation in South Fork reach.

3.3.2.6 M1 reach

Boeing Creek is located in a straight, riprap-constructed channel, with a left bank dam access road upstream of M1 dam (Photo 13). There are a few stormwater outfalls discharging water to this reach, including at the top of the channel (where Boeing Creek essentially begins being an open channel) and along Carlyle Hall Road.

Photo 13. Small riprap in Boeing Creek upstream of M1 dam

3.4 SURFACE WATER

Boeing Creek and Hidden Lake are the primary surface water features in the basin. Boeing Creek has a little more than 3 miles of open channel flow, primarily in the reaches described in Section 4.3. Approximately 6 miles of Boeing Creek and its tributaries are now conveyed in pipes, and surface water in the remaining parts of the basin is conveyed in ditches and stormwater conveyance pipes. Hidden Lake is approximately 2 acres in size, and was created by damming Boeing Creek near what is now Innis Arden Way.

A hydrologic model was developed using the US Environmental Protection Agency (EPA) stormwater management model (SWMM) to estimate current and historic (i.e., forested condition) flows, which permits an understanding of how flows have changed over time, and what level of effort it might take to return the basin to a more natural hydrologic regime. The model was constructed using local precipitation, evaporation, and drainage basin characteristics (including land use, slope, infiltration from geology, and data on existing hydraulic structures), and calibrated to historical flow gage data for Boeing Creek. Additionally, the model was compared to a previous Hydrological Simulation Program – FORTRAN (HSPF) hydrologic model developed to design the North Boeing Creek detention facility improvement project (Otak 2008). Hydrologic modeling indicates a flow increase of up to 300% more than forested conditions for the 25-year return flow, as measured at the mouth of Boeing Creek (Table 4). The hydrologic modeling memorandum is included in Appendix A.

Table 4. Summary of modeled flows for forested and existing conditions

Location	2-year Return Frequency (cfs)		25-year Return Frequency (cfs)		100-year Return Frequency (cfs)	
	Forested	Existing	Forested	Existing	Forested	Existing
Mouth of Boeing Creek	14.4	72.3	52.4	154	61.8	209.7
Upstream of sheet pile dam	14.2	73.2	34.7	154.6	45	209.5
Upstream of Hidden Lake	12.5	72.1	30.2	160.5	39.4	227.3
South Fork, upstream of confluence	8.2	60.3	20.7	99.4	27.9	117.6
North Fork, upstream of confluence	4.8	21.2	11.7	74.5	15.2	132.6

cfs – cubic feet per second

3.5 FLOODING AND FEMA FLOODPLAIN MAP

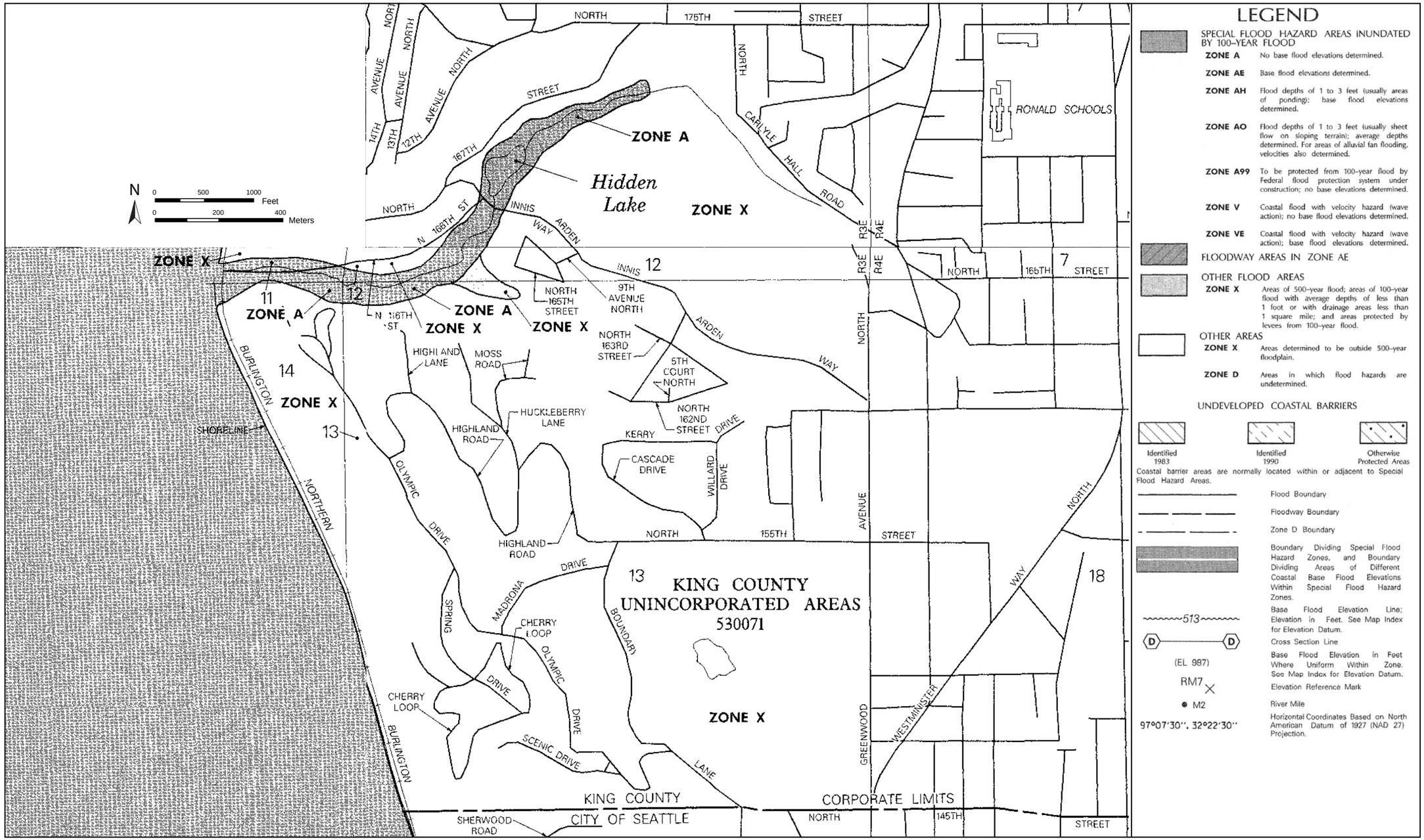
The scope of this project did not call for hydraulic modeling of the entire Boeing Creek conveyance system. The hydraulic analysis was limited to the open-channel reaches of Boeing Creek (from the waterway's mouth to M1 dam), as well as a handful of piped locations, such as:

- Culvert crossings at the BNSF railroad and Innis Arden Way
- Pipes in and out of flow control facilities or other large impoundments, including:
  - Boeing Creek Detention Pond
  - M1 dam
  - Hidden Lake
  - Seattle Golf and Country Club water supply dam
- Sub-catchment piped outfalls to Boeing Creek

The EPA SWMM analysis did not result in any locations of predicted potential flooding.

3.5.1 FEMA flood insurance map

The existing Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) includes a Zone A flood boundary for Boeing Creek (Figures 8 and 9). Zone A identifies an approximate special flood hazard area for which no base flood elevations (BFEs) have been provided. The City is interested in working with FEMA to obtain a letter of map amendment (LOMA) or letter of map revision (LOMR) to modify the Zone A boundary for Boeing Creek. The existing FIRM map Zone A flood boundaries are somewhat arbitrary and extend several tens of feet above the stream channel at elevations that would not be expected, even during extreme flow events. The EPA SWMM model was developed in consideration of FEMA flood mapping standards (FEMA 1995) such that the City can pursue modifications, if desired. Figure 9 represents



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- **ZONE A** No base flood elevations determined.
- **ZONE AE** Base flood elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE A99** To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
- **ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- **ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- **ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside 500-year floodplain.
- **ZONE D** Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

- Flood Boundary
- Floodway Boundary
- Zone D Boundary
- Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.
- 513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.
- D — D — Cross Section Line
- (EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.
- RM7 — Elevation Reference Mark
- M2 — River Mile
- 97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

Source: Federal Emergency Management Agency, Flood Insurance Rate Maps: Map Number 53033C0310 - Panel 310, Map Number 53033C0040 - Panel 40, Map Number 53033C0330F - Panel 330

Figure 8. Existing flood insurance rate maps showing 100-year flood Zone A.

Wind Ward environmental LLC

Legend

C# Channel Segment ID

Subcatchment ID

100-yr Floodplain

Pipes

Streams

Subcatchment Boundaries

FEMA Floodplain Boundary

Ponds

Wetlands

N

150 0 150 Yards

150 0 150 Meters

OSBORN CONSULTING INCORPORATED

Prepared by MLP, 9/18/2012, FIGURE9

Figure 9. Preliminary 100-yr floodplain map based on EPA SWMM model

Disclaimer: This data is not to survey accuracy and is for planning purposes only.

Boeing Creek Basin - Shoreline, WA

a map estimating the preliminary 100-year floodplain, based on a simulation of the December 29, 1996, precipitation event that resulted in a peak flow of 225.8 cfs at the mouth of Boeing Creek. For comparison, the FEMA Zone A flood boundary is also shown on Figure 9. This map is intended for planning purposes only, and is to give the City a general idea of what area(s) surrounding Boeing Creek might flood during a 100-year event. If the City intends to pursue a LOMA or LOMR with FEMA, additional analysis will be needed.

3.5.1 Rainfall

The National Oceanic and Atmospheric Administration (NOAA) publishes weather extremes, including data for the Seattle area between 1948 and 2011 (NOAA 2012a). Table 5 lists the 10 greatest recorded precipitation events that have taken place within 24-hour periods in Seattle. Weather patterns can vary greatly even between short distances, so these precipitation statistics may not be directly applicable to the City. However, they do give an idea of regional precipitation history, and the largest storms do correlate with the timing of service calls and stormwater-related issues in the City, as discussed in Section 3.6.2.

Table 5. Ten greatest precipitation events in Seattle between 1948 and 2011

Date	Inches of Precipitation in 24 hours
October 2003	5.02
December 2007	3.77
November 1959	3.41
November 2006	3.29
February 1996	3.06
January 1986	2.98
February 1951	2.98
November 1990	2.95
November 1990	2.93
January 1990	2.83

Reference: NOAA (2012b)
NOAA – National Oceanic and Atmospheric Administration

During the production of this plan, another large precipitation event occurred on November 19, 2012. Preliminary data from the NOAA precipitation gage at Sand Point Magnuson Park in Seattle indicated 2.60 in. of rain fell within a 24-hour period.

4.5.2 Water withdrawals

Do water withdrawals have an effect on Boeing Creek?

Yes. Ecology has closed Boeing Creek to further surface water appropriation (WAC 173-508-040) and concluded that further loss of base flows will further damage the fishery. However, there are pending groundwater applications in the basin that are currently under review.

Windward reviewed the Washington State Department of Ecology's (Ecology's) water rights records to determine whether there are any surface or groundwater rights holders in the basin and if so, their rates of withdrawals. Based on the review, there are 18 entities that retain water rights for surface or groundwater withdrawals and reservoir impoundments, ranging in age of priority from 1910 to 1993 (Table 6). Seven entities retain rights for surface water withdrawals ranging from 0.04 to 2.00 cfs, and the remaining entities retain rights for groundwater withdrawals of up to 200 gallons per minute (gpm). In 1996, Mr. Wayne Cottingham (Cottingham vs. Department of Ecology) was denied an application for appropriation of surface water of up to 20 gpm, in part due to the Pollution Control Hearing Board's (PCHB's) finding (No. 96-125) that "Existing senior rights on Boeing Creek, particularly that of Seattle Golf and Country Club, are often not satisfied by summer flows in the Creek. Thus any further withdrawal of water from the Creek would impair senior rights." The PCHB finding also states that "Further loss of base flows will further damage the fishery, and will interfere with current efforts to restore anadromous fish runs."

Table 6. List of water rights holders in Boeing Creek basin

Number	Owner	Date of priority	Type	Amount	Address
S1-154756CL	Mrs. John L. Scott	1954	spring	5 gpm	the Highlands
S1-136822CL	Shirley Nelsen	unknown	stream	unknown	the Highlands
S1-129571CL	Jacqueline Griffiths	unknown	surface Water	unknown	the Highlands
G1-123976CL	Otway O'M Pardee	1924	groundwater	60 gpm	none listed
S1-119356CL	Hidden Lake Corporation	1922	surface Water	12 ac-ft impounded	17020 10th Avenue NW
G1-097229CL	George C. Parker	pre-1974	groundwater	unknown	18004 Dayton Avenue N
S1-092070CL	Jas Sinclair	pre-1974	springs	unknown	617 NW 175th Street
G1-087288CL	Valerie Schmid	pre-1974	groundwater	unknown	17239 Greenwood Place
G1-082207CL	G.W. Bartholomew	pre-1974	groundwater	unknown	17202 Greenwood Place North
G1-050290CL	Harold E. Lehde	pre-1974	groundwater	unknown	17207 Dayton Avenue North
G1-016680CL	Leo Salo	1910	groundwater	5 gpm	517 NE 148th Street
G1-016680CL	Howard Muzingo	1912	groundwater	10 gpm	317 NW 185th Street

Number	Owner	Date of priority	Type	Amount	Address
G1-012524CL	Thomas Jones	1968	groundwater	0.5 gpm	1104 NW 200th Street
G1-009323CL	Milo Beattie	1945	groundwater	10 gpm	14613 Stone Avenue North
S1-00187CWRIS	Vernon Day	1966	surface Water	0.04 cfs	the Highlands
S1-02609CWRIS	W.E. Boeing	1932	fish propagation	2 cfs	the Highlands
G1-05639 CWRIS	Highlands, Inc.	1960	domestic well	200 gpm	the Highlands
G1-27202	Seattle Golf Club	1993	irrigation Well	unknown	the Highlands
R1-28527P (application only)	The Highlands	2007	reservoir	10 ac-ft	the Highlands
G1-28511 (application only)	Hanauer Park	2007	groundwater	200 gpm	the Highlands

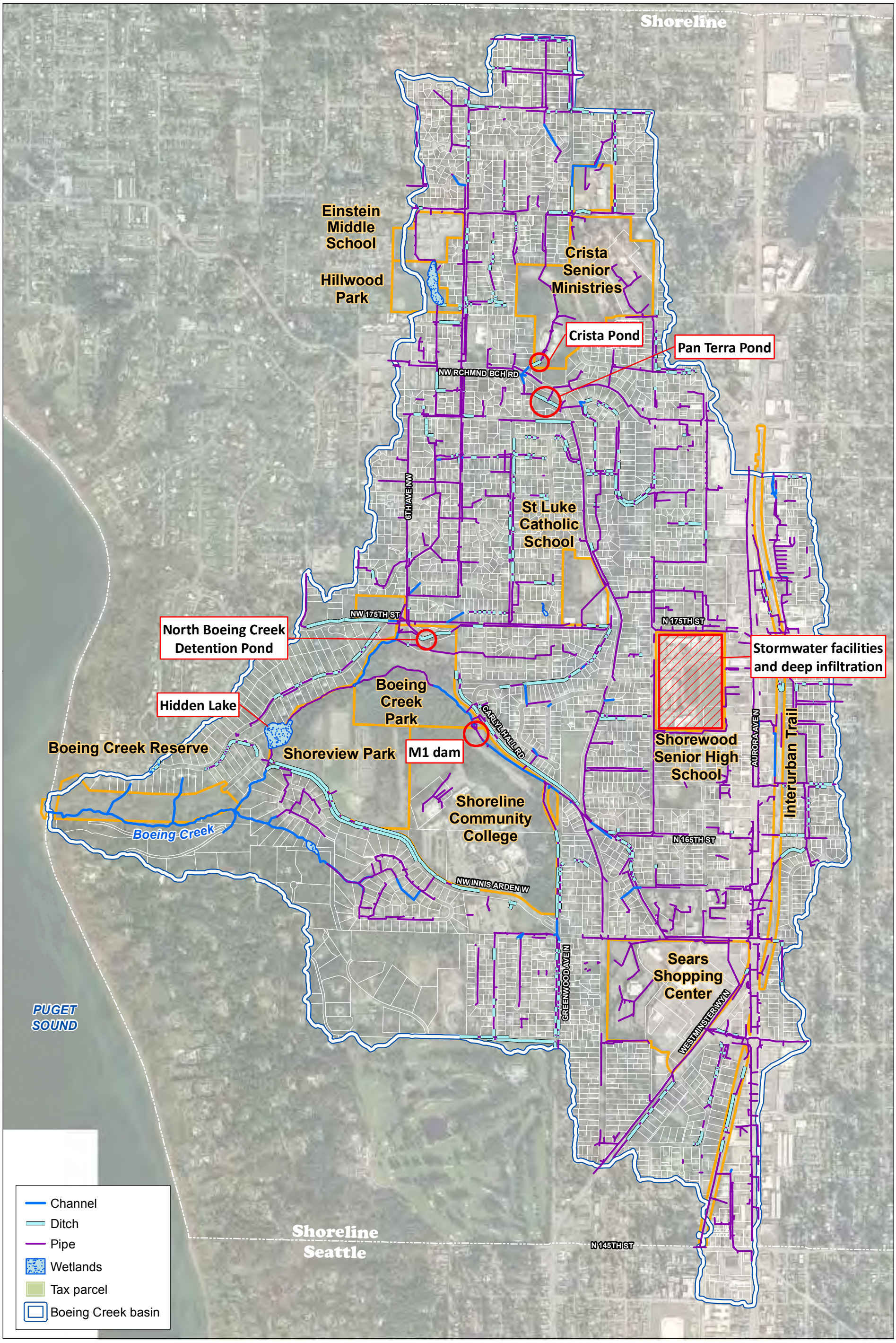
cfs – cubic feet per second
gpm – gallons per minute
ac-ft- acre-feet

Additionally, in 1996, the PCHB found in Ecology's favor to deny groundwater rights to Herzl Memorial Park (Herzl Memorial Park v. Ecology, PCHB No. 96-54) because "the hydraulic continuity between ground water at a certain place and a particular surface water need not meet any further standard or test to be given full credit in Ecology's water allocation decisions. Once established factually, hydraulic continuity with a particular surface water enables Ecology to assess logically the link between a ground water withdrawal and any resulting impairment of senior rights in that related surface water, including the rights of the public in maintaining minimum in-stream flows."

Two relatively new applications for reservoir and groundwater rights (2007) are currently under review for appropriation to Hanauer Park in the Highlands to support a pond that provides fish and wildlife enhancement and recreation. The applications state that water will be returned to Boeing Creek through infiltration or surface flow, and that the mechanism for return flow will be determined during the reservoir design process.

3.6 STORMWATER INFRASTRUCTURE

In addition to Boeing Creek, which conveys surface water and stormwater runoff from the natural and built environment, the City maintains a series of pipes, ditches, and connecting structures (i.e., catch basins and manholes) that convey and route stormwater through the basin away from houses, road surfaces, and parking lots (Figure 10). The infrastructure's condition and any problems were assessed through a video inspection of the pipe network and a review of service requests. Table 7 summarizes the types and lengths of conveyances present in the basin.



Prepared by craigh, 12/27/2012, W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 10 5162 Drainage system.mxd

Wind Ward environmental LLC

Figure 10. Boeing Creek drainage system and stormwater facilities

Table 7. Summary of conveyance types, materials, and lengths

Conveyance Type	Material	Approximate Linear Miles
Open-stream channel	na	3.23
Ditch	na	14.4
Pipe	CMP	5.85
	ADS®-1	0.49
	plastic	1.32
	concrete	22.8
	CPP	1.25
Total conveyance length		55.1

ADS® – Advanced Drainage System
CMP – corrugated metal pipe
CPP – corrugated plastic pipe
na – not applicable

The Boeing Creek basin has a few fairly large stormwater facilities, primarily for the purpose of mitigating peak flows and durations (Figure 10). Some of these facilities, particularly the Pan Terra Pond and the North Boeing Detention Pond, were upgraded recently (2009) to improve functionality. Specifically, the Pan Terra Pond was expanded to provide more storage, water quality treatment was installed, and a pump station and force main were added in order to divert flows to a new stormwater conveyance system along 3rd Avenue NW (Otak 2008) when the system is overwhelmed. The North Boeing Detention facility was also expanded for additional capacity, and flow control structures were modified (Otak 2008). Both projects included additional landscaping and aesthetic upgrades as well.

3.6.1 Condition assessment

The condition assessment included an inspection of all pipes within the Boeing Creek basin boundary 12 in. or more in diameter and 25 ft or longer, excluding the recently installed stormwater conveyance system infrastructure along Aurora Avenue North. Bravo Environmental (Bravo) inspected and rated the pipes using closed-circuit television (CCTV). Bravo began the CCTV inspections in January 2012 and completed the final inspections in October 2012. The Windward team processed and organized the CCTV inspection videos and reports and updated the City's geographic information system (GIS) database with the inspection results.

How will the condition assessment results be used?

The condition assessment results will help the City plan for future stormwater infrastructure maintenance, repair, and replacement. Recommended projects to repair pipes are included in Section 6.

The CCTV inspection included a qualitative inspection rating following the National Association of Sewer Service Companies (NASSCO) system of rating. The City decided that the ratings most useful to add to the City's GIS database included the Structural Pipe Ratings Index (SPRI), the Maintenance Pipe

Ratings Index (MPRI), and the Overall Pipe Ratings Index (OPRI). The SPRI indicates any structural damage present in the pipe, such as cracks, deformation, intruding objects, and joint offsets. The MPRI indicates any maintenance issues in the pipe that impede the flow of stormwater, such as debris, sediment, and roots. The OPRI is a combination of the SPRI and MPRI. These ratings are based on a 0 to 5 scale (Table 8).

Table 8. NASSCO rating criteria

NASSCO Grade	Description	Estimated Time to Failure
0	EXCELLENT: no defects.	unlikely in the foreseeable future
1	EXCELLENT: minor defects.	unlikely in the foreseeable future
2	GOOD: defects that have not begun to deteriorate	20 years or more
3	FAIR: moderate defects that will continue to deteriorate	10 to 20 years
4	POOR: severe defects that will become grade 5 defects within the foreseeable future	5 to 10 years
5	IMMEDIATE ATTENTION: defects requiring immediate attention	has failed or will likely fail within the next 5 years

NASSCO – National Association of Sewer Service Companies

Table 9 summarizes the number of pipes and structures inspected by Bravo, and Table 10 lists the number of pipes within each rating category. In general, the pipes' conditions are fairly good, with 76% of the inventoried pipes having 20 years or more of life left; however, 8% require immediate attention. Figure 11 shows all the pipes in the Boeing Creek basin; highlighted pipes indicate those scoring a 4 or higher in SPRI and MPRI.

Table 9. Summary of pipes and structures inspected by CCTV in the Boeing Creek basin

No. of Pipes	No. of Structures[a]	Length of Inspected Pipes (linear ft)	% of Total Pipes Inspected in Basin
1021	2,481	113,042	56

[a] Structures refers to manholes and catch basins that connect lengths of stormwater pipe.

CCTV – closed-circuit television

Table 10. Pipe condition summary

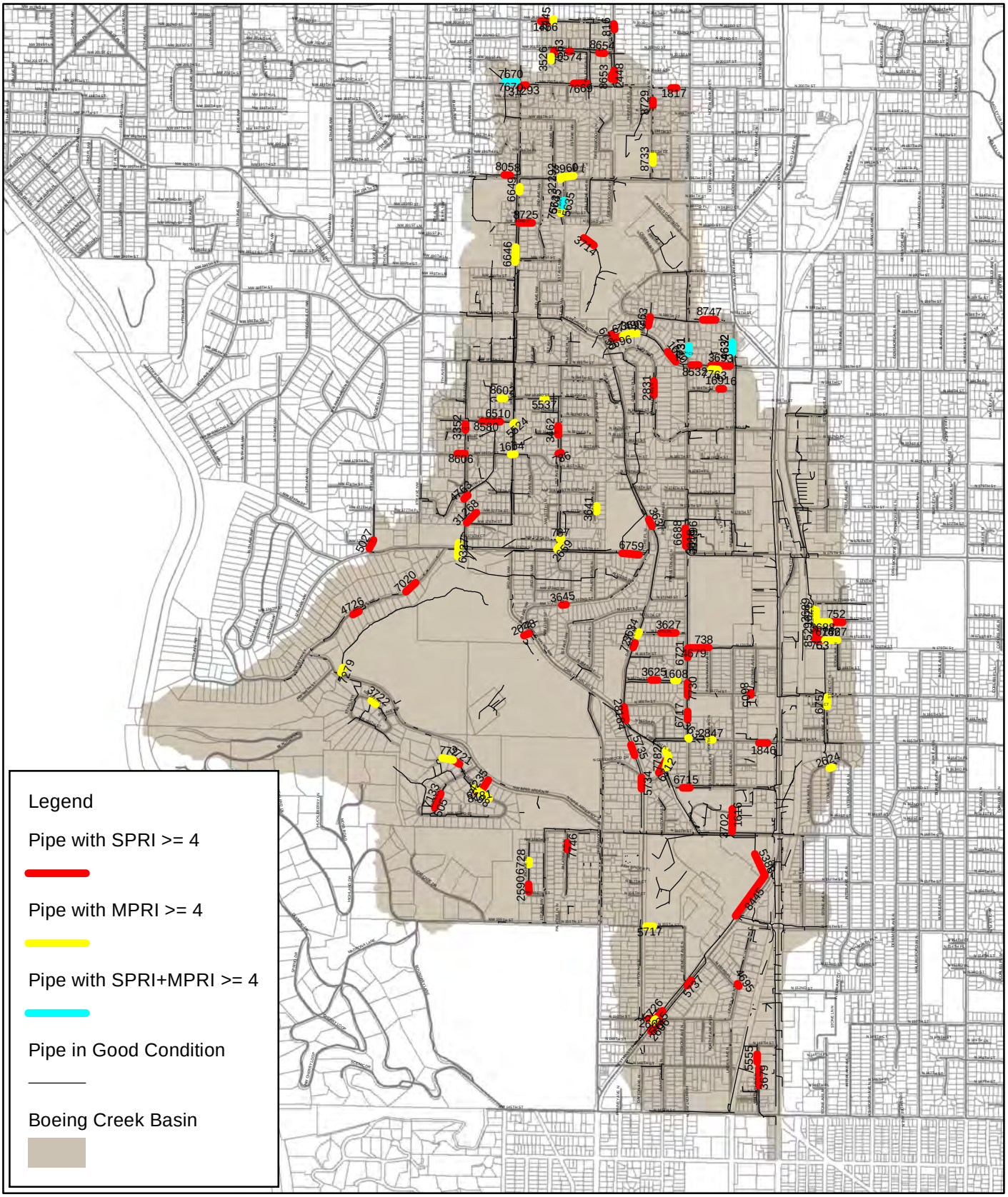
Type of Rating	No. of Pipes Inspected	No. of Pipes Within Each Category of Rating[a]				
		< 1	≥ 1 and < 2	≥ 2 and < 3	≥ 3 and < 4	≥ 4
SPRI	1,021	675	69	97	75	105
MPRI	1,021	376	52	356	186	51
OPRI	1,021	283	77	355	226	80

[a] Pipes scoring 4 or higher are in poor condition and may need immediate attention. See Table 7 for a full description of category ratings.

MPRI – Maintenance Pipe Rating Index

OPRI – Overall Pipe Rating Index

SPRI – Structural Pipe Rating Index



OSBORN CONSULTING INCORPORATED

N

650 325 0 650 Yards

650 325 0 650 Meters

Figure 11. Locations of pipes rated higher than 4 in condition assessment

Boeing Creek Basin - Shoreline, WA

3.6.2 Infrastructure service requests

Windward reviewed City service requests received between April 2001 and November 2011 to identify problematic areas in the basin and potential causes. Almost 700 calls were received regarding approximately 360 different locations in the Boeing Creek basin during this time period. Most of the calls received were related to flooding and clogged drainage infrastructure (Figure 12). Lesser numbers of calls were received for other problems, including erosion, sink holes, ineffective drainage (i.e., flow paths not going to the right place), spills, and other issues. The general types and locations of these calls are shown in Figure 14. Major precipitation events occurred in the Seattle and Shoreline area during October 2003, November 2006, and December 2007. The majority of the flooding calls were received in 2003 and 2007, and more than half of these calls were associated with the single large storm events that occurred in both of those years.

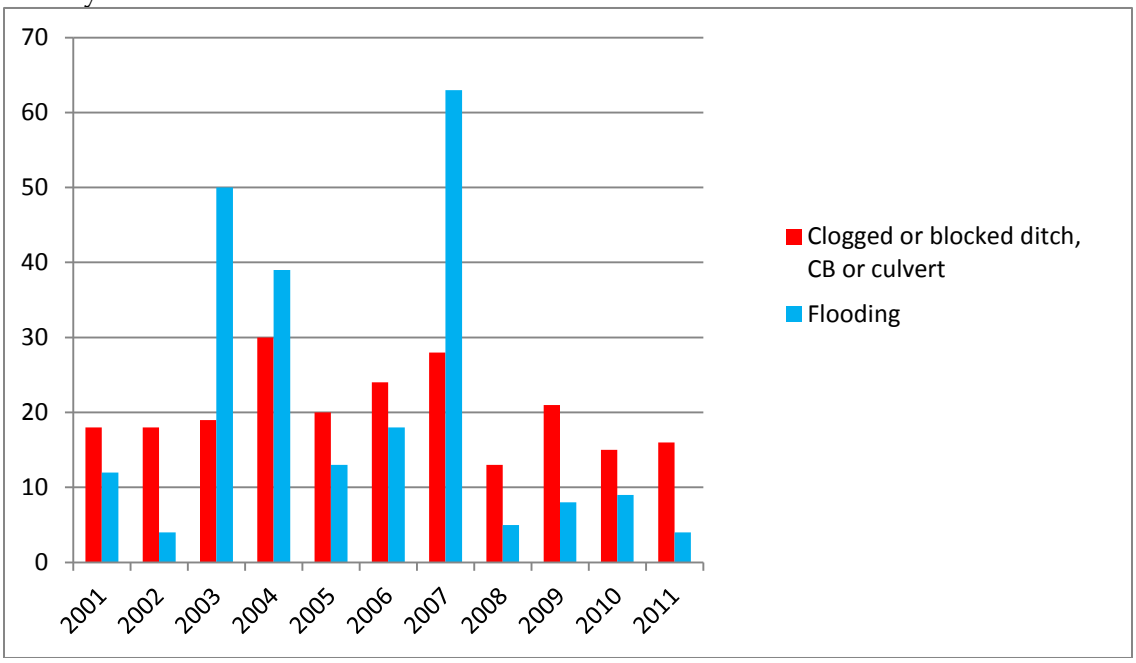


Figure 12. Number of flooding- and clogged infrastructure-related service calls received for the Boeing Creek basin by year

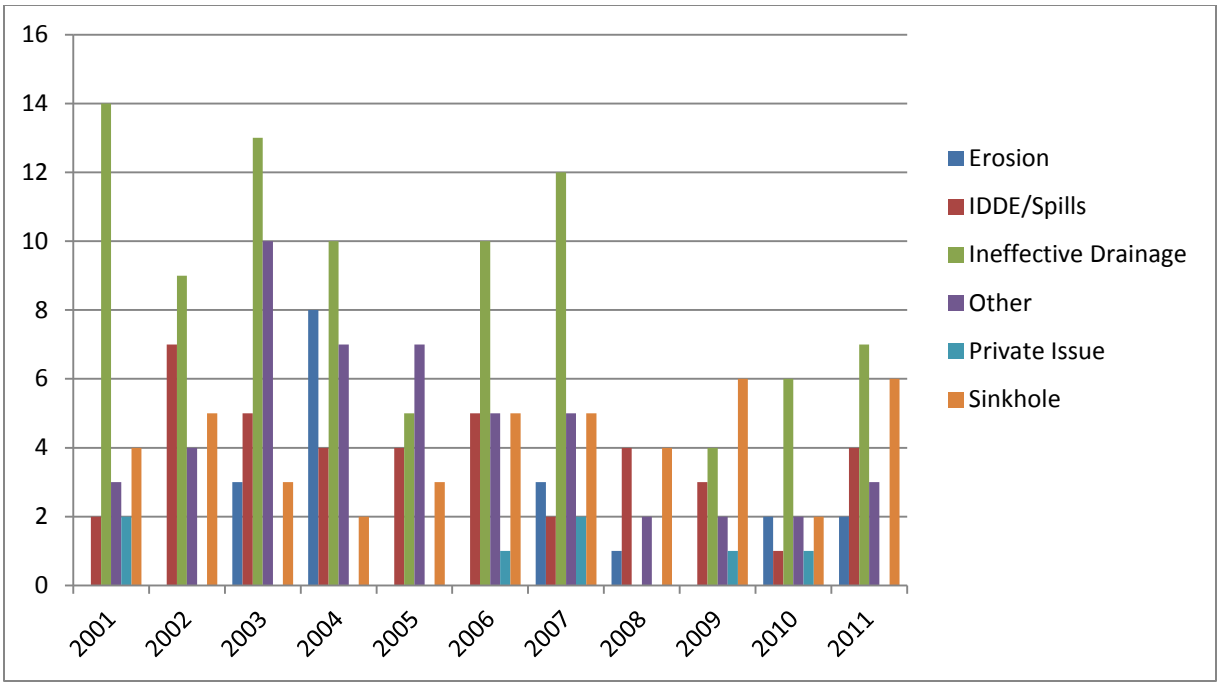


Figure 13. Number of non-flood-related service calls received for Boeing Creek basin by year

Shoreline

Einstein Middle School

Hillwood Park

Crista Senior Ministries

NW RCHMND BCH RD

6TH AVE NW

St Luke Catholic School

NW 175TH ST

N 175TH ST

Shorewood Senior High School

Boeing Creek Park

CARLYL HALL RD

AURORA AVEN

Interurban Trail

Boeing Creek Reserve

Shoreview Park

Boeing Creek

Shoreline Community College

N 165TH ST

NW INNIS ARDEN W

GREENWOOD AVE N

Sears Shopping Center

WESTMINSTER WY N

PUGET SOUND

Shoreline Seattle

N 145TH ST

Service call request

- Flooding
- Erosion
- Clogged pipe/catch basin
- Clogged ditch
- Ineffective drainage
- Sinkhole
- Other
- Channel
- Ditch
- Pipe
- Tax parcel
- Boeing Creek basin

Wind Ward environmental LLC

N

0 250 500 Yards

0 200 400 Meters

Figure 14. Location and type of service calls to the City of Shoreline stormwater utility

Prepared by craigh, 12/27/2012; W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 13 5128 Stormwater utility service calls.mxd

Approximately 1/3 of the calls received were related to localized flooding issues, and another 1/3 were related to clogged catch basins, ditches, and culverts. Ineffective drainage calls include those pertaining to surface water not being conveyed to the nearest catch basin, pipe, or ditch because of changes to pavement (during road overlays or other projects), berms that caused the water to flow in a different direction, or other obstructions. The City has resolved the majority of the flooding-related calls, such that the more recent calls received have pertained to nuisance flooding. Major capital projects, including Aurora Avenue North transportation improvements, and drainage improvements at Darnell Park and Whitman Avenue North near North 167th Street have alleviated the majority of flooding problems in the Boeing Creek basin.

Figure 15 shows the months that calls are typically received. Generally, most calls are received during the months with the greatest rainfall, between October and March; however, a large number of calls are also received in August. More than half of the August service calls were in a single year (2001), likely corresponding with higher-than-average summer rainfall. In 2001, 2.32 in. of rain fell during August, the fifth largest amount of precipitation for this month over a 59-year record of Seattle area rainfall (WRCC 2006). December 2007 included the second largest storm event on record between 1948 and 2011, and there were a number of flooding problems reported in the basin. A table of all of the service calls for the Boeing Creek basin is included in Appendix B.

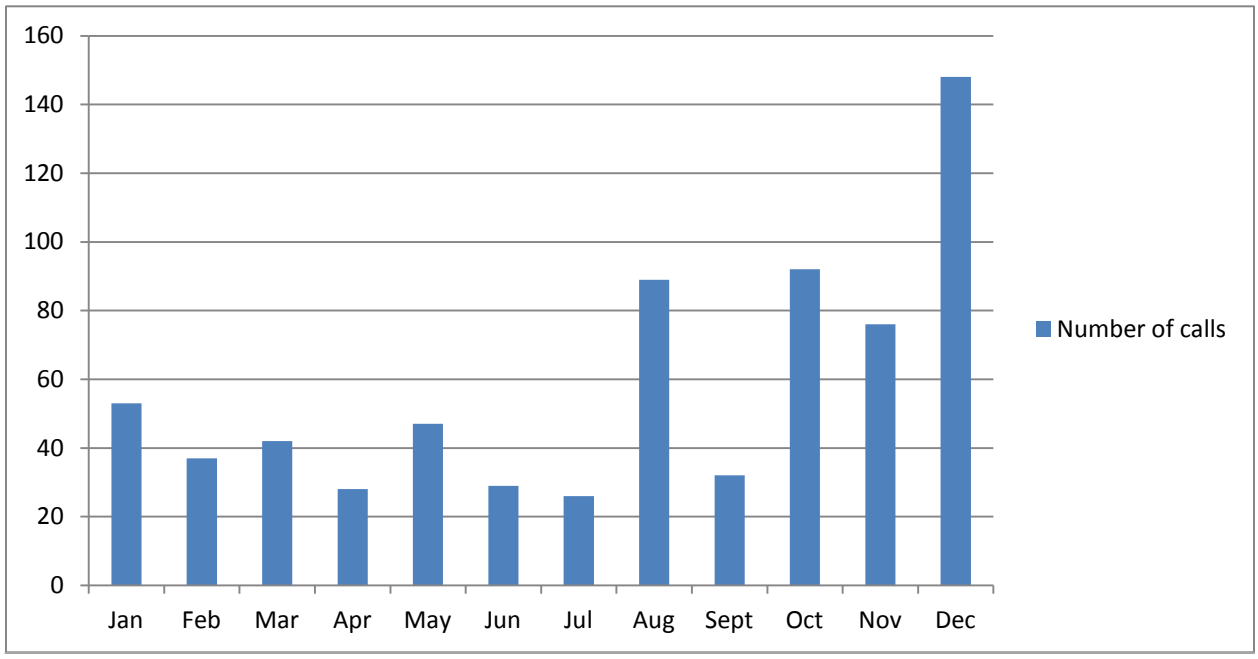


Figure 15. Number of service calls by month

3.7 BIOLOGICAL CONDITIONS

3.7.1 Wetlands

Wetlands in the Boeing Creek watershed are neither numerous nor extensive. Only five wetland areas were noted during fieldwork: two on private property, one in Hillwood Park, and two in Boeing Creek Park. Additional unidentified small wetland areas are likely present on private property. While historical wetland coverage in the basin may have been more widespread prior to development, the geography of the watershed is not conducive to the formation of large wetland areas, since it is a relatively small basin and does not have extensive lakeshore or low-gradient river systems.

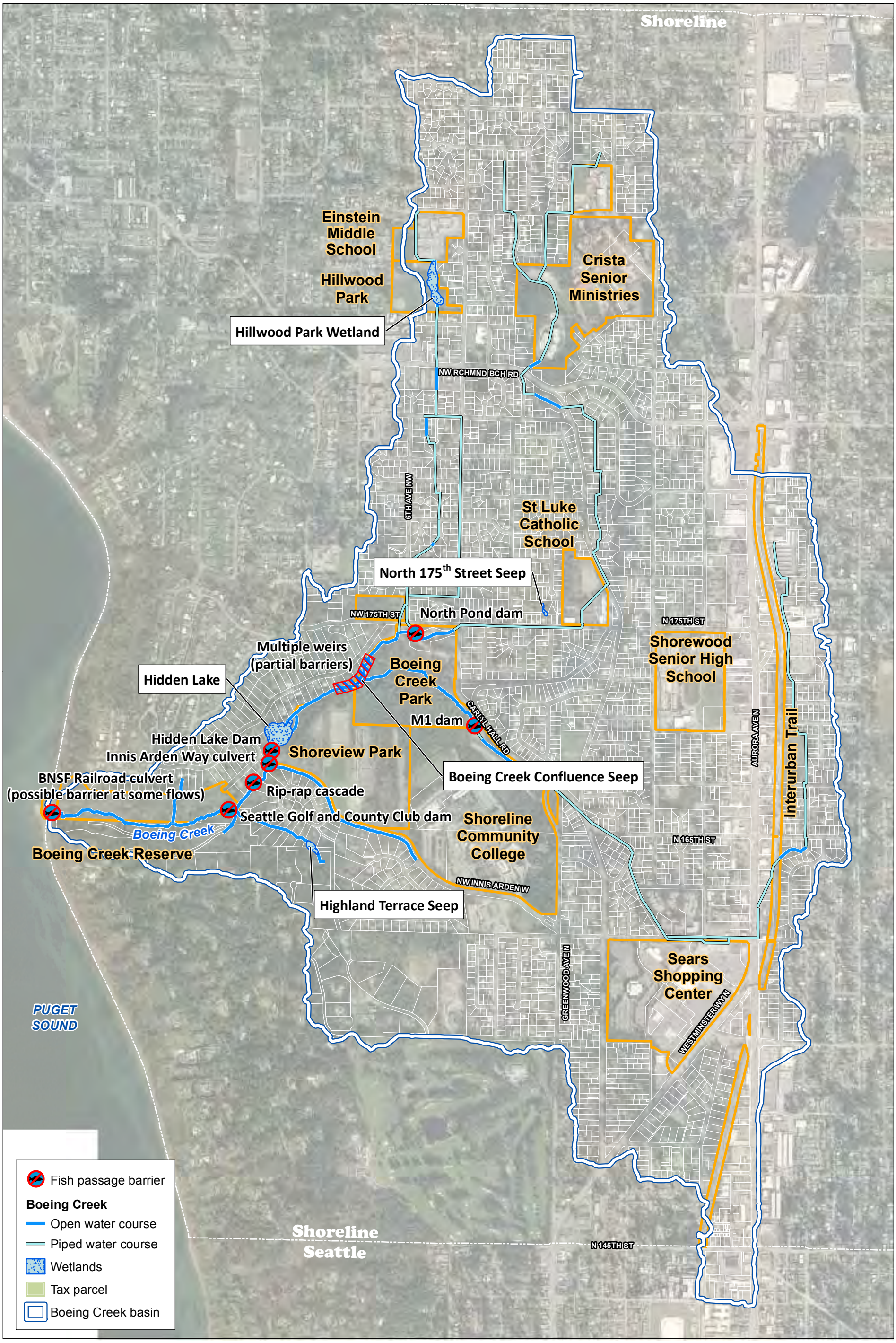
Prior basin investigations have indicated that a large wetland system was present in the vicinity of the present-day Aurora Square Shopping Center. However, examination of a 1936 aerial photo indicates this area was lightly forested; therefore, storage depths of wetlands at the time would have been less than 2 ft.

Table 11 lists the wetlands that were visited and evaluated; these wetlands are discussed in the following sections and shown on Figure 16.

Table 11. Wetlands visited and evaluated

Wetland	General Description	Approximate Size (acres)	Ecology Rating (see Table 12 for descriptions)
Hidden Lake	dammed portion of Boeing Creek in Shoreview Park	< 2	Category III
Boeing Creek confluence	seep-supported wetland	< 0.25	Category III
North 175th Street	seep-supported slope wetland	< 0.25	Category IV
Highland Terrace neighborhood	seep-supported wetland	0.5	Category III
Hillwood Park	stormwater-supported wetland	< 1	Category IV

These areas were identified using a combination of past wetland inventories and current field reconnaissance of Boeing Creek and its tributaries.



Prepared by craigh, 12/27/2012: W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 16 5146 Biological features.mxd

Wind Ward LLC environmental

Figure 16. Wetlands and fish passage barrier locations

Under the Ecology wetland rating system for Western Washington (Hruby 2004), the five wetlands were each scored according to wetland functions (i.e., water quality, hydrology, and habitat) and assigned a rating. Table 12 provides general wetland characteristics and function scores associated with the different wetland categories. Appendix C contains the wetland ratings forms.

Table 12. General characteristics of Ecology wetland categories

Category	Wetland Function Score	General Characteristics
I	> 70	unique or rare wetland type more sensitive to disturbance than most wetlands relatively undisturbed and contains ecological attributes that are impossible to replace within a human lifetime provides a high level of functions (> 70 points)
II	51 – 69	difficult, though not impossible, to replace provides high levels of some functions (51 – 69 points)
III	30 – 50	provides a moderate level of functions (30 – 50 points)
IV	< 30	provides lowest level of functions (less than 30 points) often significantly disturbed

Ecology – Washington State Department of Ecology

3.7.1.1 Hidden Lake

In the early 1900s, William Boeing dammed Boeing Creek and created Hidden Lake, which is now controlled by a more modern dam and outlet structure. The lake requires periodic dredging by the City to maintain an open-water condition, as sediment eroded from upstream hillslopes and banks is transported and deposited in Hidden Lake. Wetland conditions in the lake are limited to sparse submerged vegetation and algae in the open-water areas, with a narrow margin of emergent and shrub vegetation along the lakeshore. A narrow channel exists along the eastern part of the south margin, nearest the inlet. This channel is used to divert clean flow around the work area during dredging. The wetland area is less than 2 acres. Wetland hydrology is supported by Boeing Creek and controlled by the outlet structure. Under the Ecology wetland rating system for Western Washington (Hruby 2004), the Hidden Lake Wetland scores 16 water quality points, 8 hydrologic points, and 19 habitat points for a total score of 43 and a rating of Category III.

3.7.1.2 Boeing Creek Confluence Seep

What hydrologic benefits do wetlands in Boeing Creek basin provide?

The remaining wetlands in the Boeing Creek basin provide very few hydrologic benefits, as they are mostly small, seep-supported wetlands.

Located at the west boundary of Boeing Creek Park, this wetland is along the left (south) bank of Boeing Creek at the North Fork confluence in Boeing Creek Park. Despite its proximity to the creek, it is supported by groundwater seeps emerging from the hillside rather than stream flow. The wetland, which is dominated by native shrubs and shade-dependent groundcovers, is beneath the forest canopy, although few trees are rooted within the wetland boundaries. The wetland area is less than 0.25 acre. Under the Ecology wetland rating system for Western Washington (Hruby 2004), this wetland scores 3 water quality points, 10 hydrologic points, and 17 habitat points for a total score of 30 and a rating of Category III.

Along Boeing Creek exist multiple additional smaller seeps similar in character to the Boeing Creek confluence seep. These seeps are too small to rate and classify independently for the purposes of this report.

3.7.1.3 North 175th Street seep

Located north of North 175th Street, between St. Luke Place North and 1st Avenue NW, this wetland is situated on the south face of a steep slope. The primary source of hydrology is groundwater emerging from the slope face. The seep was active during late September 2012 following a near-record low-rainfall summer. The wetland is dominated by an overstory of young red alder trees, with an understory of giant horsetail. The wetland area is less than 0.25 acre. Under the Ecology wetland rating system for Western Washington (Hruby 2004), this wetland scores 6 water quality points, 10 hydrologic points, and 7 habitat points for a total score of 23 and a rating of Category IV.

3.7.1.4 Highland Terrace seep

This wetland is located in the stream valley southwest of NW Innes Arden Way. Most of the hydrology comes from groundwater seeps in adjacent hillsides, with only a small amount of hydrology derived from the stream. While the valley is forested on its margins, the wetland itself is dominated by salmonberry and shade-dependent native groundcover. Very little invasive blackberry is present. The wetland area is approximately 0.5 acre. Under the Ecology wetland rating system for Western Washington (Hruby 2004), this wetland scores 14 water quality points, 16 hydrologic points, and 19 habitat points for a total score of 49 and a rating of Category III.

3.7.1.5 Hillwood Park Wetland

This wetland is located in a mowed lawn area along the eastern edge of Hillwood Park. There are a few cedar, mountain ash, and willow trees in the wetland, though they are

not dense enough to qualify as forested vegetation. The wetland originates at a culvert draining from the southern boundary of Einstein Junior High School; most of the wetland hydrology is supplied from this culvert. A small ditch has been cut through the entire length of the wetland, presumably to facilitate drainage and improve lawn conditions. These drainage improvements appear to be only partially effective, as much of the lawn is subject to saturated soil conditions. Flow passes through two small culverts before exiting the park via a ditch through residential areas to the south. The wetland area is less than 1 acre. Under the Ecology wetland rating system for Western Washington (Hruby 2004), this wetland scores 4 water quality points, 4 hydrologic points, and 8 habitat points for a total score of 16 and a rating of Category IV.

3.7.2 Anadromous fish passage barriers

A number of anadromous fish passage barriers are present in Boeing Creek (Figure 16). At the mouth of Boeing Creek, a large box culvert is present under the BNSF railroad tracks (Photo 14; see Figure 7 for photo locations). This culvert may hinder or prevent upstream fish passage at certain tidal and/or flow conditions, but it is not considered to be a serious obstacle to fish entering the creek from the marine waters of Puget Sound. The culvert was replaced in 1995 in part to improve passage conditions for fish (Tetra Tech/KCM 2004c). Under favorable flow conditions (neither extremely low nor high), fish should be able to enter the creek at some time during normal tidal cycles.

Photo 14. BNSF box culvert at the mouth of Boeing Creek

Upstream of that culvert, salmonids generally have good access to the lower reaches of Boeing Creek for approximately 2,300 ft from the mouth, at which point a series of complete barriers to upstream fish movements has been identified (Figure 16). This series includes:

- Steel-pile dam originally constructed to provide irrigation water to the Seattle Golf and Country Club, but no longer used for this purpose
- Riprap cascades below Innis Arden Way
- Innis Arden Way culvert
- Hidden Lake dam

The Seattle Golf and Country Club's steel-pile dam is approximately 15 ft high and marks a complete and unequivocal barrier to all upstream fish passage, regardless of flow conditions (Photo 15; see Figure 7 for photo locations). The dam was constructed to provide irrigation water to the Seattle Golf and Country Club, but is no longer used for water supply. Sediments have filled in completely behind the dam such that no pool or reservoir remains. The Seattle Golf and Country Club now uses groundwater wells for its irrigation source to manage the golf course grounds.

Photo 15. Seattle Golf and Country Club sheet pile dam (upstream limit of anadromous fish access in Boeing Creek

Between the sheet pile dam and Northwest Innis Arden Way are several large cascades, which are also complete and formidable blockages to upstream fish passage (Photo 16). These blockages include grouting and other manipulations intended to improve armoring of the bed and banks. Photo 16 shows the highest of these cascades, which is waterfall like in appearance.

Photo 16. Grouted riprap cascade upstream of sheet pile dam

Proceeding upstream, there are three migration barriers in close proximity to NW Innis Arden Way that may be thought of as a single, combined barrier: a steep boulder cascade downstream from the roadway culvert (Photo 17), the steep-sloped twin culverts with high-flow velocities under the roadway (Photo 18), the dam and outlet control structure of Hidden Lake, which is located immediately upstream of the roadway (Photo 19).

Photo 17. Dry cascade downstream of NW Innis Arden Way

Photo 18. Culverts under NW Innis Arden Way

Photo 19. Hidden Lake dam and outfall control structure with trash rack

3.7.2.2 Resident fish barriers

Upstream of Hidden Lake, to the confluence of the North and South forks of Boeing Creek and along the North Fork, is a series of placed log weirs that have developed

quite high plunges, up to about 4 ft in height (Photo 20). These are generally barriers to upstream fish movements for resident cutthroat (however, see Section 3.7.4) and planted juvenile coho, which are found in these stream sections.

Photo 20. Channel downcutting below placed log weirs upstream of Hidden Lake; potential migration barriers at certain flow conditions

Finally, definitive migration barriers are identified at M1 dam on the south fork tributary (Photo 21), and at the outlet of the North Boeing Creek detention facility (Photo 22) on the north fork tributary before each of these tributaries enters predominantly piped systems extending farther upstream. In all, potential fish passage problems have been identified in at least eight locations in the Boeing Creek basin, including and downstream of these two detention facilities.

Photo 21. M1 dam outlet on South Fork Boeing Creek.

Photo 22. North Fork Boeing Creek detention facility outfall downstream of dam

3.7.3 Historical fish usage

As described in the previous section, fish entering Boeing Creek from the marine waters of Puget Sound have access for approximately 2,300 ft, from the mouth of the stream to the sheet pile dam. Anadromous salmonids using lower Boeing Creek consist primarily of coho and chum salmon and sea-run cutthroat trout, though occasional Chinook salmon have also been observed (Design 2004). Puget Sound Chinook salmon are listed as threatened under the Endangered Species Act (ESA), as are Puget Sound steelhead, but this latter species has not been documented in Boeing Creek (King County 2001).

Some non-salmonids capable of moving into Boeing Creek from marine waters also have access to, and are expected to be present in, the lower creek to some degree. These fish include stickleback and sculpin. Forage fish species potentially utilizing Puget Sound near the mouth of Boeing Creek include surf smelt, sand lance, Pacific herring, and longfin smelt (SAIC 2011).

Both cutthroat trout and juvenile coho salmon have also been documented upstream of the sheet pile dam migration barrier. Their presence extends upstream of Hidden Lake, but neither have been found upstream of M1 dam outlet on the south fork tributary, or the outlet of the North Pond in-stream detention facility on the north fork tributary. The cutthroat trout found upstream of one or more of the migration barriers described above are believed to be part of an isolated, self-sustaining, non-migratory population. In contrast, the juvenile coho encountered in this area are believed to be present because of outplanting activities associated with "Salmon in the Classroom," or similar programs carried out by a number of local educators and their students in cooperation with the Washington Department of Fish and Wildlife (WDFW) (Design 2004; Barnes 2012). Typically, juveniles are able to reside in these upper stream reaches for a year before migrating downstream to Puget Sound and the Pacific Ocean to mature. However, those coho that survive to return to Boeing Creek as adults are not able to access the upper stream reaches where they lived as juveniles; rather, they are confined to the lower stream reaches downstream of the sheet pile dam for spawning.

Documentation of cutthroat trout distribution along Boeing Creek includes a 1994 *Boeing Creek Tributary 0019 Special Study Report* cited by King County in its *Known Freshwater Distribution of Cutthroat Trout for WRIA 8*. According to the 1994 report, cutthroat were found up to the (then King County, now City of Shoreline) M1 in-stream retention/detention pond. Since these fish were found upstream of several complete migration barriers, an isolated resident population (or populations) is implied.

3.7.4 Current fish usage based on electrofishing

To update past findings, The Watershed Company conducted an electrofishing survey along Boeing Creek upstream from Hidden Lake on June 20, 2012. Coho fry were encountered up to the forks and also a short distance up the north fork tributary. These fish were not unexpected in light of known coho fry releases into upper Boeing Creek

by local school programs a few weeks earlier, on May 22nd and 29th (Barnes 2012). Cutthroat trout were confirmed as present upstream of Hidden Lake, including in each of the forks upstream of the confluence to M1 dam on the south fork tributary, and to the outlet of the North Boeing Detention Pond on the north fork tributary. No fish were found along the open channel section extending upstream of M1 dam. Length data were recorded for the captured fish, but the purpose of the survey was to determine the limits of fish distribution, not to conduct a population size estimate. Captured cutthroat ranged in size from 100 to 247 mm (3.9 to 9.7 in.) with a mean of 160 mm (6.3 in.). Captured coho ranged in size from 69 to 92 mm (2.7 to 3.6 in.) with a mean of 77 mm (3.0 in.).

Only certain sample stream sections were fished, rather than the entire stream length. Sample sections typically included defined pool areas, often those associated with a potential migration barrier such as a log weir, in an effort to determine if the upper limit of distribution might coincide with that feature.

Although several of the large log weirs on the main stem and north fork appear to be substantial barriers (Photo 20), a few cutthroat trout were still found above nearly all of these weirs. The conclusion is that cutthroat trout appear to use upper Boeing Creek stream channels, up to near the detention ponds and dams on each fork, to some degree. However, it is not clear how the few fish found above the higher plunges originally got there. It may be possible for them to move around under certain high-flow conditions, and/or they may have been there for a relatively long period of time. Most of the cutthroat found above potential migration barriers were fairly large, with only a few being medium sized. Based on size, all of the cutthroat trout captured were more than 1 year old. Fry of the year, which should have been relatively abundant, were absent. The smallest cutthroat captured (100 mm) was larger than the largest coho fry (92 mm) captured. Cutthroat fry would be expected to be significantly smaller than coho fry of the same year class, since cutthroat are smaller at emergence and emerge later (by at least one month) than coho fry. One explanation is that the relatively few larger cutthroat found upstream of one or more of the weirs neither move around nor reproduce to a great extent. Electrofishing results and sampling locations are provided in Appendix D.

3.7.4 General habitat conditions

Habitat conditions in and along Boeing Creek exhibit extreme contrast. Large areas of mature forest are present in the lower portions of the basin, including some old-growth trees, while the upper portions, where nearly all of the upper stream segments are piped, are very urbanized.

Habitat conditions along the main stem of Boeing Creek and its north and south tributaries within Shoreview and Boeing Creek Parks benefit notably from generally forested conditions along both banks of the stream segments. These forested areas include approximately 6 acres of riparian forest adjacent to Boeing Creek (ranging from 100 to 250 ft wide), and more than 30 acres of coniferous and coniferous/deciduous

forest in Boeing Creek and Shoreview Parks (Seattle Urban Nature 2008). Extending upstream from Hidden Lake along the main stem of Boeing Creek, sand and silt are dominant in the substrate, and areas of riprap bank stabilization are evident. Significant slope failures have occurred in this area due to sandy soils in combination with high peak flows. As described previously, several log and concrete weirs are present that may hinder fish passage, particularly during low flows.

From NW Innis Arden Way, Boeing Creek flows downslope to a steel pile dam that acts as a complete barrier to upstream fish passage. From the steel-pile dam, the stream descends 2,300 ft through maturing forest to the mouth of the creek. Many stream sections below the dam have experienced adjoining sideslope failure, resulting in a substrate that has been filled in with fine sediments. Such substrate conditions generally provide poor spawning habitat for salmonids (King County 1994). Though the lower portions of the Boeing Creek basin still contain natural stream channels and seep-supported wetlands, such natural watercourses and wetlands are largely absent from the upper basin due to extensive human alteration. As a result of the loss of these natural habitat features in the upper basin, higher peak flows and associated increases in erosion and sedimentation have occurred along the lower channel sections, despite the high-quality forested areas these sections pass through (SAIC 2011). Lower Boeing Creek flows through a ravine that includes a fairly wide riparian forest, much of it fairly mature, and the riparian zone in the lower stream reaches is among the best riparian habitat of any direct drainage into Puget Sound in water resource inventory area (WRIA) 8. This forested area has contributed a substantial amount of large woody debris (LWD) to the stream channel, which has in turn helped retain some pool complexes and fish habitat amidst slope failures and associated sediment loading of the stream (Kerwin 2001).

3.7.5 Vegetation/forested cover

Though the Boeing Creek basin has experienced little recent development, past extensive urban development on the upper plateau has resulted in the removal of most forested areas there, as well as any wetlands that may have existed pre-development. However, between the mouth of Boeing Creek at Puget Sound and the stormwater retention/detention facilities on each fork, the Boeing Creek channels in the lower basin pass through wooded ravines forming a fairly continuous green belt of mid- to late-seral-stage forest (Kerwin 2001). Forested uplands between Innis Arden to the north and the Highlands to the south, and including Shoreview Park and Shoreline Community College, make the Boeing Creek basin the most heavily forested basin in the City (Tetra Tech/KCM 2004b). Included in these forested areas are a few old-growth Douglas fir trees.

Most of the forested areas that remain in the lower basin are characterized by a mixed conifer-deciduous upper canopy that includes western red cedar, western hemlock, Douglas fir, Pacific madrone, red alder, and big leaf maple. Some areas are more heavily dominated by conifers than others. Understory vegetation in the basin has been

moderately disturbed by the introduction of non-native ivy (Photo 23) and Himalayan blackberry. However, a full complement of native plants populate the less-disturbed portions, including sword fern, lady fern, salmonberry, red huckleberry, devil's club, hazelnut, vine maple, Oregon grape, ocean spray, and salal (Tetra Tech/KCM (2004b) and 2011 field observations).

Photo 23. Example of ivy along dry Boeing Creek ravine

Non-native plant species found in the subbasin include numerous ornamental species associated with plantings by private and public landowners. Exotic species of plants more closely associated with riparian and aquatic environments include Scotch broom (noted in Shoreview Park), reed canarygrass, and Himalayan blackberry (Kerwin 2001).

3.8 WATER QUALITY

The City has been monitoring the ecological health of Boeing Creek in several ways, including the collection and analysis of water and benthic invertebrate samples. Water quality samples have been collected monthly at two stations in Boeing Creek since 2001: Station BC-2 (north branch of Boeing Creek) and Station BC-3 (south branch of Boeing Creek), both located downstream of the North Pond dam confluence (Figure 17). The north and south branches of Boeing Creek merge approximately 250 ft downstream of the sampling locations (Williams 2010). Monthly water quality samples have also been collected from Hidden Lake (Station HLO-1), specifically from the lake outlet point at the south end of the lake. Benthic macroinvertebrates were also sampled at Station BC-2, as well as a second site (BC-4 [mouth of Boeing Creek]) in 2002 and 2007.

Legend	
Avg	Average
DO	DIssolved Oxygen (mg/L)
FC	Fecal Coliforms (col/100 mL)
Max	Maximum
Min	Minimum
n	Number of Samples
Temp	Temperature (°C)
TN	Total Nitrogen (mg/L)
TP	Total Phosphorus (mg/L)
TSS	Total Suspended Solids (mg/L)
Turb	Turbidity (NTU)

BC-3

	Temp	DO	pH	FC	TN	TP	TSS	Turb
Criteria	16	9.5	6.5 - 8.5	50				
Avg	10.5	10.1	7.83	10	1.477	0.0448	1.55	2.8
Min	6.4	0.12	4.90	0	0.653	0.0285	0.25	0.0
Max	13.7	12.64	8.50	560	1.920	0.0794	29.0	52.4
n	142	142	134	51	51	51	51	133
Exceedances	0	24	1	8				

BC-2

	Temp	DO	pH	FC	TN	TP	TSS	Turb
Criteria	16	9.5	6.5 - 8.5	50				
Avg	10.1	9.56	7.72	8	0.95	0.0378	1.9	2.7
Min	5.9	0.98	5.61	0	0.602	0.0242	0.06	0.0
Max	20.5	12.36	8.70	1000	1.350	0.1210	44.5	52.4
n	155	155	145	51	51	51	51	146
Exceedances	2	61	3	7				

HLO-1

	Temp	DO	pH	Turb
Criteria	16	9.5	6.5 - 8.5	
Avg	10.8	10.0	7.76	4.1
Min	5.1	0.95	6.32	0.0
Max	20.5	16.0	8.92	32.5
n	139	138	130	128
Exceedances	8	50	8	

Shoreline

Water quality monitoring station

Boeing Creek

Open water course

Piped water course

Wetlands

Tax parcel

Boeing Creek basin

Einstein Middle School

Hillwood Park

Crista Senior Ministries

St Luke Catholic School

Shorewood Senior High School

Boeing Creek Park

BC-3

BC-2

HLO-1

Shoreview Park

Boeing Creek Reserve

Boeing Creek

Shoreline Community College

Sears Shopping Center

NW 175TH ST

N 175TH ST

CARLYLE HALL RD

AURORA AVEN

Interurban Trail

N 165TH ST

NW INNIS ARDEN W

GREENWOOD AVE N

WEST MINSTER WY N

N 145TH ST

PUGET SOUND

Notes:
1. Temperature, DO, pH, and Turbidity data from 2001-2011
2. Fecal coliform, TN, TP, and TSS data from 2007-2011
3. Temperature, DO, and pH: WAC 173-201A-200 criteria for Core Summer Salmonid Habitat
4. Fecal coliform: WAC 173-201A-200 criteria for Extraordinary Primary Contact Recreation
5. Fecal coliform criteria and average are geometric mean values

Wind Ward environmental LLC

N

0 250 500 Yards

0 200 400 Meters

Figure 17. Boeing Creek monitoring stations and data

Prepared by craigh, 12/27/2012, W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 17 5147 Water quality.mxd

3.8.1 Boeing Creek and Hidden Lake

Water quality samples from Boeing Creek and Hidden Lake are analyzed monthly, *in situ*, for pH, dissolved oxygen (DO), temperature, turbidity, conductivity/specific conductivity, and flow rate (estimated visually) using field instruments. Beginning in 2007, water samples from Stations BC-2 and BC-3 (but not from Station HLO-1) were also collected and analyzed for fecal coliform (FC) bacteria, nitrogen, phosphorus, and total suspended solids (TSS) so that water quality in the two branches of Boeing Creek could be assessed using Ecology's water quality index (WQI) scoring matrix. Table 13 presents a summary of the water quality parameters identified for evaluation in Boeing Creek. Raw monitoring data are included in Appendix E and summary statistics are presented in Figure 17.

Table 13. Water quality monitoring conducted by the City of Shoreline

Monitoring Station ID and Location	Portion of Stream Measured for Water Quality	Ambient Parameters (2001–2011)	WQI Parameters (2007–2011)
		pH, DO, Temp., Turb., Conductivity, Spec. Cond., Flow	FC, TN, TP, TSS
BC-2	lower Boeing Creek	yes	yes
BC-3	upper Boeing Creek	yes	yes
HLO-1	Hidden Lake Outlet	yes	no

DO – dissolved oxygen
FC – fecal coliform
ID – identification
TN – total nitrogen
TP – total phosphorus
TSS – total suspended solids
WQI – water quality index

Monitoring results are compared to Washington State water quality standards, which are designed to protect public health and aquatic life. Washington Administrative Code (WAC) 173-201A-602 does not specifically identify Boeing Creek or Hidden Lake; however, it does identify "fresh surface waters that are tributaries to extraordinary aquatic life marine waters" (WAC 173-201A-610 through 173-201A-612). WAC 173-201A-612 designates Puget Sound as an extraordinary aquatic life marine water; therefore, as a tributary to Puget Sound with no supplemental spawning requirements, Boeing Creek is to be protected for the designated uses of core summer salmonid habitat; extraordinary primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.

The water quality criteria (WQC) for temperature, DO, pH, and bacteria (FC) corresponding to the designated uses (WAC 173-201A-200) are listed in Table 14.

Table 14. Water quality criteria (WAC 173-201A-200) for unnamed freshwater tributaries to extraordinary aquatic life marine waters

Category	DO (Lowest 1-Day Min.)	Temperature (Highest 7-Day Max.)	pH	Fecal Coliform Bacteria (FC)
Core summer salmonid habitat	9.5 mg/L	16°C (60.8°F)	6.5 – 8.5	na
Extraordinary primary contact recreation	na	na	na	geomean < 50 colonies/ 100 mL, with < 10% of samples > 100 colonies/100 mL

DO – dissolved oxygen
FC – fecal coliform
na – not applicable
WAC – Washington Administrative Code

Water quality in Boeing Creek appears to be typical of urban streams in the Puget Sound area:

- Most ambient water temperatures met the listed 16°C criterion for core summer salmonid habitat at both BC-2 and BC-3 (< 1% exceedances). A 2007 bioassessment report on City streams (Watershed Company 2007) indicated that in the lower study reaches of Boeing Creek, percent canopy closure did not change significantly between 2003 and 2007. Additionally, the lower reaches of the creek flow through a deep, well-forested ravine, receiving good shading and protection from a canopy composed of native trees and shrubs and broad riparian buffers (more than 200 ft on either side).
- DO was inversely correlated with temperature (Figure 18). At both BC-2 and BC-3, DO concentrations of less than the 9.5 mg/L criterion were often (but not always) observed in warmer water temperatures, usually 10°C or above. There were more than double the number of exceedances at station BC-2 (n=61) than at station BC-3 (n=24).. When DO was observed below the criterion, it usually remained above 7.5 mg/L, less than 2 mg/L below the criterion.
- FCs occasionally exceeded the criterion (50 colonies/100 mL) at both BC-2 (14% exceedances) and BC-3 (16% exceedances); however, the overall geometric mean at each station (8.2 and 9.7 colonies/100 mL, respectively) did not exceed the criterion. The maximum value observed at either BC-2 or BC-3 (1,000 colonies/100 mL), while of concern, does not indicate severe pollution.

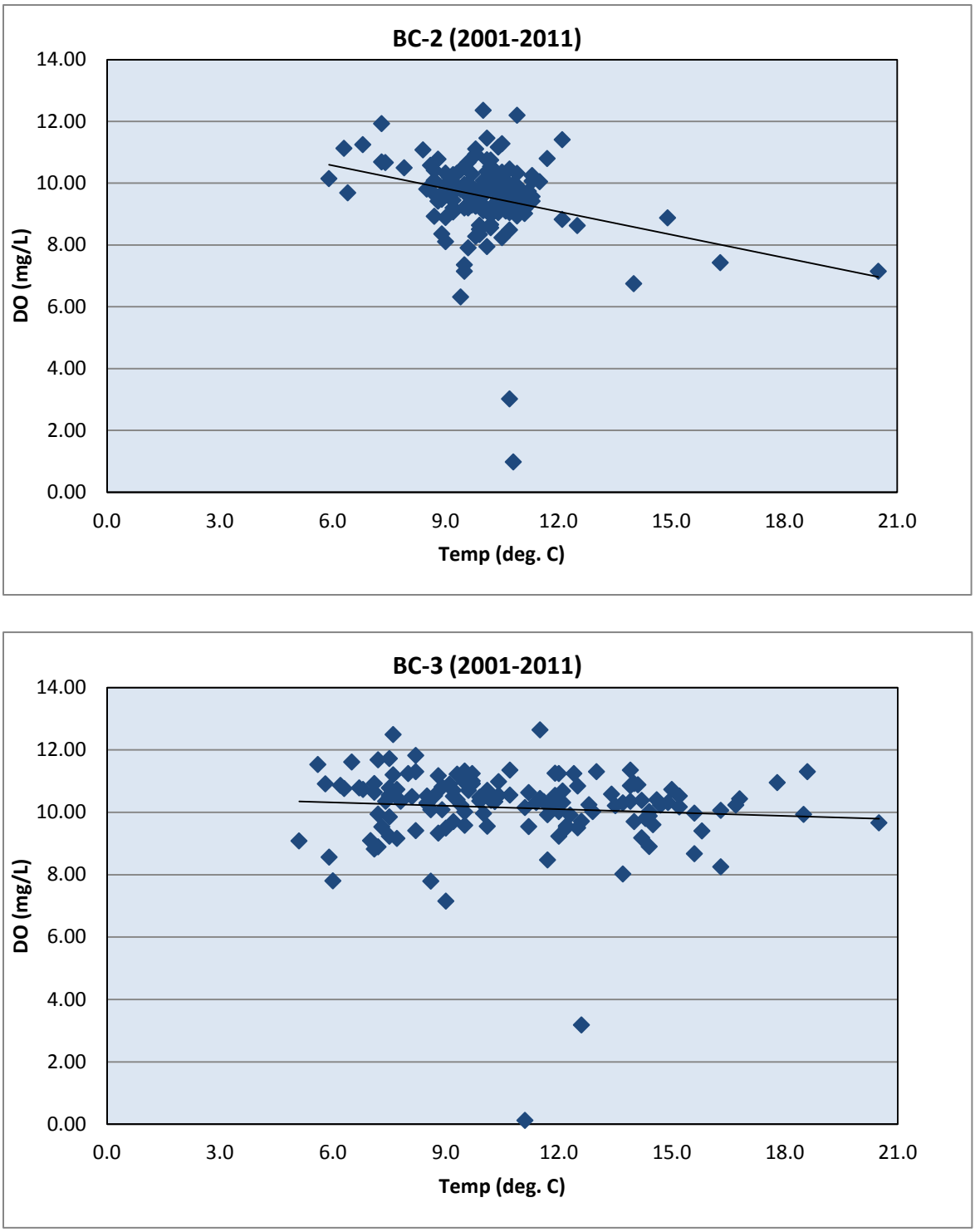


Figure 18. Dissolved oxygen versus ambient water temperature at BC-2 and BC-3

Ecology did not include the City's data in its 2008 water quality assessment (i.e., the "303(d) list," or determination of impaired water bodies) (Ecology 2008). No impaired water body segments were identified for Boeing Creek; however, this may have been due to a lack of available data, rather than definitive data showing that Boeing Creek met tested standards.

In 2007, the City started collecting the additional data required to use Ecology's WQI scoring matrix (Hallock 2002) at Stations BC-2 and BC-3, in order to evaluate the relative conditions of City streams. The WQI parameters are FCs, total phosphorous, total nitrogen, TSS, DO, pH, temperature, and turbidity. WQI parameter data were not collected at Station HLO-1. Monthly data for each water year are entered into a formula spreadsheet, and a water quality score is calculated for each stream. Temperature, pH, FC, and DO data are compared to Washington State WQC (WAC 173-201A-200). Nutrient and sediment data with no specific criteria are compared to expected conditions for the stream ecoregion (Omernik 1987).

The WQI score is a unitless number ranging from 1 to 100, with higher numbers indicating better water quality. Scores of 80 and greater mean expectations for water quality are generally met, and the streams are considered to be of lowest concern (i.e., the least impaired). Scores of 40 to 80 indicate marginal concern (i.e., moderate impairment), while scores below 40 indicate that the stream did not meet expectations (i.e., is of "highest concern). Table 15 shows the WQI scores for Stations BC-2 and BC-3 for the water years 2007/2008 through 2010/2011, calculated using the most recent version of the matrix (version 5, updated on September 9, 2009); copies of the WQI spreadsheets are included in Appendix F.

Table 15. Water Quality Index scores and impairment levels for Boeing Creek

Station	Water Year	WQI Score[a]	Impairment Level
Boeing Creek (BC-2)	2007–2008	55	moderate concern
	2008–2009	73	moderate concern
	2009–2010	61	moderate concern
	2010–2011	59	moderate concern
Boeing Creek (BC-3)	2007–2008	61	moderate concern
	2008–2009	75	moderate concern
	2009–2010	65	moderate concern
	2010–2011	62	moderate concern

[a] Calculated using Ecology WQI Spreadsheet Version 5: 2009.09.09.

Ecology – Washington State Department of Ecology

WQI – water quality index

WQI scores for both Boeing Creek stations ranged from 55 to 75, indicating that the water quality in Boeing Creek is of moderate concern due to impacts from urbanization. A breakdown of the WQI scores by parameter for each station is shown in Figure 19.

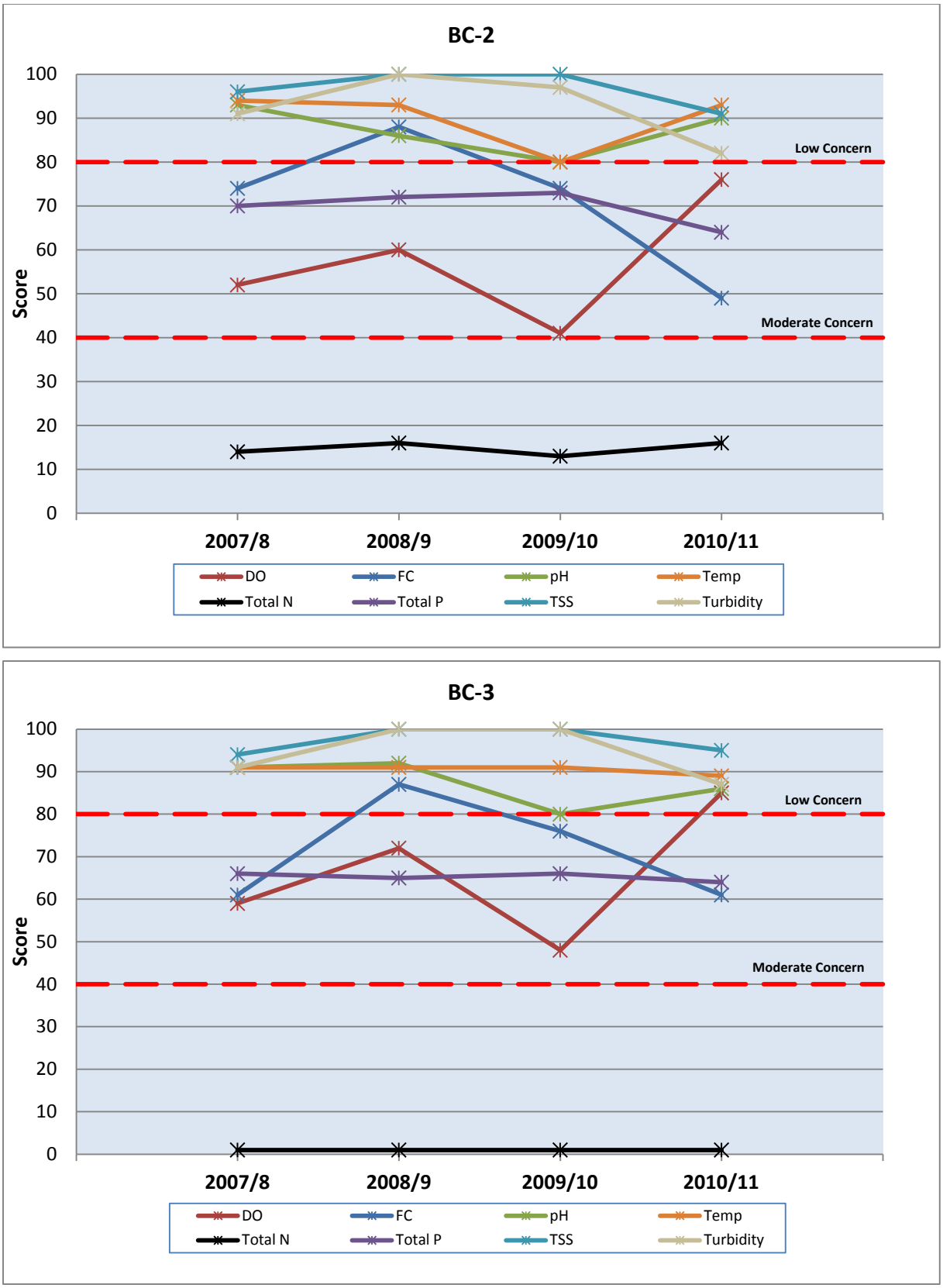


Figure 19. Boeing Creek water quality index scores by parameter

WQI scores for individual parameters show that DO, FC, phosphorus, and nitrogen levels have the greatest impact on water quality in Boeing Creek. Phosphorus and nitrogen do not have Washington State WQC; the WQI scores for these parameters are based on a comparison against a distribution of historical monitoring data during high- and low-flow seasons from stations within a similar ecoregion. Poor index scores for these constituents indicate poor water quality relative to other stations in the same ecoregion, and may not necessarily indicate impairment or inability to support beneficial uses (Hallock 2002). However, an EPA (2000) guidance document for supporting the development of state and tribal nutrient criteria in the Puget Sound lowlands (ecoregion 2) presents reference values for both total phosphorus (0.0195 mg/L) and total nitrogen (0.24 mg/L), based on historical monitoring data at reference locations within the lowlands region (EPA 2000). It should be noted that these values are not laws or regulations—they are only guidance that states and tribes may use as a starting point for the development of water quality standards. However, when compared to these values, all of the samples collected from Boeing Creek (at both Stations BC-2 and BC-3) from 2007 to 2011 were in exceedance of both parameters.

The WQI is designed to indicate how well water quality at a given station meets expectations, not how good the absolute quality is. However, the parameters are compared to state water quality standards and take into account critical parameters for which no standards currently exist. The WQI summaries present data in an easily understood format that can demonstrate overall water quality conditions to political decision makers, non-technical water managers, and the general public. Further details about the WQI, as well as the latest version of the spreadsheet developed for WQI calculations, can be found on Ecology's website (http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html).

3.8.2 Benthic invertebrates

The City has monitored stream health in Boeing Creek by collecting samples of benthic invertebrates for assessment. Benthic invertebrates are an important link in the food chain for fish in the creek, and are an excellent indicator of stream health. In both 2003 and 2007, benthic invertebrate samples were collected and analyzed, and benthic invertebrate index scores were calculated for Boeing Creek using the Benthic Index of Biotic Integrity (B-IBI). The B-IBI is a quantitative scoring system based on field samples of benthic macroinvertebrates. The scores are based on richness (i.e., diversity), density, and tolerance of species to pollutants. In general, lower scores indicate poor habitat conditions (including water quality), and higher scores indicate better habitat conditions.

Why are benthic invertebrates good indicators of stream health?

Benthic invertebrates are an important link in the food chain and their presence/absence, diversity, species type, and population densities provide important information about water quality and aquatic habitat conditions.

The overall effects of urbanization were most evident in the B-IBI wherein biological impairment of Boeing Creek was rated as extreme (Station BC-2 B-IBI = 14, Station BC-4 [Mouth] B-IBI = 14) in 2007. The 2007 results differed little from those reported in 2003, when Stations BC-2 and BC-4 received low B-IBI scores (12 and 14, respectively) (Watershed Company 2009). Other observations from the 2007 study included:

- Overall macro-invertebrate taxa richness in Boeing Creek was very low; community compositions suggest that nutrient enrichment or organic pollutants are present in the stream system. Evidence of "catastrophic events," possibly including thermal extremes, periodic de-watering, habitat disruption, or extended periods of low DO, was evident in the upper reach of Boeing Creek based on the macro-invertebrate community.
- Fine sediment deposition has likely limited macro-invertebrate access to stony substrate habitats.
- Pool habitats in upper Boeing Creek, while limited in percent area, were of relatively high quality. Percent pool area in lower Boeing Creek was greater than observed in the upper sample reach, and quality was also relatively high (Watershed Company 2009).

3.8.3 Water quality projects completed

Water quality improvements have been implemented in the Aurora Avenue corridor through recent projects, including the addition of a wetland to Darnell Park pond in 2009, and the addition of water quality treatment facilities along Aurora Avenue between 145th and 185th Streets since 2008 as part of the Aurora Avenue Corridor Improvement Project (SAIC 2011).These water quality facilities include rain gardens, Filterra® systems, and storm filter cartridge vault systems.

4 Community and Regulatory Framework

4.1 COMMUNITY STAKEHOLDERS

The Boeing Creek basin encompasses portions of the following City neighborhoods: Innis Arden, Hillwood, Richmond Highlands, Highland Terrace, Westminster Triangle, the Highlands, and minor parts of Meridian Park and Parkwood. The Innis Arden, Highlands, and Highland Terrace neighborhoods have the most direct connection to Boeing Creek, with Boeing Reserve and Highlands community property being located along the largest open channel and most natural section of the creek. Additionally, Shoreview and Boeing Creek Parks in the Highland Terrace neighborhood encompass Boeing Creek and an extensive trail network. Shoreline Community College is located adjacent to Shoreview and Boeing Creek Parks, and students in geography and geology classes regularly use Boeing Creek as an outdoor classroom (Dodd 2011).

4.1.1 Public meetings and outreach

Two open houses were held to solicit public input on the Boeing Creek Basin Plan. The first one was held at Shoreline City Hall on September 14, 2011. The purpose of the first open house was to gather input from Boeing Creek basin residents and interested parties as to stormwater-related issues in the basin. The second open house was held in Boeing Creek Park on August 28, 2012, to present draft findings and potential solutions to the Boeing Creek stormwater issues. The issues residents expressed interest in included water quality (including the treatment of stormwater runoff) and the condition of aquatic and terrestrial habitat. Suggestions from residents included signage to indicate basin boundaries, such as "you are now entering the Boeing Creek Basin," similar to signs used in other jurisdictions to indicate streams and water bodies that receive runoff from upland surfaces. Another suggestion was to implement a restoration project to enhance a small open-channel section of Boeing Creek in Hillwood Park. The initial findings for the Boeing Creek basin plan will be presented to the City Council on November 13, 2012.

4.1.2 Public priorities for surface water identified in 2011 surface water comprehensive plan

Public priorities for City-wide surface water were identified during the review process of the 2011 surface water comprehensive plan (SAIC 2011) and are as follows:

- Water quality
- Flooding
- Aging drainage pipes/facilities and aquatic habitat (identical priority)
- Sustainability
- System maintenance

- Keep rates affordable
- Public outreach

4.2 REGULATORY FRAMEWORK

The City governs land use, stormwater, and the use of natural resources through codes and ordinances that are specific to the City, or dictated by overarching state and federal regulations. These regulations, along with the goals outlined in the City's comprehensive plan (City of Shoreline 2011c), were considered in the development of solutions to address stormwater management issues in the Boeing Creek basin. Table 16 summarizes existing federal, state, and local regulations related to stormwater runoff and natural resources, and the relevance of these regulations to the Boeing Creek basin.

Table 16. Regulatory framework of surface and stormwater management in the Boeing Creek basin

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Boeing Creek Basin
CWA	Ecology	NPDES Phase II Municipal Separate Storm Sewer System Permit	Eliminate discharge of pollutants into the nation's water, and achieve water quality levels that are protective of beneficial uses.	The City is a NPDES Phase II permittee and must comply with conditions of the permit. The permit is currently entering its second cycle, and new conditions are likely in the next phase of the permit (beginning in 2013).
	Ecology	Surface Water Quality Standards	Protect and regulate the quality of surface water in Washington State by 1) sustaining designated uses, 2) meeting numeric WQC, and 3) implementing anti-degradation policies.	Boeing Creek is not listed on the state's 303(d) list for non-compliance with water quality standards.
	Ecology and USACE	Sections 401 and 404	Requires a permit of activities classified by the USACE for dredge or discharge of fill material to Waters of the United States.	Boeing Creek and associated wetlands and Puget Sound are considered Waters of the United States. In-water activities that meet minimum dredge and fill limits require a permit.

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Boeing Creek Basin
Tribal Agreements and Related Case Law	Muckleshoot Tribe	na	Protect fish populations in traditional fishing grounds of Native American tribes.	The Muckleshoot Tribe is party to SEPA review of development proposals within the Boeing Creek basin.
ESA	USFWS and NOAA Fisheries in consultation with lead federal agencies	na	Prevent further decline of listed terrestrial and aquatic species.	Puget Sound Chinook salmon, listed as endangered under ESA, have been observed in the lower reach of Boeing Creek (Design 2004). Any projects that require federal permits or approvals and have the potential to impact Chinook salmon would require consultation with NOAA Fisheries under Section 7 of the ESA.
SEPA	City conducts review and issues SEPA determinations on proposed projects within its jurisdiction	na	Identify and require mitigation of the environmental impacts of proposals and programs.	SEPA is used to address impacts from projects in the Boeing Creek basin that are not covered in other City code requirements.
Shoreline Management Act	City (master plan)	na	Protect use and functions (economic, ecological, aesthetic) of shoreline areas.	Boeing Creek discharges to Puget Sound, which is included in the City's Master Program.
Washington State Hydraulic Code	WDFW	na	Set requirements for placement of culverts and other hydraulic devices that may affect fish use.	Projects within the ordinary high water mark of streams must obtain a Hydraulic Project Approval permit from WDFW. Culverts must be passable by fish where fish are present.
GMA	City	City comprehensive plan	Regulate land use to meet growth targets while providing necessary services and protecting sensitive environmental resources.	na
Water Quality Protection Act	Ecology	Puget Sound Partnership	Provide an integrated stormwater management program to protect and restore Puget Sound.	Boeing Creek discharges to Puget Sound and has a small but direct effect.

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Boeing Creek Basin
Chapter 13.10 Surface Water Utility	City	drainage standards for new and redevelopment	Promote public health, safety, and welfare by providing design, construction, and maintenance criteria for permanent and temporary surface water drainage facilities for development and redevelopment activities.	The City has adopted the 2005 *Stormwater Management Manual for Western Washington* (Ecology 2005); however a new version is now available.

City – City of Shoreline
CWA – Clean Water Act
Ecology – Washington State Department of Ecology
ESA - Endangered Species Act
GMA – Growth Management Act
na – not applicable
NOAA – National Oceanic and Atmospheric Administration
NPDES – National Pollutant Discharge Elimination System
SEPA – State Environmental Policy Act
USACE – US Army Corps of Engineers
USFWS – US Fish and Wildlife Service
WDFW - Washington State Department of Fish and Wildlife
WQC – water quality criteria

A thorough review and description of relevant codes and their relationship to the City can be found in the City's *Surface Water Master Plan Update* (SAIC 2011). Additionally, key National Pollutant Discharge Elimination System (NPDES) permit changes that may affect the City's stormwater management activities in the Boeing Creek basin, as well as the rest of the City, are discussed in that report.

4.3 CITY'S COMPREHENSIVE PLAN AND THE BOEING CREEK BASIN

The following statement is an excerpt from the City's vision statement in the comprehensive plan:

> Shoreline is a regional and national leader for living sustainably. Everywhere you look there are examples of sustainable, low impact, climate-friendly practices come to life- cutting edge energy-efficient homes and businesses, vegetated roofs, rain gardens, bioswales along neighborhood streets, green buildings, solar-powered utilities, rainwater harvesting systems, and local food production to name only a few. Shoreline is deeply committed to caring for its seashore, protecting and restoring its streams to bring back the salmon, and to making sure its children can enjoy the wonder of nature in their own neighborhoods.

Several elements of this vision statement directly relate to stormwater management and the implementation of low-impact development opportunities. As discussed in Section 4.1, the Boeing Creek basin was developed at a time when stormwater management facilities neither required nor routinely constructed with new development. Today, state, regional, and local leaders understand the impact of development without stormwater mitigation. That being said, it would be a monumental task to retrofit areas such as Boeing Creek with current stormwater controls, let alone low-impact development alternatives, which typically require space where none may exist. As lots are redeveloped over time, the Boeing Creek basin will

slowly be retrofit with stormwater controls. However, realistic expectations that balance resources against potential benefits must be considered in the short-term future. The list of recommended projects and solutions in Section 5 has been compared to goals outlined in the City's comprehensive plan, where applicable, in an effort to promote consistency.

5 Summary of Basin Issues and Recommended Strategies

The specific built and natural characteristics of the Boeing Creek basin, along with associated issues and potential solutions, are shown in Figure 19. Many of the current issues in the Boeing Creek basin began with the development of the Aurora Avenue corridor, piping of stream flow, and increased stormwater discharges to highly erodible segments of Boeing Creek. Starting with King County in the 1980s and continuing with the City from the mid-1990s, efforts have been made to repair and prevent further degradation of Boeing Creek. With respect to stormwater management, the following beneficial characteristics and deficiencies have been noted:

Beneficial characteristics:

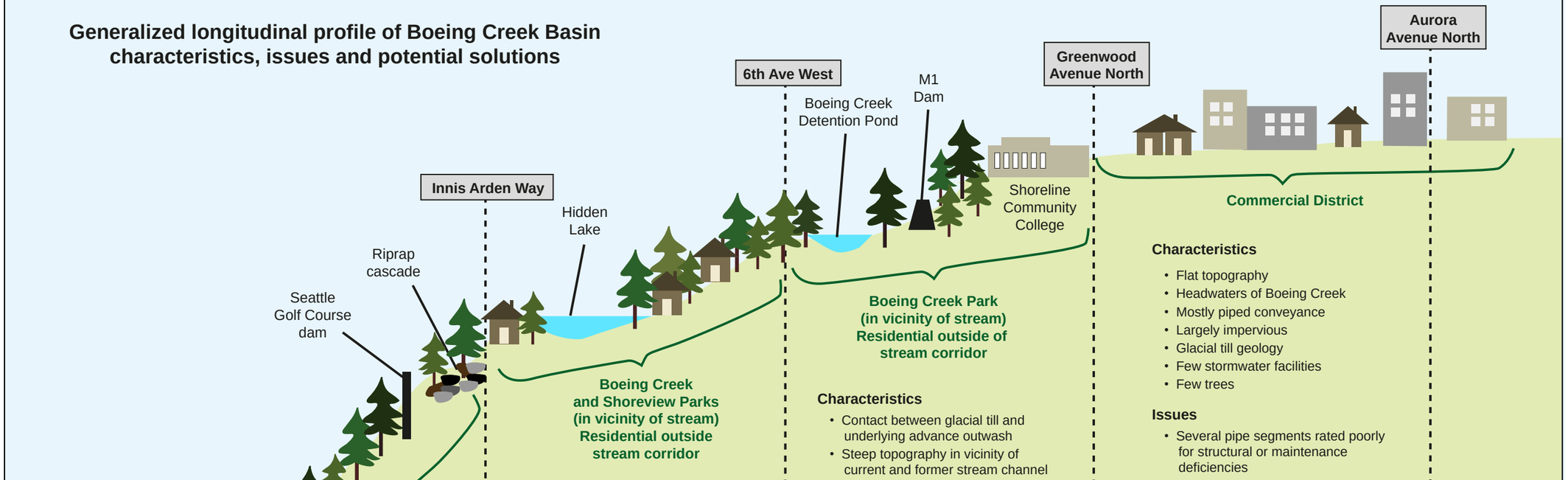
- Boeing Reserve and Shoreview and Boeing Creek Parks provide fish habitat (anadromous and resident fish, such as cutthroat trout, in the lower 0.5 mile, and only resident fish in the upper reaches), excellent riparian conditions, and forest canopy. The Boeing Creek basin has the largest contiguous forested area in the City, and water quality conditions are better in Boeing Creek than in any other monitored stream in the City.
- Glacial advance outwash geology at relatively shallow depths provides shallow and deep infiltration opportunities for stormwater retrofit. Deep stormwater infiltration wells were recently installed at Shoreview Senior High School, indicating this technology may be a viable alternative to surface stormwater discharges.
- Very few chronic flooding problems exist outside of areas where solutions have already been implemented.

Deficiencies

- Approximately 16% of the pipes are in fair to poor condition and will need to be replaced in the next 20 years. An additional 8% of the pipes need to be addressed immediately (i.e., within 5 years).
- Multiple impassable fish barriers limit upstream access for anadromous fish, and potentially limit movement of resident fish confined to the upper reaches of Boeing Creek.
- Stormwater management facilities to mitigate runoff from developed areas are primarily limited to large, in-stream facilities at the heads of the open channel sections of Boeing Creek. Management of stormwater closer to the source could improve conditions and augment the functionality of these facilities.
- Glacial outwash geology in areas of steeper slopes is very erodible. Geologic conditions, combined with excessive stormwater inputs from upstream development, have contributed to major hillslope and channel instability issues in and adjacent to Boeing Creek.

- Sediment input from hillslope and bank erosion is deposited in low-gradient reaches, causing aggradation of sedimentation in spawning gravels, as well as maintenance issues in Hidden Lake.
- Water quality is of moderate concern, primarily because of FC bacteria and high nutrients.
- Low B-IBI scores in Boeing Creek are representative of extreme biological impairment.
- Localized flooding appears to be primarily related to clogged culverts and ditches, rather than hydraulic constrictions in the system.
- Water quantity is of concern in the Boeing Creek basin, as evidenced by Ecology's recent decision to close the basin to further appropriation of surface and ground water. Several applications for new water rights have been denied.

Generalized longitudinal profile of Boeing Creek Basin characteristics, issues and potential solutions



Innis Arden Boeing Reserve and Highlands (forested ravine)

Characteristics

- Contact between advance glacial outwash and underlying transitional beds (clay deposits)
- Seepage at geologic contact
- Local landslides/slumps
- Sediment deposition zone in lower reaches (low gradient)
- Wide forested riparian area

Issues

- Blocked fish passage above dam and rip-rap cascade
- Pools filled with sediment
- Stormwater discharges onto erosive slopes

Potential Solutions

- Tightline discharges to stream channel
- Remove dam (determine use)

Boeing Creek and Shoreview Parks (in vicinity of stream) Residential outside stream corridor

Characteristics

- Glacial advance outwash geology
- Sediment deposition zone in Hidden Lake
- Local landslides along valley walls
- Forested in stream vicinity

Issues

- Maintenance dredging at Hidden Lake
- Blocked fish passage under Innis Arden Way and Hidden Lake dam and weirs in park

Potential Solutions

- Restoration of Boeing Creek and Hidden Lake to minimize maintenance and improve fish passage for resident fish

Boeing Creek Park (in vicinity of stream) Residential outside of stream corridor

Characteristics

- Contact between glacial till and underlying advance outwash
- Steep topography in vicinity of current and former stream channel
- Piped conveyance outfalls to open streams
- M1 dam, Boeing Creek Detention pond and Pan Terra pond stormwater facilities
- Forested in stream vicinity

Issues

- In-stream fish barriers (weirs)
- Localized erosion on hillslopes and trails
- Lack of stormwater quality treatment (fair water quality conditions)

Potential Solutions

- Restoration of trail and stream within park
- Public education and outreach for water quality issues in upstream neighborhoods

Commercial District

Characteristics

- Flat topography
- Headwaters of Boeing Creek
- Mostly piped conveyance
- Largely impervious
- Glacial till geology
- Few stormwater facilities
- Few trees

Issues

- Several pipe segments rated poorly for structural or maintenance deficiencies
- Localized flooding (many, if not all flooding issues have been resolved)
- Clogged catch basins and ditches
- Large areas of untreated flow (water quantity and quality)

Potential Solutions

- Retrofit large impervious areas as commercial areas get redeveloped
- Stream restoration/pipe daylighting opportunities, where appropriate (Hillwood Park, Interurban Trail)

Not to Scale

Wind Ward environmental LLC

Figure 20. Schematic of Boeing Creek basin characteristics, issues, and potential solutions

The existing stormwater-related issues are connected mostly to urbanization that, largely, occurred prior to the City's incorporation in 1995. The Boeing Creek basin was, by and large, built out prior to 1990, when modern stormwater management techniques started to be employed in order to reduce water quality problems and erosion in small stream channels. However, large--scale erosion and sedimentation issues that developed in Boeing Creek, as well as flooding issues in the Happy Valley neighborhood, resulted in the construction of several stormwater facilities designed to control peak flows and limit downstream flooding and erosion. Stabilization strategies in Boeing Creek were extreme: the stream channel was filled in many places with concrete and asphalt debris and large rocks, particularly downstream of M1 dam and Innis Arden Way.

The basin is largely developed, but the larger forested park properties (i.e., Boeing Reserve, Boeing and Shoreview Parks, and private parcels in the Highlands) are unlikely to be developed in the future, because they are either public or private park land or part of a neighborhood with an aesthetic that values open space. The potential for significant land use changes in this basin is from the redevelopment of properties not currently developed to their full potential for their zone, or from larger institutions that could improve or expand their existing operations (i.e., Crista Ministries and Shoreline Community College). Additionally, the City has plans for redevelopment in what will be the Shoreline Town Center. Under current stormwater regulations, as redevelopment occurs, stormwater management practices will be implemented where none currently exist. In order to speed up the process, Windward has recommended some potential options for stormwater retrofit, described below.

The following comprehensive plan (City of Shoreline 2011c) goals were used as a filter in the identification of strategies recommended below:

Goal LU XVII: Manage the stormwater and surface water system through a combination of engineered solutions and the preservation of natural systems in order to:

- Provide for public safety
- Prevent property damage
- Protect water quality
- Preserve and enhance fish and wildlife habitat and critical areas
- Maintain a hydrologic balance

Goal LU XVIII: Preserve, protect, and where feasible, restore wetlands, shoreline, surface water, and ground water for wildlife, appropriate human use, and the maintenance of hydrological and ecological processes.

Goal LU XIX: Use education as a tool to increase protection of critical areas and understanding of environmental values.

5.1 RECOMMENDED STRATEGIES

The recommended strategies discussed in this section include capital projects, programmatic and policy-oriented changes, and educational programs to affect social change for improved water quality and stormwater management functions. It should be noted that certain projects to improve anadromous fish passage are not included in the recommended list of strategies at this time, because of the sheer magnitude such projects would require. As discussed in Section 3.7.2, there are at least four fish passage barriers downstream of Hidden Lake that prevent upstream migration of salmonids from Puget Sound. In order to give salmonids access to appreciable upstream habitat, all of these barriers would need to be eliminated. Whereas these projects are not recommended at this time, they may be worth considering as part of an overall restoration strategy for Boeing Creek.

The projects are discussed according to the type of issue addressed by the recommendation (i.e., water quality improvement, minimization of erosion, improvement of fish passage, infrastructure maintenance and repair, etc.). However, most recommendations to solve specific issues will also have secondary benefits, which are also described. Table17 and Figure 21 list the recommended stormwater management strategies. Individual recommendations are also discussed below.

Table 17. Summary list of recommended projects

Issue	How was it Identified?	Specifics	Projects					
			 Capital	 Monitoring	 Education	 Studies	 Habitat	 Maintenance
Water quality	City-led water quality monitoring	high FC, TN, and TP; low DO	water quality could be incorporated into other projects	(BC-Mon-1) improve water quality monitoring program	(BC-Ed-1) pet waste control and education	na	na	na
Hillslope and bank erosion and sedimentation in lower reach of Boeing Creek	field evidence	Boeing Reserve slope failures and sedimentation downstream of Seattle Golf and Country Club steel-pile dam	na	na	BC-Ed-2) educate Highlands homeowner associations regarding problems with stormwater directed to mid-slope outfalls and potential solutions	na	na	na

Issue	How was it Identified?	Specifics	Projects					
			 Capital	 Monitoring	 Education	 Studies	 Habitat	 Maintenance
Conveyance pipe maintenance and structural deficiencies	CCTV inspection	Approximately 4,400 linear ft of pipe in the basin needs repair or replacement; other pipes require removal of utility crossings or modification of improper drainage connections. Significant cleaning, modified maintenance frequency, or monitoring are recommended for some pipe segments.	(BC-CIP-1) open cut pipe replacement and modification of drainage structures	(BC-Mon-2) monitor pipes not recommended for immediate replacement	na	na	na	(BC-Main-1) pipe maintenance needed that was not accomplished during condition assessment
			(BC-CIP-2) trenchless pipe repair	na	na	na	na	(BC-Main-2) pipe repairs to be handled by City operations and maintenance staff
			(BC-CIP-3) remove utility crossings*	na	na	na	na	na

Issue	How was it Identified?	Specifics	Projects					
			 Capital	 Monitoring	 Education	 Studies	 Habitat	 Maintenance
Habitat and fish passage	field evidence	multiple barriers, including Seattle Golf and Country Club steel-pile dam, riprap cascade, Innis Arden Way culvert, Hidden Lake dam, and degraded stream channel habitat; maintenance of Hidden Lake	na	(BC-Mon-3) Partner with Shoreline Community College to continue conducting geomorphic cross section monitoring in Boeing Creek.	BC-Ed-3 educate homeowners regarding the importance of removing invasive species such as English ivy	na	(BC-Hab-1) Develop feasibility study to determine the best course of action for long-term maintenance and restoration of Hidden Lake and Boeing Creek within Boeing Creek and Shoreview Parks.	na
			na	na	na	na	(BC-Hab-2) Develop an overall restoration plan for Boeing Creek that includes fish barrier removal, in-stream habitat enhancement, and daylighting of piped sections of the stream.	na

Issue	How was it Identified?	Specifics	Projects					
			 Capital	 Monitoring	 Education	 Studies	 Habitat	 Maintenance
			na	na	na	na	(BC-Hab-3) restore Boeing Creek in Hillwood Park	na
Flooding	service requests, City comprehensive plan, and City staff recommendations	flooding, catch basin surcharging in the vicinity of North 175th Street between Linden Avenue North and Dayton	(BC-CIP-4) stormwater upgrades between Linden Avenue and Dayton	na	na	na	na	na
City transportation master plan opportunity projects	City transportation master plan	There are several recommended transportation improvement projects, including re-channelization, preservation, pedestrian safety, and intersection improvements(City of Shoreline 2011b)	(BC-CIP-5) incorporation of water quality improvements, such as rain gardens in conjunction with re-channelization of North 160th Street between Greenwood Avenue North and Aurora Avenue North	na	na	na	na	na

Issue	How was it Identified?	Specifics	Projects					
			 Capital	 Monitoring	 Education	 Studies	 Habitat	 Maintenance
***Continued:** City transportation master plan opportunity projects			(BC-CIP-6) utilize low-impact development techniques for new sidewalk projects; incorporate stormwater retrofit into projects	na	na	na	na	na
			(BC-CIP-7) Incorporate stormwater improvements on major roadway preservation projects in the Boeing Creek basin; create an opportunity fund for transportation projects.	na	na	na	na	na

Issue	How was it Identified?	Specifics	Projects					
			 Capital	 Monitoring	 Education	 Studies	 Habitat	 Maintenance
General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	field evidence and service requests	There are many stormwater retrofit opportunities that will help reverse previous impacts and incrementally improve overall basin conditions.	(BC-CIP-8) City light interurban trail bio-infiltration swales	(BC-Mon-4) Monitor the functionality of deep stormwater injection wells at Shorewood Senior High School as a case study for similar stormwater management strategies in other parts of the basin and City.	(BC-Ed-4) Develop materials and tools to educate owners of large properties in the basin about stormwater retrofit opportunities. (Locations shown on map).	(BC-Study-1) Conduct a study to evaluate the potential for City-owned and -operated regional facilities that assess capital facilities charges to redeveloping properties.	na	na
			(BC-CIP-9) Westminster triangle bio-infiltration facility	na	(BC-Ed-5) Facilitate a focus group with owners of large properties in the basin to discuss stormwater retrofit options for their redevelop-ment projects.	(BC-Study-2) Develop an infrastructure plan for Shoreline Town Center that incorporates goals of the adopted Subarea Plan (City of Shoreline 2011d) and sets forth implementation and financing options.	na	na

Issue	How was it Identified?	Specifics	Projects					
			 Capital	 Monitoring	 Education	 Studies	 Habitat	 Maintenance
***Continued:** General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	Greenworks priority list (Leighton 2012)	opportunities for stormwater retrofit on City-owned ROW	16733 Linden Avenue North Rain Garden	na	na	na	na	na
The current Zone A flood boundary does not conform well to local topography.	review of existing FEMA maps		na	na	na	(BC-Study-3) Prepare FEMA LOMA for Boeing Creek	na	na

* To be conducted by others.

CCTV – closed circuit television

DO – dissolved oxygen

FC – fecal coliform

FEMA – Federal Emergency Management Agency

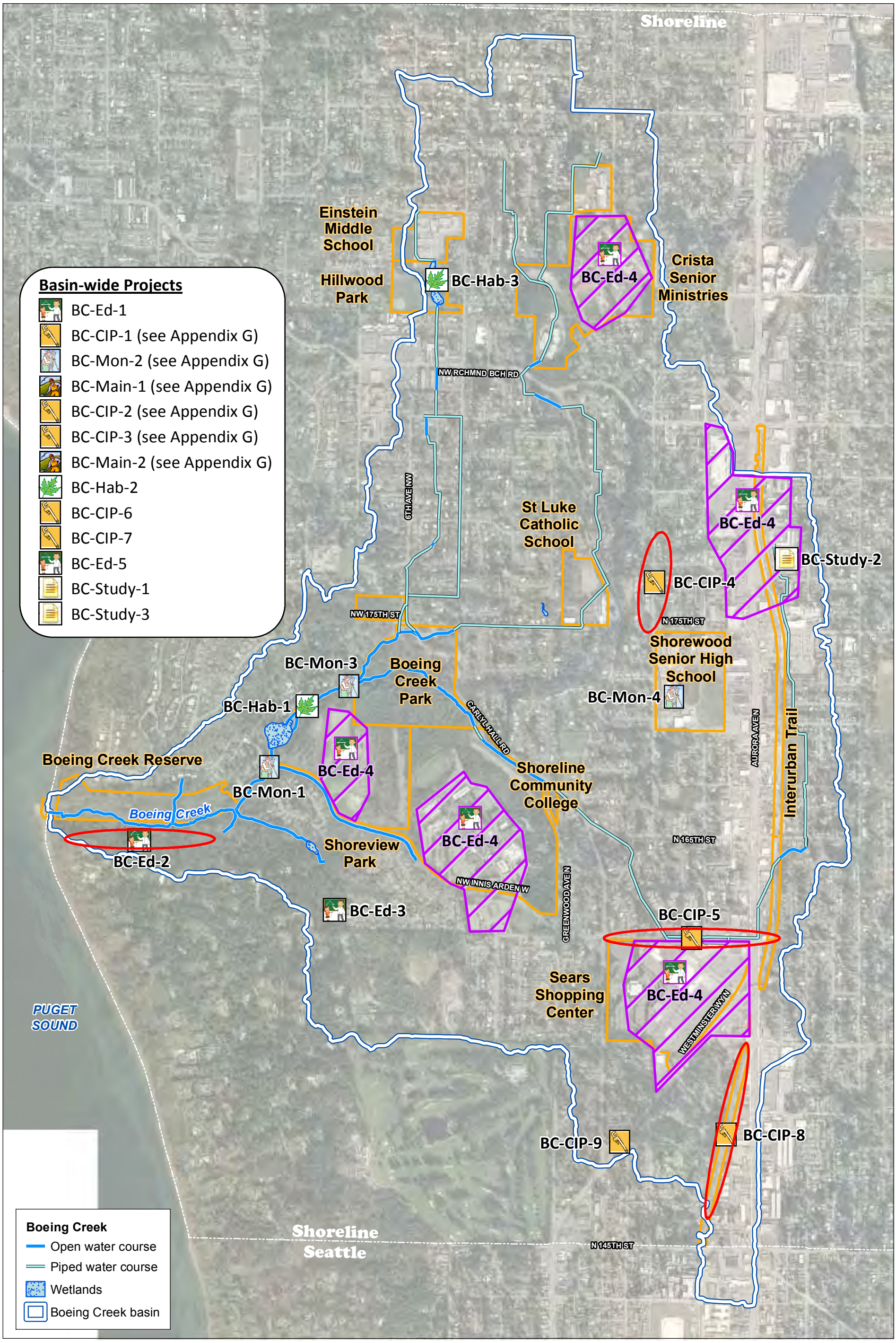
LOMA – letter of map amendment

na – not applicable

ROW – right-of-way

TN – total nitrogen

TP – total phosphorus



Wind Ward LLC environmental

Figure 21. Locations of recommended projects

Prepared by craigh, 12/28/2012; W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig 21 5187 Recommended projects.mxd

5.1.1 Water quality

Water quality concerns in the Boeing Creek basin are related to high levels of FC bacteria and nutrients. While the open channel reaches of Boeing Creek are mostly forested and consist of fairly high-quality riparian conditions, the water quality and benthic organisms in Boeing Creek are still impacted by runoff in the urban environment. The purpose of the projects listed below will be to improve water quality conditions in Boeing Creek, focusing on these particular constituents. Additionally, recommendations for modifications to the water quality monitoring program in Boeing Creek should be considered (Section 5.1.1.1). Projects that would reduce peak flows to Boeing Creek are discussed in Section 5.1.2. Some of these peak flow reduction opportunities would also enhance summer base flows to the stream channel through stormwater infiltration. While the primary goal of flow reduction projects is to prevent flooding and erosion, a secondary benefit is improved water quality; surface pollutants are less likely to be routed to receiving waters, such as Boeing Creek and Puget Sound, when there is less flow and more aquifer recharge that contributes to summer base flow in the stream.

5.1.1.1 Improve current water quality monitoring program (BC-Mon-1)

Stormwater runoff has a significant impact on surface water quality in urban area streams. To get the best overall picture of water body health and trends, monitoring data must be collected and tracked over several years. The City has a substantial monitoring program in place for all City-area water bodies, and has been collecting water quality data in Boeing Creek since 2001; however, several potential improvements to the current monitoring program are recommended, including:

- Minimize data gaps—If field meters become inoperable during sampling events, or if results appear abnormal, confirmatory sampling should be re-scheduled, or grab samples should be collected and submitted to a laboratory for analysis of the parameters of interest.
- Additional monitoring—Add a monitoring location downstream of Hidden Lake to evaluate the effect of Hidden Lake on downstream water quality conditions, and to monitor any improvements that may occur with the implementation of other projects, such as BC-Hab-1, described below.
- Improve control programs—Evaluate and expand (if necessary) City programs designed to control contaminant sources and the amount of stormwater runoff being produced. This includes the Illicit Discharge Detection and Elimination (IDDE) Program, the Car Wash Kit Program, and the Commercial Storm Drain Inspection Program.

5.1.1.2 Reduce bacterial (fecal coliform) contamination

Sources of bacterial contamination in Boeing Creek are unknown. All homes in the Boeing Creek basin are connected to a sanitary sewer, so septic systems are not anticipated to be a source. The most likely sources are domestic and wild animals, as indicated by a study of bacterial sources in a similar urban Seattle stream (City of Seattle 1993). One Boeing Creek basin-specific approach is recommended for reducing FC bacteria. Other approaches were recommended in the Storm Creek Basin Plan (Windward 2012) and the City's 2011 Surface Water Master Plan Update (SAIC 2011), including the improvement of soils and ground vegetation in riparian buffers (ST-Ed-1). The Boeing Creek stream corridor is primarily forested and not likely impacted significantly by adjacent residential properties.

Implement Targeted Pet Waste Control Education and Outreach (BC-Ed-1)

Review and expand ongoing education, outreach, and incentive programs to inform the public on improved pet waste control. This project could also involve installation of signs and pet waste bags at the primary access points to the Boeing Reserve trail adjacent to the creek, Boeing Creek and Shoreview Parks, and Shoreline Community College campus.

5.1.1.3 Reduce nutrient (total nitrogen and phosphorus) concentrations

Sources of nutrients in urban stormwater include fertilizer, pet waste, erosion, atmospheric deposition, sludge, and septic systems. These sources are able to affect surface waters easily in urban areas due to the large amount of impervious surfaces, which do not allow runoff and its associated pollutants to be absorbed into the ground. Developed areas within the Boeing Creek basin have the most potential for increased nutrient levels in stormwater runoff. Projects to reduce nutrient levels were recommended as part of the Storm Creek Basin Plan (Windward 2012). These projects are described below for reference, but are not included with the recommended Boeing Creek projects.

Evaluate City Procedures for Landscape Maintenance on Public Properties

Evaluate City landscaping procedures for parks and other public properties in the basin. Determine if reductions in the application of fertilizers and pesticides are possible, and if native vegetation could be planted to improve habitat, reduce maintenance costs, and filter runoff.

 Partner with Local Community Groups to Educate People on Alternative Yard Care

Review and expand ongoing education, outreach, and incentive programs to inform landowners on improved vegetation management techniques to reduce applications of fertilizers, properly dispose of yard waste, and improve riparian buffer conditions in the upper reaches of Boeing Creek that flow through highly developed residential areas (such as un-piped sections in Hillwood Park). Potential community partnerships could be with Birds, Bees, Fish and Trees, or other local groups.

5.1.2 Erosion in lower reaches of Boeing Creek

The lower reaches of Boeing Creek flow through a wide, forested area (approximately 500 ft on both sides to the nearest homes). However, on the south side of the channel near Beach Drive in the Highlands, several stormwater pipes discharge flow directly to the slopes above Boeing Creek. Gullies and small slumps have occurred where these pipes discharge, resulting in sediment input to the channel. The project recommended in Section 5.1.2.1 (described in more detail in Appendix G) is designed to reduce hillslope erosion and subsequent sediment transport to Boeing Creek.

5.1.2.1 Educate homeowners regarding tightlining methods to reduce slope erosion caused by stormwater flows to Boeing Creek (BC-Ed-2)

This project involves working education of and outreach to Highlands homeowners to solve erosion problems on the hillslopes above Boeing Creek resulting from stormwater discharges. Potential options include providing information to the homeowners association regarding appropriate stormwater conveyances and discharges in areas of slope instability, as well as possible ways to remedy conditions that are occurring adjacent to Boeing Creek.

5.1.3 Repair and replacement of conveyance pipes

Approximately 4,000 linear ft of pipe were identified as having poor structural or maintenance rating scores during the condition assessment. Additionally, other types of problems were identified during the condition assessment, including utility crossings that cut through stormwater pipe, and improper storm drain connections. For the purpose of recommending projects to improve stormwater conveyance infrastructure, similar projects have been grouped into a single project. The benefit of this approach is that several small repairs or replacement projects could be completed under one contract with the same equipment.

5.1.3.1 Open-cut pipe replacement and modification of drainage structures (BC-CIP-1)

There are 15 pipe segments (totaling 330 ft) recommended for complete replacement using an open-cut technique. Most of these pipe segments were rated very poorly (greater than 4 on the SPRI) and require immediate attention within the next few years, either because of their location or the type of failure. This project would include upgrades and replacement of stormwater pipes and structures throughout the Boeing Creek basin. The project would include multiple locations but be advertised as one construction project. The bid items at each location would be very similar, achieving economy of scale and ultimately, lower bid pricing. The locations would include high-priority open-cut pipe replacement and installation of storm structures. Appendix G lists the specific problems, proposed solutions, and locations of the pipes and drainage structures recommended for replacement.

5.1.3.2 Trenchless pipe repair (BC-CIP-2)

There are 26 pipe segments (totaling 1,750 ft) recommended for trenchless repair. This category includes pipes that received a poor structural rating, were relatively high risk and, upon further investigation, were identified to be candidates for a trenchless solution. Trenchless solutions include slip-lining, cured-in-place pipe (CIPP), pipe bursting, pipe reaming, and others. Appendix G lists the specific problems, proposed solutions, and locations of the pipes recommended to be repaired with trenchless solutions.

5.1.3.3 Remove utility crossings (BC-CIP-3, by others)

Structural deficiencies have resulted directly from utility crossings through the storm drain pipe. Unidentified conduits, likely containing cable, fiber optic, or electrical services, are the primary crossing issues, but there are also some waterlines identified. It is recommended that the City identify the likely utility owner and coordinate relocation of the utility crossings and repair of the stormwater pipe. This project would be conducted by others, but would require City staff time to contact utility companies and inspect completed work. Appendix G lists the specific utility crossing locations and conduit sizes.

5.1.3.4 Monitor pipes not recommended for immediate repair (BC-Mon-2)

Pipes that did not fall into the categories described above, yet received a poor structural rating, are included in this category. A total of 23 pipe segments (3,150 ft) had structural deficiencies, including fractures, holes, minor deformities, and other problems. It is

recommended that the City actively monitor these pipes to ensure the structural deficiency does not worsen. Appendix G lists the specific problems, proposed solutions, and locations recommended for monitoring.

5.1.3.5 Pipe maintenance (BC-Main-1)

During the CCTV inspection work, several pipe segments required heavy cleaning and root cutting in order to proceed with the CCTV inspection. The pipe segments that the City considered highest priority were cleaned; however, there are many pipe segments that were not cleaned and therefore not inspected. Potentially, these pipes may also need to be replaced in the future if heavy sedimentation and debris buildup is caused by inadequate design, or if other issues are discovered when CCTV work is conducted after the pipes are cleaned. Appendix G lists the specific problems, proposed solutions, and locations recommended for monitoring.

5.1.3.6 Pipe maintenance to be accomplished by City staff (BC-Main-2)

Four pipe segments with poor SPRI ratings were determined to be issues that could readily be fixed by City maintenance staff, because the problems were generally acute and localized (i.e., a hole at a specific location in the segment). A map and table showing the pipes to be fixed by City maintenance staff are included in Appendix G.

5.1.4 Habitat and fish passage

Stormwater quality and quantity and adequate fish passage are foremost considerations with respect to in-stream habitat along Boeing Creek. High-quality stream and wetland habitat are generally not attainable if flows are too flashy and/or water quality suffers from high turbidity, heavy sedimentation, and/or high levels of chemical contaminants. In fact, for a basin such as Boeing Creek, where the riparian forest surrounding the creek is relatively wide and continuous, stormwater inputs from upstream in the basin and the presence of numerous fish passage barriers result in less than adequate habitat conditions for aquatic organisms. The projects listed below are primarily habitat related, but would also provide water quality benefits and, in some cases, improved water quantity control functions.

Implied and encompassed within the below-described projects is the preservation and enhancement of areas of existing, mostly native vegetation along the stream. These well-vegetated buffer areas provide important bio-filtration and infiltration functions that improve water quality and provide flow attenuation for the stream and its receiving water, Puget Sound.

5.1.4.1 Hidden Lake and Boeing Creek channel restoration, fish passage, and trail improvement feasibility study (BC-Hab-1)

This project involves developing a feasibility study for multi-functional restoration in Shoreview and Boeing Creek Parks that encompasses Hidden Lake, Boeing Creek, and the recreational trail adjacent to the creek. The issues through this reach include bank erosion that has affected the adjacent recreational trail, log weirs that may not be passable to fish at different stages of flow, and sedimentation in Hidden Lake, a large annual maintenance expense for the City. One option to be considered is the discontinuation of maintenance dredging in Hidden Lake. If this were to occur, Hidden Lake would, over time, fill in with sediment and become more vegetated with additional wetland characteristics. Another option is the construction of a single-thread channel through what is now Hidden Lake. Opportunities to improve fish passage and habitat through this reach of Boeing Creek would also be considered in the feasibility study. Details for this project are included in Appendix G.

5.1.4.2 Develop overall restoration plan for Boeing Creek (BC-Hab-2)

There are at least eight fish passage barriers in Boeing Creek, in addition to reaches that have been thoroughly modified by the large rocks, debris, and other materials placed in the channel to minimize erosion and stabilize otherwise eroding bed and banks. Nonetheless, the Boeing Creek riparian corridor has many elements that could sustain stream restoration improvements, if actions were taken upstream to further reduce high peak flows and durations that contribute to in-channel erosion. The task of restoring Boeing Creek to more natural conditions capable of sustaining anadromous and resident fish populations would be significant, both in cost and time. The degradation of Boeing Creek has occurred over many decades, although the initial degradation was probably quite rapid, coinciding with the input of high flows after the development of the Sears shopping center. Similarly, the overall restoration of Boeing Creek can be expected to take many decades; stormwater retrofit must occur in the upper watershed, and in-stream restoration projects will be tackled as money becomes available and the desire to reach a long-term restoration goal is articulated by the City, residents, and interested stakeholders. This project would require working with stakeholders to devise a long-term plan for the restoration of Boeing Creek, including a timeframe of what projects should be accomplished first. Several recommended projects in this plan would benefit the overall stream health of Boeing Creek, but a restoration plan with a vision of what Boeing Creek could be and how to get there would be especially beneficial.

5.1.4.3 Hillwood Park wetland improvement (BC-Hab-3)

Hillwood Park in the northwest corner of the Boeing Creek basin includes a short open-channel section of Boeing Creek just downstream of Einstein Middle School. This

project involves enhancing the existing wetland in the vicinity of the open channel to enhance water quality, produce wildlife habitat, and provide some storage for stormwater runoff during higher flows. Details of this project are provided in Appendix G.

5.1.4.4 Removal of ivy (BC-Ed-3)

This project involves removal of ivy within the Highlands. Ivy infestation threatens to destroy very old conifer trees and prevents native shrub and groundcover growth. This project would entail labor-intensive methods to remove ivy, followed by native re-vegetation. More details are provided in Appendix G.

5.1.4.5 Cross section monitoring (BC-Mon-3)

This project involves annual evaluation of physical channel conditions in Shoreview and Boeing Creek Parks to monitor changes for the purpose of understanding the stability of the existing channel. Shoreline Community College conducts class exercises that involve installation of cross sections as part of geography and geology coursework (Dodd 2011). If the procedures for monitoring cross sections were modified to be standard and repeatable, this information could be very useful to both City and students for evaluating channel stability in the context of basin changes, particularly stormwater retrofits that occur with redevelopment. Details about this project are provided in Appendix G.

5.1.5 Flooding

As described in Sections 4.5 and 4.6.2, much of the flooding in the Boeing Creek basin has resulted from clogged ditches or pipes or inadequate conveyance capacity. Most of the basin's flooding issues have been resolved in the last 5 years with the construction of 3rd Avenue drainage improvements (Otak 2008), Pan Terra regional stormwater improvements (Otak 2008), and flood hazard reduction projects on Midvale Avenue North and Darnell Park Neighborhood Drainage (SAIC 2011). An additional chronically flooded area was identified in the 2011 Comprehensive Stormwater Plan (SAIC 2011) and by City staff. The project in Section 5.1.5.1 addresses flooding.

5.1.5.1 Flood reduction in Linden Avenue neighborhood (BC-CIP-4)

This project includes upgrading the pipe network along Linden Avenue North, Fremont Avenue North, Evanston Avenue North, and Dayton Avenue North, north of North 175th Street, and installing bio-retention facilities along Linden Avenue North and Fremont Avenue North to slow stormwater runoff from these areas, such that the system downstream does not flood. Currently, the system (which collects runoff from

the Town Center along Linden Avenue North) overflows and surcharges. Updates would include increasing the pipe diameter from 12 in. to 18 in. and repairing one failing pipe. In addition to the proposed capital improvement project (CIP), programmatic and policy changes should be considered to reduce the runoff volume generated by the Town Center. This project could be completed in conjunction with a pedestrian improvement project to construct sidewalks on one or both sides of the street between North 175th Street and North 185th Street (City of Shoreline 2011b).

5.1.6 Transportation master plan opportunities

The City's transportation master plan (City of Shoreline 2011b) was reviewed for potential project opportunities in connection with identified road and pedestrian projects. Several projects are located in the Boeing Creek basin and include pedestrian improvement and road preservation projects that could have water quality components. Potential stormwater enhancements are recommended in association with these projects.

5.1.6.1 Water quality improvements in association with North 160th Street re-channelization project (BC-CIP-5)

One of the projects recommended for funding in the City's transportation master plan (City of Shoreline 2011b) is to re-channelize the existing four-lane cross section of North 160th Street between Greenwood Avenue North and Aurora Avenue North to create a boulevard-style three-lane cross section with bicycle lanes on both sides of the street and median landscaping. Incorporation of a water quality treatment method in the median landscaping, such as a bio-infiltration or rain garden, would provide aesthetic landscaping as well as water of improved quality to receiving waters.

5.1.6.2 Utilize low-impact development techniques for sidewalk improvements (BC-CIP-6)

At least eight pedestrian improvement projects are identified for the Boeing Creek basin in the City's transportation master plan (City of Shoreline 2011b). There are several potential low-impact development opportunities in conjunction with new sidewalks, including installation of roadside bio-infiltration swales for water quality treatment, and construction of sidewalks utilizing permeable materials. The following locations are recommended as priority pedestrian projects according to the transportation master plan:

- NW 175th Street between 6th Avenue Northwest and St. Luke's Place North
- North Innis Arden Way between 10th Avenue Northwest and Greenwood Avenue North

- 3rd Avenue Northwest/Carlyle Hall Road Northwest between North 175th Street and Dayton Avenue North
- Fremont Avenue North between North 165th Street and North 205th Street
- Linden Avenue North between North 175th Street and North 185th Street
- North 170th Street between Fremont Avenue North and Aurora Avenue North
- North 165th Street between Dayton Avenue North and Aurora Avenue North

More details are provided in Appendix G.

5.1.6.3 Stormwater improvements associated with major roadway preservation projects (BC-CIP-7)

Significant maintenance work on several arterials is recommended for funding in the City's transportation master plan (City of Shoreline 2011b). This project involves setting aside money to improve storm drainage systems at the same time that roads are already torn up or closed for transportation-related construction. Specifically, Fremont Avenue North between North 175th Street and North 185th Street is recommended for re-channelization; it is also in the vicinity of recommended capital project BC-CIP-6, discussed in Section 5.1.5.1.

5.1.7 General stormwater runoff improvements

As discussed in Section 3.3, the Boeing Creek basin has stream channel bank and bed erosion issues as a result of increased stormwater runoff associated with intense development throughout the basin. While there have been many attempts to control runoff to alleviate flooding and erosion problems, Boeing Creek is still being affected by higher than natural peak flows and durations. The opportunity to reverse the effects of past unmitigated development rests with the redevelopment that will likely occur in the Boeing Creek basin and City over the next decade. Both Shoreline Community College and Crista Ministries have master development plans to renovate their campuses. The City has also adopted a Town Center subarea plan (City of Shoreline 2011d) that has specific goals for stormwater management, and Ecology's Phase II NPDES permit requires certain stormwater management actions associated with redevelopment activities. The projects listed below are designed to take advantage of City-owned property where improvements can be implemented, as well opportunities associated with public and private redevelopment or new treatment techniques.

5.1.7.1 Construct bio-infiltration swales adjacent to Interurban Trail (BC-CIP-8)

The Interurban Trail is owned by Seattle City Light but maintained by the City. The trail represents a great opportunity to provide water quality treatment for the trail itself, as

well as off-site drainage areas (where it makes sense) using bio-infiltration swales. Not only is there sufficient space adjacent to the trail, but this is also a heavily used public amenity, where low-impact development techniques could be highlighted for the general public.

5.1.7.2 Construct bio-infiltration swale in right-of-way adjacent to Westminster Triangle Park (BC-CIP-9)

This project involves replacing an existing ditch along North 150th Street with a formal bio-retention swale or rain garden. Currently, a system of pipes leads water to a rock-lined ditch on the north end of the small park. Updates to the ditch would include installing underdrain pipes, filter media, filter fabric, and hydrophylic plants.

5.1.7.3 Monitor and evaluate the functionality of deep infiltration wells installed at Shorewood High School (BC-Mon-4)

Shorewood High School underwent a recent renovation that included the addition of stormwater treatment facilities, such as detention vaults, functional landscaping that infiltrates stormwater, stormwater treatment filters, and deep stormwater infiltration following appropriate water quality treatment. The deep injection wells are perforated within the highly infiltrative advance outwash to allow stormwater to percolate out into this geological formation above the regional groundwater table. This project involves monitoring the success of this technique to determine if it would be appropriate for other locations within the City or the Boeing Creek basin.

5.1.7.4 Develop educational materials targeting developers and property owners in areas targeted for redevelopment (BC-Ed-4)

This project involves targeting developers and owners that will be involved in major redevelopment projects, such as the Shoreline Town Center, Shoreline Community College, and Crista Ministries. City planning staff will work with these entities to develop informational brochures describing the City's environmental goals regarding sustainability, the City's requirements under the Phase II NPDES permit, and potential ways that developers can meet those goals and requirements through low-impact development/redevelopment.

5.1.7.5 Evaluate potential for City-owned stormwater facilities that provide regional benefits (BC-Study-1)

This project involves conducting an evaluation of potential opportunities for the City to construct a regional stormwater facility funded by facility charges, connection fees for redeveloped properties, or sub-basin-specific capital facilities charges. This approach

would give the City control over where and how the facility operates, while also providing developers with certain stormwater management on their redeveloped properties.

5.1.7.6 Facilitate focus group of owners of large properties who have redevelopment plans (BC-Ed-5)

This project involves conducting a focused public outreach to owners of large properties with redevelopment plans in the Boeing Creek basin. The purpose of the focus group would be to solicit input on redevelopment plans and the incorporation of stormwater facilities into the design and function of those plans, and to determine how the City can best support and encourage redevelopment while accomplishing its own goals for environmental improvements and compliance with regulations. Shoreline Community College and Crista Ministries both have master development plans with different levels of stormwater management options. Another potential redevelopment property is the Sears shopping center, although no specific plans are currently in place. Participation in a focus group could be beneficial to City planners as they help these entities through the permitting process.

5.1.7.7 Develop infrastructure plan for Shoreline Town Center, including financing options (BC-Study-2)

This project involves developing an infrastructure plan and potential financing options for the Shoreline Town Center that emphasize the City's Town Center Vision for "green infrastructure" and environmental quality, economic vitality, and social equity (City of Shoreline 2011d). The specific environmental quality goals for the Town Center are that the "Town Center's tree canopy and native vegetation are all part of a strategic system for capturing and treating stormwater on-site and protecting and enhancing overall environmental quality."

5.1.7.8 Prepare FEMA Letter of Map Amendment for Boeing Creek (BC-Study-3)

This project involves applying for a LOMA to modify the current Zone A boundary. The City should contact the FEMA regional project officer (RPO) for guidance on which method would be most appropriate for Boeing Creek. Reference guidance documents outlining the map revision include:

- *Guideline and Specifications for Flood Hazard Mapping Partners- Appendix C: Guidance for Riverine Flooding Analysis and Mapping. FEMA, April 2003*
- *Managing Floodplain Development in Approximate Zone A Areas: A guide for obtaining and developing base (100-year) flood elevations. FEMA, July 1995*

5.2 RECOMMENDED "GREENWORKS" PROJECTS IN THE BOEING CREEK BASIN

One project in the Boeing Creek basin is on the priority "greenworks" project list (Leighton 2012): 16733 Linden Avenue North Rain Garden.

This project is included in the list of recommendations for Boeing Creek, but details are provided elsewhere.

6 Project Prioritization and Costs

The projects recommended in Section 5 represent a variety of strategies to manage stormwater in the Boeing Creek basin. Many of the projects involve specific infrastructure repair and replacement opportunities based on the results of the condition assessment; others require longer-term commitments to reduce the effects of past development practices that occurred when stormwater BMPs were less known and infrequently used. Several criteria were used to prioritize the projects within the context of just the Boeing Creek basin. These projects will no doubt be prioritized with regard to the City's entire stormwater management program, and may rank lower with respect to other City-wide issues.

6.1 CRITERIA

Table 18 lists the criteria for project prioritization and shows the conditions under which each criterion's score will rank as high, medium, or low.

Table 18. Criteria and scoring for project prioritization

Criteria	Rank Scores		
	High (5 points)	Medium (3 points)	Low (1 point)
Likelihood of success	proven in other cases	mixed results	unproven
Number of issues addressed (water quality, habitat, erosion, flooding)	three	two	one
Protects infrastructure and public safety	both	one or the other	none
On public property	in ROW or existing easement	requires easement on other public property	private property
Cost	low (< $20,000)	medium ($20K to $50K)	high (> $50,000)

ROW – right-of-way

The combined scores of individual criteria were ranked according to the following total points:

- Low priority (13 points or fewer)
- Medium priority (13 to 18 points)
- High priority (19 points or more)

6.2 MATRIX OF PROJECTS

Table 19 lists the recommended projects from highest to lowest according to issue addressed, cost, and prioritization criteria.

Table 19. Matrix of prioritized projects

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
WQ	(BC-Mon-1) improve water quality monitoring program		medium (3)	low (1)	low (1)	high (5)	low $ (5)	MEDIUM (15)
	(BC-Ed-1) pet waste control and education		medium (3)	low (1)	medium (3)	medium (3)	low $ (5)	MEDIUM (15)
Hillslope and bank erosion and sedimentation in lower reach of Boeing Creek	(BC-Ed-2) educate Highlands' homeowner associations as to the problems with stormwater directed to mid-slope outfalls and potential solutions		medium (3)	medium (3)	low (1)	low (1)	low $ (5)	MEDIUM (13)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
Conveyance pipe maintenance and structural deficiencies	(BC-CIP-3) remove utility crossings BY OTHERS		high (5)	low (1)	high (5)	high (5)	low $ (5)	HIGH (21)
	(BC-Main-2) pipe repairs to be handled by City operations and maintenance staff		high (5)	medium (3)	high (5)	high (5)	medium $ (3)	HIGH (21)
	(BC-CIP-1) open cut pipe replacement and modification of drainage structures		high (5)	medium (3)	high (5)	high (5)	high $ (1)	HIGH (19)
	(BC-Mon-2) monitor pipes not recommended for immediate replacement		high (5)	low (1)	medium (3)	high (5)	low $ (5)	HIGH (19)
	(BC-Main-1) pipe maintenance needed that was not accomplished during condition assessment		medium (3)	medium (3)	high (5)	high (5)	medium $ (3)	HIGH (19)
	(BC-CIP-2) trenchless pipe repair		high (5)	medium (3)	high (5)	high (5)	high $ (1)	HIGH (19)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
Habitat and fish passage	(BC-Hab-1) develop feasibility study to determine the best course of action for long-term maintenance and restoration of Hidden Lake and Boeing Creek within Boeing Creek and Shoreview Parks.		medium (3)	high (5)	medium (3)	high (5)	high $ (1)	MEDIUM (17)
	(BC-Mon-3) partner with Shoreline Community College to continue conducting geomorphic cross section monitoring in Boeing Creek.		high (5)	low (1)	low (1)	high (5)	low $ (5)	MEDIUM (17)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
Continued: Habitat and fish passage	(BC-Hab-2) develop an overall restoration plan for Boeing Creek that includes fish barrier removal, in-stream habitat enhancement, and daylighting of piped sections of the stream.		medium (3)	high (5)	medium (3)	medium (3)	high $ (1)	MEDIUM (15)
	(BC-Hab-3) restore Boeing Creek in Hillwood Park		high (5)	medium (3)	low (1)	high (5)	high $ (1)	MEDIUM (15)
	(BC-Ed-3) educate homeowners about the importance of removal of invasive species such as English ivy		medium (3)	low (1)	medium (3)	low (1)	low $ (5)	MEDIUM (13)
Flooding	(BC-CIP-4) stormwater upgrades between Linden Avenue and Dayton		high (5)	medium (3)	high (5)	high (5)	high $ (1)	HIGH (19)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
City transportation master plan opportunity projects	(BC-CIP-5) incorporation of water quality improvements, such as rain gardens in conjunction with re-channelization of North 160th Street between Greenwood Avenue North and Aurora Avenue North		medium (3)	medium (3)	medium (3)	high (5)	high $ (1)	MEDIUM (15)
	(BC-CIP-6) utilize low-impact development techniques for new sidewalk projects; incorporate stormwater retrofit into projects		medium (3)	medium (3)	medium (3)	high (5)	high $ (1)	MEDIUM (15)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
Continued: City transportation master plan opportunity projects	(BC-CIP-7) incorporate stormwater improvements on major roadway preservation projects in the Boeing Creek basin; create an opportunity fund for transportation projects.		medium (3)	medium (3)	medium (3)	high (5)	high $ (1)	MEDIUM (15)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	(BC-Mon-4) monitor the functionality of deep stormwater injection wells at Shorewood Senior High School as a case study for similar stormwater management strategies in other parts of the basin and City.		high (5)	medium (3)	medium (3)	high (5)	low $ (5)	HIGH (21)
	(BC-Ed-4) develop materials and tools to educate owners of large properties in the basin about stormwater retrofit opportunities. (Locations shown on map).		high (5)	high (5)	high (5)	low (1)	low $ (5)	HIGH (21)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
Continued: General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	(BC-Study-1) conduct a study to evaluate the potential for City-owned and -operated regional facilities that assess capital facilities charges to redeveloping properties.		high (5)	high (5)	high (5)	high (5)	high $ (1)	HIGH (21)
	(BC-CIP-8) City light interurban trail bio-infiltration swales		high (5)	medium (3)	medium (3)	high (5)	high $ (1)	MEDIUM (17)
	(BC-Ed-5) facilitate a focus group with owners of large properties in the basin to discuss stormwater retrofit options for their redevelopment projects.		medium (3)	high (5)	high (5)	low (1)	medium $ (3)	MEDIUM (17)

Issue	Project name	Type	Prioritization Criteria					
			Likelihood of Success	Number of Issues Addressed	Protects Infrastructure or Public Safety	On Public Property	Cost	Total Score and Priority
Continued: General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	(BC-Study-2) develop an infrastructure plan for Shoreline Town Center that incorporates goals of the adopted Subarea Plan (City of Shoreline 2011d) and sets forth implementation and financing options.		medium (3)	medium (3)	medium (3)	high (5)	medium $ (3)	MEDIUM (17)
	(BC-CIP-9) Westminster triangle bio-infiltration facility		medium (3)	medium (3)	low (1)	high (5)	medium $ (3)	MEDIUM (15)
	(BC-Study-3) prepare FEMA Letter of Map Amendment for Boeing Creek (BC-Study-3)		high (5)	low (1)	medium (3)	low (1)	low $ (5)	MEDIUM (15)

6.3 ESTIMATED COSTS FOR HIGH-PRIORITY PROJECTS AND PROGRAMS

The estimated cost for the projects and program elements that ranked highest in priority is approximately $1.6 million. Table 20 summarizes the projects and issues that would be addressed through the implementation of these projects. Conveyance pipe maintenance and repair projects account for nearly 75% of the $1.6 million estimate. Some of these conveyance pipe projects could be deferred for a few years, but should be addressed within the next 5 years to minimize the chance of pipe failure or other associated problems.

Table 20. Summary list of highest priority projects and estimated costs

Issue	Project Name	Type	Total Score and Priority	Estimated Cost
Conveyance pipe maintenance and structural deficiencies	(BC-CIP-3) remove utility crossings BY OTHERS		HIGH (21)	$8,000
	(BC-Main-2) pipe repairs to be handled by City operations and maintenance staff		HIGH (21)	$40,000
	(BC-CIP-1) open cut pipe replacement and modification of drainage structures		HIGH (19)	$508,000
	(BC-Mon-2) monitor pipes not recommended for immediate replacement		HIGH (19)	$15,750 every other year
	(BC-Main-1) pipe maintenance needed that was not accomplished during condition assessment		HIGH (19)	$118,000
	(BC-CIP-2) trenchless pipe repair		HIGH (19)	$447,000

Issue	Project Name	Type	Total Score and Priority	Estimated Cost
Flooding	(BC-CIP-4) stormwater upgrades between Linden Avenue and Dayton		HIGH (19)	$386,380
General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	(BC-Mon-4) monitor the functionality of deep stormwater injection wells at Shorewood Senior High School as a case study for similar stormwater management strategies in other parts of the basin and City.		HIGH (21)	$2,000 annually
	(BC-Ed-4) develop materials and tools to educate owners of large properties in the basin about stormwater retrofit opportunities. (Locations shown on map).		HIGH (21)	$15,000
	(BC-Study-1) conduct a study to evaluate the potential for City-owned and -operated regional facilities that assess capital facilities charges to redeveloping properties.		HIGH (21)	$50,000

City – City of Shoreline

Long-term solutions to continuing flow quantity issues and associated erosion problems can be addressed through redevelopment and strategic projects to retrofit existing properties. The Shorewood High School deep infiltration retrofit is an example of a potential stormwater management technique that could be used elsewhere in the City. One of the low-cost high-priority projects recommended in this plan is to use the data and lessons learned from the Shorewood High School project to benefit other projects in the City (BC-Mon-4). Two other projects are recommended for long-term stormwater retrofit planning: development of educational materials to help facilitate retrofits at large properties slated for redevelopment (BC-Ed-4), and evaluation of regional City-owned and -operated facilities (BC-Study-1).

Five additional projects were ranked on the high end of medium priority, one of which is very low cost and could be done in partnership with Shoreline Community College (BC-Mon-3). These additional projects would help facilitate the retrofit of the Boeing Creek basin to more current stormwater management standards, and would help

alleviate flow-related erosion issues in Boeing Creek over the long-term. Table 21 lists these higher-ranked medium-priority projects and associated costs.

Table 21. Summary list of highest-ranked medium-priority projects and estimated costs

Issue	Project Name	Type	Total Score and Priority	Estimated Cost
Habitat and fish passage	(BC-Hab-1) develop feasibility study to determine the best course of action for long-term maintenance and restoration of Hidden Lake and Boeing Creek within Boeing Creek and Shoreview Parks.		MEDIUM (17)	$100,000
	(BC-Mon-3) partner with Shoreline Community College to continue conducting geomorphic cross section monitoring in Boeing Creek.		MEDIUM (17)	$2,200 annually
General stormwater runoff issues, including channel bank and bed erosion, localized flooding, and conveyance issues	(BC-CIP-8) Interurban trail bio-infiltration swales along City light ROW		MEDIUM (17)	$745,416
	(BC-Ed-5) facilitate a focus group with owners of large properties in the basin to discuss stormwater retrofit options for their redevelopment projects.		MEDIUM (17)	$20,000
	(BC-Study-2) develop an infrastructure plan for Shoreline Town Center that incorporates goals of the adopted Subarea Plan (City of Shoreline 2011d) and sets forth implementation and financing options.		MEDIUM (17)	$40,000

City – City of Shoreline
ROW – right-of-way

7 Partnerships/Grant Opportunities

Funding stormwater management programs in addition to other City functions has been a challenge in recent years. Increasingly, many communities are looking to partnerships and grant funding to relieve some of the financial strain. For the various projects recommended in this plan, there are opportunities to partner with community and educational organizations, and business interests for implementation, as well as to pursue grant opportunities from a myriad of organizations. Potential community groups and organizations that could be partnered with for some of the recommended options are shown in Table 22.

Table 22. Recommended projects with opportunities for partnerships

Recommended Project	Potential Partners										
	Seattle Golf and Country Club	Neighborhood Groups	Shoreline Community College	Shoreline School District	Seattle City Light	City business and property owners	City Planning Staff	City Parks Department	Birds, Bees, Fish and Trees	City Transportation Department	Shoreline Residents
BC-Ed-1		√						√			
BC-Ed-2		√									√
BC-CIP-1										√	
BC-CIP-2										√	
BC-Mon-3			√								
BC-Ed-3		√									
BC-Hab-1		√	√					√	√		
BC-Hab-2	√	√	√						√	√	√
BC-Hab-3		√		√					√		
BC-CIP-4										√	√
BC-CIP-5										√	
BC-CIP-6										√	
BC-CIP-7										√	
BC-CIP-8					√			√		√	√
BC-CIP-9								√			
BC-Mon-4				√							
BC-Ed-4							√				
BC-Ed-5			√	√		√	√			√	
BC-Study-2							√	√		√	

Grant opportunities that could be utilized for some of the recommended projects, particularly those related to water quality, are listed in Table 23.

Table 23. Potential grant opportunities for Boeing Creek basin recommended projects

Title of Grant	Granting Agency	Website	Timeframe	Requirements (Matching Funds, Nonprofit, etc.)	Types of Projects Covered
Centennial Clean Water Fund	Ecology	http://www.ecy.wa.gov/programs/wq/funding/funding.html	September – November, annually	varies	non-point source pollution reduction, stormwater, low-impact development
CWA Section 319 Grant Program	Ecology	http://www.ecy.wa.gov/programs/wq/funding/funding.html	September – November, annually	varies	high priority on load reductions of nutrients, phosphorus, and sediment
Washington State Pollution Control Board Revolving Fund	Ecology	http://www.ecy.wa.gov/programs/wq/funding/funding.html	September – November, annually	varies, requires state matching	varies
Invasive Plant Management Fund	Center for Invasive Plant Management	http://www.weedcenter.org	varies	varies	water quality, habitat restoration/improvements, community involvement
Environmental Education Grants	EPA	http://www.epa.gov/education/grants/index.html	fall	match, typically $25,000 maximum	education
Land and Water Conservation Fund	Washington State Conservation Commission	http://www.rco.wa.gov/grants/lwcf.shtml	fall	50% match	acquisition and development of passive and active recreation areas

CWA – Clean Water Act
Ecology – Washington State Department of Ecology
EPA – US Environmental Protection Agency

8 References

Barnes E. 2012. Personal communication (email to Rick Leary regarding reserve 'O' salmon report for April, May, and June 2012). Shoreline, WA. July 11, 2012.

Booth DB, Cox BF, Troost KG, Shimel SA, cartographers. 2004. Composite geologic map of the Sno-King area. Scale: 1:24,000. Seattle-Area Geologic Mapping Project, University of Washington, Seattle, WA. Available from: http://geomapnw.ess.washington.edu/services/publications/map/data/Geology_SnoKing_Draft.pdf.

City of Seattle. 1993. Pipers Creek bacteriological source tracking investigation. Prepared by Herrera Environmental Consultants, Inc. and University of Washington Department of Environmental Health for Seattle Engineering Department, Drainage and Wastewater Utility. Seattle, WA.

City of Shoreline. 2011a. 2011-2017 parks, recreation and open space plan. City of Shoreline, WA.

City of Shoreline. 2011b. 2011 transportation master plan. Draft. City of Shoreline, WA.

City of Shoreline. 2011c. Comprehensive plan [online]. City of Shoreline, WA. Available from: http://www.cityofshoreline.com/index.aspx?page=478

City of Shoreline. 2011d. Town center subarea plan. City of Shoreline, WA.

Design D. 2004. Fish utilization in City of Shoreline streams. Appendix C, *City of Shoreline stream and wetland inventory assessment.* Prepared for Tetra Tech/KCM. Daley Design, Bainbridge, WA.

Dodd C. 2011. Personal communication (meeting with Erin Nelson, Windward, regarding installation of cross sections in Boeing Creek). Professor of Geography, Shoreline Community College, Shoreline, WA. November 2, 2011.

Ecology. 2005. Stormwater management manual for Western Washington. Water Quality Program, Washington State Department of Ecology, Olympia, WA.

Ecology. 2008. Washington State water quality assessment: 305(b) report and 303(d) list. Washington State Department of Ecology, Olympia, WA.

Ecology. 2012. Water resources explorer: Welcome to the Department of Ecology's statewide water rights web map [online]. Washington State Department of Ecology, Seattle, WA. Available from: http://www.ecy.wa.gov/programs/wr/info/webmap.html.

EPA. 2000. Ambient water quality criteria recommendations: Information supporting the development of State and Tribal nutrient criteria for rivers and streams in nutrient ecoregion II. EPA 822-B-00-015. US Environmental Protection Agency, Washington, DC.

ESA Adolfson. 2010. Shoreline inventory and characterization. Prepared for City of Shoreline. ESA Adolfson, Seattle, WA.

FEMA. 1995. Managing floodplain development in approximate Zone A areas: a guide for obtaining and developing base (100-year) flood elevations. FEMA 265/July 1995. Federal Emergency Management Agency, Washington, DC.

Hallock D. 2002. A water quality index for Ecology's stream monitoring program. Pub no 02-03-052. Environmental Assessment Program, Washington State Department of Ecology, Olympia, WA.

Henshaw PC, Booth DB. 2000. Natural restabilization of stream channels in urban watersheds. J Am Wat Res Assoc 36(6):1219-1236.

Hruby T. 2004. Washington State wetland rating system for Western Washington. Revised. Annotated Version August 2006. Ecology publication #04-06-025. Washington State Department of Ecology, Olympia, WA.

Kerwin J. 2001. Salmonid habitat limiting factors: Water Resources Inventory Area (WRIA) 8 final report. Washington State Conservation Commission, Olympia, WA.

Kilburn Architects, Triad Associates. 2010. Crista Campus Master Development Plan drawings, final master plan approved by City Council May 10, 2010. Kilburn Architects LLC, Seattle, WA; Triad Associates, Kirkland, WA,

King County. 1994. Storm Creek drainage improvement plan sheet, SW 1/4, Sec. 1, T.26, R.3E, W.M. #2001-72. Surface Water Management Division, King County Public Works, Seattle, WA.

King County, cartographer. 2001. Known freshwater distribution of steelhead trout for water resource inventory area (WRIA) 8. King County, Seattle, WA.

Leighton A. 2012. City of Shoreline greenworks prioritization criteria matrix. Draft. SvR Design Company, Seattle, WA.

NOAA. 2012a. National Climatic Data Center: climate data online [online database]. National Oceanic and Atmospheric Administration Satellite and Information Service, Washington, DC. Available from: http://www.ncdc.noaa.gov/cdo-web/search;jsessionid=C3A945D6FA40F7FE94F0F24A4D607F0A.lwf3.

NOAA. 2012b. National weather service forecast office. [online]. National Oceanic and Atmospheric Administration, Seattle, WA.

Omernik JM. 1987. Ecoregions of the conterminous United States. Ann Assoc Amer Geogr 77(1):118-125.

Otak. 2008. North Boeing Creek Improvements Project: final design report. Prepared for City of Shoreline Public Works. Otak, Kirkland, WA.

SAIC. 2011. Surface water master plan update, City of Shoreline. Draft report. Science Applications International Corporation, Bothell, WA.

SCC. 2011. Shoreline Community College master development plan. Draft. Shoreline Community College, Shoreline, WA.

Seattle Urban Nature. 2008. Boeing Creek and Shoreview Parks vegetation management plan. Seattle, WA.

Tetra Tech/KCM. 2004a. City of Shoreline stream and wetland inventory and assessment. Appendices. Tetra Tech/KCM, Inc., Seattle, WA.

Tetra Tech/KCM. 2004b. City of Shoreline stream inventory and assessment. Tetra Tech/KCM, Inc., Seattle, WA.

Tetra Tech/KCM. 2004c. Middle Puget Sound basin characterization report. Prepared for the City of Shoreline, WA. Tetra Tech/KCM, Inc., Seattle, WA.

Watershed Company. 2007. 2007 Bioassessment report: biological and habitat assessment of Shoreline streams. Final. The Watershed Company, Kirkland, WA.

Watershed Company. 2009. 2007 Bioassessment report: biological and habitat assessment of Shoreline streams. Final. The Watershed Company, Kirkland, WA.

Williams J. 2010. 2009 fresh water assessment report: state of the water quality in Shoreline streams, lakes and wetlands. Public Works Department, City of Shoreline, WA.

Windward. 2012. City of Shoreline Storm Creek basin plan. Windward Environmental LLC, Seattle, WA.

WRCC. 2006. Seattle Tacoma WSCMO AP, Washington: monthly total precipitation (inches) [online]. Western Regional Climate Center. Updated July 25, 2006. Available from: http://www.wrcc.dri.edu/cgi-bin/cliMONtpre.pl?waseat.

APPENDIX A. HYDROLOGIC MODELING MEMORANDUM

OSBORN CONSULTING INCORPORATED

1800 NE 112TH AVENUE NE
SUITE 220-E
BELLEVUE, WA 98004
(425) 451-4009

Date:	September 19, 2012, Revised December 17, 2012
To:	Stuart Currie, Windward Environmental
CC:	Erin Nelson, Brown and Caldwell
From:	Marie Phelan, E.I.T., and Laura Ruppert, P.E., Osborn Consulting, Inc.
Subject:	City of Shoreline Boeing Creek Basin – Hydrologic Modeling Technical Memorandum (Draft)

This memorandum presents the methods and results of the Hydrologic and Hydraulic Modeling completed as part of the development of the Boeing Creek Basin Plan for the City of Shoreline. The Hydrologic and Hydraulic Modeling was conducted by Osborn Consulting Inc. (OCI) as a sub-consultant to Windward Environmental under contract to the City of Shoreline (City).

MODEL SELECTION

The best estimate of stream flow is from a stream gage. In the absence of sufficient stream gage data, simulated data from a continuous flow model is the next best source. An Environmental Protection Agency (EPA) Stormwater Management Model (SWMM) continuous flow model was developed to model the basin-wide hydrology of the Boeing Creek Basin.

EPA-SWMM

An EPA-SWMM was developed for the Boeing Creek Basin to simulate:

- existing surface water runoff conditions for problem area identification (25-year design standard),
- test alternative stormwater management scenarios, and
- identify areas inundated during a 100-year recurrence interval flow event.

EPA-SWMM was selected because it is a Federal Emergency Management Agency (FEMA) approved continuous flow model that performs both hydrologic and hydraulic modeling. Continuous flow models, as opposed to event based models, provide a more accurate depiction of rainfall patterns in the northwest and allow for better facility sizing to meet flow duration standards in the most recent state and local stormwater management manuals. Use of a FEMA approved model is important because it allows the City to pursue modifications to the current FEMA flood insurance mapping. EPA-SWMM is a publically available model that could easily be updated and used by City staff as infrastructure is replaced or upgraded throughout the basin.

EPA-SWMM METHODS

The EPA-SWMM model uses local precipitation, evaporation and drainage basin characteristics to simulate the runoff response within a basin. This section describes the data sources and methodologies used to model the Boeing Creek Basin.

DRAFT

Precipitation

Precipitation drives the response in the basin. It is important to select a precipitation record that accurately reflects the actual precipitation in your basin. The EPA-SWMM model simulates twenty one years (1990-2010) of rainfall using fifteen-minute precipitation data from King County flow gage 04U, located in the Boeing Creek Basin of Shoreline. Precipitation from nearby gage 35U (Bruggers Bog) was used to fill in gaps in the 04U data set (December 2007 through June 2008). While the Seatac precipitation gage has a much longer period of record (1948-current) the Shoreline gages were used because their close proximity to the study area offers the best available representation of actual precipitation in the Boeing Creek Basin.

Evaporation

Evaporation was simulated using mean monthly pan evaporation data for Puyallup, Washington as documented in *NOAA Technical Report NWS 34 Mean Monthly, Seasonal, and Annual Pan Evaporation for the United States, 1982*. Puyallup, the closest pan evaporation data site available, is approximately 50 miles away from the Boeing Creek Basin. However, since evaporation does not vary greatly within the Puget Sound lowlands this distance from the study area is not significant.

Drainage Basins

City of Shoreline Geographic Information System (GIS) data was used to delineate the 1,765 acre Boeing Creek Basin into thirty-one subcatchments. GIS data used includes: topography, stormwater conveyance, streams/ditches, and parcels. Basin and subcatchment boundaries were confirmed with a site visit. The thirty-one Boeing Creek subcatchments range in size from 1.5 acres to 249 acres, with an average size of 57 acres. Subcatchment areas are shown on **Figure 1: Boeing Creek Subcatchment Boundaries**. The information used to define each subcatchment in the EPA-SWMM model is defined in **Table 1: EPA-SWMM Subcatchment Properties**.

Land Use

The City provided GIS land use data and mapped impervious areas were used to estimate current land use conditions. Aerial photography, City code, and King County recommendations were used to develop assumed impervious, grass and forested coverage for each land use category. The mapped impervious areas were used to confirm those assumptions and to perform site specific adjustments where appropriate. The resulting land use impervious cover assumptions are presented in **Table 2**.

Percent impervious for the Boeing Creek subcatchments ranges from a minimum of 10-percent to a maximum of 90%, with the average being 54% impervious. Subcatchment specific land use assumptions including impervious, grass, and forest are included in **Appendix A**.

The Boeing Creek Basin is primarily built out, and stormwater treatment and detention requirements are in place for future development, so increased runoff as a result of future development is not anticipated. Therefore the future zoning land use condition (and associated increased impervious surface) was not modeled. Instead, the future condition assumes redevelopment of select commercial areas will reduce stormwater runoff. The specifics of the future land use condition are explained in more detail below.

Table 1: EPA-SWMM Subcatchment Properties	
Property	Definition
Name	User-assigned subcatchment name.
Rain Gage	Name of the rain gage associated with the subcatchment.
Outlet	Name of the node or subcatchment that receives the subcatchment's runoff.
Area	Area of the subcatchment, (acres).
Width	Characteristic width of the overland flow path for sheet flow runoff (feet).
% Slope	Average percent slope of the subcatchment.
% Imperv	Percent of the land area which is impervious.
N-Imperv	Manning's n for overland flow over the impervious portion of the subcatchment.
N-Perv	Manning's n for overland flow over the pervious portion of the subcatchment.
Dstore-Imperv	Depth of depression storage on the impervious portion of the subcatchment (inches).
Dstore-Perv	Depth of depression storage on the pervious portion of the subcatchment (inches).
% Zero-Imperv	Percent of the impervious area with no depression storage.
Subarea Routing	Choice of internal routing of runoff between pervious and impervious areas: *IMPERV:* runoff from pervious area flows to impervious area *PERV:* runoff from impervious flows to pervious area *OUTLET:* runoff from both areas flows directly to outlet
% Routed	Percent of runoff routed between subareas.
Infiltration	SCS runoff curve number and drying time.

Table 2: Land Use Impervious Cover Assumptions	
Land Use Category	**Percent Impervious Cover**
Low Density Residential	30-45%
Medium Density Residential	45-65%
High Density Residential	65-85%
Park	0-50%*
Business	85-90%
School/Public Facility	0-90%*
Right of Way	70-90%
*Subcatchment specific coverage calculated using GIS mapped impervious areas.	

Slope

City of Shoreline GIS data was used to calculate the average slope of each subcatchment. Boeing Creek subcatchment average slopes range from a minimum 4.3-percent to maximum 42.8-percent with the average being 13.4-percent.

Infiltration / SCS Runoff Curve Number

Vegetation coverage and soil types were used to calculate a composite SCS Curve number for each subcatchment. Vegetation (forest or grass) coverage areas were based on the land use assumptions described above. The Boeing Creek Basin is 18-percent Type A/B soil and 82-percent C/D soil. Soil data was derived from City provided GIS surface geology. Surface geology was categorized by Hydrologic Soil Group and overlaid with percent impervious to determine SCS curve numbers. The resulting composite SCS Curve number values are provided in the EPA-SWMM Subcatchment Data Table in **Appendix A.**

Hydraulics – Channels & Flow Control Facilities

The hydraulic analysis focused on the open channel reaches of Boeing Creek from the mouth up through Boeing Creek Pond and M1-Dam. The model is comprised of open channel conveyance, four flow control facilities, and select pipe conveyance. The scope of this project did not include hydraulic modeling of the Boeing Creek stormwater conveyance system. A schematic of the EPA-SWMM model is included as **Figure 2**.

Seven different cross sections were used to simulate Boeing Creek. Channel characteristics are based on field measurements and data provided by Windward. Manning's roughness assumptions are based on pebble count data and/or photographs. Channel lengths and slopes were estimated based on City provided GIS data and are documented in the Streams table in **Appendix A**. Boeing Creek cross section data is included in **Appendix B**.

The four flow control facilities are included in the model are described in **Table 3: Flow Control Facilities**. City provided GIS data and as-built data (where available) was used to simulate these facilities. Stage-storage relationships, weirs, orifices, and rating curve details are included in **Appendix A**.

Table 3: Flow Control Facilities

Name	Description	Subcatchment	Owner
Boeing Creek Pond	7 acre-feet in-line flow control facility on the North Branch of Boeing Creek.	310	City
M-1 Dam	9 acre-feet in-line flow control facility on the South Branch of Boeing Creek.	215	City
Hidden Lake	14 acre-feet in-line private pond on Boeing Creek. City provides sediment management and upkeep every other year.	130	Private; maintained by City
Water Supply Dam	Private water supply source which is currently unmaintained. Dam has filled with sediment and now acts as a weir with a 10 foot drop.	110	Private

Hydraulic analysis of the Pan Terra Pump Station, located in subcatchment area 330, was not included in the model because it is located in the northern part of the basin separated from Boeing Creek by hundreds of feet of piped stormwater conveyance. All contributing areas

remain in the model. For detailed modeling analysis of this facility, see the *North Boeing Creek Improvements Project – Final Design Report*, 2008, prepared by Otak, Inc.

Only select conveyance pipes were included in the model such as: culvert crossings at the railroad and Innis Arden Way, pipes in and out of flow control facilities, and subcatchment piped outfalls to Boeing Creek.

Flow frequency analysis

Flow frequency analyses were performed using the federal standard Log Pearson Type III probability distribution following the procedures outlined in Bulletin 17B (United States Water Resources Council, 1981). This method meets the requirements of the FEMA's Flood Hazard Mapping Program.

CALIBRATION

Model calibration was performed by comparing simulated peak flows to flow gage data from Boeing Creek gage 04j and comparing runoff with that of other studies performed within the basin. The calibration efforts described below found:

- Runoff and peak flows predicted by the Boeing Creek EPA-SWMM model are reasonably accurate.
- The EPA-SWMM model under-predicts base flows. King County gage data is the preferred source for base flow information.

Boeing Creek Gage Data

Boeing Creek stream flow data from multiple gaging stations is available from King County. See **Figure 3: King County Gage Locations**. These gages are no longer in operation, but contain flow data within our analysis period. Gage 04j was selected for calibration because it is located at the same approximate location as channel segment C3.

One year of flow data from Boeing Creek gage 04j (March 19, 1992 to March 19, 1993) was compared with the same year of flow data from the EPA-SWMM model. A chart documenting the comparison titled *Calibration* is included in **Appendix A**. The following observations were made:

- Pattern of rainfall events (spikes) mimics gage data
- The maximum daily average flows are within 16.5% of each other
- SWMM model does not accurately predict base flows; shows periods of zero flow compared to gage data which shows summer base flows of about 2 cfs.

Reducing the percent impervious assumptions throughout the basin was considered as a method of slowing down surface runoff and improving base flows. Percent impervious was reduced to the amount practical based on City provided GIS impervious area data, however, simulated base flow conditions did not improve.

Field observations by Windward Environmental confirmed base flows are present and noted groundwater seeps contributing to the lower reaches of Boeing Creek. It is assumed the groundwater seeps are contributing to the base flows.

Precipitation becomes one of three things in the EPA-SWMM model: evaporation, infiltration, or surface runoff. Evaporation and Infiltration are lost from the system and only surface runoff contributes to Boeing Creek flows. The existing land use has the following distribution:

- 25% Evaporation loss
- 35% Infiltration loss
- 40% Surface runoff contributing to Boeing Creek.

The 35% infiltration loss may account for the lack of base flows. Groundwater modeling is necessary to confirm this assumption, however, was not included in the scope of work for this project.

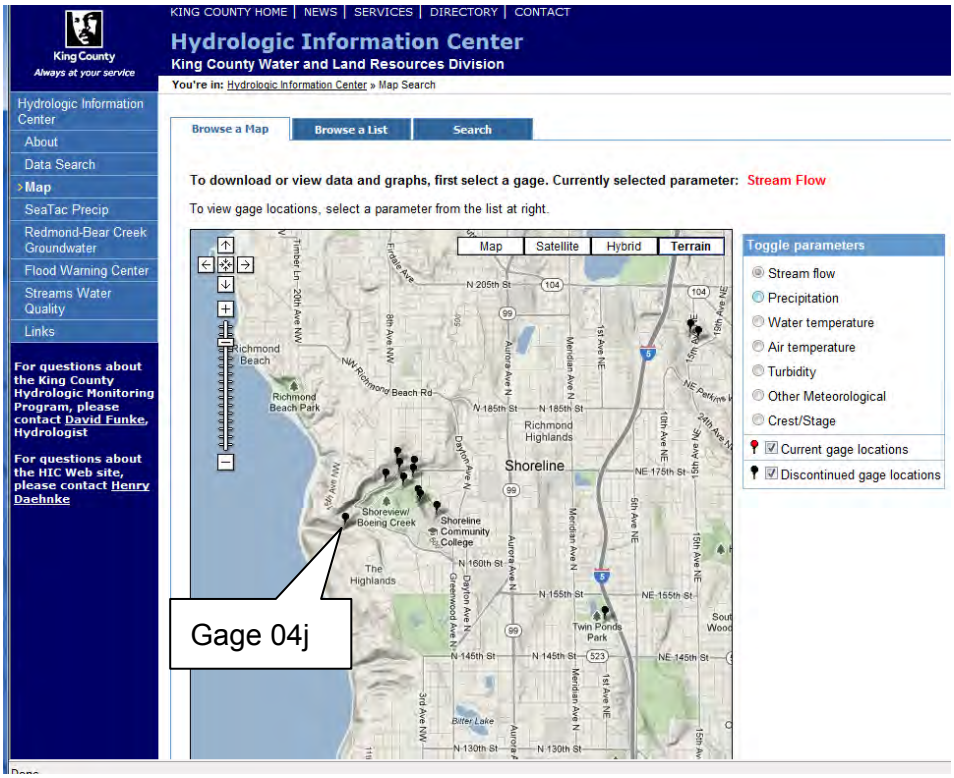


Figure 3: King County Gage Locations

North Boeing Creek Basin Study

EPA-SWMM runoff results were compared with runoff results from the *North Boeing Creek Improvements Project Final Design Report,* prepared by Otak, December 2008. The North Boeing Creek hydrology was developed with an HSPF model. The runoff rates per acre for two nearly overlapping subcatchment areas are very similar (see **Table 4**). This further supports the peak flows from EPA -SWMM are reasonable.

Table 4: EPA-SWMM and HSPF: Runoff rate comparison				
Model	Subcatchment	Area (Ac)	2-yr	25-yr
Boeing Creek EPA-SWMM	420	57.13	0.10 CFS/Ac	0.27 CFS/Ac
N. Boeing Creek HSPF	41	58.87	0.13 CFS/Ac	0.31 CFS/Ac

MODEL SCENARIOS

Three scenarios were modeled with EPA-SWMM: Current Land Use, Pre-Developed Forested, and Redevelopment. Descriptions of the three scenarios are provided in this section. Flow frequency analysis results are provided later in this memorandum.

Current Land Use

The Current Land Use model simulates the current/existing land use and conveyance condition in the Boeing Creek Basin. This model's development is based primarily on City GIS data as described above. This model serves as the base line condition. The EPA-SWMM output file for this model is included as **Appendix C.**

Pre-Developed Forest

A forested land use condition model was developed to assess how flow rates have changed as the basin developed. Washington State Department of Ecology Stormwater Management Manual for Western Washington, 2005 (Ecology-2005) has defined forest as the standard pre-developed condition. The current land use model was copied and modified to have zero impervious area and SCS curve numbers and Manning's roughness for overland flow were modified to simulate forest. SWMM input information is provided in the EPA-SWMM Pre-Developed Subcatchment Data Table in **Appendix A.**

Redevelopment

A proposed condition model was developed to assess how redevelopment at select public and private properties affects peak flows in Boeing Creek. This scenario assumes redevelopment will retrofit the entire property to the Ecology-2005 pre-developed Forest condition. Redevelopment areas, corresponding subcatchments, areas and ownership are presented in **Table 5: Redevelopment Areas**. The current land use model was copied and redevelopment subcatchment areas were modified to have no impervious area and SCS curve numbers and Manning's roughness for overland flow was modified to simulate forest. See **Figure 4: Redevelopment Scenario.** SWMM input information is provided in the EPA-SWMM Redevelopment Subcatchment Data Table in **Appendix A**.

Table 5: Redevelopment Areas

Name	Subcatchments	Area (acres)	Owner
Crista Ministries	340, 355 & 415	57.1	Private
Town Center	235 & 325	102.1	City ROW and Private Development
Shoreline Community College	127, 205 & 215	80.6	Public University
Aurora Square	225	37.5	Private Development
InterUrban Trail	220	24.2	Seattle City Light and Private Development

MODELING RESULTS

Flow frequency analysis results are reported at several key locations in the model. These locations were selected for one of the following reasons:

- Boeing Creek Channel
- Flow Control Facility
- Flow analysis needed to support CIP development (Hillwood Park in subcatchment 420)

EPA-SWMM Key Locations and their importance are presented in **Table 6: EPA-SWMM - Key Locations** and shown on **Figure 2: Boeing Creek Model Schematic.**

Table 6: EPA-SWMM – Key Locations	
Link	Description
P1	8 ft wide by 6 ft deep culvert under railroad. Outfall to Puget Sound.
C1-C6	Open channel Boeing Creek. Multiple links were used to establish flow change locations at subcatchment boundaries and to incorporate cross section and/or slope changes.
C7A	Open channel Boeing Creek - South Branch. Multiple links were used to establish flow change locations at subcatchment boundaries and to incorporate cross section and/or slope changes.
C7B	
C7C	
C8	Open channel Boeing Creek - North Branch.

The results of the EPA-SWMM flow frequency analysis for existing land use conditions are presented in **Table 7**. No flooding was identified by the EPA-SWMM analysis for the Boeing Creek Basin.

Table 7: EPA-SWMM – Flow Frequency Analysis Existing Land Use				
Link	2-yr (cfs)	25-yr (cfs)	100-yr (cfs)	Contributing Area (acres)
P1	72.3	154.0	209.8	1,770
C1	72.3	154.0	209.8	1,770
C2	73.5	154.9	209.7	1770
C3	73.2	154.5	209.3	1730
C4	73.2	154.6	209.5	1730
C5	69.7	149.1	203.9	1570
C6	72.1	160.5	227.3	1430
C7A	60.3	99.4	117.6	730
C7B	60.3	98.9	116.9	730
C7C	59.3	166.5	269.5	690
C8	21.2	74.5	132.6	700

Results of the Pre-developed flow frequency analysis are presented in **Table 8**. Pre-developed peak runoff rates are approximately 20% of the Existing Land Use runoff rates. This demonstrates runoff rates increased as the basin developed.

Table 8: EPA-SWMM – Flow Frequency Analysis Pre-Developed Forest				
Link	2-yr (cfs)	25-yr (cfs)	100-yr (cfs)	Contributing Area (acres)
P1	14.4	52.2	61.7	1770
C1	14.3	35.1	45.5	1770
C2	14.4	35.2	45.5	1770
C3	14.2	34.7	45.0	1730
C4	14.2	34.7	45.0	1730
C5	12.5	30.7	40.3	1570
C6	12.5	30.2	39.4	1430
C7A	8.2	20.7 27.9		730
C7B	8.2	20.7 27.9		730
C7C	8.1	20.5 27.7		690
C8	4.8	11.7 15.2		700

Results of the Redevelopment flow frequency analysis are presented in **Table 9**. The Redevelopment scenario reduces peak runoff rates throughout Boeing Creek by approximately75% compared to existing conditions. The Redevelopment scenario is shown on **Figure 4**.

Table 9: EPA-SWMM – Flow Frequency Analysis Redevelopment				
Link	2-yr (cfs)	25-yr (cfs)	100-yr (cfs)	Contributing Area (acres)
P1	54.4	118.4 162.8		1770
C1	54.4	118.4 162.7		1770
C2	55.3	119.5 163.6		1770
C3	55.1	118.8 162.5		1730
C4	55.1	118.6 162.3		1730
C5	51.5	112.4 155.5		1570
C6	53.6	115.8 159.1		1430
C7A	43.0	82.5	105.0 730	
C7B	42.8	82.0	104.5 730	
C7C	42.1	119.8 193.9		690
C8	16.7	45.1	69.2	700

A flow frequency analysis was performed to establish design flows for a potential capital improvement project at Hillwood Park. Hillwood Park is shown on **Figure 2: Boeing Creek Model Schematic** (located in subcatchment 420). Results of the Hillwood Park flow frequency analysis are presented in **Table 10**.

Table 10: EPA-SWMM – Flow Frequency Analysis
Hillwood Park Design Flows

Subcatchment	1.25-yr (cfs)	2-yr (cfs)	25-yr (cfs)	100-yr (cfs)	Contributing Area (acres)
420	4.1	5.7	15.6	24.5	60

FEMA FLOODPLAIN MAPPING

Current Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) mapping includes a Zone A flood boundary for Boeing Creek. Zone A identifies an approximately studies special flood hazard area for which no base flood elevations (BFEs) have been provided. The Boeing Creek Zone A flood boundary is shown on FIRM Map Numbers: 53033C0040F, 53033C0310F, and 53033C0330F included as **Appendix D**. These maps were last revised May 16, 1995.

The following restrictions are placed on Zone A properties:

- flood insurance is required as a condition of obtaining a loan from a Federally insured or regulated lender
- new development shall be constructed using methods that will minimize flood damages. This often requires obtaining or calculating BFEs at a development site.

The current Zone A boundary does not conform well to local topography. This results in properties that are not likely within the 100-yr flood zone to be encumbered by the restrictions described above.

The Boeing Creek EPA-SWMM model was developed with FEMA flood mapping standards in mind so that it may be used by the City to pursue modifications to the Zone A boundary. **Figure 5: Preliminary 100-yr Floodplain Map** depicts the approximate 100-yr Boeing Creek Floodplain as simulated by EPA-SWMM. The approximate 100-yr floodplain is based on a simulation of the December 29, 1996 precipitation event. The December 29, 1996 event resulted in a peak flow of 225.8 cfs at the mouth of Boeing Creek which exceeds the statistical 100-yr peak flow by 7.7%.

A letter of map amendment (LOMA) or letter of map revision (LOMR) request will need to be made to modify the Zone A boundary. The City should contact the FEMA Regional Project Officer (RPO) for guidance on which method is most appropriate for Boeing Creek. Reference guidance documents outlining the map revision include the following:

- *Guidelines and Specifications for Flood Hazard Mapping Partners - Appendix C: Guidance for Riverine Flooding Analysis and Mapping.* FEMA, April 2003.
- *Managing Floodplain Development in Approximate Zone A Areas: A guide for obtaining and developing base (100-year) flood elevations.* FEMA, July 1995.

RECOMMENDED PROJECTS

Three recommended projects are identified as part of the hydrologic and hydraulic analysis.

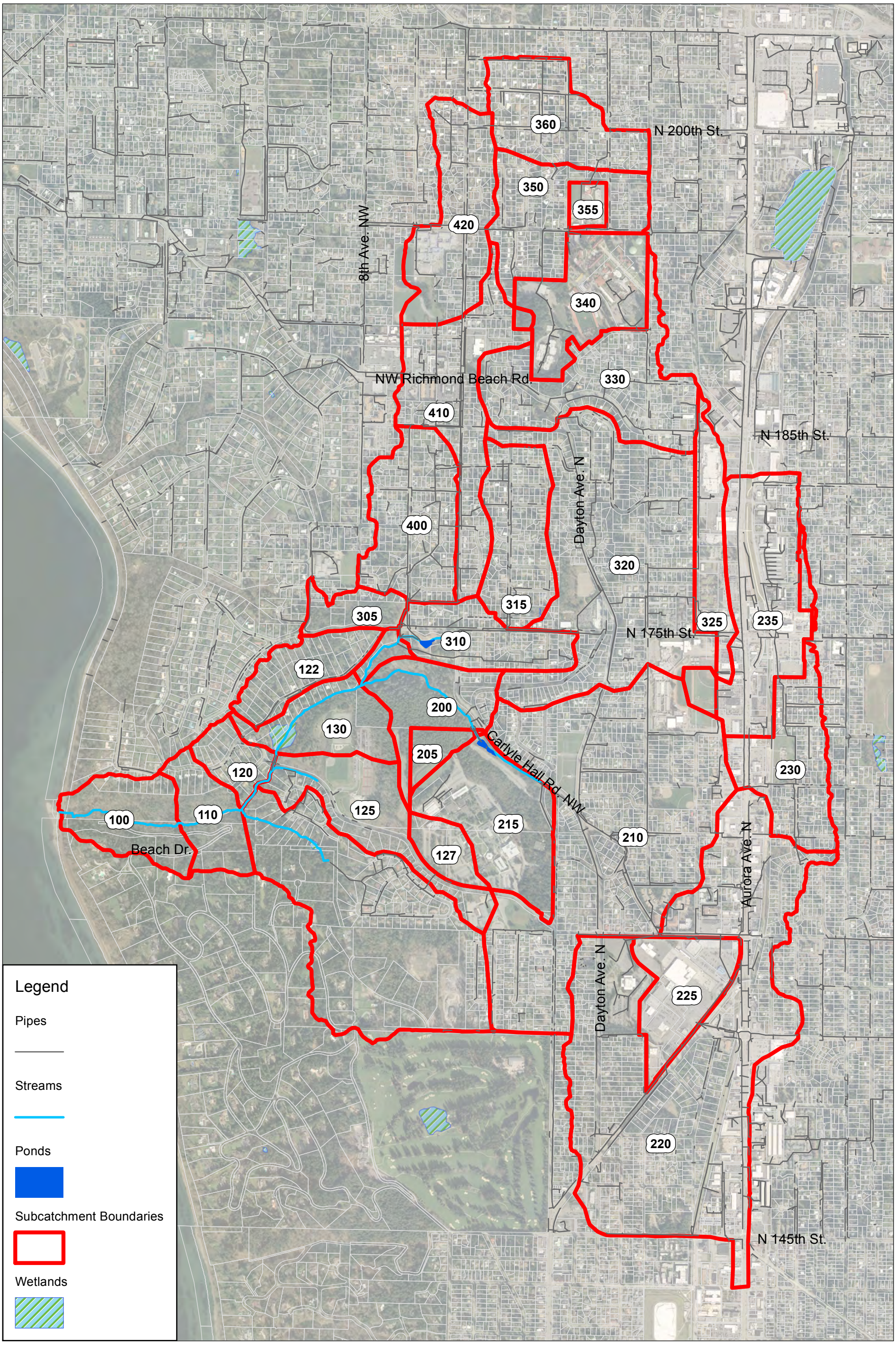
1. FEMA Flood Insurance Map adjustment
2. Retrofit InterUrban Trail City Right-of-Way to 2005 Ecology standards
3. Work with developers to retrofit redevelopment areas

CIP 1: FEMA Flood Insurance Map Adjustment	
Issue	Current Flood Insurance Rate Map (FIRM) mapping of the Zone A flood boundary for Boeing Creek does not correlate well with local topography. This results in properties that are not likely within the 100-yr flood zone to be encumbered by flood insurance and development requirements.
How was it identified?	City review of FIRM Zone A mapping for Boeing Creek. Panels: 40, 310, and 330 (of 1725) Map No.: 53033C0040F, 53033C0310F, and 53033C0330F
Specifics	A letter of map amendment (LOMA) or letter of map revision (LOMR) request will need to be made to modify the Zone A boundary. The City should contact the FEMA Regional Project Officer (RPO) for guidance on which method is most appropriate for Boeing Creek. Reference guidance documents outlining the map revision include the following: • *Guidelines and Specifications for Flood Hazard Mapping Partners - Appendix C: Guidance for Riverine Flooding Analysis and Mapping.* FEMA, April 2003. • *Managing Floodplain Development in Approximate Zone A Areas: A guide for obtaining and developing base (100-year) flood elevations.* FEMA, July 1995.
Cost	$16,800 (cost estimate included in Appendix E)

CIP 2: Retrofit InterUrban Trail City Right-of-Way to 2005 Ecology standards (within City ROW)	
Issue	Current flows are much greater than the Pre-Developed Forested Condition. Result is increased runoff and increased peak flows in Boeing Creek.
How was it identified?	The Boeing Creek basin is nearly built out to fully developed condition with little water quality or detention to mitigate the change from forested condition. EPA-SWMM analysis indicates the existing 100-yr flow rate at the Boeing Creek Mouth is over 300% greater than the predicted pre-developed forest condition.
Specifics	City ROW (including the trail) = 8.21 acres; is located in type D soil. Infiltration facilities are typically recommended for type A/B soils and detention facilities for C/D soils.

Capital	Install detention and/or redevelop using low impact development techniques.
Policy	City to provide treatment and detention for all impervious areas (as opposed to just new impervious area).
Education	Education opportunity to install signage along public pedestrian and bike path.
Cost	8.2 ac @ $54,900/ac = $450,000 *Cost based on City of Marysville Regional Detention unit price of $3.60/CF for light industrial development (85% impervious). Unit price translates to approximately $52,000/acre of development and includes design and construction costs for a regional facility and conveyance trunkline. Increased price by 5% to account for higher property costs in Shoreline. Actual costs may vary based on project site and size.

CIP 3: Work with developers to retrofit redevelopment areas	
Issue	Current flows are much greater than the Pre-Developed Forested Condition. Result is increased runoff and increased peak flows in Boeing Creek.
How was it identified?	EPA-SWMM analysis indicates the existing 100-yr flow rate at the Boeing Creek Mouth is over 300% greater than the predicted pre-developed forest condition. EPA-SWMM analysis of the Re-development Scenario demonstrates existing peak flows throughout the Boeing Creek Basin can be reduced by up to 25% by retrofitting select areas to meet 2005 Ecology flow control standards.
Specifics	Redevelopment Areas include (see Figure 4): • Christa Ministries • Town Center • Shoreline Community College • Aurora Square • InterUrban Trail (ROW portion identified as CIP #2) Provide flow control (infiltration and/or detention facilities) such that runoff from these areas matches pre-developed (forest) runoff.
Capital	NA
Policy	City to work with developers to encourage use of preferred stormwater treatment and low impact development solutions. City provided standard details may help to encourage uniformity throughout the basin which may improve the efficiency of development reviews and future maintenance.
Cost	$20,000 (Consultant costs to develop framework)



OSBORN CONSULTING INCORPORATED

Figure 1: Boeing Creek Subcatchment Boundaries

Boeing Creek Basin - Shoreline, WA

Prepared by MLP 9/14/2012- FIGURE1

Legend

- J# Junction ID
- W# Weir ID
- P# Pipe ID
- C# Channel Segment ID
- XXX Storage Node
- ### Subcatchment ID
- Junctions
- Weirs
- Pipes
- Streams
- Subcatchment Boundaries
- Ponds
- Wetlands

355 350 420 Hillwood Park 340 415 NW Richmond Beach Rd. 330 410 8th Ave. NW 400 315 320 J13 Boeing Creek Pond P10 P11 305 CS2 P7 N 175th St. J11 310 C8 W6 J14 300 P9 J12 122 C7A C7B C6 J9A 200 J10 J8 P4 J9 P5 CS1 130 P6 W2 Hidden Lake W3 205 Carlyle Hall Rd. NW S C5A 120 P3 J7A W4 C7C C5 M1 Dam P1 C1 J2 J4 C4 J7 J10A C2 C3 125 J6 C4A 100 110 215 J1 J5 J3 J6A Beach Dr. Water Supply Dam 127 W1 115 210 Greenwood Ave. N 220

OSBORN CONSULTING INCORPORATED

N

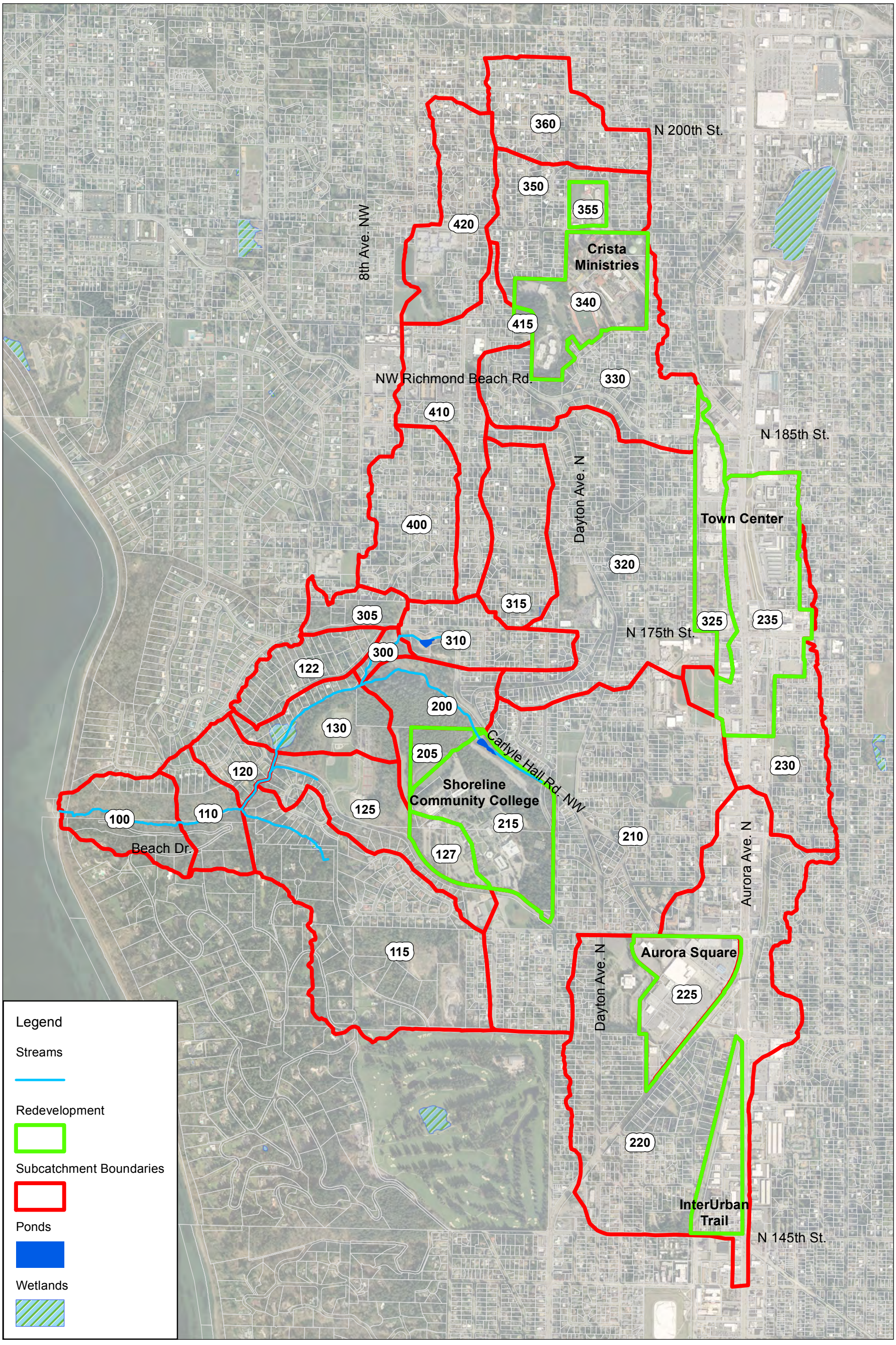
250 0 250 Yards

250 0 250 Meters

Figure 2: Boeing Creek Model Schematic

Boeing Creek Basin - Shoreline, WA

Prepared by MLP, 9/14/2012; FIGURE2


360
N 200th St.
350
355
420
8th Ave. NW
Crista Ministries
340
415
330
NW Richmond Beach Rd.
410
N 185th St.
Dayton Ave. N
Town Center
400
320
315
305
325
235
N 175th St.
310
300
122
200
130
205
Carlyle Hall Rd. NW
230
120
Shoreline Community College
125
215
100
110
210
Aurora Ave. N
Beach Dr.
127
115
Aurora Square
225
220
InterUrban Trail
N 145th St.
Legend
Streams
Redevelopment
Subcatchment Boundaries
Ponds
Wetlands
OSBORN CONSULTING INCORPORATED
N
400 0 400 Yards
400 0 400 Meters
Figure 4: Redevelopment Scenario
Boeing Creek Basin - Shoreline, WA
Prepared by MLP, 9/14/2012: FIGURE4

APPENDIX A: SWMM INFORMATION

- Existing Land Use
- Land Use Assumptions
- N-Pervious Calculations
- EPA-SWMM Input Table: Existing Condition
- Stream hydraulic assumptions
- Flow Control Facilities
- Calibration Chart
- EPA-SWMM Input Table: Pre-Developed Scenario
- EPA-SWMM Input Table: Redevelopment Scenario
- Flow Frequency Analysis Results

100	Total Area (acres) =	35.7503
Type	Area	% of Total Area
Low Density Residential	14.0582	39.32%
Private Open Space	20.6726	57.82%
Public Facility	0.9884	2.76%
Road	0.0312	0.09%

110	Total Area (acres) =	26.3504
Type	Area	% of Total Area
Low Density Residential	14.4554	54.86%
Private Open Space	10.8923	41.34%
Road	1.0027	3.81%

115	Total Area (acres) =	139.6660
Type	Area	% of Total Area
Low Density Residential	88.8142	63.59%
Private Open Space	4.3041	3.08%
Public Facility	0.1376	0.10%
Special Study Area	39.1662	28.04%
Road	7.2438	5.19%

120	Total Area (acres) =	15.7233
Type	Area	% of Total Area
Low Density Residential	12.9316	82.24%
Private Open Space	0.2463	1.57%
Public Open Space	0.0559	0.36%
Road	2.4895	15.83%

122	Total Area (acres) =	27.5928
Type	Area	% of Total Area
Low Density Residential	24.6599	89.37%
Road	2.9329	10.63%

125	Total Area (acres) =	46.9532
Type	Area	% of Total Area
Institution/Campus	0.5010	1.07%
Low Density Residential	13.7893	29.37%
Public Facility	3.8150	8.13%
Public Open Space	22.3668	47.64%
Road	6.4811	13.80%

127	Total Area (acres) =	13.4023
Type	Area	% of Total Area
Institution/Campus	12.9956	96.97%
Public Open Space	0.4055	3.03%
Road	0.0012	0.01%

130	Total Area (acres) =	34.1937
Type	Area	% of Total Area
Low Density Residential	8.0670	23.59%
Public Facility	1.1234	3.29%
Public Open Space	24.4578	71.53%
Road	0.5455	1.60%

200	Total Area (acres) =	34.3929
Type	Area	% of Total Area
Low Density Residential	4.0551	11.79%
Public Open Space	26.3167	76.52%
Road	4.0211	11.69%

205	Total Area (acres) =	8.9392
Type	Area	% of Total Area
Institution/Campus	8.9212	99.80%
Road	0.0180	0.20%

210	Total Area (acres) =	210.3590
Type	Area	% of Total Area
High Density Residential	5.1184	2.43%
Low Density Residential	121.6594	57.83%
Medium Density Residential	1.2541	0.60%
Mixed Use	5.7013	2.71%
Private Open Space	6.0938	2.90%
Public Facility	16.4720	7.83%
Public Open Space	4.3249	2.06%
Town Center District	0.4604	0.22%
Road	49.2748	23.42%

215	Total Area (acres) =	58.2414
Type	Area	% of Total Area
Institution/Campus	57.1583	98.14%
Road	1.0831	1.86%

220	Total Area (acres) =	249.4210
Type	Area	% of Total Area
Community Business	20.5556	8.24%
High Density Residential	7.0959	2.84%
Low Density Residential	95.4905	38.28%
Medium Density Residential	7.2482	2.91%
Mixed Use	26.6709	10.69%
Private Open Space	2.3362	0.94%
Public Facility	27.9503	11.21%
Public Open Space	3.1077	1.25%
Road	58.9657	23.64%

225	Total Area (acres) =	37.5096
Type	Area	% of Total Area
Community Business	36.8514	98.25%
Road	0.6582	1.75%

230	Total Area (acres) =	56.9022
Type	Area	% of Total Area
High Density Residential	0.7815	1.37%
Low Density Residential	20.5494	36.11%
Medium Density Residential	8.8541	15.56%
Mixed Use	6.2118	10.92%
Private Open Space	4.5305	7.96%
Public Facility	7.2006	12.65%
Road	8.7742	15.42%

SWMM Information
Existing Land Use

235	Total Area (acres) =	73.0558
Type	Area	% of Total Area
Town Center District	73.0309	99.97%
Road	0.0249	0.03%

300	Total Area (acres) =	5.1689
Type	Area	% of Total Area
Low Density Residential	1.8864	36.49%
Public Open Space	3.1596	61.13%
Road	0.1230	2.38%

305	Total Area (acres) =	15.1444
Type	Area	% of Total Area
Low Density Residential	8.1927	54.10%
Public Facility	0.0139	0.09%
Public Open Space	4.2292	27.93%
Road	2.7087	17.89%

310	Total Area (acres) =	35.9054
Type	Area	% of Total Area
Low Density Residential	22.8141	63.54%
Public Facility	0.0547	0.15%
Public Open Space	6.4061	17.84%
Road	6.6305	18.47%

315	Total Area (acres) =	45.6795
Type	Area	% of Total Area
Low Density Residential	36.0590	78.94%
Public Facility	0.0246	0.05%
Road	9.5959	21.01%

320	Total Area (acres) =	158.5040
Type	Area	% of Total Area
Community Business	0.0182	0.01%
High Density Residential	2.5117	1.58%
Low Density Residential	113.9532	71.89%
Medium Density Residential	0.0853	0.05%
Mixed Use	0.9607	0.61%
Public Facility	9.3440	5.90%
Road	31.6309	19.96%

325	Total Area (acres) =	29.0893
Type	Area	% of Total Area
Town Center District	29.0826	99.98%
Road	0.0067	0.02%

330	Total Area (acres) =	70.9339
Type	Area	% of Total Area
Community Business	1.9195	2.71%
High Density Residential	0.2294	0.32%
Low Density Residential	45.4301	64.05%
Medium Density Residential	1.3813	1.95%
Mixed Use	2.1904	3.09%
Public Facility	1.9112	2.69%
Town Center District	0.5123	0.72%
Road	17.3597	24.47%

340	Total Area (acres) =	49.0869
Type	Area	% of Total Area
Institution/Campus	47.0299	95.81%
Public Facility	2.0566	4.19%
Road	0.0005	0.00%

350	Total Area (acres) =	50.0539
Type	Area	% of Total Area
Low Density Residential	35.9524	71.83%
Road	14.1015	28.17%

355	Total Area (acres) =	6.5618
Type	Area	% of Total Area
Institution/Campus	6.5556	99.91%
Road	0.0062	0.09%

360	Total Area (acres) =	49.1081
Type	Area	% of Total Area
Low Density Residential	39.0177	79.45%
Road	10.0904	20.55%

400	Total Area (acres) =	55.6330
Type	Area	% of Total Area
Low Density Residential	44.5166	80.02%
Public Facility	0.1055	0.19%
Road	11.0109	19.79%

410	Total Area (acres) =	66.7071
Type	Area	% of Total Area
High Density Residential	7.2269	10.83%
Low Density Residential	39.7696	59.62%
Mixed Use	4.2800	6.42%
Public Open Space	0.5534	0.83%
Road	14.8771	22.30%

415	Total Area (acres) =	1.4905
Type	Area	% of Total Area
Institution/Campus	1.4858	99.69%
Road	0.0046	0.31%

420	Total Area (acres) =	57.1339
Type	Area	% of Total Area
Low Density Residential	31.7728	55.61%
Public Facility	9.0429	15.83%
Public Open Space	6.6305	11.61%
Road	9.6877	16.96%

SWMM Information
Existing Land Use

Land Use Assumptions

	Low Density Residential			Medium Density Residential			High Density Residential			Park			Business			School / Public Facility			ROW
Basins	% Imperv	% Grass	% Forest	% Imperv	% Grass	% Forest	% Imperv	% Grass	% Forest	% Imperv	% Grass	% Forest	% Imperv	% Grass	% Forest	% Imperv	% Grass	% Forest	% Imperv
100	35%	10%	55%							0%	5%	95%				0%	95%	5%	70%
110	35%	10%	55%							0%	5%	95%							70%
115	35%	10%	55%							15%	10%	75%				50%	25%	25%	70%
120	35%	20%	45%							0%	0%	100%							70%
122	30%	15%	55%																70%
125	35%	30%	35%							25%	40%	35%				50%	35%	15%	70%
127										0%	15%	85%				70%	15%	15%	70%
130	30%	30%	40%							25%	25%	50%				20%	30%	50%	70%
200	40%	35%	25%							15%	5%	80%							70%
205																10%	15%	75%	70%
210	45%	35%	20%	65%	30%	5%	70%	30%	0%	0%	95%	5%	90%	5%	5%	70%	20%	10%	80%
215																50%	10%	40%	80%
220	45%	40%	15%	45%	50%	5%	75%	25%	0%	25%	50%	25%	85%	10%	5%	70%	25%	5%	90%
225													90%	5%	5%				90%
230	45%	45%	10%	55%	40%	5%	85%	15%	0%	15%	80%	5%	85%	10%	5%	70%	25%	5%	90%
235													90%	10%	0%				90%
300	35%	15%	50%							0%	5%	95%							70%
305	35%	10%	55%							0%	10%	90%				50%	45%	5%	70%
310	45%	40%	15%							50%	25%	25%				0%	100%	0%	80%
315	45%	40%	15%													0%	100%	0%	80%
320	45%	40%	15%	65%	30%	5%	75%	25%	0%				85%	5%	10%	70%	15%	15%	80%
325													90%	5%	5%				90%
330	45%	30%	25%	65%	30%	5%	70%	30%	0%				85%	10%	5%	50%	25%	25%	80%
340																70%	15%	15%	80%
350	45%	40%	15%																80%
355																84%	15%	1%	80%
360	45%	40%	15%																80%
400	45%	40%	15%													0%	100%	0%	80%
410	45%	40%	15%				85%	15%	0%	25%	15%	60%	85%	10%	5%				80%
415																10%	20%	70%	80%
420	45%	40%	15%							25%	80%	-5%				90%	10%	0%	80%

SWMM Information
Assumptions

		Existing Land Use			
	Basin	Grass	Light Forest	Dense Forest	N Perv
N -->	ID	0.15	0.40	0.80	Total
Area ->	100	0.09		0.77	0.73
	110	0.08		0.69	0.74
	115	0.09		0.58	0.71
	120	0.16	0.39		0.33
	122	0.13	0.49		0.35
	125	0.31	0.28		0.27
	127	0.15	0.17		0.28
	130	0.26	0.47		0.31
	200	0.08		0.64	0.73
	205	0.15		0.75	0.69
	210	0.28	0.13		0.23
	215	0.10	0.39		0.35
	220	0.23	0.08		0.21
	225	0.05	0.05		0.28
	230	0.33	0.06		0.19
	235	0.10	0.00		0.15
	300	0.09		0.76	0.73
	305	0.08		0.55	0.72
	310	0.30	0.14		0.23
	315	0.32	0.12		0.22
	320	0.30	0.12		0.22
	325	0.05	0.05		0.28
	330	0.21	0.17		0.26
	340	0.15	0.15		0.28
	350	0.29	0.11		0.22
	355	0.15	0.01		0.17
	360	0.32	0.12		0.22
	400	0.32	0.12		0.22
	410	0.26	0.10		0.22
	415	0.20	0.70		0.34
	420	0.00	0.08		0.40

EX_LU	N_Perv
Min	0.15
Max	0.74
Ave	0.36

SWMM Information
N_Perv

	100	110	115	120	122	125	127	130	200	205	210	215	220	225	230	235	300	305	310	315	320	325	330	340	350	355	360	400	410	415	420
Description	Lower	Lower	Lower	Lower	Lower	Lower	Lower-Campus	Lower	South	South-Campus	South	South-Campus	South	South-Business	South	S Town Center	North	North west	North	North west	North east	NE Town Center	North east	NE - Christa	North east	NE-Christa	North east	North west	North west	North west	North west
Rain Gage	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U
Area (acres)	35.7503	26.3504	139.6660	15.7233	27.5928	46.9532	13.4023	34.1937	34.3929	8.9392	210.3590	58.2414	249.4210	37.5096	56.9022	73.0558	5.1689	15.1444	35.9054	45.6795	158.5040	29.0893	70.9339	49.0869	50.0539	6.5618	49.1081	55.6330	66.7071	1.4905	57.1339
Flow Path (ft)	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Width	7,786	5,739	30,419	3,425	6,010	10,226	2,919	7,447	7,491	1,947	45,816	12,685	54,324	8,170	12,393	15,912	1,126	3,298	7,820	9,949	34,522	6,336	15,449	10,691	10,902	1,429	10,696	12,117	14,529	325	12,444
% Slope	42.26%	42.78%	18.84%	31.97%	27.29%	23.10%	10.46%	31.84%	31.52%	13.82%	8.36%	15.89%	7.50%	7.12%	6.56%	4.32%	42.56%	23.84%	13.04%	11.19%	16.28%	5.56%	9.80%	14.11%	9.00%	6.11%	6.62%	13.32%	6.19%	8.43%	6.58%
% Imperv (LU)	13.82%	21.86%	30.61%	39.87%	34.25%	36.45%	67.88%	26.73%	24.38%	10.12%	54.97%	50.56%	66.43%	90.00%	59.19%	90.0%	14.44%	31.50%	52.29%	52.33%	54.19%	90.0%	56.78%	70.00%	54.86%	84.00%	52.19%	51.84%	59.54%	10.22%	55.74%
N-Impervious	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
N-Pervious (LU)	0.73	0.74	0.71	0.33	0.35	0.27	0.28	0.31	0.73	0.69	0.23	0.35	0.21	0.28	0.19	0.15	0.73	0.72	0.23	0.22	0.22	0.28	0.26	0.28	0.22	0.17	0.22	0.22	0.22	0.34	0.40
Dstore-Impervious	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Dstore-Pervious	0.25	0.25	0.2	0.2	0.2	0.2	0.15	0.2	0.25	0.25	0.1	0.15	0.1	0.1	0.1	0.1	0.25	0.25	0.12	0.12	0.12	0.1	0.12	0.15	0.15	0.12	0.12	0.12	0.12	0.12	0.12
% Zero-Impervious	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Subarea Routing	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet
Percent Routed	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	200%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Infiltration (CN)	69	70	78	63	54	69	92	56	50	73	85	83	90	96	89	96	37	65	67	83	79	96	85	90	85	95	86	80	86	83	87
Drying Time (days)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

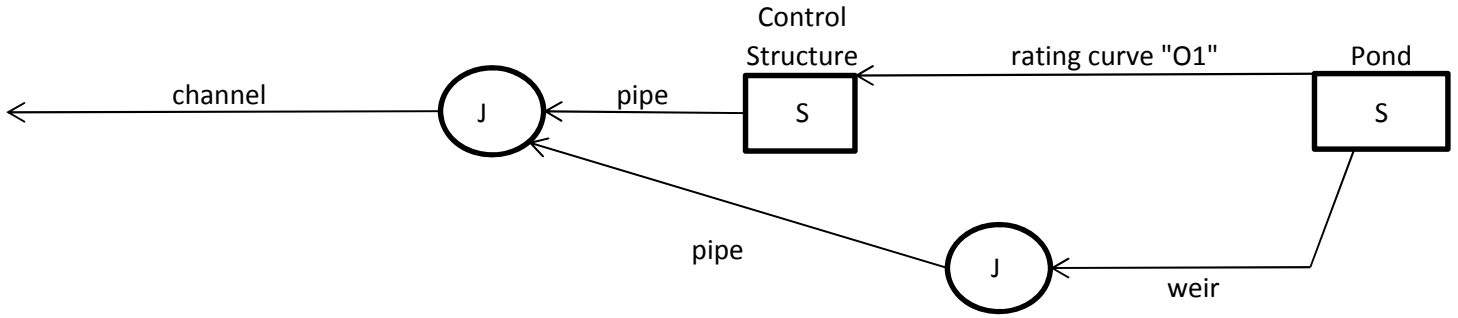
SWMM Information
Inputs

	Conduit	Basin	Stream Length (ft)	Culvert Length (ft)	ObjectID	IE In (ft)	IE Out (ft)	Diam. (in)	Diam. (ft)	Type	Slope %	Notes
Downstream	P_1	100	--	40		14	10		8x6	Conc	10.0%	estimated using GIS topo
	C_1	100	400	--		17.9	14				1.0%	estimated using GIS topo
	C_2	100	1316.01	--		67	17.9				3.7%	estimated using GIS topo
	C_3	110	644.58	--		84	67				2.6%	estimated using GIS topo and WindWard project
	C_4	110	229.13	--		111.3	94				7.6%	estimated using GIS topo
	C_5	120	742.29	--		187	111.3				10.2%	estimated using GIS topo
	P_3	130	--	109.2	5299/8343	192	187	60	5	CPP	4.6%	estimated using GIS topo
	C_6	130	1059.88	--		220.2	184				3.4%	estimated using GIS topo
	C_7A	200	1127.49	--		277	220.2				5.0%	estimated using GIS topo
	C_7B	200	775.58	--		314	277				4.8%	M1 Dam Sheets and GIS topo
	P_5	205&215	--	155	6161	318	314	60	5	Conc	2.6%	M1 Dam Sheets and GIS topo
	P_6	215	--	35	6162	334	320.7	20	1.67	DI	38.0%	M1 Dam Control Structure Sheet
	C_7C	215	731.07	--		370	342.5				3.8%	M1 Dam Sheets and GIS topo
	C_8	300	896.30	--		261.84	220.2				4.6%	GIS topo and Boeing Creek Pond Sheets
	P_7	310	--	162.9	7327	286.59	261.84	24	2	CPP	15.2%	Boeing Creek Pond Sheets
	P_9	300	--	150	6323	291.3	261.84	36	3	CPP	19.6%	Boeing Creek Pond Sheets and GIS topo
	P_10	310&400	--	605	2285	325.84	290.68	30	2.5	Plastic	5.8%	Boeing Creek Pond Sheets and GIS topo
	P_11	310&315	--	660.7	5518	336.26	290.68	36	3	Conc	6.9%	Boeing Creek Pond Sheets and GIS topo
Laterals	C_4A	115	1441.44	--		309	111.3				13.7%	estimated using GIS topo
	C_5A	125	338.4	–		235.8	187				14.4%	estimated using GIS topo open channel flow
	P_4	122&130	--	489.2	3226	258	184	12	1	Conc	15.1%	estimated using GIS topo

Junctions

ID	IE	Max Depth	Notes
Mouth	10	7	GIS topo
J1	14	7	GIS topo
J2	17.9	7	GIS topo
J3	67	7	GIS topo
J4	84	7	GIS topo
J5	94	7	GIS topo
J6	111.3	7	GIS topo
J6A	309	7	GIS topo
J7	187	5	GIS topo
J7A	235.8	5	GIS topo
J8	258	6.5	GIS topo
J9	220.2	6.5	GIS topo
J9A	277	4	GIS topo
J10	314	5	GIS topo
J10A	370	7.5	GIS topo
J11	261.84	4	Boeing Creek Pond Sheets
J12	291.3	4	Boeing Creek Pond Sheets
J13	325.84	4	GIS database information
J14	336.26	4	GIS database information

SWMM Information
Streams



Pond Storage Unit:

Elevation	Area[1]
290	11,128
292	11,900
294	12,692
296	15,680
298	16,046
300	16,416
302	20,502
304	21,128
306	21,766
308	22,416

Assumptions:
[1]Areas estimated using topo in Otak Plans.

Outlet:

Inlet Offset[1] (ft)
0

Assumptions:
[1]Set flow control at pond outlet elevation.

Control Structure:

Diameter[1] (ft)	Depth[2] (ft)	Invert Elevation[3]
8	19.2	286.59

Assumptions:
[1]Estimated from GIS.
[2]Estimated from Otak Plans.
[3]Otak Plans show rim elevation of manhole to be at 305.79.

SWMM Information
Boeing Creek Pond

Outlet Pipe:

Length[1] (ft)	Diameter[2] (in)	n[3]	Inlet Offset[4] (ft)
162.9	24	0.021	0.8

Assumptions:
[1]Length estimated from GIS/Otak Plans.
[2]Discrepancy within Otak Plans and GIS. Assumed smallest diameter.
[3]WSDOT Hydraulics Manual used. (Chow does not have CPP.) Closed conduits, Thermoplastic Pipe, Corrugated Polyethylene. (Appendix A4-1-3)
[4]Otak Plans show outlet pipe invert elevation to be at 286.59.

Spillway Weir:

Weir Length[1] (ft)	Height[2] (ft)	Inlet Offset[3] (ft)
38	1.68	16.32

Assumptions:
[1]Estimated from GIS/Otak Plans.
[2]Maximum pond elevation of 308.68, weir elevation of 307.
[3]Otak Plans show inlet structure elevation to be 290.68 and spillway elevation to be 307.

Spillway Pipe:

Length[1] (ft)	Diameter[2] (in)	n[3]
150.0	36	0.021

Assumptions:
[1]Estimated from GIS.

[3]WSDOT Hydraulics Manual used. (Chow does not have CPP.) Closed conduits, Thermoplastic Pipe, Corrugated Polyethylene. (Appendix A4-1-3)

Control Structure *Boeing Creek Pond* ***Designer:*** ***MLP***
PROJECT TITLE: ***City of Shoreline Basin Plans - Boeing Creek Subbasin*** ***Reviewer:*** ***LCR***
PROJECT NO.: ***10-110014*** ***Date:*** 8/13/2012

Control	Cd Coeff.	Diameter (inches)	Area (ft^2)	Invert Elev (ft)	Centroid Elev (ft)	Elevation Description
Sluice Gate	0.62	12	1.000	288.63	289.13	Boeing Creek Plans; assumed to be h=0
16" Orifice	0.62	16	1.396	297.24	297.91	Boeing Creek Plans
24" Orifice	0.62	24	3.142	301.75	302.75	Boeing Creek Plans

h (feet)	h (inches)	Elevation (ft)	Q (Sluice Gate) (cfs)	Q (16" Orifice) (cfs)	Q (24" Orifice) (cfs)	Total Q	
0.00	0.00	289.13	0.00	0.00	0.00	0.00	**<--Sluice Gate centroid**
0.00	0.01	289.13	0.14	0.00	0.00	0.14	
0.50	6.00	289.63	3.52	0.00	0.00	3.52	**<--Sluice Gate top**
1.50	18.00	290.63	6.09	0.00	0.00	6.09	
2.50	30.00	291.63	7.87	0.00	0.00	7.87	
3.50	42.00	292.63	9.31	0.00	0.00	9.31	
4.50	54.00	293.63	10.55	0.00	0.00	10.55	
5.50	66.00	294.63	11.67	0.00	0.00	11.67	
6.50	78.00	295.63	12.69	0.00	0.00	12.69	
7.50	90.00	296.63	13.63	0.00	0.00	13.63	
8.11	97.36	297.24	14.17	0.00	0.00	14.17	**<--16" Orifice IE**
8.78	105.36	297.91	14.74	0.40	0.00	15.14	**<--16" Orifice centroid**
9.45	113.36	298.58	15.29	5.69	0.00	20.98	**<--16" Orifice top**
10.45	125.36	299.58	16.08	8.98	0.00	25.06	
11.45	137.36	300.58	16.83	11.35	0.00	28.19	
12.45	149.36	301.58	17.55	13.31	0.00	30.86	
12.66	151.92	301.79	17.70	13.69	0.00	31.39	**<--24" Orifice IE**
13.66	163.92	302.79	18.39	15.35	3.13	36.87	**<--24" Orifice centroid**
14.66	175.92	303.79	19.05	16.85	15.94	51.84	**<--24" Orifice top**
15.66	187.92	304.79	19.69	18.23	22.33	60.24	
16.66	199.92	**305.79**	20.31	19.51	27.25	**67.07**	**<--Top of Control Structure**

SWMM Information
BCcontrol

Orifice Equation

$Q = Cd * A * (2gh)^{1/2}$

Cd = coefficient of discharge

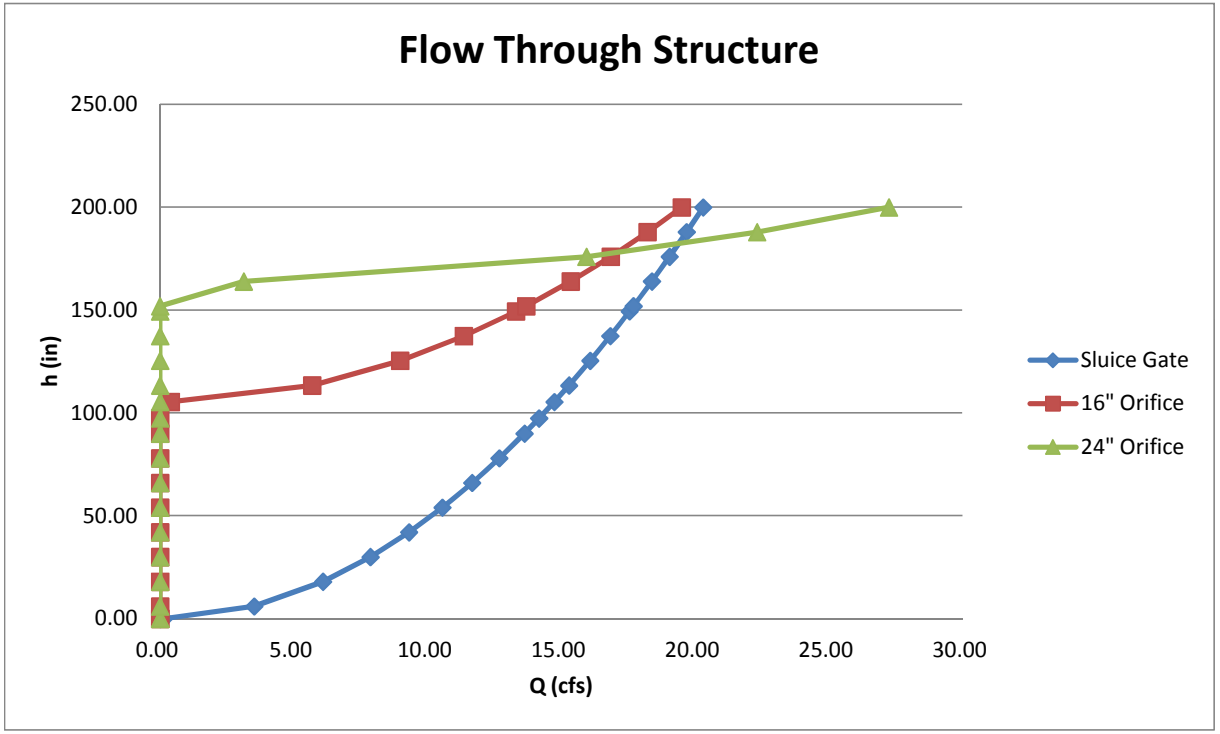
A = area of orifice (SF)

g = acceleration from gravity (32.2 ft/s/s)

h = head acting on the centerline (ft)

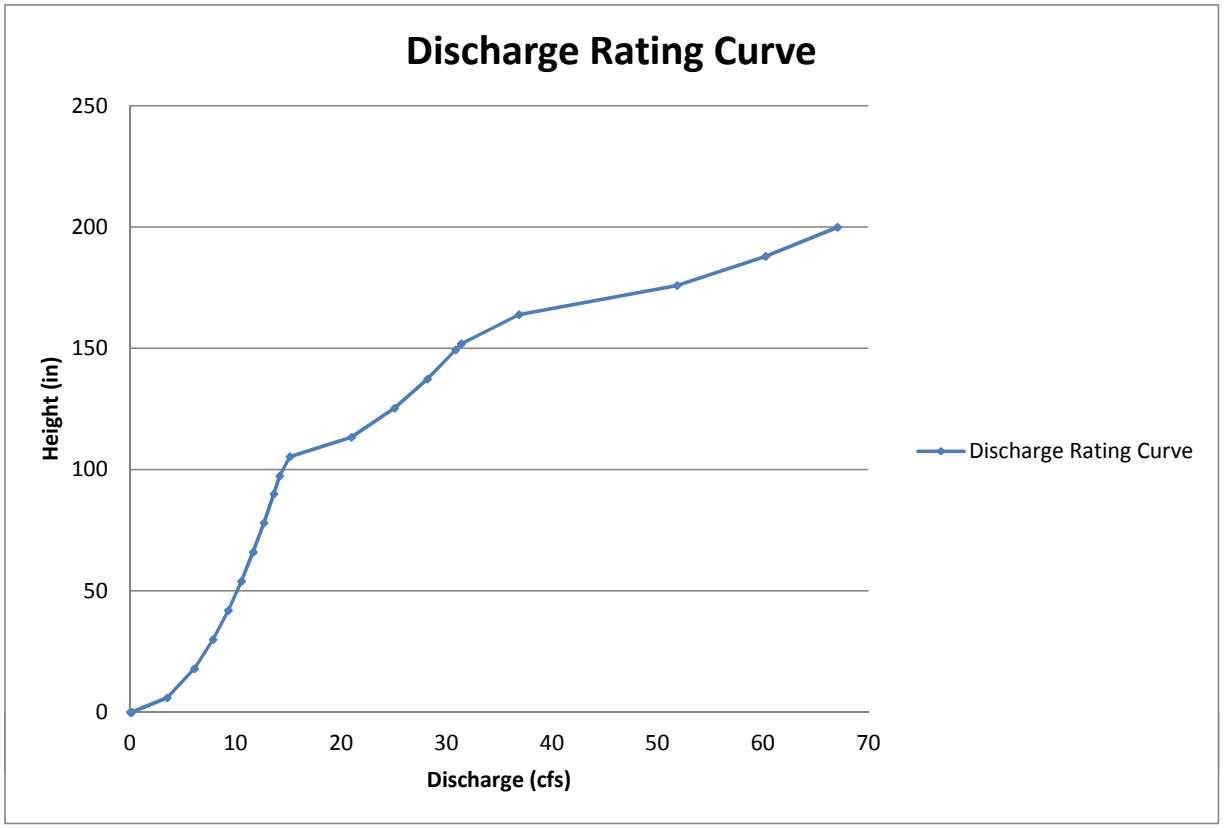
Outlet Pipe Max Discharge

Q = discharge =	k/n * A * Rh^2/3 * S^1/2	
k = unit converter =	1.49	
n = Manning's Roughness coefficient =	0.021	(see Boeing Cr Pond tab "Spillway Pipe")
A = area of pipe =	3.142	ft^2
Rh = hydraulic radius =	0.5	ft
S = slope of pipe =	15.2	(see Streams tab "P_7")
Pipe leaving Structure Q_{max} =	**72.42**	**cfs**

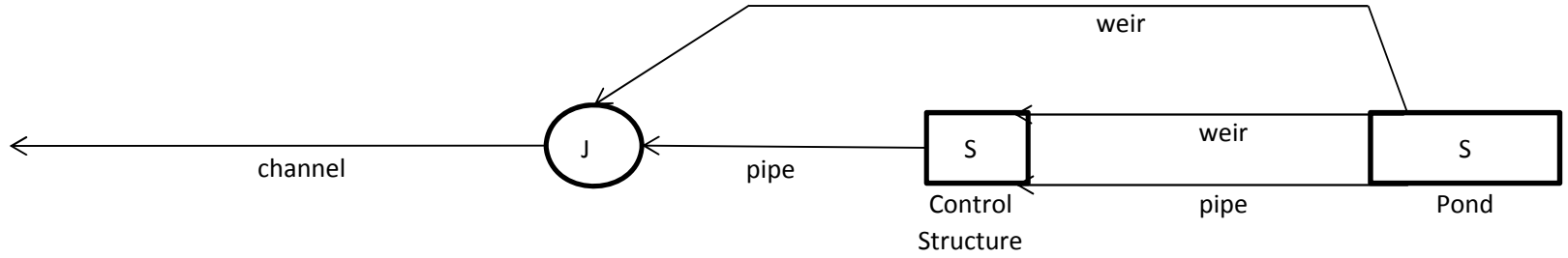


SWMM Information

BCcontrol



SWMM Information
BCcontrol



Pond Storage Unit:

Elevation	Area[1]
334 [2]	4,032.13
336 [2]	8,490.18
338	13,135.17
340	17,562.19
342	22,908.56
344	28,607.64
346	35,887.06
348	42,721.75
350	49,556.04

Assumptions:

[1]Areas found using topo in GIS/CAD.

[2]GIS shows current inlet structure elevation to be at 334 and current surface elevation to be at 336.

Overflow weir:

Length[1] (ft)	Height[2] (ft)	Inlet Offset[3] (ft)
31.42	1.39	13

Assumptions:

[1]Control Structures sheet and GIS show manhole to be 10' diameter. Length is assumed to be circumference.

[2]Height above control structure which causes outlet pipe to reach maximum capacity.

[5]Control Structures sheet shows manhole top to be 6 ft above ground level on the south side. If the inlet structure elevation is estimated at 334 and the elevation at the manhole top is 347, the outlet offset is 13 ft.

Pipe to Control Structure:

Length[1] (ft)	Diameter[1] (in)	n^2
35	20	0.014

Assumptions:

[1]Control Structure sheet states dimensions of pipe.

[3]Chow (1959) Manning's n used. Closed conduit, cast iron, uncoated.

SWMM Information
M1 Dam

Control Structure:

Diameter[1] (ft)	Depth[1] (ft)	Invert Elevation[2]
10	30	317

Assumptions:

[1]Control Structures sheet shows manhole to be 10' diameter and depth to be 30'.

[2]Control Structure sheet shows control structure top to be 6' above ground on south side. If current inlet structure elevation is estimated at 334 and the elevation of the control structure top is 347, the invert elevation is 317.

Spillway Weir:

Weir Length[1] (ft)	Height[2] (ft)	Inlet Offset[3] (ft)
65	2	14

Assumptions:

[1]Estimated from GIS.

[2]Maximum pond elevation of 350, weir elevation of 348.

[3]If inlet structure elevation is estimated at 334 and weir elevation is 348, the inlet offset is 14 ft.

Outlet Pipe:

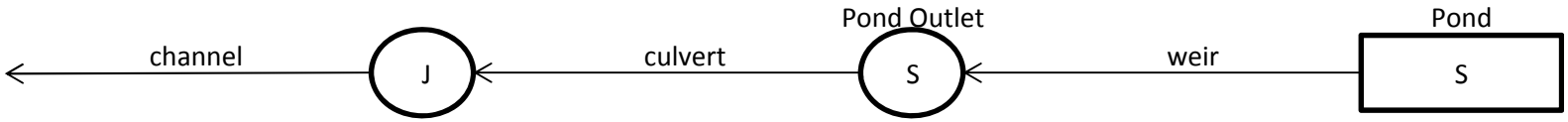
Length[1] (ft)	Diameter[2] (in)	n[3]	Inlet Offset (ft)
155	60	0.013	1

Assumptions:

[1]Length estimated from GIS.

[2]GIS shows pipe width. Control structures sheet confirms.

[3]GIS shows as concrete pipe. Chow (1959) Manning's for closed conduit, concrete, some debris.



Pond Storage Unit:

Elevation	Area[1]
184	9,316
194	59,938
196	94,636
197	111,985

Assumptions:

[1]Areas estimated using topo in GIS/CAD and assumptions.

Weir:

Weir Length[1] (ft)	Height[2] (ft)	Inlet Offset[3] (ft)
45	3	10

Assumptions:

[1]Estimated from GIS.

[2]Maximum pond elevation of 197, weir elevation assumed to be 194.

[3]Pond bottom elevation assumed to be 184.

Pond Outlet Storage Unit:

Elevation	Area[1]
194	3,863
196	5,863
197	6,863

Assumptions:

[1]Areas estimated using topo in GIS and assumptions.

Culvert:

Length[1] (ft)	iameter[1] (ir	n[2]	Inlet Offset[4] (ft)
109.2	60	0.021	0

Assumptions:

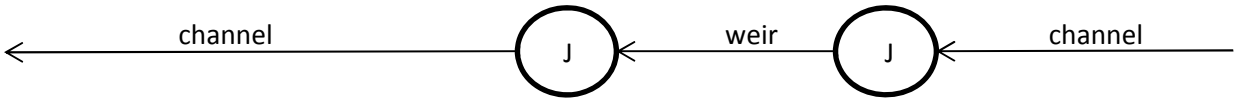
[1]Estimated from GIS.

[2]WSDOT Hydraulics Manual used. (Chow does not have CPP.) Closed conduits, Thermoplastic Pipe, Corrugated Polyethylene. (Appendix A4-1-3)

[4]Culvert inlet estimated be 192.

SWMM Information

Hidden Lake



Spillway Weir:

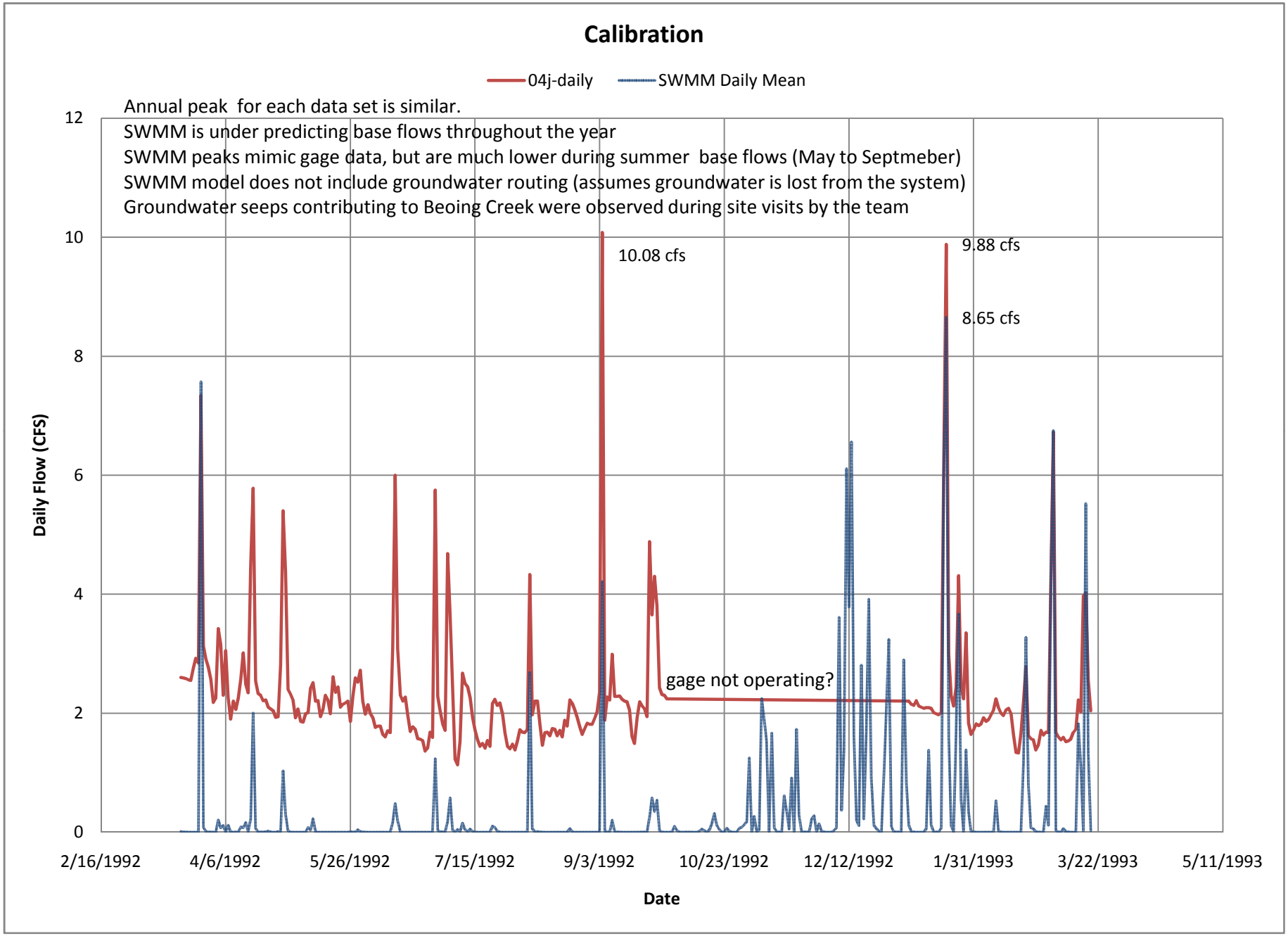
Weir Length[1] (ft)	Height[1] (ft)	Inlet Offset[1] (ft)
21.3	0	0

Assumptions:

[1]Estimated from WindWard Project List.

SWMM Information

Water Supply Dam


Calibration
04j-daily
SWMM Daily Mean
Annual peak for each data set is similar.
SWMM is under predicting base flows throughout the year
SWMM peaks mimic gage data, but are much lower during summer base flows (May to Septmeber)
SWMM model does not include groundwater routing (assumes groundwater is lost from the system)
Groundwater seeps contributing to Beoing Creek were observed during site visits by the team
10.08 cfs
9.88 cfs
8.65 cfs
gage not operating?
Daily Flow (CFS)
0
2
4
6
8
10
12
2/16/1992
4/6/1992
5/26/1992
7/15/1992
9/3/1992
10/23/1992
12/12/1992
1/31/1993
3/22/1993
5/11/1993
Date

	100	110	115	120	122	125	127	130	200	205	210	215	220	225	230	235	300	305	310	315	320	325	330	340	350	355	360	400	410	415	420
Description	Lower	Lower	Lower	Lower	Lower	Lower	Lower-Campus	Lower	South	South-Campus	South	South-Campus	South	South-Business	South	S Town Center	North	North west	North	North west	North east	NE Town Center	North east	NE - Christa	North east	NE-Christa	North east	North west	North west	North west	North west
Rain Gage	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U
Area (acres)	35.7503	26.3504	139.6660	15.7233	27.5928	46.9532	13.4023	34.1937	34.3929	8.9392	210.3590	58.2414	249.4210	37.5096	56.9022	73.0558	5.1689	15.1444	35.9054	45.6795	158.5040	29.0893	70.9339	49.0869	50.0539	6.5618	49.1081	55.6330	66.7071	1.4905	57.1339
Flow Path (ft)	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Width	7,786	5,739	30,419	3,425	6,010	10,226	2,919	7,447	7,491	1,947	45,816	12,685	54,324	8,170	12,393	15,912	1,126	3,298	7,820	9,949	34,522	6,336	15,449	10,691	10,902	1,429	10,696	12,117	14,529	325	12,444
% Slope	42.26%	42.78%	18.84%	31.97%	27.29%	23.10%	10.46%	31.84%	31.52%	13.82%	8.36%	15.89%	7.50%	7.12%	6.56%	4.32%	42.56%	23.84%	13.04%	11.19%	16.28%	5.56%	9.80%	14.11%	9.00%	6.11%	6.62%	13.32%	6.19%	8.43%	6.58%
% Imperv (LU)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
N-Impervious	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
N-Pervious (LU)	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Dstore-Impervious	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Dstore-Pervious	0.25	0.25	0.2	0.2	0.2	0.2	0.15	0.2	0.25	0.25	0.1	0.15	0.1	0.1	0.1	0.1	0.25	0.25	0.12	0.12	0.12	0.1	0.12	0.15	0.15	0.12	0.12	0.12	0.12	0.12	0.12
% Zero-Impervious	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Subarea Routing	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet
Percent Routed	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	200%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Infiltration (CN)	64	63	71	42	32	47	77	39	35	70	75	68	77	77	77	77	26	54	25	70	56	77	72	67	77	77	77	61	75	77	77
Drying Time (days)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Parameters changed in SWMM.

SWMM Information
Inputs

	100	110	115	120	122	125	127	130	200	205	210	215	220	225	230	235	300	305	310	315	320	325	330	340	350	355	360	400	410	415	420
Description	Lower	Lower	Lower	Lower	Lower	Lower	Lower-Campus	Lower	South	South-Campus	South	South-Campus	South	South-Business	South	S Town Center	North	North west	North	North west	North east	NE Town Center	North east	NE - Christa	North east	NE-Christa	North east	North west	North west	North west	North west
Rain Gage	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U	04U
Area (acres)	35.7503	26.3504	139.6660	15.7233	27.5928	46.9532	13.4023	34.1937	34.3929	8.9392	210.3590	58.2414	249.4210	37.5096	56.9022	73.0558	5.1689	15.1444	35.9054	45.6795	158.5040	29.0893	70.9339	49.0869	50.0539	6.5618	49.1081	55.6330	66.7071	1.4905	57.1339
Flow Path (ft)	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Width	7,786	5,739	30,419	3,425	6,010	10,226	2,919	7,447	7,491	1,947	45,816	12,685	54,324	8,170	12,393	15,912	1,126	3,298	7,820	9,949	34,522	6,336	15,449	10,691	10,902	1,429	10,696	12,117	14,529	325	12,444
% Slope	42.26%	42.78%	18.84%	31.97%	27.29%	23.10%	10.46%	31.84%	31.52%	13.82%	8.36%	15.89%	7.50%	7.12%	6.56%	4.32%	42.56%	23.84%	13.04%	11.19%	16.28%	5.56%	9.80%	14.11%	9.00%	6.11%	6.62%	13.32%	6.19%	8.43%	6.58%
% Imperv (LU)	13.82%	21.86%	30.61%	39.87%	34.25%	36.45%	0.00%	26.73%	24.38%	0.00%	54.97%	0.00%	58.85%	0.00%	59.19%	0.0%	14.44%	31.50%	52.29%	52.33%	54.19%	0.0%	56.78%	0.00%	54.86%	0.00%	52.19%	51.84%	59.54%	0.00%	55.74%
N-Impervious	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
N-Pervious (LU)	0.73	0.74	0.71	0.33	0.35	0.27	0.80	0.31	0.73	0.80	0.23	0.80	0.41	0.80	0.19	0.80	0.73	0.72	0.23	0.22	0.22	0.80	0.26	0.80	0.22	0.80	0.22	0.22	0.22	0.80	0.40
Dstore-Impervious	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Dstore-Pervious	0.25	0.25	0.2	0.2	0.2	0.2	0.15	0.2	0.25	0.25	0.1	0.15	0.1	0.1	0.1	0.1	0.25	0.25	0.12	0.12	0.12	0.1	0.12	0.15	0.15	0.12	0.12	0.12	0.12	0.12	0.12
% Zero-Impervious	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Subarea Routing	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet	outlet
Percent Routed	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	200%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Infiltration (CN)	69	70	78	63	54	69	77	56	50	35	85	68	88	77	89	77	37	65	67	83	79	77	85	67	85	77	86	80	86	77	87
Drying Time (days)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Categories affected by Redevelopment
Subbasins affected by Redevelopment
Parameters changed in SWMM

SWMM Information
Inputs

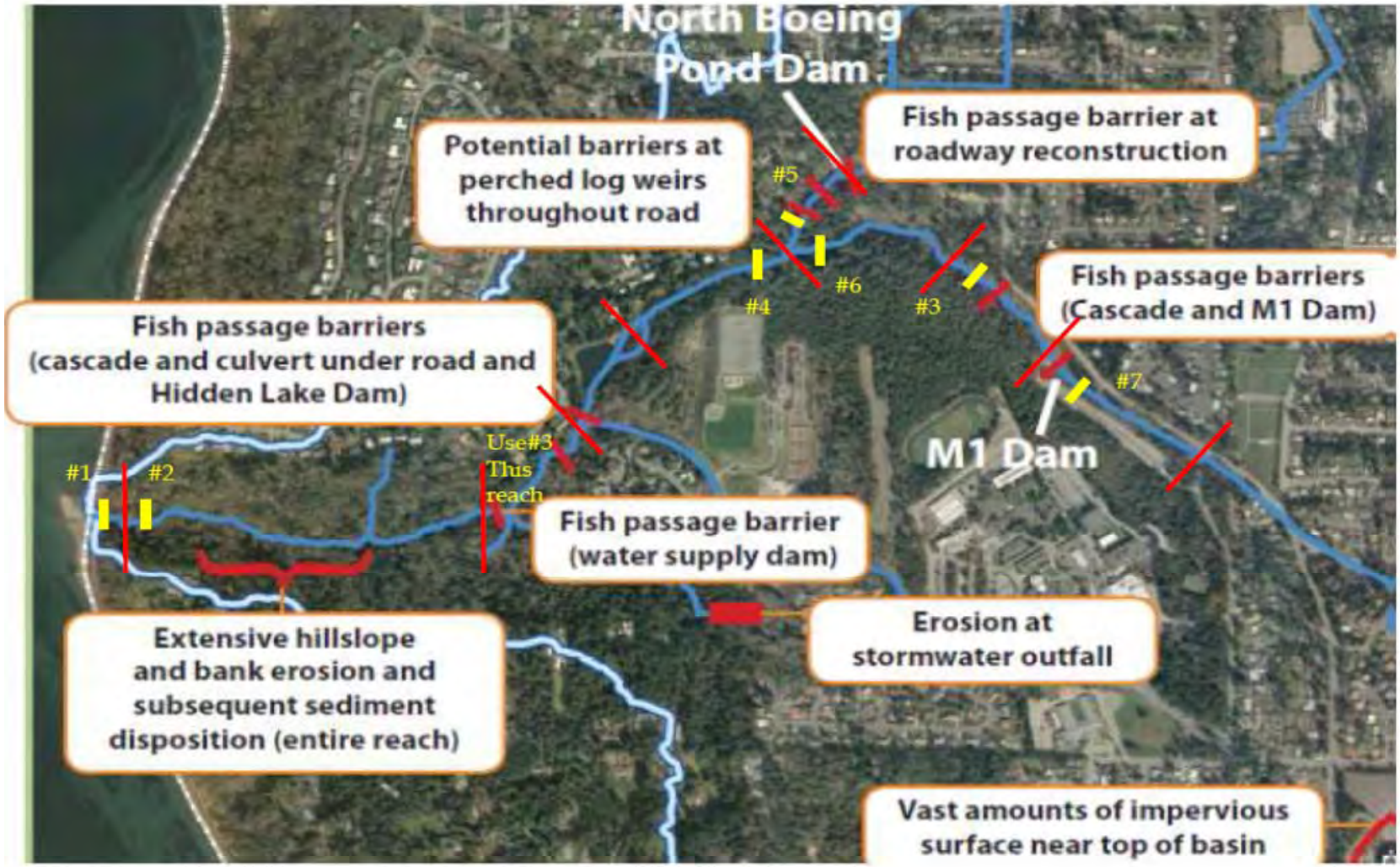
Boeing Creek
City of Shoreline
12/7/2012
EPA-SWMM Flow Frequency Results

This table presents Boeing Creek peak flows for three conditions: Existing, Pre-developed Forest, and Proposed Redevelopment
See Figure 2: Model Schematic for a graphical representation of the Key Locations
See Table #6 EPA SWMM - Key Locations for location descriptions of the SWMM links listed below.

Peak Flow at Key Locations

Key Location (SWMM link ID)	Existing Land Use			Pre-developed:						Proposed:						
	2-yr	25-yr	100-yr	2-yr		25-yr		100-yr		2-yr		25-yr		100-yr		
	(cfs)	(cfs)	(cfs)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	
P1	72.3	154.0	209.8	14.4	20%	52.2	34%	61.7	29%	54.4	75%	118.4	77%	162.8	78%	Outfall
C1	72.3	154.0	209.8	14.3	20%	35.1	23%	45.5	22%	54.4	75%	118.4	77%	162.7	78%	
C2	73.5	154.9	209.7	14.4	20%	35.2	23%	45.5	22%	55.3	75%	119.5	77%	163.6	78%	
C3	73.2	154.5	209.3	14.2	19%	34.7	22%	45.0	21%	55.1	75%	118.8	77%	162.5	78%	
C4	73.2	154.6	209.5	14.2	19%	34.7	22%	45.0	21%	55.1	75%	118.6	77%	162.3	77%	
C5	69.7	149.1	203.9	12.5	18%	30.7	21%	40.3	20%	51.5	74%	112.4	75%	155.5	76%	
C6	72.1	160.5	227.3	12.5	17%	30.2	19%	39.4	17%	53.6	74%	115.8	72%	159.1	70%	Confluence
C7A	60.3	99.4	117.6	8.2	14%	20.7	21%	27.9	24%	43.0	71%	82.5	83%	105.0	89%	South Branch
C7B	60.3	98.9	116.9	8.2	14%	20.7	21%	27.9	24%	42.8	71%	82.0	83%	104.5	89%	
C7C	59.3	166.5	269.5	8.1	14%	20.5	12%	27.7	10%	42.1	71%	119.8	72%	193.9	72%	
C8	21.2	74.5	132.6	4.8	22%	11.7	16%	15.2	11%	16.7	79%	45.1	61%	69.2	52%	North Branch

APPENDIX B: BOEING CREEK CROSS SECTIONS



Boeing Creek cross sections
Overview of locations

Location #1
In constructed channel just east of RR culvert and mouth

Bankfull width ~8 feet
Bankfull depth ~ 2.5 - 3 feet

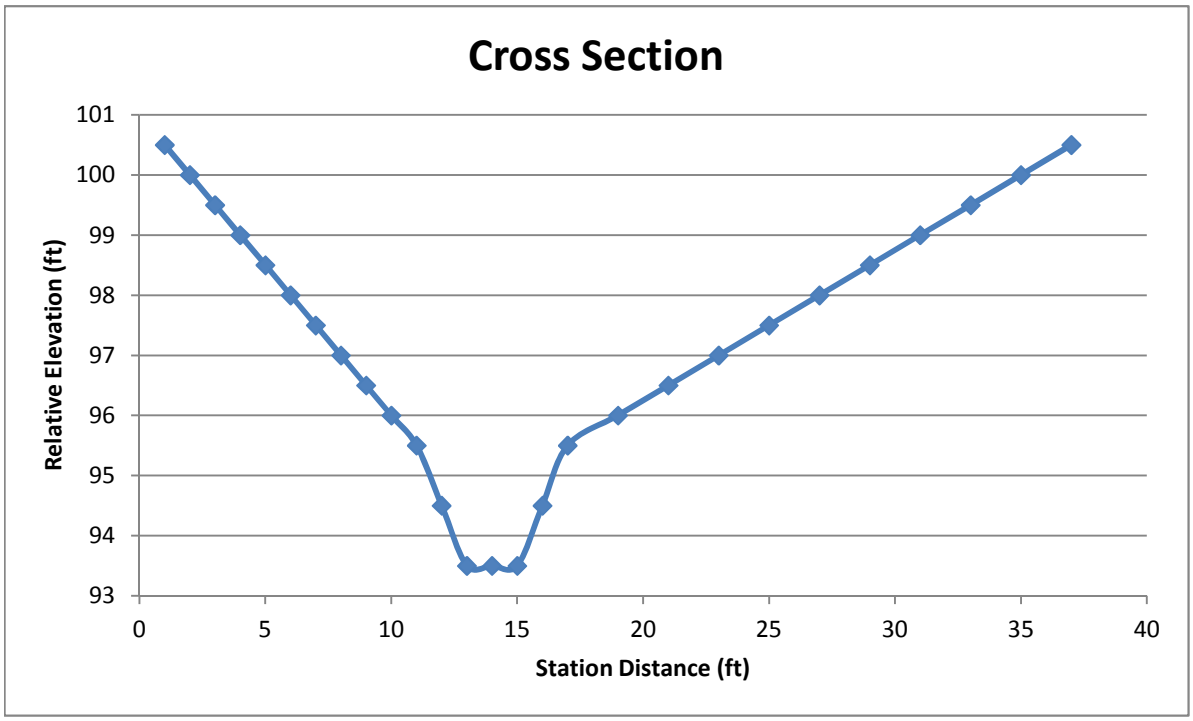
Rip rap sides (large 1 - 2 man rocks) and sandy bottom
n = 0.030

SWMM Assumptions

The leftbank is on the left when looking down stream
Chow (1959) was used for Roughness Coefficient (n)
The picture is looking upstream
Depth of water is 6''
n in channel is 0.03 (Chow 1.a.)
n floodplain is 0.04 (Chow 3; light brush and some trees)
side slope assumptions based on GIS

Assumed Cross Section		
Station (LB ->RB) (ft)	Elevation (ft)	Comments
1	100.5	2H:1V
2	100	
3	99.5	
4	99	
5	98.5	
6	98	
7	97.5	
8	97	
9	96.5	
10	96	
11	95.5	Top of LB (bankfull)
12	94.5	
13	93.5	Channel bottom
14	93.5	Channel bottom
15	93.5	Channel bottom
16	94.5	
17	95.5	Top of RB (bankfull)
19	96	4H:1V
21	96.5	
23	97	
25	97.5	
27	98	
29	98.5	
31	99	
33	99.5	
35	100	
37	100.5	

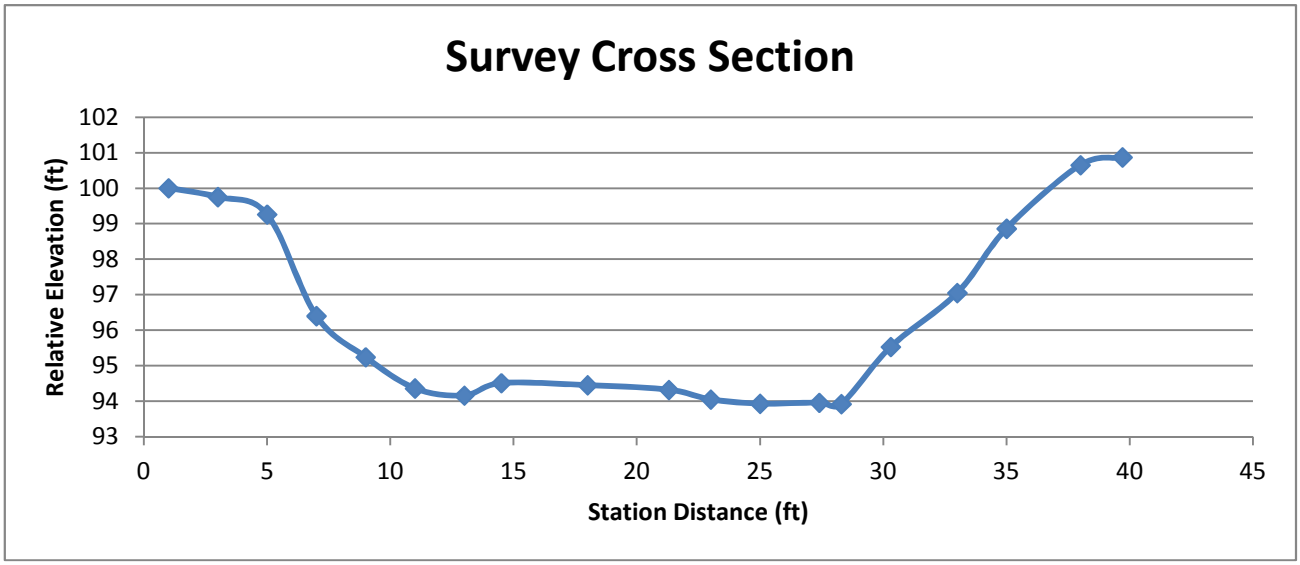
Boeing Creek cross sections
Location #1



Boeing Creek cross sections
Location #1

Location #2
Boeing Creek upstream of foot bridge, approximately 300 - 400 feet upstream of mouth
(indicative of reach up to sheet pile dam)

Station (distance starting at right bank)	Elevation (feet, relative)	HI	Foresight	Comments	Depth of water (feet)	Water Surface Elevation
1	100	103.4	3.4	Assumed elevation		
3	99.75		3.65			
5	99.26		4.14			
7	96.4		7			
9	95.24		8.16			
11	94.36		9.04			
13	94.16		9.24		0.25	94.41
14.5	94.51		8.89			
18	94.45		8.95			
21.3	94.32		9.08			
23	94.05		9.35		0.3	94.35
25	93.93		9.47	Thalweg	0.45	94.38
27.4	93.96		9.44		0.3	94.26
28.3	93.92		9.48			
30.3	95.53		7.87			
33	97.05		6.35			
35	98.86		4.54			
38	100.65		2.75			
39.7	100.87		2.53			



Boeing Creek cross sections
Location #2

SWMM Assumptions

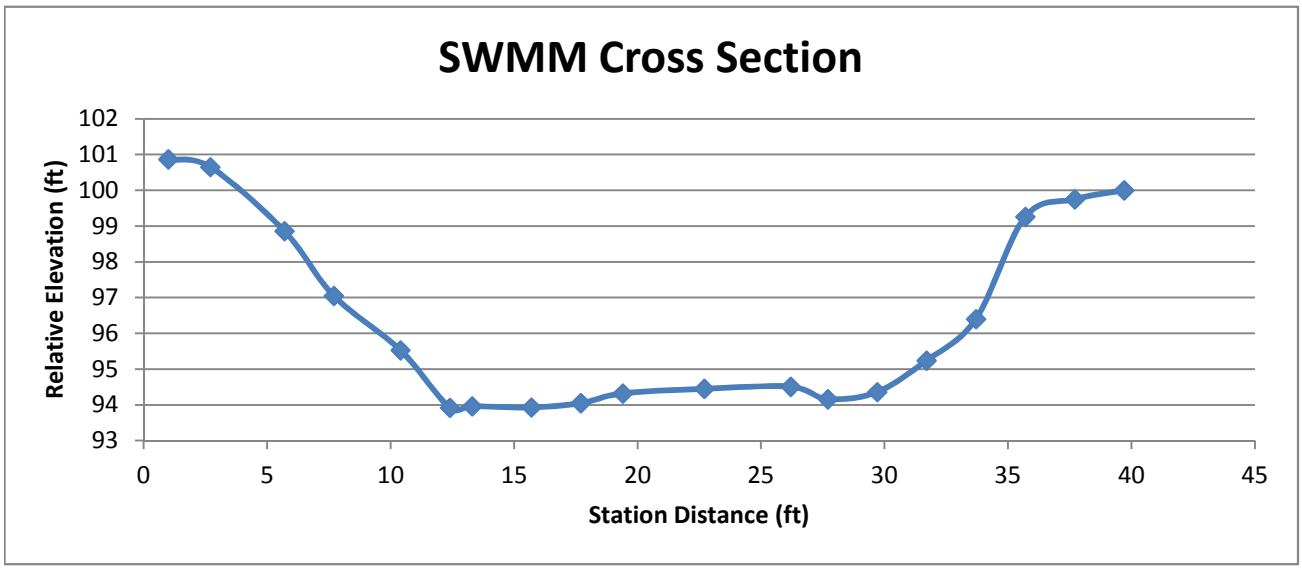
The leftbank is on the left when looking down stream
The picture is looking downstream
The data shall be mirrored in SWMM so that the left bank will be on the left
n in channel is 0.03 (Ref 2.a because no veg in channel, banks usually steep, trees
n in overbank is 0.05 (heavy veg)

Data Input to SWMM (mirrored)

Station (starting at right bank)	Elevation (feet)	Flipped with Survey Elevation	
1	100	39.7	1
3	99.75	38	2.7
5	99.26	35	5.7
7	96.4	33	7.7
9	95.24	30.3	10.4
11	94.36	28.3	12.4
13	94.16	27.4	13.3
14.5	94.51	25	15.7
18	94.45	23	17.7
21.3	94.32	21.3	19.4
23	94.05	18	22.7
25	93.93	14.5	26.2
27.4	93.96	13	27.7
28.3	93.92	11	29.7
30.3	95.53	9	31.7
33	97.05	7	33.7
35	98.86	5	35.7
38	100.65	3	37.7
39.7	100.87	1	39.7

Used in SWMM

Station (starting at left bank)	Elevation (feet)
1	100.87
2.7	100.65
5.7	98.86
7.7	97.05
10.4	95.53
12.4	93.92
13.3	93.96
15.7	93.93
17.7	94.05
19.4	94.32
22.7	94.45
26.2	94.51
27.7	94.16
29.7	94.36
31.7	95.24
33.7	96.4
35.7	99.26
37.7	99.75
39.7	100



Boeing Creek cross sections
Location #2

Boeing Creek cross sections
Location #2

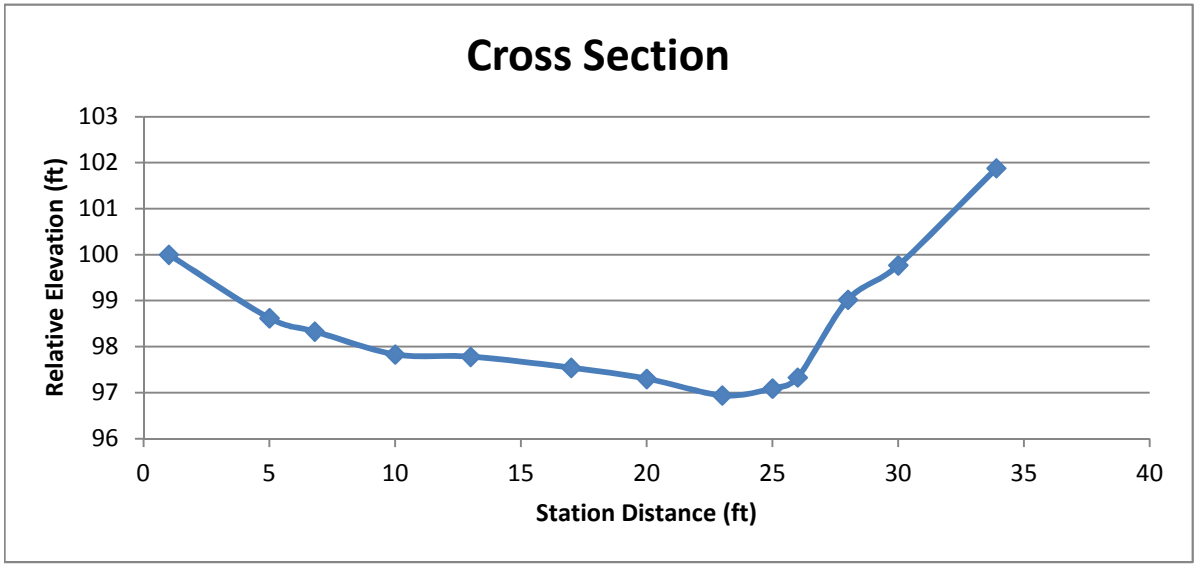
Location #3
South Fork Boeing Creek downstream of cascade and upstream of confluence with north fork

n = 0.033 dry rubble/rip rap

Station (distance starting at left bank)	Elevation (feet, relative)	HI	Foresight	Comments	Depth of water (feet)	Water Surface Elevation
1	100	102.97	2.97	Assumed elevation		
5	98.62		4.35			
6.8	98.33		4.64	Stake at pink tape		
10	97.83		5.14	start cobbles/rip rap		
13	97.78		5.19	Edge of water		
17	97.54		5.43		0.1	
20	97.3		5.67	in stream	0.12	97.42
23	96.94		6.03	thalweg	0.53	97.47
25	97.09		5.88		0.35	97.44
26	97.33		5.64	Edge of water	0.1	97.43
28	99.02		3.95			
30	99.77		3.2			
33.9	101.88		1.09	Right bank stake		

SWMM Assumptions

The leftbank is on the left when looking down stream
The picture is looking upstream
n in channel is 0.035 (Ref 2.a because no veg in channel, banks usually steep, trees and brush along banks submerged at high stages)
n in banks in 0.04 (same as channel but more veg)

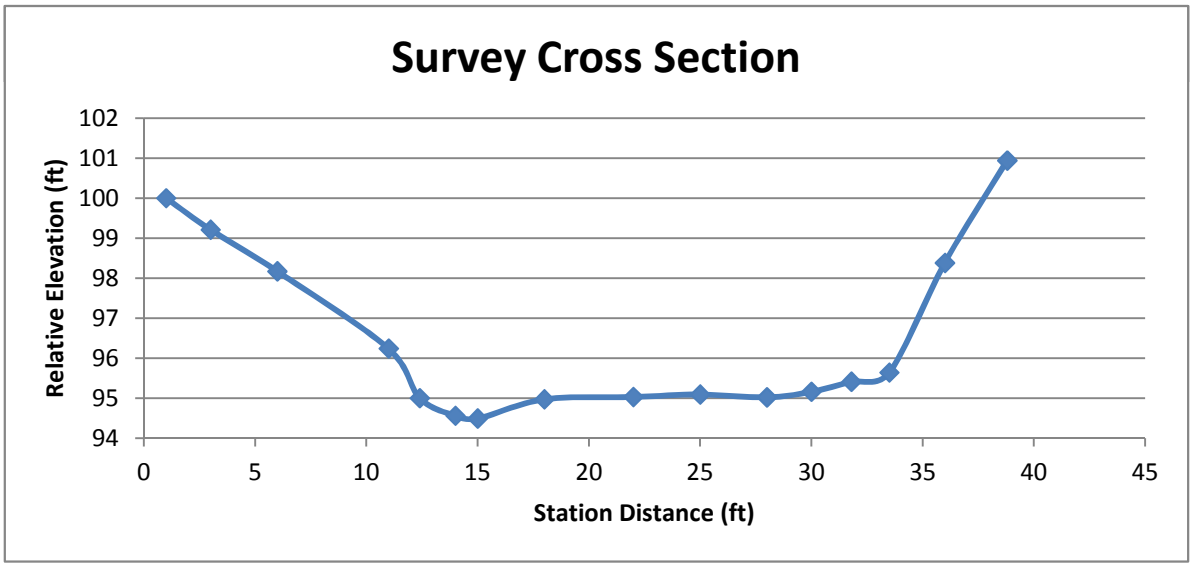


Boeing Creek cross sections
Location #3

Boeing Creek cross sections
Location #3

Location #4
Main stem Boeing Creek downstream of confluence and stepping stone crossing

Station (distance starting at right bank)	Elevation (feet, relative)	HI	Foresight	Comments	Depth of water (feet)	Water Surface Elevation
1	100	103.3	3.3	RB stake		
3	99.21		4.09	Rt bank		
6	98.17		5.13			
11	96.24		7.06			
12.4	95		8.3	Edge of water		
14	94.56		8.74	Water	0.57	95.13
15	94.49		8.81		0.64	95.13
18	94.97		8.33		0.15	95.12
22	95.03		8.27		0.32	95.35
25	95.09		8.21		0.35	95.44
28	95.02		8.28		0.5	95.52
30	95.16		8.14		0.3	95.46
31.8	95.41		7.89	Edge of water		
33.5	95.64		7.66	side of trail		
36	98.38		4.92			
38.8	100.94		2.36	LB stake		



Boeing Creek cross sections
Location #4

SWMM Assumptions

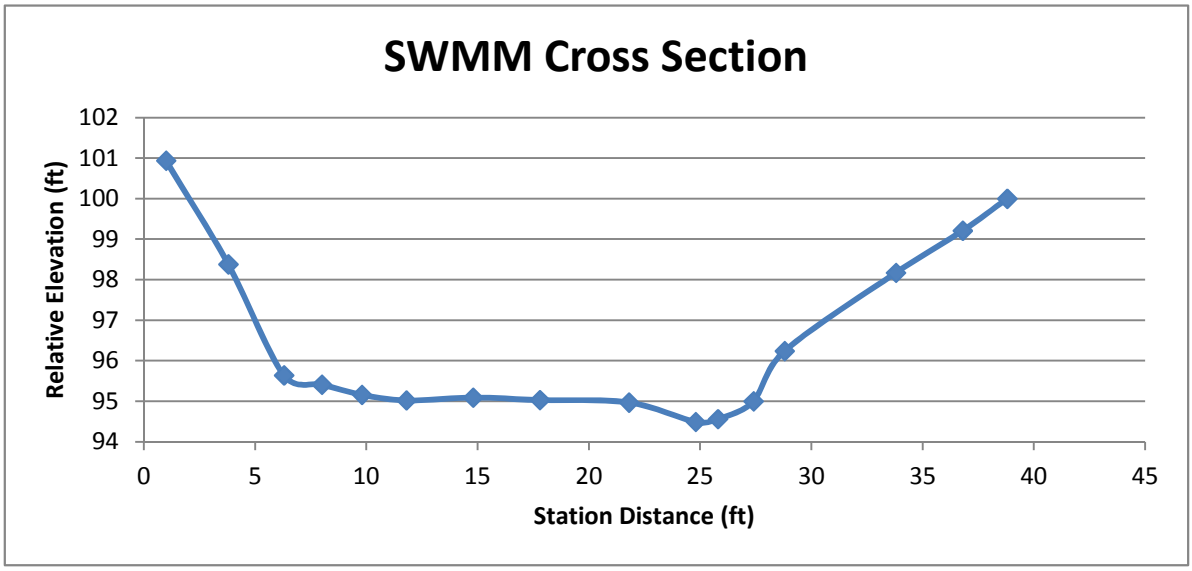
The leftbank is on the left when looking down stream
The picture is looking upstream
The data shall be mirrored in SWMM so that the left bank will be on the left
n in channel is 0.035 (Ref 2.a because no veg in channel, banks usually steep, trees and brush along banks submerged at high stages)
n in banks in 0.04 (same as channel but more veg)

Data Input to SWMM (mirrored)

Station (starting at right bank)	Elevation (feet)	Flipped with Survey Elevation	
1	100	38.8	1
3	99.21	36	3.8
6	98.17	33.5	6.3
11	96.24	31.8	8
12.4	95	30	9.8
14	94.56	28	11.8
15	94.49	25	14.8
18	94.97	22	17.8
22	95.03	18	21.8
25	95.09	15	24.8
28	95.02	14	25.8
30	95.16	12.4	27.4
31.8	95.41	11	28.8
33.5	95.64	6	33.8
36	98.38	3	36.8
38.8	100.94	1	38.8

Used in SWMM

Station (starting at left bank)	Elevation (feet)
1	100.94
3.8	98.38
6.3	95.64
8	95.41
9.8	95.16
11.8	95.02
14.8	95.09
17.8	95.03
21.8	94.97
24.8	94.49
25.8	94.56
27.4	95
28.8	96.24
33.8	98.17
36.8	99.21
38.8	100



Boeing Creek cross sections
Location #4

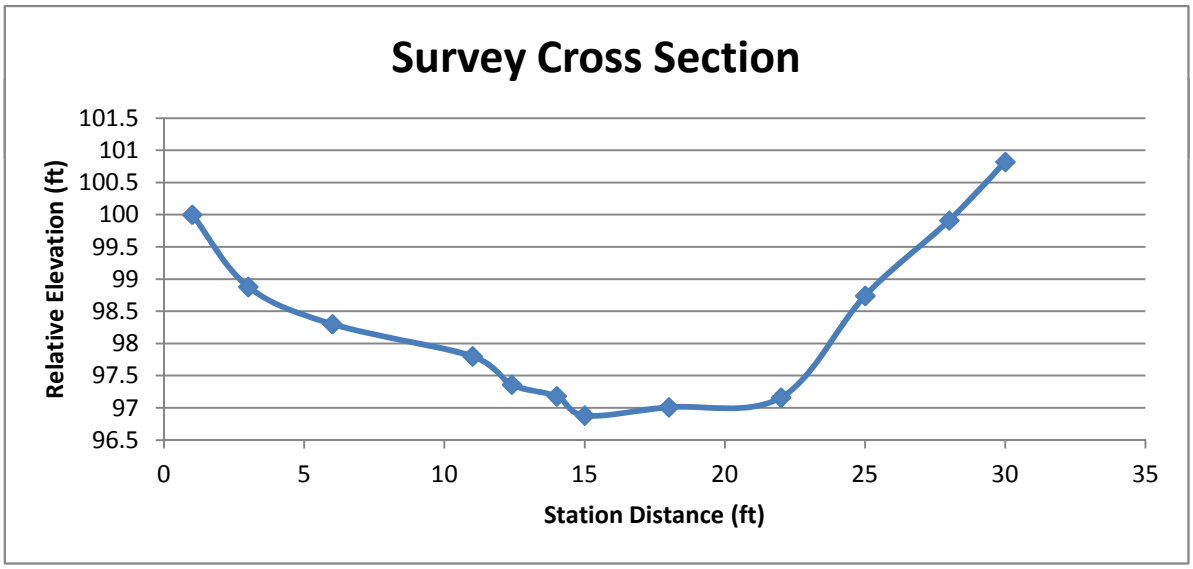
Substrate = small rip-rap and rounded cobbles and gravel, minor sand

Boeing Creek cross sections
Location #4

Location #5
North fork Boeing Creek, 50 feet upstream from confluence

n = 0.032

Station (distance starting at right bank)	Elevation (feet, relative)	HI	Foresight	Comments	Depth of water (feet)	Water Surface Elevation
1	100	102.3	2.3	RB stake		
3	98.88		3.42			
6	98.3		4			
11	97.8		4.5			
12.4	97.36		4.94	Edge of water		
14	97.18		5.12	Water	0.15	97.33
15	96.88		5.42	thalweg	0.48	97.36
18	97.01		5.29		0.35	97.36
22	97.16		5.14	Edge of water	0.2	97.36
25	98.74		3.56			
28	99.91		2.39			
30	100.82		1.48	LB stake		



Boeing Creek cross sections
Location #5

SWMM Assumptions

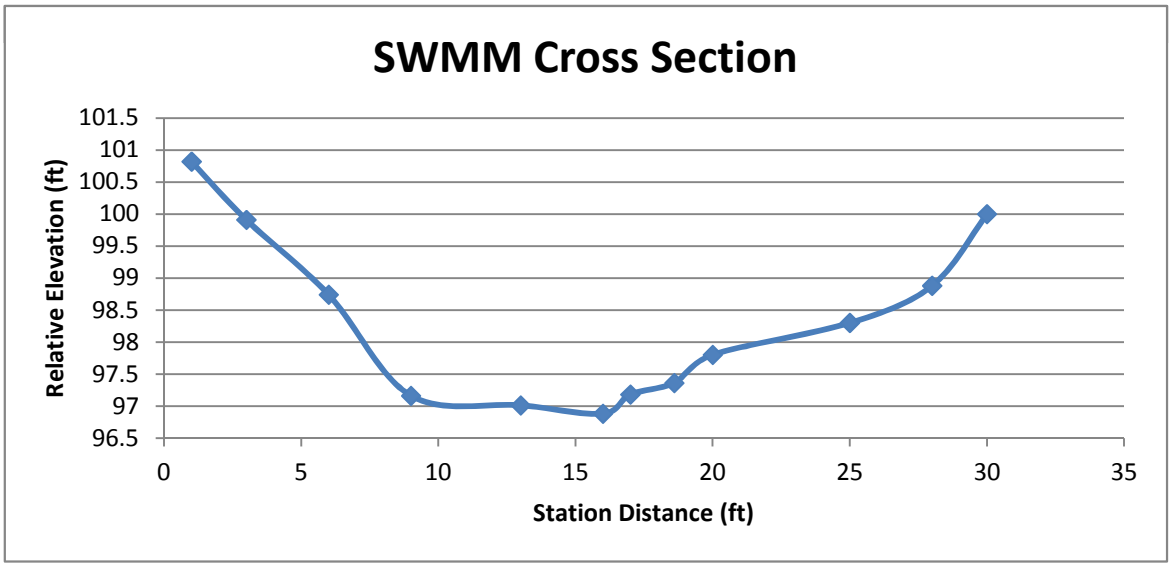
The leftbank is on the left when looking down stream
The picture is looking downstream
The data shall be mirrored in SWMM so that the left bank will be on the left
n in channel is 0.04 (Ref 2.a because no veg in channel, banks usually steep, trees and brush along banks submerged at high stages)
n in banks in 0.05 (same as channel but more veg)

Data Input to SWMM (mirrored)

Station (starting at right bank)	Elevation (feet)	Flipped with Survey Elevation	
1	100	30	1
3	98.88	28	3
6	98.3	25	6
11	97.8	22	9
12.4	97.36	18	13
14	97.18	15	16
15	96.88	14	17
18	97.01	12.4	18.6
22	97.16	11	20
25	98.74	6	25
28	99.91	3	28
30	100.82	1	30

Used in SWMM

Station (starting at left bank)	Elevation (feet)
1	100.82
3	99.91
6	98.74
9	97.16
13	97.01
16	96.88
17	97.18
18.6	97.36
20	97.8
25	98.3
28	98.88
30	100



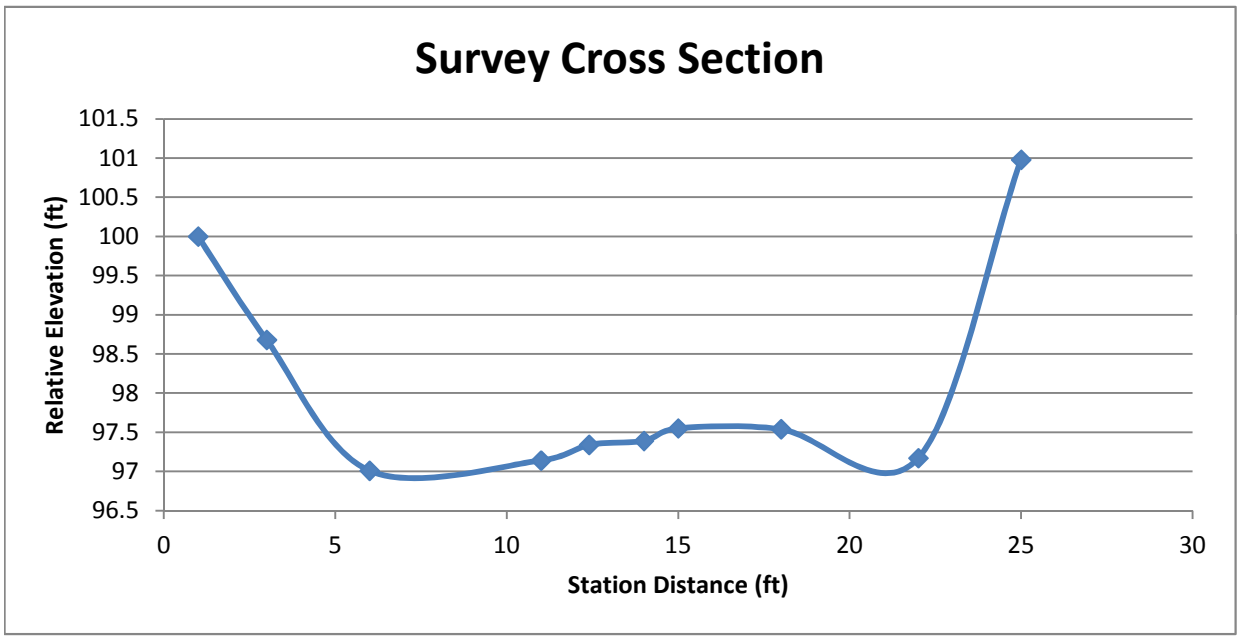
Boeing Creek cross sections
Location #5

Substrate = cobbles and gravel, minor sand

Boeing Creek cross sections
Location #5

Location #6
South fork Boeing Creek, 50 feet upstream of confluence

Station (distance starting at right bank)	Elevation (feet, relative)	HI	Foresight	Comments	Depth of water (feet)	Water Surface Elevation
1	100	102.9	2.9	RB stake		
3	98.68		4.22			
6	97.01		5.89	edge of water		
11	97.14		5.76		0.55	97.69
12.4	97.34		5.56		0.2	97.54
14	97.39		5.51		0.28	97.67
15	97.55		5.35		0.05	97.6
18	97.54		5.36	dry, gravel bar	0	97.54
22	97.17		5.73	edge of water	0.2	97.37
25	100.98		1.92	LB stake		



Boeing Creek cross sections
Location #6

SWMM Assumptions

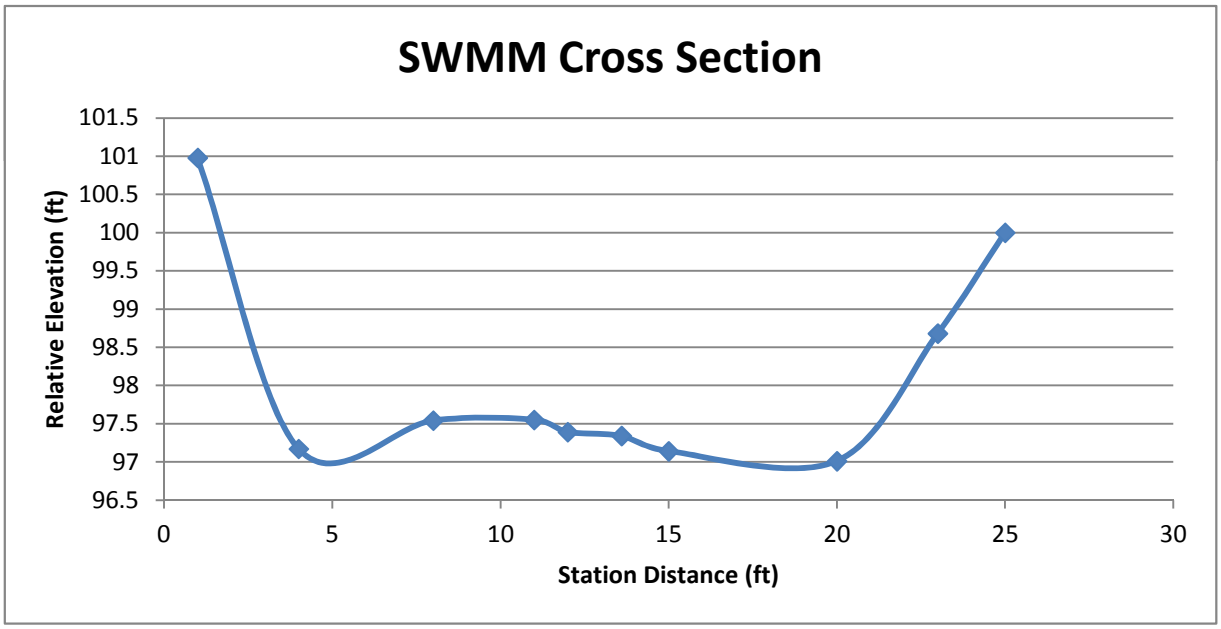
The leftbank is on the left when looking down stream
The data shall be mirrored in SWMM so that the left bank will be on the left
n in channel is 0.035 (Ref 2.a because no veg in channel, banks usually steep, trees and brush along banks submerged at high stages)
n in banks in 0.04 (same as channel but more veg)

Data Input to SWMM (mirrored)

Station (starting at right bank)	Elevation (feet)	Flipped with Survey Elevation	
1	100	25	1
3	98.68	22	4
6	97.01	18	8
11	97.14	15	11
12.4	97.34	14	12
14	97.39	12.4	13.6
15	97.55	11	15
18	97.54	6	20
22	97.17	3	23
25	100.98	1	25

Used in SWMM

Station (starting at left bank)	Elevation (feet)
1	100.98
4	97.17
8	97.54
11	97.55
12	97.39
13.6	97.34
15	97.14
20	97.01
23	98.68
25	100



Boeing Creek cross sections
Location #6

Substrate = sand and gravel

Boeing Creek cross sections
Location #6

Location #7
Upstream of M1 dam, constructed, straight channel

Bankfull width ~16 feet
Bankfull depth ~ 2feet

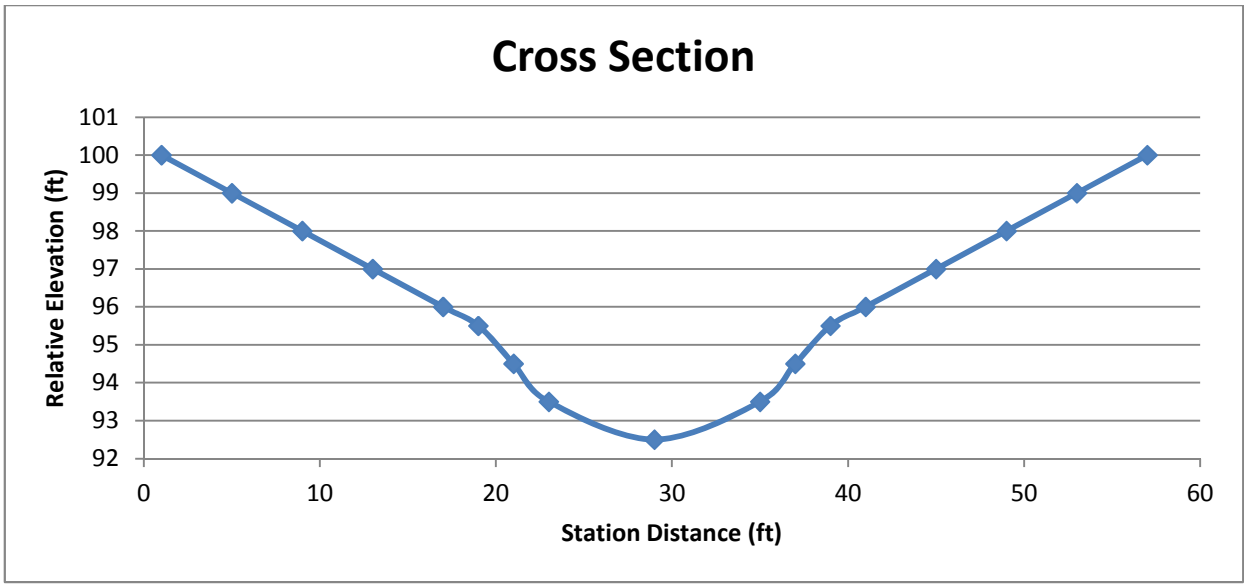
Rip rap sides (large 1 - 2 man rocks)
n = 0.030

SWMM Assumptions

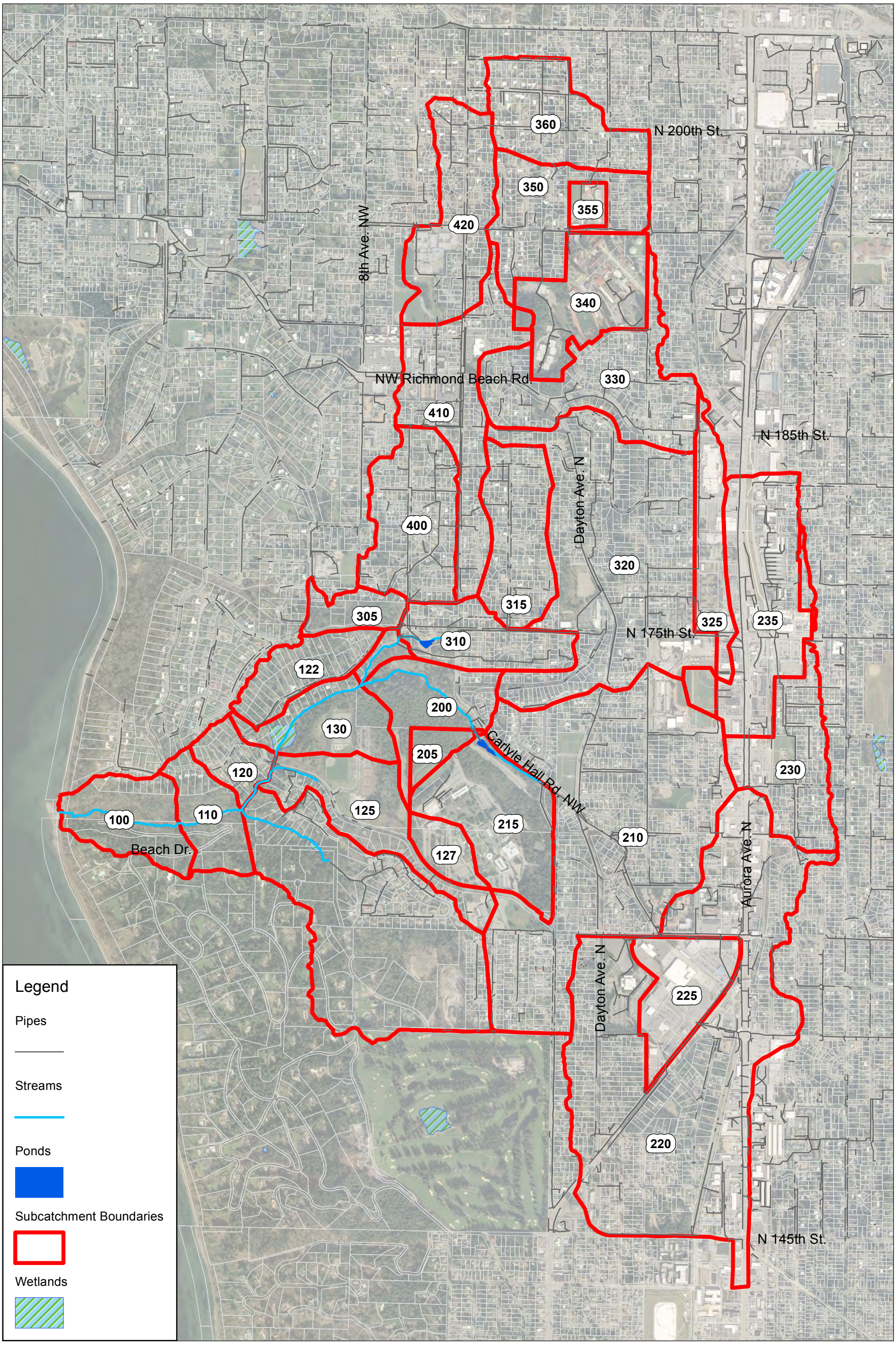
The leftbank is on the left when looking down stream
Depth of water is 6''
n in channel is 0.035 (Ref 2.a because no veg in channel, banks usually steep, trees and brush along banks submerged at high stages)
n in banks in 0.04 (same as channel but more veg)

Assumed Cross Section		
Station (LB ->RB) (ft)	Elevation (ft)	Comments
1	100	4H:1V
5	99	
9	98	
13	97	
17	96	
19	95.5	
21	94.5	Top of LB (bankfull)
23	93.5	Channel bottom
29	92.5	Channel bottom
35	93.5	Channel bottom
37	94.5	Top of RB (bankfull)
39	95.5	4H:1V
41	96	
45	97	
49	98	
53	99	
57	100	

Boeing Creek cross sections
Location #7



Boeing Creek cross sections
Location #7



OSBORN CONSULTING INCORPORATED

Figure 1: Boeing Creek Subcatchment Boundaries

Boeing Creek Basin - Shoreline, WA

Prepared by MLP 9/14/2012- FIGURE1

APPENDIX C: BOEING CREEK EPA-SWMM OUTPUT FILE

Boeing Creek Existing Condition Land Use - (Years 1990-2011; 15min)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------

Boeing Creek Existing Condition Land Use - (Years 1990-2011; 15min)

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ JAN-01-1990 00:00:00
Ending Date .............. DEC-31-2011 23:45:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:15:00
Routing Time Step ........ 30.00 sec


*********************
Rainfall File Summary
*********************
Station    First        Last         Recording   Periods    Periods    Periods
ID         Date         Date         Frequency  w/Precip    Missing    Malfunc.
-------------------------------------------------------------------------------
04u        JAN-01-1990  DEC-31-2011     15 min    771203          0          0


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......      27992.552       190.355
Evaporation Loss .........       7032.593        47.823
Infiltration Loss ........       9848.632        66.973
Surface Runoff ...........      11210.052        76.231
Final Surface Storage ....          8.353         0.057
Continuity Error (%) .....         -0.383


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......          0.000         0.000
Wet Weather Inflow .......      11210.086      3652.974
Groundwater Inflow .......          0.000         0.000
RDII Inflow ..............          0.000         0.000
External Inflow ..........          0.000         0.000
External Outflow .........      11146.268      3632.178
Internal Outflow .........          0.000         0.000
Storage Losses ...........          0.000         0.000
Initial Stored Volume ....          0.000         0.000
Final Stored Volume ......         10.129         3.301
Continuity Error (%) .....          0.479


***************************
Time-Step Critical Elements
***************************
Link P6 (41.33%)
Link P7 (2.43%)


*******************************
```

Highest Flow Instability Indexes
****
Link P1 (6)
Link O1 (3)
Link P7 (1)

****
Routing Time Step Summary
****
Minimum Time Step : 0.50 sec
Average Time Step : 17.45 sec
Maximum Time Step : 30.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.04

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
100	190.35	0.00	16.62	145.14	28.89	28.04	3.29	0.152
110	190.35	0.00	21.23	130.41	39.18	28.03	3.83	0.206
115	190.35	0.00	28.02	106.38	56.52	214.35	28.45	0.297
120	190.35	0.00	29.89	104.65	56.56	24.15	4.17	0.297
122	190.35	0.00	25.42	119.30	46.30	34.69	6.29	0.243
125	190.35	29.86	34.41	104.55	81.87	104.37	19.97	0.372
127	190.35	0.00	53.25	33.31	104.60	38.07	8.11	0.550
130	190.35	0.00	21.00	132.02	37.88	35.17	6.08	0.199
200	190.35	0.00	18.99	138.74	33.13	30.94	5.58	0.174
205	190.35	0.00	16.04	144.24	30.28	7.35	0.60	0.159
210	190.35	204.23	63.75	60.88	270.60	1545.67	306.48	0.686
215	190.35	0.00	40.24	71.52	79.37	125.52	27.22	0.417
220	190.35	0.00	51.14	40.96	98.99	670.46	151.43	0.520
225	190.35	0.00	65.25	7.72	118.25	120.43	24.70	0.621
230	190.35	0.00	46.99	51.77	92.27	142.56	33.07	0.485
235	190.35	0.00	65.86	7.72	117.50	233.08	48.00	0.617
300	190.35	0.00	11.44	160.26	18.98	2.66	0.50	0.100
305	190.35	0.00	25.80	118.26	46.91	19.29	3.17	0.246
310	190.35	937.89	80.56	78.24	970.41	946.10	140.82	0.860
315	190.35	0.00	40.97	68.32	81.78	101.44	22.13	0.430
320	190.35	140.32	50.68	68.24	212.46	914.40	146.55	0.642
325	190.35	0.00	65.55	7.72	117.87	93.10	19.08	0.619
330	190.35	188.63	56.31	58.11	265.21	510.83	72.28	0.700
340	190.35	178.87	64.54	32.91	272.58	363.32	68.51	0.738
350	190.35	82.23	52.95	59.89	160.36	217.95	45.98	0.588
355	190.35	0.00	62.57	13.73	114.86	20.46	4.30	0.603
360	190.35	0.00	42.13	65.04	83.82	111.77	26.32	0.440
400	190.35	0.00	39.81	73.58	77.71	117.39	21.27	0.408
410	190.35	76.67	54.49	54.40	158.73	287.52	58.40	0.594
415	190.35	0.00	17.72	128.59	44.25	1.79	0.32	0.232
420	190.35	0.00	44.51	58.13	88.36	137.08	28.38	0.464

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min
J2	JUNCTION	0.61	4.35	22.25	2554	20:10
J3	JUNCTION	0.23	1.49	68.49	2554	20:07
J6	JUNCTION	0.31	1.58	112.88	2554	20:05
J7	JUNCTION	0.26	1.48	188.48	2554	20:04
J1	JUNCTION	0.08	0.94	14.94	2554	20:10
J6A	JUNCTION	0.05	0.50	309.50	2554	19:14
J9	JUNCTION	0.33	1.84	222.04	2554	19:52
J10	JUNCTION	0.26	1.36	315.36	2554	19:45
J11	JUNCTION	0.19	1.62	263.46	2554	19:50
J4	JUNCTION	0.26	1.64	85.64	2554	20:06

J5	JUNCTION	0.17	2.17	96.17	2554	20:06
J12	JUNCTION	0.42	2.13	292.81	2554	19:49
J7A	JUNCTION	0.06	0.56	236.36	2554	19:15
J8	JUNCTION	0.03	0.47	258.47	2554	19:10
J13	JUNCTION	0.11	1.51	327.35	2554	19:15
J14	JUNCTION	0.05	0.72	336.98	2554	19:15
J9A	JUNCTION	0.19	1.08	278.08	2554	19:46
J10A	JUNCTION	0.30	2.50	372.50	2554	19:15
Mouth	OUTFALL	0.08	0.94	10.94	2554	20:10
HiddenLake	STORAGE	10.09	11.54	195.54	2554	20:03
M1Dam	STORAGE	0.18	12.72	346.72	2554	19:56
BoeingCreekPond	STORAGE	1.02	17.14	307.82	2554	19:49
CS1	STORAGE	1.24	2.76	319.76	2554	19:56
CS2	STORAGE	1.02	19.11	305.70	2554	20:14
S	STORAGE	0.33	2.98	194.98	2554	20:04

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
J2	JUNCTION	0.00	226.78	2554	20:07	0.000	3651.845
J3	JUNCTION	3.29	226.97	2554	20:06	28.068	3649.125
J6	JUNCTION	3.83	226.88	2554	20:04	28.059	3622.168
J7	JUNCTION	4.17	224.12	2554	20:04	24.177	3378.670
J1	JUNCTION	0.00	225.87	2554	20:10	0.000	3648.533
J6A	JUNCTION	28.45	28.45	2554	19:10	214.528	214.347
J9	JUNCTION	0.00	268.82	2554	19:50	0.000	3191.381
J10	JUNCTION	6.18	109.22	2554	19:45	38.331	1709.674
J11	JUNCTION	3.67	161.78	2554	19:49	21.977	1474.551
J4	JUNCTION	0.00	226.66	2554	20:06	0.000	3620.942
J5	JUNCTION	0.00	226.67	2554	20:05	0.000	3620.774
J12	JUNCTION	0.00	93.94	2554	19:49	0.000	0.667
J7A	JUNCTION	19.93	19.93	2554	19:14	104.457	104.374
J8	JUNCTION	6.29	6.29	2554	19:10	34.728	34.686
J13	JUNCTION	79.54	79.54	2554	19:14	405.190	404.915
J14	JUNCTION	22.11	22.11	2554	19:14	101.532	101.439
J9A	JUNCTION	0.00	109.10	2554	19:45	0.000	1710.743
J10A	JUNCTION	333.25	333.25	2554	19:15	1672.022	1671.198
Mouth	OUTFALL	0.00	225.87	2554	20:10	0.000	3631.908
HiddenLake	STORAGE	6.08	263.64	2554	19:52	35.214	3253.922
M1Dam	STORAGE	0.00	326.88	2554	19:15	0.000	1671.499
BoeingCreekPond	STORAGE	140.76	224.05	2554	19:15	946.249	1453.970
CS1	STORAGE	0.00	107.82	2554	19:56	0.000	1671.475
CS2	STORAGE	0.00	67.07	2554	19:45	0.000	1452.107
S	STORAGE	0.00	218.23	2554	20:03	0.000	3249.994

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
CS2	STORAGE	1.38	16.309	0.091

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Boeing Creek Existing Condition Land Use - (Years 1990-2011; 15min)

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
HiddenLake	352.145	58	0	459.271	76	2554 20:03	218.23
M1Dam	0.833	0	0	248.075	63	2554 19:56	107.82
BoeingCreekPond	12.550	4	0	286.643	94	2554 19:49	161.01
CS1	0.097	4	0	0.217	9	2554 19:56	107.82
CS2	0.051	5	0	0.961	100	2554 20:14	67.44
S	1.416	4	0	15.966	50	2554 20:04	218.11

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
Mouth	77.98	9.58	225.87	3631.908
System	77.98	9.58	225.87	3631.908

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
C1	CHANNEL	225.87	2554 20:10	17.23	0.22	0.38
C2	CHANNEL	226.78	2554 20:07	4.80	0.05	0.42
C3	CHANNEL	226.67	2554 20:06	9.23	0.05	0.23
C4	CHANNEL	226.67	2554 20:05	8.57	0.07	0.38
C4A	CHANNEL	28.40	2554 19:14	6.24	0.00	0.13
C5	CHANNEL	224.08	2554 20:04	11.97	0.06	0.31
C6	CHANNEL	262.54	2554 19:52	2.92	0.07	0.64
C7A	CHANNEL	108.89	2554 19:46	7.87	0.07	0.37
C8	CHANNEL	160.78	2554 19:50	7.70	0.14	0.44
P1	CONDUIT	225.87	2554 20:10	30.12	0.09	0.16
P5	CONDUIT	107.82	2554 19:56	20.63	0.26	0.31
P6	CONDUIT	107.82	2554 19:56	49.40	1.30	1.00
P7	CONDUIT	67.44	2554 19:49	25.08	1.21	0.90
P9	CONDUIT	93.94	2554 19:49	25.23	0.51	0.52
P3	CONDUIT	218.11	2554 20:04	25.71	0.63	0.45
C5A	CHANNEL	19.80	2554 19:15	5.94	0.00	0.19
P4	CONDUIT	6.29	2554 19:10	10.16	0.45	0.74
P10	CONDUIT	79.35	2554 19:15	37.17	0.68	0.80
P11	CONDUIT	22.05	2554 19:15	18.42	0.13	0.62
C7B	CHANNEL	109.10	2554 19:45	9.33	0.05	0.25
C7C	CHANNEL	326.88	2554 19:15	11.46	0.07	0.40
W1	WEIR	226.66	2554 20:06			0.31
W3	WEIR	0.00	0 00:00			0.00
W4	WEIR	0.00	0 00:00			0.00
W6	WEIR	93.94	2554 19:49			0.49
W2	WEIR	218.23	2554 20:03			0.51
O1	DUMMY	67.07	2554 19:45			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
C1	1.00	0.00	0.00	0.00	0.45	0.55	0.00	0.00	0.99	0.0000
C2	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.33	0.0000
C3	1.00	0.00	0.00	0.00	0.52	0.48	0.00	0.00	0.92	0.0000
C4	1.00	0.00	0.00	0.00	0.02	0.98	0.00	0.00	3.69	0.0000

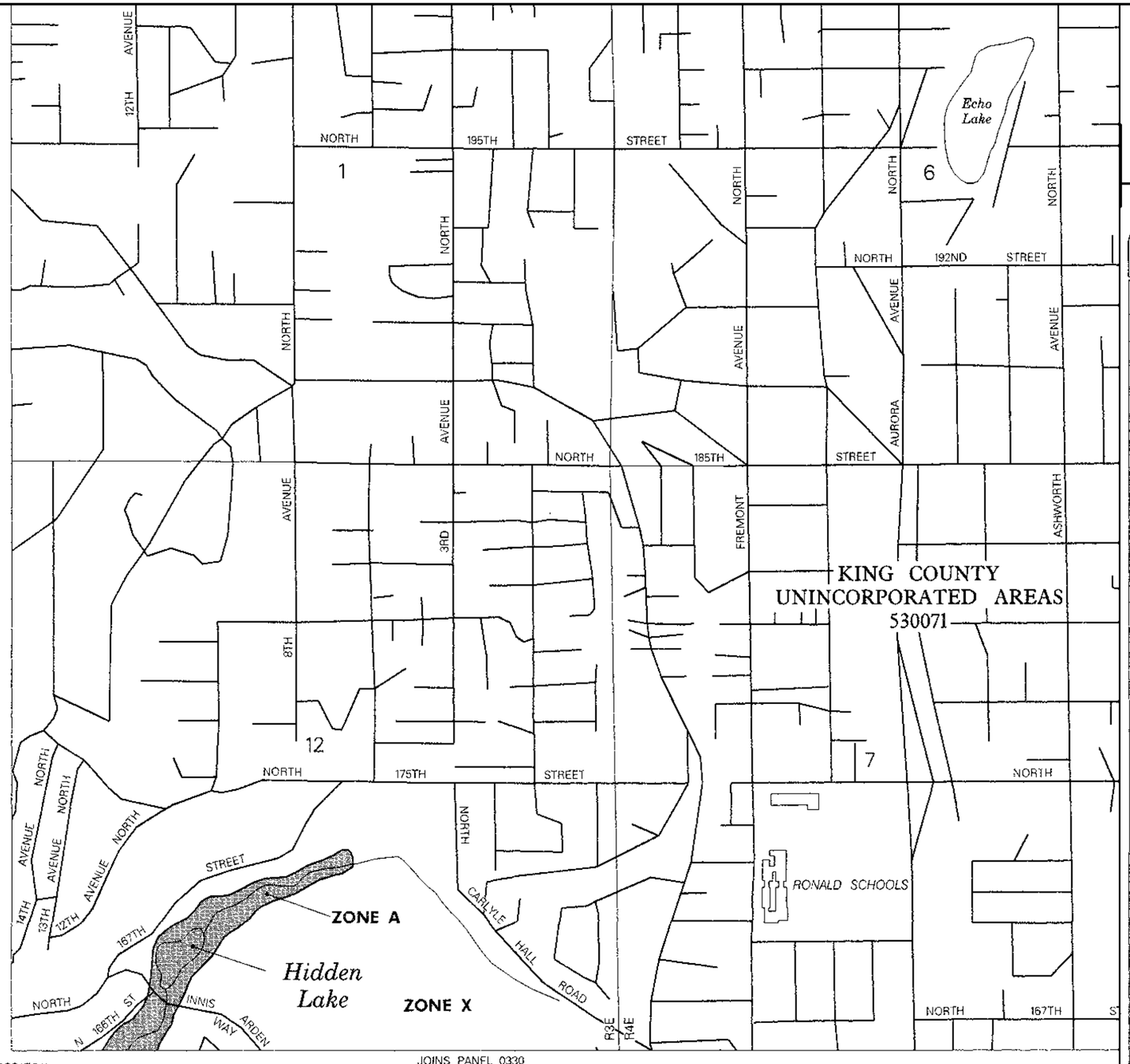
C4A	1.00	0.00	0.30	0.00	0.70	0.00	0.00	0.00	0.11	0.0000
C5	1.00	0.00	0.00	0.00	0.16	0.84	0.00	0.00	1.29	0.0000
C6	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.01	0.0000
C7A	1.00	0.00	0.00	0.00	0.80	0.20	0.00	0.00	0.70	0.0000
C8	1.00	0.00	0.00	0.00	0.92	0.08	0.00	0.00	0.51	0.0000
P1	1.00	0.10	0.03	0.00	0.03	0.84	0.00	0.00	2.91	0.0000
P5	1.00	0.00	0.29	0.00	0.22	0.49	0.00	0.00	1.21	0.0000
P6	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	4.91	0.0000
P7	1.00	0.00	0.38	0.00	0.08	0.54	0.00	0.00	1.99	0.0000
P9	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
P3	1.00	0.00	0.06	0.00	0.40	0.54	0.00	0.00	1.45	0.0000
C5A	1.00	0.00	0.10	0.00	0.88	0.03	0.00	0.00	0.16	0.0000
P4	1.00	0.00	0.44	0.00	0.56	0.00	0.00	0.00	0.05	0.0000
P10	1.00	0.11	0.00	0.00	0.68	0.21	0.00	0.00	0.72	0.0000
P11	1.00	0.12	0.01	0.00	0.80	0.08	0.00	0.00	0.27	0.0000
C7B	1.00	0.00	0.00	0.00	0.14	0.86	0.00	0.00	1.34	0.0000
C7C	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.91	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
P6	2.07	2.07	2.07	2.54	2.07
P7	0.01	0.01	0.01	1.14	0.01

Analysis begun on: Thu Dec 06 10:27:35 2012
Analysis ended on: Thu Dec 06 10:55:31 2012
Total elapsed time: 00:27:56

APPENDIX D: FLOOD INSURANCE MAPS



APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 40 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530071	0040	F

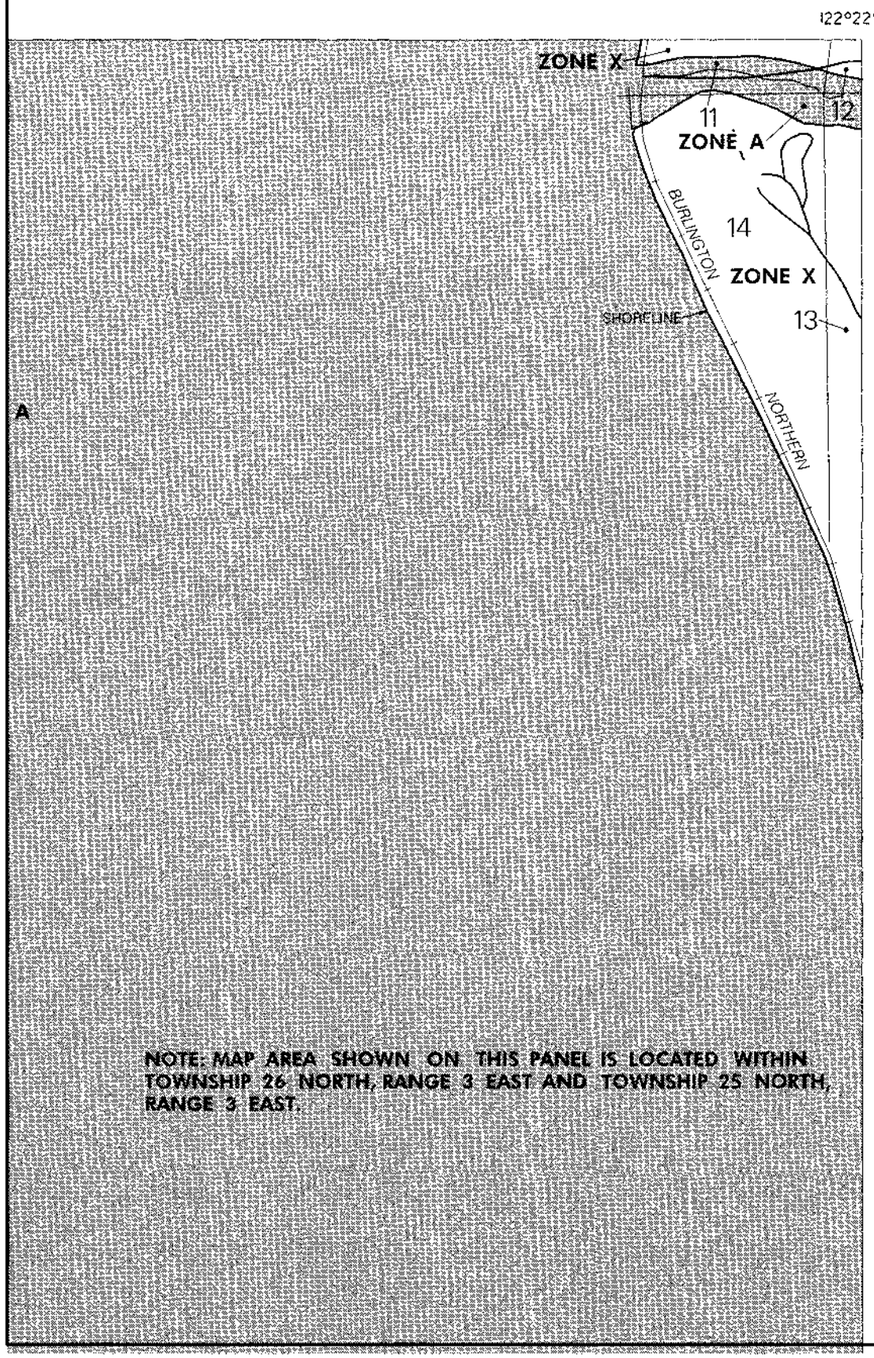
MAP NUMBER
53033C0040 F

MAP REVISED:
MAY 16, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

E F



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 26 NORTH, RANGE 3 EAST AND TOWNSHIP 25 NORTH, RANGE 3 EAST.

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 × — Elevation Reference Mark

• M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 310 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

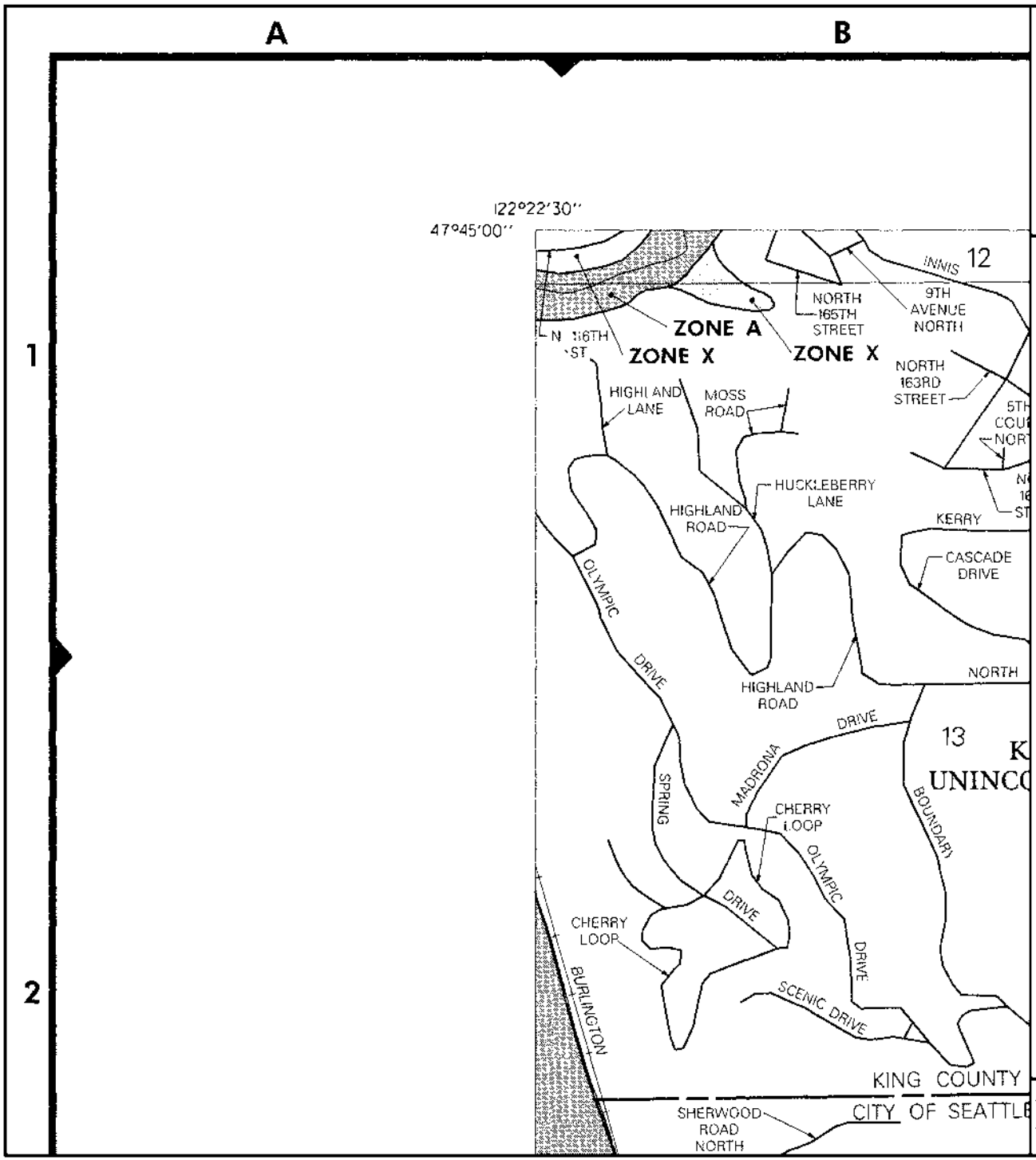
COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530071	0310	F
SEATTLE, CITY OF	530099	0310	F

MAP NUMBER 53033C0310 F

MAP REVISED: MAY 16, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 330 OF 1725

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY UNINCORPORATED AREAS	530071	330	F
SEATTLE CITY OF	530099	330	F

MAP NUMBER
53033C0330 F

MAP REVISED:
MAY 16, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

E F

122°18'45"

47°48'45"

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 — Elevation Reference Mark

M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from

APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 40 OF 1725

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

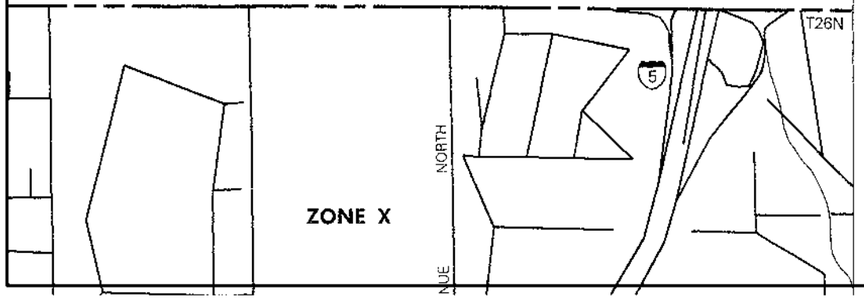
COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530071	0040	F

MAP NUMBER 53033C0040 F

MAP REVISED: MAY 16, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 — Elevation Reference Mark

M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of Special Flood Hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and /or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101–591).

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:

SEPTEMBER 29,1989

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:
Revised May 16, 1995 to update map format.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638–6620.

APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 40 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530071	0040	F

MAP NUMBER
53033C0040 F

MAP REVISED:
MAY 16, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX E: FEMA FLOOD INSURANCE MAP ADJUSTMENT COST ESTIMATE

Project: FEMA Flood Insurance Map Adjustment

	OCI		
Classification	**Proj. Mngr./PE**	**Engn. I/II**	
Hourly Rate	$136.80	$106.56	
Project Tasks	Hours Estimate		Cost Estimate
Work Element 1: LOMR Submittal			
Project Management	8	4	$1,520.64
Client/FEMA coordination meetings	8	4	$1,520.64
Draft/Final Letter of Map Revision	8	32	$4,504.32
Mapping	8	20	$3,225.60
Total Hours	32	60	$10,771.20
Work Element 2: Comment Response Contingency			
Client/FEMA comment review meeting	4	0	$547.20
Response to FEMA comments: model, map or memo	8	24	$3,651.84
Submit Revised Letter of Map Revision	4	8	$1,399.68
Total Hours	16	32	$5,598.72
Mileage, Printing, Fees & misc.			$350.00
		Total Fee:	**$16,719.92**
		Total Fee (rounded)	**$16,800.00**

APPENDIX B. SUMMARY OF TABLE OF SURFACE WATER SERVICE CALLS, 2000–2011

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
10/20/2000	103 NW 188TH ST	Clogged CB/SD	STORM DRAIN CLOGGED BIG POOL OF WATER IN DRIVEWAY. MMM
12/1/2000	1138 N 160TH ST	Clogged CB/SD	CB CLOGGED WITH DEBRIS ON S-SIDE OF 160TH, SW CORNER. LH
5/17/2001	600 N 179TH ST	Clogged CB/SD	THERE IS A CB IN FRONT OF HIS HOUSE THAT IS PLUGGED AND OVERFLOWS.
6/15/2001	20010 5TH AVE NW	Clogged CB/SD	CITIZEN SAYS THERE IS A DRAINAGE PROBLEM IN THE CATCH BASIN IN FRONT OF THEIR HOUSE AT AT THE DEAD END ON THEIR STREET.(PER PAT RANDALL) AR
6/28/2001	17504 AURORA AVE N	Clogged CB/SD	CLAUDIA FROM KEY BANK CALLED TO REPORT A BACKED UP DRAIN ON AURORA AT 175TH ST. IT IS ON THE KEY BANK CORNER AND IS BACKED UP AND SPILLING INTO THE F
9/4/2001	MIDVALE AVE N	Clogged CB/SD	THE CATCHBASIN IN THE ROW ON N 178TH IS PLUGGED AND CAUSING WATER TO BACK UP IN THE STORAGE FACILITY IN THE PARKING LOT.
11/13/2001	LINDEN AVE N	Clogged CB/SD	DRAIN IS FLOODING AT THIS LOCATION NEEDS TO BE CLEANED OUT OF ALL THE DEBRIS.
11/14/2001	915 N 167TH ST	Clogged CB/SD	FRONT AND BACKYARD IS FLOODING. DRIVEWAY IS FLOODED. DRAIN IS PLUGGED, WATER ON THE ROAD. AR
11/28/2001	LINDEN AVE N	Clogged CB/SD	SAYS DRAIN IS PLUGGED AT THIS LOCATION THERE IS WATER ON THE ROAD.
12/10/2001	FREMONT AVE N	Clogged CB/SD	SAYS A BIG PUDDLE IS FORMING AT THIS LOCATION. DRAIN IS NOT DRAINING PROPERLY. WOULD LIKE TO HAVE SOMEONE COME OUT AND LOOK AT THIS AND SEE WHAT CAN B
1/7/2002	NW RICHMOND BEACH RD	Clogged CB/SD	SAYS THE STORM DRAINS IN FRONT OF THESE 2 RENTAL PROPERTIES (18833 & 18827) AT THIS LOCATION ARE NOT WORKING PROPERLY AND CAUSING LARGE PUDDLES TO FOR
2/6/2002	LINDEN AVE N	Clogged CB/SD	SAYS DRAIN IS CLOGGED AND NEEDS TO BE CLEANED OUT. CAUSING FLOODING TO OCCUR.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/10/2002	720 N 179TH ST	Clogged CB/SD	DRAIN IN FRONT OF CALLER'S PROPERTY IS CLOGGED / BLOCKED UP. YELLOW BRONCO IN FRONT OF CALLER'S PROPERTY
1/7/2003	16357 AURORA AVE N	Clogged CB/SD	DRAIN CLOGGED/PLUGGED AT THIS LOCATION, FLOODING CALLER'S BASEMENT. CALLER WOULD LIKE DRAIN CLEARED UP
1/22/2003	AURORA AVE N	Clogged CB/SD	2 STROM DRAINS PLUGGED AND CAUSING FLOODING IN STREET
5/27/2003	518 N 167TH ST	Clogged CB/SD	CUSTOMER WOULD LIKE THE STROM DRAIN RAISED & BLACK TOP PUT AROUND THE DRAIN TO KEEP GRAVEL FROM GOING IN AND CLOGGING THE DRAIN.
11/18/2003	16302 NORTH PARK AVE N	Clogged CB/SD	DRAIN IS PLUGGED ON THE WEST CORNER WATER IS STANDING AND NOT DRAINING PROPERLY 163 @ NORTH PARK N
11/18/2003	400 N 199TH ST	Clogged CB/SD	CUSTOMER REPORTS WATER BACKING UP INTO THEIR DRIVEWAY BECAUSE THE CATCH BASIN OR DITCH IS NOT DRAINING PROPERLY AT THE EDGE OF THEIR PROPERTY
12/22/2003	528 N 170TH CT	Clogged CB/SD	CUSTOMER LIVES ON PRIVATE STREET AND WOULD LIKE TO KNOW IF A CATCH BASIN CAN BE ADDED TO THE CITY ROUTINE CLEANING MAINTENANCE SCHEDULE.
8/9/2004	18201 EVANSTON AVE N	Clogged CB/SD	PLUGGED STORM DRAIN FLOODED CUSTOMERS YARD AND WATER IN GARAGE.
8/9/2004	DAYTON AVE N	Clogged CB/SD	STORM DRAIN
8/9/2004	17542 FREMONT AVE N	Clogged CB/SD	CB'S OVERFLOWING, WATER SURROUNDING HIS HOUSE. HE SAID THIS WAS THE FIRST TIME THIS HAS HAPPENED. HE BELIEVES THE CAUSE IS THE NEW SUNQUIST DEVELOPMEN
8/11/2004	DAYTON AVE N	Clogged CB/SD	CITIZEN WOULD LIKE THE DRAIN IN FRONT OF HIS HOUSE CLEANED OUT BEFORE WINTER STORMS START. HE SAID HE SPOKE WITH THE MAINTENANCE YARD LAST YEAR AND NO

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
8/23/2004	FREMONT PL N	Clogged CB/SD	THE CB'S ON BOTH THE NORTH AND SOUTH SIDES OF THE ROAD ARE NOT DRAINING. PLEASE VACTOR OUT THESE BASINS AND JET THE PIPES.
8/23/2004	AURORA AVE N	Clogged CB/SD	BASINS ON BOTH THE NORTH AND SOUTH SIDE OF THE ROAD ARE HEAVILY IMPACTED WITH DEBRIS. PLEASE VACTOR THE CB'S AND JET THE PIPES.
8/23/2004	18041 3RD AVE NW	Clogged CB/SD	ON-GOING PROBLEM WITH DRAINAGE HE WOULD LIKE IT FIXED AND SOMEONE TO COME OUT TODAY TO ADDRESS IT. HE SAID THE STORM DRAIN IN FRONT OF HIS HOUSE IS PL
8/23/2004	18502 3RD PL NW	Clogged CB/SD	DRAIN CLOGGED AT 3RD PL NW @ NW 185TH ST.
8/24/2004	15038 LINDEN AVE N	Clogged CB/SD	WOULD LIKE DRAINS DIRECTLY NEAR MCDONALDS CHECKED. CULVERT HAS LOTS OF ROCKS AND DEBRIS.
8/25/2004	16343 DAYTON AVE N	Clogged CB/SD	DRAIN IN FRONT OF CALLER'S PROPERTY SEEMS TO BE CLOGGED DEEP INSIDE IT. (ACCORDING TO CALLER).
9/1/2004	14912 NORTH PARK AVE N	Clogged CB/SD	WATER IN GARAGE THIS IS THE 3RD TIME THIS HAS HAPPENED IN AUGUST. DRAINS IN FRONT OF HOUSE CLOGGED.
9/14/2004	415 NW 162ND ST	Clogged CB/SD	WATER COMING OUT OF STORM DRAIN AND MANHOLE, FLOODING STREET.
11/5/2004	ST LUKES PL N	Clogged CB/SD	STORM DRAIN AT INTERSECTION NEEDS TO BE CLEARED IT IS CLOGGED WITH LEAVES. CALLER WOULD LIKE IT DONE BEFORE THIS WEEKEND AS THERE IS A PREDICTION FOR
12/8/2004	720 N 179TH ST	Clogged CB/SD	CALLER REPORTS CLOGGED DRAIN IN FRONT OF HER HOUSE.
12/13/2004	RONALD PL N	Clogged CB/SD	SGT FAGERSTROM REPORTS A CLOGGED C/B AT THIS LOCATION.
5/12/2005	520 N 170TH PL	Clogged CB/SD	THE CUST CALLED SEATTLE AND THEN THEY CALLED US. HE TOLD THEM THE CB IN FRONT OF HIS HOUSE HAS PROBLEMS. DAMAGED TOP, POSSIBLY FULL, WATER DOESN'T FLO
8/5/2005	17215 MIDVALE AVE N	Clogged CB/SD	CALLER IS REQUESTING THAT THE CITY LOOK AT / INVESTIGATE A DRAIN BEHIND HIS PROPERTY ON THE INTERURBAN TRAIL. HE SAYS THAT WHEN IT RAINS, THERE IS FLO

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
10/2/2005	17818 AURORA AVE N STE A	Clogged CB/SD	SHE CALLED TO REPORT FLOODING AT HER SITE AND THE CB LID IS FRONT HAD BEEN BLOWN (BY WATER) OFF THE BASIN. SHE SAID SHE HAD LOSSES OF THOUSANDS OF
10/3/2005	EVANSTON AVE N	Clogged CB/SD	STREET FLOODING CB LID BLOCKED BY 2 FEET OF WATER
10/3/2005	17608 EVANSTON AVE N	Clogged CB/SD	WATER FOUNTAINING WATER FROM THE CB. WATER FLOODING THE CUL DE SAC.
10/3/2005	19830 PALATINE AVE N	Clogged CB/SD	CUSTOMER SAYS THE STORM DRAIN ABOVE HIS DRIVEWAY FLOODED HIS GARAGE. CUSTOMER ALSO HAS QUESTIONS ABOUT FLOODING AND DRAINAGE CAPACITY
10/13/2005	202 N 201ST ST	Clogged CB/SD	CUSTOMER IS REQUESTING CLEANING / CLEARING OF DRAINS IN FRONT OF 202 N 201ST ST (PALATINE AVE N @ N 201ST ST) SHE IS ALSO REQUESTING CLEARING OF SOME
10/25/2005	16533 ASHWORTH AVE N	Clogged CB/SD	CUSTOMER IS REPORTING A "BLOCKED INLET" NEAR HIS RESIDENCE AT 16533 ASHWORTH AVE N
1/6/2006	15717 GREENWOOD AVE N	Clogged CB/SD	CALLER SAYS A STORM DRAIN APPEARS TO NOT DRAIN FAST ENOUGH WHILE IT'S RAINING. IT CREATES A VERY LARGE PUDDLE, BUT WHEN IT'S NOT RAINING, IT SLOWLY DR
2/2/2006	18317 1ST AVE NW	Clogged CB/SD	CUSTOMER SAYS THAT THE STORM DRAIN BETWEEN THE TWO HOUSES NEXT DOOR TO HIM APPEARS TO BE CLOGGED, IT'S NOT DRAINING PROPERLY AT ALL, AND WATER ENDS UP
5/18/2006	15604 1ST AVE NW	Clogged CB/SD	CUSTOMER SAYS THAT SCHOOL STUDENTS KICK GRAVEL INTO THE CATCH BASIN WHILE WAITING FOR THE BUS. HE IS REQUESTING THAT THE SIGNIFICANT AMOUNT OF GRAVEL
11/6/2006	3RD AVE NW	Clogged CB/SD	CUSTOMER STATES THAT THE DRAIN IS CLOGGED UNDER THE DRAIN/STREET LEVEL AT 3RD AVE NW @ NW 200TH ST. NO FLOODING OR DAMAGE AT THIS TIME.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/6/2006	15276 GREENWOOD AVE N	Clogged CB/SD	CUSTOMER STATES THAT THE PEOPLE WHO RECENTLY INSTALLED A NEW SIDEWALK LEFT SOME KIND OF LANDSCAPING FABRIC INSIDE THE DRAIN NEXT TO THE CALLER'S DRIVE
11/13/2006	415 NW 162ND ST	Clogged CB/SD	WATER IS BUBBLING OUT OF THE STREET AND FLOWING INTO HER YARD.
11/14/2006	AURORA AVE N	Clogged CB/SD	OBSERVED SOME WOOD BLOCKING A CATCHBASIN AT AURORA AVE N @ N 163RD ST. REQUEST FOR ERIC IN SURFACE WATER TO DISCUSS THIS ISSUE WITH BOB CROZIER.
11/19/2006	720 N 179TH ST	Clogged CB/SD	THE CB IN FRONT OF THERE HOUSE IS OVERFLOWING LIKE A FOUNTAIN.
11/21/2006	NW RICHMOND BEACH RD	Clogged CB/SD	CUSTOMER STATES THAT A DRAIN IS CLOGGED IN FRONT OF THE BUS STOP AT 3RD AVE NW @ NW RICHMOND BEACH ROAD
12/6/2006	17236 3RD AVE NW	Clogged CB/SD	CUSTOMER REQUESTING THAT THE CITY REMOVE DEBRIS AND "MUCK" FROM THE CATCH BASIN IN FRONT OF 17236 3RD AVE NW
12/14/2006	741 N 184TH ST	Clogged CB/SD	STORM DRAIN APPEARS TO BE PLUGGED AND WATER IS STARTING TO BUILD UP. IT IS NOT CAUSING ANY FLOODING PROBLEMS AT THIS TIME, BUT CUSTOMER THINKS THAT IT
12/14/2006	19838 5TH AVE NW	Clogged CB/SD	OBSERVED AND CLEARED CATCH BASIN IN FRONT OF 19838 5TH AVE NW
12/14/2006	N RICHMOND BEACH RD	Clogged CB/SD	CUSTOMER REPORTING 2X STORM DRAINS BUBBLING OVER AT THE BOTTOM OF RICHMOND BEACH ROAD, WHERE IT INTERSECTS WITH RICHMOND BEACH DRIVE (INTERSECTION NOT
12/14/2006	19818 5TH AVE NW	Clogged CB/SD	CORNER DRAIN ACROSS THE STREET IS PONDING, AND WATER IS GETTING CLOSE TO NEIGHBOR'S GARAGE DOOR (NEIGHBOR NOT HOME AT THIS TIME)
12/18/2006	328 NW RICHMOND BEACH RD 10	Clogged CB/SD	CLOGGED BASIN AT MAPLEWOOD COURT APTS EOC#1017

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/27/2006	327 NW 189TH ST	Clogged CB/SD	CALLER'S SON LIVES WITH HIS ROOMMATE AT THIS LOCATION. THERE IS A DRAIN THAT RUNS FROM HILLWOOD PARK BESIDE THIS LOCATION. IT APPEARS TO BE FULL AND
12/27/2006	19309 1ST AVE NW	Clogged CB/SD	CUSTOMER SAYS STORM DRAIN IN FRONT OF HER HOUSE IS OVERFLOWING.
1/2/2007	LINDEN AVE N	Clogged CB/SD	CUSTOMER REPORTING A CLOGGED STORM DRAIN AT LINDEN AVE N @ N 153RD PL, AND REQUESTING THAT IT BE CLEARED OUT. HE ALSO REQUESTED THAT THE DEBRIS BE COM
2/8/2007	14829 LINDEN AVE N	Clogged CB/SD	STORM DRAIN C/B IN FRONT OF THIS SITE IS CLOGGED. CALLER IS CONCERNED THAT IF IT REMAINS PLUGGED WATER WILL ENTER INTO THEIR BASEMENT.
3/12/2007	FREMONT AVE N	Clogged CB/SD	STORM DRAIN IS "CRONICALLY CLOGGED" - THIS HAS BEEN A PROBLEM FOR MULTIPLE YEARS.
4/9/2007	515 N 190TH ST	Clogged CB/SD	OBSERVED CATCH BASIN FULL OF DIRT ON THE NORTH SIDE OF THE STREET.
5/22/2007	17327 1ST AVE NW	Clogged CB/SD	NEW STORM DRAINS ARE GETTING BLOCKED WITH DEBRIS CONSTANTLY, AND WATER POURS OVER INTO CALLER'S DRIVEWAY. THE NEW STORM DRAINS RECENTLY ADDED DON'T HA
8/17/2007	351 NW RICHMOND BEACH RD 10	Clogged CB/SD	TWO STORM DRAINS IN THE PARKING LOT OF "HENRY HOUSE" HAVE HIGHER THAN NORMAL WATER LEVELS. CALLER STATES THAT THE CITY DOES THE MAINTENANCE ON THESE S
9/30/2007	LINDEN AVE N	Clogged CB/SD	THE CB AT 163RD PL AND LINDEN AVE N WAS PLUGGED AND FLOODING. THEY REQUESTED A RESPONSE FOR CLEARING.
10/19/2007	18526 3RD AVE NW	Clogged CB/SD	CLEARED BACKED UP CB'S.
12/3/2007	NW 185TH ST	Clogged CB/SD	DRAIN OVER FLOWING
12/3/2007	741 N 184TH ST	Clogged CB/SD	STORM DRAIN CLEAR NOT DRAINING, FLOODING GARAGE - EOC# 1004

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/4/2007	17021 DAYTON AVE N	Clogged CB/SD	STORM DRAIN THAT IS NOT ALLOWING WATER TO ENTER (CLOGGED / BLOCKED?)
12/4/2007	15235 AURORA AVE N 101	Clogged CB/SD	DRAIN OVERFLOWING
12/4/2007	15532 PALATINE AVE N	Clogged CB/SD	DRAINS IN BACK YARD NOT DRAINING - CONCERNED.
12/4/2007	LINDEN AVE N	Clogged CB/SD	STORM DREAINS ON 16700 LINDEN AVE N ARE CLOGGED AND WATER IS RUNNING OVER THE STREET. 16737- FLOODING IN YARDS, NORTH AND SOUTH OF 16728.
12/4/2007	18537 PALATINE PL N	Clogged CB/SD	DRAIN PLUGGED IN FRONT OF HER HOME. WATER IN THE BASEMENT.
12/4/2007	723 N 180TH ST	Clogged CB/SD	DRAIN FULL - REQUESTING SANDBAGS
12/18/2007	16733 LINDEN AVE N	Clogged CB/SD	"STORM DRAIN CLOGGED. WATER ON ROADWAY. HAS NOT BEEN CLEANED SINCE RESTORED AFTER BIG RAIN STORM 2 WEEKS AGO".
5/16/2008	509 N 173RD ST	Clogged CB/SD	WATER INSIDE STORM DRAINS IS HIGH (15 INCHES FROM THE TOP). IT'S IN (2) STORM DRAINS ON N 173RD ST (DEAD END STREET) - CALLER STATES THAT THEY MAY CAU
6/3/2008	19134 2ND AVE NW	Clogged CB/SD	STREET DRAINS ARE OVERFLOWING, AND CALLER THINGS THE SYSTEM NEEDS TO BE "FLUSHED"
6/3/2008	3RD AVE NW	Clogged CB/SD	CUSTOMER STATES THAT THE DRAIN IS CLOGGED UNDER THE DRAIN/STREET LEVEL AT 3RD AVE NW @ NW 200TH ST. NO FLOODING OR DAMAGE AT THIS TIME.
6/4/2008	309 NW 189TH ST	Clogged CB/SD	STORM DRAIN IS CLOGGED - ON THE STREET SIDE OF CALLER'S DRIVEWAY AT 309 NW 189TH ST. ALSO, NEIGHBORING STORM DRAIN MAY BE CLOGGED AS WELL, AT 18839 3R
1/22/2009	LINDEN AVE N	Clogged CB/SD	OBSERVED AND CLEARED DEBRIS OUT OF SEVERAL CATCH BASINS ALONG N 155TH ST, NEAR LINDEN AVE N
5/5/2009	1122 N 180TH ST 1	Clogged CB/SD	OBSERVED AND CLEARED CATCH BASIN, SOUTH SIDE OF THE STREET

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
5/5/2009	AURORA AVE N	Clogged CB/SD	OBSERVED AND CLEARED PLUGGED CATCHBASIN ON SOUTHBOUND AURORA AVE N, NEAR WESTMINSTER WAY N
10/5/2009	14525 AURORA AVE N	Clogged CB/SD	CATCH BASIN VACTORING IS NEEDED FOR THE ONLY C.B. DIRECTLY IN FRONT OF HIDEAWAY CARDROOM (14525 AURORA AVE N)
10/26/2009	AURORA AVE N	Clogged CB/SD	CATCH BASINS NOT DRAINING PROPERLY NEAR AURORA AVE N @ N 172ND ST, LARGE PUDDLE FORMED NEAR A SHARED DRIVEWAY TO SEVERAL BUSINESSES.
10/26/2009	AURORA AVE N	Clogged CB/SD	CLEARED CATCH BASIN - FLOODING (EAST SIDE OF AURORA @ N 183RD ST)
10/26/2009	AURORA AVE N	Clogged CB/SD	CLEARED CATCH BASIN - FLOODING (EAST SIDE OF AURORA @ N 180TH ST)
10/26/2009	AURORA AVE N	Clogged CB/SD	CLEARED CATCH BASIN - FLOODING (EAST SIDE OF AURORA @ N 181ST ST)
10/26/2009	AURORA AVE N	Clogged CB/SD	CLEARED CATCH BASIN - FLOODING (EAST SIDE OF AURORA @ N 182ND ST)
11/9/2009	719 N 184TH ST	Clogged CB/SD	LEAVES HAVE CLOGGED DRAIN IN FRONT OF HIS HOUSE.
11/20/2009	357 NW RICHMOND BEACH RD	Clogged CB/SD	CUSTOMER STATES THAT LARGE DRAIN ON THE SOUTH EAST SIDE OF BUILDING ISN'T DRAINING. HE STATES ABOUT TWO YEARS AGO WHEN THIS LAST HAPPENED THE CITY CA
1/11/2010	16733 LINDEN AVE N	Clogged CB/SD	DRAIN NEAR NEIGHBORING SITE (16733 LINDEN AVE N) IS NOT DRAINING CORRECTLY, CALLER THINKS THAT IT'S FULL OF "HARD PAN" SOIL AND COULD POTENTIALLY REQU
11/17/2010	WESTMINSTER WAY N	Clogged CB/SD	CLEARED CLOGGED STORM DRAIN NEAR 155TH AND WESTMINSTER WAY
12/14/2010	18012 DAYTON AVE N	Clogged CB/SD	STORM DRAIN PLUGGED IN FRONT OF HOUSE. WHEN IT RAINS, WATER GETS CLOSE TO THE GARAGE DOOR.
1/12/2011	WESTMINSTER WAY N	Clogged CB/SD	OBSERVED AND CLEARED CATCH BASINS FROM WESTMINSTER WAY N @ N 155TH ST

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
3/9/2011	AURORA AVE N	Clogged CB/SD	CATCH BASIN REQUIRES CLEARING, PONDING IN THE ROADWAY - ON WESTMINSTER WAY, JUST SOUTH OF AURORA AVE N
3/14/2011	1115 N 183RD ST 101	Clogged CB/SD	OBSERVED AND CLEARED IMPACTED CATCH BASINS
3/14/2011	AURORA AVE N	Clogged CB/SD	CLEARED CATCH BASINS ON SOUTHBOUND OUTSIDE LANE OF AURORA AVE N @ N 155TH ST
3/14/2011	WESTMINSTER WAY N	Clogged CB/SD	CLEARED CATCH BASINS - WESTMINSTER WAY @ N 155TH ST
4/20/2011	14909 NORTH PARK AVE N	Clogged CB/SD	STORM DRAIN ACROSS FROM THIS ADDRESS IS CLOGGED.
5/19/2011	15725 DAYTON AVE N	Clogged CB/SD	CLOGGED CATCH BASIN ON THE EAST SIDE OF DAYTON AVE N, JUST NORTH OF THE DRIVEWAY ENTRANCE TO 15725 DAYTON AVE N
7/26/2011	17236 RONALD PL N	Clogged CB/SD	CB's on Ronald Pl all filled with sediment.
7/26/2011	500 N 149TH ST 201	Clogged CB/SD	Basin needs to be cleaned.
11/23/2011	18548 1ST AVE NW	Clogged CB/SD	There is a clogged storm drain on 3rd Ave NW just north of Richmond Beach Road.
11/23/2011	19113 3RD AVE NW	Clogged CB/SD	Drain on west side of 3rd NW just north of 191st doesn't drain. Water blowiing out drain leaving a large puddle on 3rd NW. This has happened every rai
11/28/2011	15725 DAYTON AVE N	Clogged CB/SD	THE CATCH BASIN IS BLOCKED. DURING HEAVY RAINS THE WATER FLOWS OVER CATCH BASIN TOWARD 160TH AND ERODES STREET
12/30/2011	15711 AURORA AVE N	Clogged CB/SD	HEAVILY BLOCKED BASIN CREATING THE WESTMINSTER PUDDLE.
1/13/2012	17305 STONE CT N A	Clogged CB/SD	DRAIN GRATE IS COVERED WITH MUCK BETWEEN 17305 STONE CT N AND 1218 173RD ON THE NORTH SIDE OF 173RD.
1/5/2001	17900 LINDEN AVE N B	Clogged culvert	water was flooding the street, the problem was at the culvert just north of the methodist church parking lot.
8/22/2001	EVANSTON AVE N	Clogged culvert	WATER COMING DOWN THE ROAD DUE TO ONE OF THE CULVERTS BEING PLUGGED WITH WATER. AR
4/23/2002	521 N 170TH PL	Clogged culvert	PLEASE VACTOR THE LINE UNDERNEATH THE DRIVEWAY. WEST OF THE CULVERT THE WATER PONDS, CAN THIS BE CORRECTED.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
5/31/2002	224 N 201ST ST	Clogged culvert	CUSTOMER CALLED TO REPORT A DRAIN CULVER THAT IS 1/2 FULL OF DIRT AND DEBRIS. HE DID NOT EVEN KNOW THE PIPE WAS THERE. HE IS A NEW OWNER AND HAS JUS
4/12/2004	18532 3RD PL NW	Clogged culvert	CUSTOMER REPORTS KIDS FROM THE HIGHLAND APARTMENTS ARE BLOCKING THE DRAINAGE CULVERT ON 3RD PL NW NEAR HER RESIDENCE. SHE SAID THERE IS ALSO GRAFFITI
4/15/2004	750 N 188TH ST	Clogged culvert	CUSTOMER CAME IN AND WANTED TO SEE IF THE CITY WOULD CLEAN OUT THE DRIVEWAY CULVERTS AND DITCHES ON THE NORTH SIDE OF N 188TH ST. THEY HAVE 2 LOCATIO
8/23/2004	15TH AVE NW	Clogged culvert	THE DITCHLINES AND PIPE CROSSINGS AT DRIVEWAYS ARE FULL OF SEDIMENT. THE MATERIAL NOW RUNS INTO THE ROADWAY.
1/30/2006	15557 MIDVALE AVE N	Clogged culvert	CUSTOMER SAYS THAT A CULVERT IS OVERFLOWING/FLOODING ON THE WEST SIDE OF MIDVALE AVE N, NEAR 15557 MIDVALE AVE N
11/7/2008	1ST AVE NW	Clogged culvert	A VERY LARGE ROCK FELL INTO THE OPEN DITCH PARTIALLY BLOCKING THE CULVERT.
11/10/2008	104 NW 180TH ST	Clogged culvert	Had to call the City to have a boulder removed from a culvert in front of his house. Response time was prompt and thorough. Feels very re-assured. See
10/14/2009	235 NW 200TH ST	Clogged culvert	the culvert on 3rd ave NW is blocked and is ready to run over into the street. It has not flooded his property yet, but it will if it continues to ra
12/17/2010	15557 MIDVALE AVE N	Clogged culvert	RESIDENT CALLED TO SAY THAT A CULVERT ON THE NW CORNER OF N157 & MIDVALE APPEARS PLUGGED OR SLOW DRAINING. HER HOUSE WAS IMPACTED BY THE BACKED UP WA
2/18/2011	16320 FREMONT PL N	Clogged culvert	CALLER REPORTING CLOGGED CULVERT PIPE UNDER HIS DRIVEWAY AT 16320 FREMONT PL N. HE ALSO STATES THAT A NEARBY CATCH BASIN IS "HIGHER" THAN THE GROUND L

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
3/14/2011	725 NW INNIS ARDEN WAY	Clogged culvert	CALLER UN-BLOCKED A CULVERT PIPE AT 0500 HOURS THIS MORNING, IT WAS FLOODING AND WASHING OUT THE GRAVEL. * GRAVEL IS NOW WASHED AWAY AND SHOULDER REST
3/13/2001	20024 PALATINE AVE N	Clogged pipe	PAM CALLED TO INFORM US THAT SHE RECENTLY DISCOVERED A SEWER PROBLEM RELATED TO TREE ROOTS IN FRONT OF HER PROPERTY. SHE IS HAVING THE PROBLEM FIXED,
11/14/2001	18201 FREMONT AVE N	Clogged pipe	SAYS THERE IS A PLASTIC PIPE ON THE CORNER OF N 182ND ST & FREMONT. PIPE IS CLOGGED AND HAS CLASPED CAUSING WATER TO FLOW ON HIS PROPERTY AND FLOOD. W
2/13/2003	6TH AVE NW	Clogged pipe	CUSTOMER WOULD LIKE TO KNOW IF THE CITY CAN VACTOR THE PIPES IN FRONT OF THE HOUSE AT 344 NW 185TH.
10/20/2003	915 N 167TH ST	Clogged pipe	REPORTS THE CITY HAS GOT TO DO SOMETHING ABOUT THE BUSINESS THAT HAS PLUGGED THE PIPE NEXT TO MANNS WELDING AND THE CAR LOT. CUSTOMER SAID SHE MISSED
1/15/2004	1202 N 155TH ST	Clogged pipe	CUSTOMER OWNS BUILDING AT 1202 N 155TH ST. THERE IS A PLUGGED DRAIN LINE NEAR THE STREET ON N 155TH ST. HE HAS HAD SOMEONE COME OUT AND LOOK AT IT B
8/9/2004	16517 CARLYLE HALL RD N	Clogged pipe	THERE IS AN UNDERGROUND DRAINAGE PIPE THAT SURFACES IN HIS YARD. THERE IS A HIGH VOLUME OF WATER FLOODING HIS SITE. THIS IS AN ONGOING PROBLEM.
8/20/2008	19110 3RD AVE NW	Clogged pipe	SOME PART OF THE SURFACE WATER SYSTEM HAS BEEN CLOGGED AT THIS LOCATION, AND AT SOME POINT FURTHER DOWN THE LINE, WATER IS ERUPTING FROM ONE OF THE OT
12/17/2009	125 NW 173RD ST	Clogged pipe	Caller is asking for an investigation of the pipes on NW 172nd to see if anything is backed up or clogged

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
7/12/2010	327 NW 183RD ST	Clogged pipe	CUSTOMER STATES THAT THE SUBJECT PROPERTY OWNER HAS PLACED FIREWOOD INSIDE THE CULVERT PIPE, COMPLETELY BLOCKING IT. CALLER IS CONCERNED THAT THIS BLO
1/25/2001	LINDEN AVE N	Clogged ditch	CALLER SAYS HE HAS CALLED BEFORE AND LEFT A MESSAGE REGARDING THIS INCIDENT. THERE IS A DITCH AT THIS LOCATION NEAR RONALD METHODIST CHURCH THAT IS FL
6/25/2001	15329 LINDEN AVE N	Clogged ditch	CUSTOMER CALLED TO COMPLAIN ABOUT THE DITCH ON HER STREET. SHE HAS COMPLAINED BEFORE (24944-52311 IN THE OLD SYSTEM.) THE PROBLEM IS GETTING WORSE.
8/22/2001	6TH AVE NW	Clogged ditch	THE OPEN DITCH AT THIS LOCATION IS DRAINING WATER AND STARTING TO BACKUP INTO THE BACKYARD AND WILL CAUSE FLOODING IF NOT HANDLED SOON.
8/24/2001	1149 N 165TH ST	Clogged ditch	There is an open storm drain across from her house needs to be cleaned out of the vegetation. Has sticker bushes and debris in it. Also she mentioned
11/19/2001	LINDEN AVE N	Clogged ditch	THERE IS YARD DEBRIS AND GARBAGE IN THE DITCH AT THIS LOCATION THAT NEEDS TO BE CLEANED OUT. AR
1/10/2002	3RD AVE NW	Clogged ditch	SAYS HE HAS 5 PROPERTIES AT THIS LOCATION. THERE IS A DITCH THAT'S NOT DRAINING PROPERLY AND CAUSING WATER ON THE ROAD WHEN IT RAINS WOULD LIKE SOMEON
1/31/2002	19330 3RD AVE NW	Clogged ditch	SAYS THERE IS A DITCH IN FRONT OF HER HOUSE ON THE WEST SIDE THAT NEEDS TO BE CLEANED OUT. SAYS DITCH IS FULL OF WEEDS AND DEBRIS.
2/4/2002	6TH AVE NW	Clogged ditch	CITY COUNCILMAN CHANG CALLED CONCERNED ABOUT THE TREE DEBRIS IN THE OPEN DITCHES ALONG INNIS ARDEN WAY BETWEEN GREENWOOD AVE. N & HIDDEN LAKE. HE

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
6/7/2002	104 NW 180TH ST	Clogged ditch	SOMEONE IS DUMPING GRASS CLIPINGS INTO THE DITCH. PLEASE CHECK THIS OUT.
11/14/2002	741 N 188TH ST	Clogged ditch	DITCH IN FRONT OF CLALER'S PROPERTY IS FULL OF DIRT, CALLLER WOULD LIKE THE CITY TO CLEAR / REMOVE IT ALL IF POSSIBLE.
3/13/2003	116 N 155TH ST	Clogged ditch	THE CUSTOMER REPORTED THAT THE DRAINAGE DITCH IS FULL AND OVER FLOWING. IT HAS BEEN LIKE THIS FOR MONTHS AND NEEDS TO BE CLEARED.
9/5/2003	LINDEN AVE N	Clogged ditch	DITCH IN FRONT OF HOUSE IS FILLED WITH BLACKBERRIES AND NEEDS TO BE CLEARED.
9/16/2003	3RD AVE NW	Clogged ditch	CUSTOMER REPORTS CHILDREN ARE BUILDING A DAM BEHIND HER RESIDENCE AND SHE SAID IT NEEDS TO BE REMOVED. **THIS IS A GROUP HOME**
9/22/2003	18520 6TH AVE NW	Clogged ditch	LETTER FROM CUSTOMER REGARDING DRAINAGE DITCH IN THEIR BACKYARD THAT FLOODS.
11/13/2003	DAYTON AVE N	Clogged ditch	THE DRAINAGE DITCH ON 183RD IS OVERGROWN WITH VEGETATION AND PEOPLE ARE DUMPING AND LITTERING IN THE DITCH. CUSTOMER WOULD LIKE THE DITCH CLEANED OUT
2/3/2004	3RD AVE NW	Clogged ditch	CUSTOMER REPORTS LITTER/GARBAGE IN DITCH SHE IS TIRED OF PICKING IT UP AND SPENDING THE MONEY TO MAINTAIN THIS AREA THAT IS THE CITY'S RESPONSIBILITY.
3/25/2004	18532 3RD AVE NW	Clogged ditch	THERE ARE TWO DITCHES BEHIND THE HOUSE THAT ARE FLOODING OVER AND THE DITCHES ARE BEING BLOCKED BY A LOT OF PINE CONES
8/9/2004	18532 3RD PL NW	Clogged ditch	2 DITCHES, WALKWAY FLOODED
8/23/2004	15028 LINDEN AVE N	Clogged ditch	THE DRAINAGE DITCH ALONG THE INTERURBAN (BEHIND HER HOUSE OVERFLOWED AGAIN). THE BANK IS ERODING AWAY ALSO. IT OVERFLOWED S/O THE POWER POLE. YOU CAN

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
8/31/2004	17818 RONALD PL N	Clogged ditch	THE DITCHES ON RONALD PLACE ADJACENT TO THE OLYMPIC BOAT CENTER NEED TO BE DUG OUT. DURING THE HEAVY RAINS IT BACKED WATER UP AND FLOODED THE OLYMPIC
11/2/2004	18532 3RD PL NW	Clogged ditch	THE DITCH BEHIND THE HENRY APTS. IS PLUGGED. HE SAID WE COULD GO THROUGH THE GATE TO CHECK.
5/18/2005	3RD PL NW	Clogged ditch	DITCH 1 BLOCK WEST OF 3RD PL NW HAS A LARGE AMOUNT OF ROCKS AND PINE NEEDLES & CONES THROWN INTO IT BY LOCAL KIDS. ABOUT HALF OF THE DRAIN IS BLOCKED.
5/31/2005	18532 3RD PL NW	Clogged ditch	KIDS DUMPED MAGAZINES IN THE DITCH & NOW IT FLOODS WHILE RAINING.
10/5/2005	MIDVALE AVE N	Clogged ditch	CUSTOMER IS REQUESTING THAT THE DITCH SOUTHWEST OF TOP FOODS (BEHIND THE DEAD END OF MIDVALE AVE N SOUTH OF N 175TH ST) BE CLEARED OUT, OR LOOKED AT T
12/27/2005	19010 3RD AVE NW	Clogged ditch	CUSTOMER SAYS THAT THE DITCH IN FRONT OF HER HOME IS FULL OF WATER, AND APPEARS TO BE BLOCKED SOMEWHERE. THERE IS A "LAKE" IN FRONT OF HER HOUSE AND I
1/27/2006	130 NW 155TH ST	Clogged ditch	ONE YARD OF GRAVEL NEEDS TO BE REMOVED FROM THIS DITCHLINE SO THAT IT WILL OPERATE CORRECTLY.
9/18/2006	331 N 200TH ST	Clogged ditch	CUSTOMER REQUESTING CLEARING FOR THE DRAINAGE DITCH NEAR 331 N 200TH ST. HE STATES THAT IT'S FULL OF DIRT, AND ROCKS.
10/25/2007	502 N 170TH PL	Clogged ditch	Resident requested that the ditch in front of his house be cleaned.
12/4/2007	220 NW 191ST ST	Clogged ditch	OPEN DITCH OVERFLOWING.
12/11/2007	1315 N 167TH ST	Clogged ditch	CLOGGED OPEN DRAINAGE DITCH - BLOCKED WITH GRASS CLIPPINGS, BRANCHES, AND OTHER MISC. VEGETATION.
3/31/2008	GREENWOOD PL N	Clogged ditch	OPEN DITCH ON GREENWOOD PL N, FROM 175TH TO THE SOUTH. THE DITCH IS CLOGGED WITH BOTTLES, LITTER, ETC, AND COMPLETELY PLUGGED.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
2/25/2009	STONE AVE N	Clogged ditch	CLEARED DEBRIS BLOCKING FLOW IN THIS OPEN DITCH LINE.
5/5/2009	LINDEN AVE N	Clogged ditch	DITCH NOT DRAINING AT N155 AND LINDEN.
10/15/2009	19859 PHINNEY AVE N	Clogged ditch	CALLER IS REQUESTING THAT THE CITY CLEAN OUT THE DRAINAGE DITCH IN FRONT OF A NEIGHBORING PROPERTY @ 19859 PHINNEY AVE N (NEIGHBORS AREN'T LIVING THER
11/23/2009	605 NW 182ND ST	Clogged ditch	The resident of 605 NW 182 called to report that the ditch on the side of their house was full of water and getting ready flow over the road on 6th Av
3/1/2010	19304 2ND AVE NW	Clogged ditch	SOMEONE HAS FILLED IN THE DRAINAGE DITCH WITH APPROX 4-5 YARDS OF DIRT. THE LOCATION IS ON 2ND AVE NW BETWEEN 191ST - 195TH
8/3/2010	814 N 150TH ST	Clogged ditch	CALLER IS REQUESTING THAT THE CITY CLEAR VEGETATION FROM THE DITCH ON THE LINDEN AVE N SIDE OF THE PROPERTY AT 814 N 150TH ST. SHE STATES THAT DURING
11/18/2010	15070 WESTMINSTER WAY N	Clogged ditch	CALLER STATES THAT THE DRAINAGE DITCH IS FULL (OF LEAVES, DIRT, NEEDLES, ETC..) NEAR 15070 WESTMINSTER WAY N. CALLER HAS SOME HEALTH ISSUES AND IS UNA
12/14/2010	18201 FREMONT AVE N	Clogged ditch	OWNER OF RENTAL HOUSE STATES THAT OPEN DITCH AT NW CORNER IS FULL OF BLACKBERRIES ETC AND PLUGGING CULVERT AGAIN. THIS IS CAUSING FLOODING ON HIS PRO
12/23/2011	16324 FREMONT AVE N	Clogged ditch	WATER IN DITCH IN FRONT OF HOME. PATCH FILLED INF RONT OF HOME WITHIN LAST FIVE YEARS. SUSPECTED SERVICE LEAK, BUT SW TO CHECK.
4/11/2002	401 NW 175TH ST	Creek blocked	IT HAS BEEN REPORTED ANONYMOUSLY THAT THE BOEING CREEK DOWN AT DUFFY'S MEADOW FOOTBRIDGE HAS BEEN DAMNED UP AND IS CAUSING FLOODING.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
9/27/2002	18509 2ND AVE NW	CB/SD grates	CUSTOMER WOULD LIKE US TO CHANGE THE GRATES ON TWO CATCH BASINS IN FRONT OF HER HOUSE. HER DOG JUST GOT HIS FOOT STUCK IN THE GRATE FOR THE SECOND TI
9/12/2007	NW 177TH PL	CB/SD grates	CALLER SAYS THAT THERE ARE 3 OR 4 CATCH BASIN GRATES THAT ARE BROKEN
10/8/2007	804 N 145TH ST	CB/SD grates	CONCERNED ABOUT A STORM DRAIN GRATE ON N 145TH ST NEAR THE INTERUBAN TRAIL, ON THE NORTH SIDE OF THE STREET.
2/27/2002	14849 FREMONT PL N	Damaged CB/SD/pipe	SAYS THE DRAIN SYSTEM PIPE IN FRONT OF HIS HOUSE IS BROKEN. HE HAD IT INSPECTED BY A DRAINAGE INSPECTOR AND THEY TOLD HIM THE PIPE WAS BROKE. SO HE WO
2/19/2003	118 N 177TH ST	Damaged CB/SD/pipe	DRAINAGE VAULT HAS CRUMBLED APART AND NOW THERE IS A HOLE THAT SOMEONE COULD TRIP INTO.
8/21/2006	DAYTON PL N	Damaged CB/SD/pipe	CUSTOMER REQUESTING REPAIR / PAVING FOR A DRAINAGE PIPE CROSSING BETWEEN CATCH BASINS ON DAYTON PL N @ N 183RD ST. THE PIPE CROSSING GOES E/W, THE PAV
12/27/2006	17608 EVANSTON AVE N	Damaged CB/SD/pipe	THE CUSTOMER'S BASEMENT WAS FLOODING DUE TO HIS STATED BREAK IN THE UNDERGROUND STORM PIPE. HE SAID SINCE THE WATER WAS INFILTRATING HIS BASEMENT THRO
4/24/2007	1ST AVE NW	Damaged CB/SD/pipe	CUSTOMER FAXED IN LETTER LETTER REQUESTING RE-PAVING FOR A CATCH BASIN AT THE SOUTHEAST CORNER OF 1ST AVE NW @ NW 181ST ST. (SIMILAR TO HOW THE CATCH
3/25/2008	555 N 167TH ST	Damaged CB/SD/pipe	STORM DRAIN IN FRONT OF CALLER'S HOUSE APPEARS TO BE SINKING. SHE WANTS TO SEE IF IT CAN BE BROUGHT UP TO BE LEVEL WITH THE REST OF THE PARKING STRIP.
8/18/2008	335 NW 189TH ST	Damaged CB/SD/pipe	CALLER SAYS THERE IS A BREAK IN THE STORM DRAIN IN FRONT OF HIS HOUSE AND HIS NEIGHBORS HOUSE ALONG THE FENCE LINE. HE SAYS ITS NOT CAUSING ANY DAMAGE

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
9/5/2008	210 N 201ST ST	Damaged CB/SD/pipe	CALLER SAYS THAT THE NEIGHBOR WAS DIGGING A NOTICED A CRACK IN THE STORM DRAIN IN FRONT OF HIS HOUSE. THE PIPE IS IN BETWEEN HOUSE 224 201ST AND 210 2
11/19/2009	717 N 184TH ST	Damaged CB/SD/pipe	PIPE FROM N 184TH TO ALLEYWAY IS BROKEN. OWNERS HAVE CLEARED THE ALLEY DRAIN OF MUD BUT SAY THAT IT IS THE PIPE ON N 184TH THAT IS THE PROBLEM. MUD CO
2/5/2010	521 NW 162ND ST	Damaged CB/SD/pipe	CONCRETE AROUND THE STORM DRAIN (UPPER EDGE) IS CRACKED, AND THE METAL CORNER OF STORM DRAIN GRATE IS COMPLETELY MISSING. DAMAGE HAPPENED EITHER WEDNE
2/5/2010	521 NW 162ND ST	Damaged CB/SD/pipe	CUSTOMER LEFT A VOICE MAIL INFORMING THAT THE STORM DRAIN PIPE WAS DAMAGED BY UTILITY WORK (VERIZON). HE STATES THAT THERE IS A BARRIER ON HIS DRIVEWA
4/26/2010	15558 PALATINE AVE N	Damaged CB/SD/pipe	DAMAGE DONE TO THE ROAD ASPHALT NEXT TO THE STORM DRAIN, DUE TO SOME LARGE VEHICLES AND HEAVY EQUIPMENT PARKED THERE ON SATURDAY FOR REMOVING A NEIGHB
4/26/2001	AURORA AVE N	Missing grate/MH cov	CALLED TO REPORT A PARTIALLY UNCOVERED MAN HOLE. SAYS IT IS STICKING UP ON ONE SIDE. IT IS LOCATED IN THE CENTER OF THE ROAD ON THE CROSSWALK AT N 160
1/11/2002	15501 DAYTON AVE N	Missing grate/MH cov	THERE IS A CB LID OFF IN FRONT OF THIS LOCATION. IT IS BELIEVED TO BE BROKEN.
2/20/2002	LINDEN AVE N	Missing grate/MH cov	A CB LID HAS FALLEN INTO THE CB.
4/9/2002	17510 1ST AVE NW	Missing grate/MH cov	THERE IS A CB LID THAT HAS BEEN REMOVED AND THE LID DROPPED DOWN INTO THE BASIN. THIS IS AT THE INTERSECTION OF NW 175TH AND 1ST AVE NW.
4/26/2002	AURORA AVE N	Missing grate/MH cov	THERE IS AN OPEN MANHOLE AT THE TOP OF THE HILL ON N 152ND JUST AS YOU TURN ON TO AURORA. SAYS IT IS ACROSS THE STREET FROM MCDONALDS.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
4/14/2003	FREMONT AVE N	Missing grate/MH cov	MANHOLE 1 BLOCK SOUTH ON EASTSIDE OF STREET POSSIBLY LID IS REMOVED. CHILDREN WERE CLIMBING IN AND OUT OF IT THIS WEEKEND. THIS WAS REFERRED TO KRIS B
6/26/2003	N RICHMOND BEACH RD	Missing grate/MH cov	NUMEROUS CB LIDS HAVE BEEN DROPPED INTO THE CB'S, WATER METER LIDS AND TRAFFIC CONTROL BOX LIDS HAVE ALSO BEEN REMOVED.
6/26/2003	DAYTON AVE N	Missing grate/MH cov	CB LID FELL THROUGH, IS IN THE CATCH BASIN.
9/19/2003	STONE AVE N	Missing grate/MH cov	MIKE FROM RONALD REPORTS LID HAS BEEN REMOVED FROM THE CATCH BASIN.
11/20/2003	3RD AVE NW	Missing grate/MH cov	POSSIBLE MANHOLE COVER MISSING HEADING NORTH JUST BEFORE 195TH.
4/19/2004	701 N 160TH ST	Missing grate/MH cov	SHORELINE COMMUNITY COLLEGE SECURITY REPORTED A MISSING CB LID ON THE SEARS SITE NEAR 160TH.
6/23/2004	18326 DAYTON PL N	Missing grate/MH cov	NO GRATES OVER OPENING OF TUBES. WHEN RAIN FALLS HEAVY WATER GETS FLOWING REAL FAST AND A CHILD OR ANIMAL CAN GET WASHED AWAY VERY QUICKLY. DRAINAGE
8/26/2004	3RD AVE NW	Missing grate/MH cov	POLICE DISPATCH CALLED TO REPORT A MISSING MANHOLE LID ON 3RD AVE NW AT NW 193RD ST. OPERATOR 75 WAS GOING TO DIPATCH AN OFFICER ALSO TO SECURE THE H
3/31/2005	15282 DAYTON AVE N	Missing grate/MH cov	BROKEN WATER METER LID, REQUIRES REPLACEMENT.
6/27/2005	STONE AVE N	Missing grate/MH cov	CALLER IS REPORTING A CATCH BASIN LID THAT FELL INTO THE CATCH BASIN CREATING A HOLE IN THE SIDE OF THE ROAD.
7/7/2005	18532 3RD PL NW	Missing grate/MH cov	CALLER SAYS THAT A STORM DRAIN LID WAS REMOVED BY LOCAL CHILDREN, AND THE LID IS NOW LOOSE. CALLER SAYS THEY MAY HAVE PUT OBJECTS INTO THE DRAIN THAT
7/19/2005	NW RICHMOND BEACH RD	Missing grate/MH cov	POLICE OFFICER REPORTING LOOSE/OPEN MANHOLE COVER AT 3RD AVE NW @ NW RICHMOND BEACH ROAD.
9/12/2005	FREMONT PL N	Missing grate/MH cov	CATCHBASIN LID LOOSE OR OUTSIDE OF THE DRAIN.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
9/19/2005	1225 N 178TH ST 101	Missing grate/MH cov	CUSTOMER IS REPORTING THAT A DRAIN / CATCH BASIN BETWEEN THE APARTMENT COMPLEX SHE MANAGES, AND THE ONE NEXT DOOR HAS A MISSING LID, AND A SMALL BLUE
10/3/2005	EVANSTON AVE N	Missing grate/MH cov	MISSING CATCH BASIN LID.
1/30/2006	1ST AVE NW	Missing grate/MH cov	CUSTOMER IS REPORTING A MISSING CATCH BASIN LID AT THE INTERSECTION OF 1ST AVE NW @ NW 181ST ST. CUSTOMER SAYS THERE ARE CONES IN PLACE ALREADY.
8/10/2006	18111 1ST AVE NW	Missing grate/MH cov	CUSTOMER STATES THAT THERE IS AN OPEN STORM DRAIN (BARRICADED OFF WITH CONES AND CAUTION TAPE) IN FRONT OF HIS HOUSE AT 18111 1ST AVE NW. CUSTOMER WAN
4/9/2007	DAYTON AVE N	Missing grate/MH cov	CUSTOMER REPORTING A MISSING UTILITY LID IN THE SIDEALK, CUSTOMER THINKS THAT SOMEONE COULD BE INJURED BY IT. SHE STATES THAT THERE WAS A BARRICADE OV
5/22/2007	DAYTON AVE N	Missing grate/MH cov	MISSING STORM DRAIN GRATE ON THE SOUTH SIDE OF THE STREET AT DAYTON AVE N @ N 185TH ST
7/10/2007	AURORA AVE N	Missing grate/MH cov	C/B LID OFF S/B ON AURORA NORTH OF 145TH IN THE RIGHT LANE.
12/4/2007	DAYTON AVE N	Missing grate/MH cov	MISSING CB LID SS OF RB ROAD BETWEEN FREMONT AND DAYTON
12/31/2007	DAYTON AVE N	Missing grate/MH cov	MANHOLE COVER FELL INTO ITSELF AT THE SOUTHWEST CORNER OF DAYTON AVE N @ CARLYLE HALL RD N.
4/4/2008	6TH AVE NW	Missing grate/MH cov	POLICE REPORTED A LID FROM A TYPE 2 CB HAD BEEN DROPPED INTO THE CB. THEY REQUESTED A RESPONSE TO FISH IT OUT.
10/16/2008	9TH PL NW	Missing grate/MH cov	OPEN MANHOLE COVER, COVER IS MISSING IN THE MIDDLE OF THE STREET - ON NW 165TH ST, NEAR 9TH AVE NW (NW INNIS ARDEN WAY), SHOREWOOD HILLS # 2
3/23/2009	FREMONT AVE N	Missing grate/MH cov	CUSTOMER REPORTING A LOOSE / MISSING MANHOLE COVER AT FREMONT AND 180TH ST, POTENTIAL HAZARD

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
5/18/2009	16610 AURORA AVE N	Missing grate/MH cov	OBSERVED MISSING METER LID ON THE PARKING STRIP IN FRONT OF 16610 AURORA AVE N. IMMEDIATE HAZARD, ADVISED CRT ADMIN TO CONTACT SPU WATER FOR REPAIR
1/7/2010	420 NW 185TH ST	Missing grate/MH cov	MANHOLE COVER (IN THE MIDDLE OF THE STREET) IS LOOSE, AND MAKING NOISE WHEN PEOPLE DRIVE OVER IT
7/12/2010	CARLYLE HALL RD N	Missing grate/MH cov	MISSING CATCH BASIN LID/COVER NEAR GREENWOOD AVE N @ CARLYLE HALL RD N
10/19/2010	GREENWOOD AVE N	Missing grate/MH cov	STORM DRAIN COVER IS "OFF" ON THE EAST SIDE OF GREENWOOD AVE N, SOUTH OF N 203RD ST.
1/10/2012	FREMONT AVE N	Missing grate/MH cov	CL-12-002 DRIVING ON FREMONT AVE N, DROVE OVER (IN MY LANE) A OPEN MAN-HOLE. LEFT REAR TIRE BLEW - UNAWARE WHAT I DROVE OVER UNTIL SHORELINE POLICE
10/12/2000	15721 GREENWOOD AVE N	Paved over CB/SD/va	WALK-IN CUSTOMER IS WORRIED THAT HIS HOME WILL BE FLOODED DURING A HEAVY RAIN BECAUSE A CB NEARBY WAS ASPHALTED OVER BY A NEIGHBOR. HE HAS NOTICED HIS
9/26/2002	15725 DAYTON AVE N	Paved over CB/SD/va	BY THE SOUTH DRIVEWAY (SOUTH OF MAILBOXES) OF 15275 DAYTON AVE N, THERE IS A DRAIN THAT IS COMPLETELY COVERED OVER BY ASPHALT FROM THE PAVING ON DAYTO
8/9/2004	19916 2ND AVE NW	Paved over CB/SD/va	OVERLAY COVERED DRAIN THAT WAS ONCE ON THE STREET CALLER IS REQUESTING DRAINS BE UNCOVERED AGAIN, TO RESTORE PROPER DRAINAGE
8/2/2005	6TH AVE NW	Paved over CB/SD/va	CALLER SAYS THAT TWO STORM DRAINS IN THE INTERSECTION OF 6TH AVE NW @ NW 175TH ST (OR POSSIBLY NW 175TH CT) WERE PAVED OVER/COVERED OVER BY OVERLAY PA

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/2/2009	10TH AVE NW	Paved over CB/SD/va	SEATTLE CITY LIGHT MADE A CLAIM AGAINST THE CITY REGARDING 2 PAVED OVER VAULTS. ON NW 175TH ST: V-745, NW 175TH ST, 1 E of 10TH AVE NW V-854, N/
11/16/2000	15412 LINDEN AVE N	Erosion	SHOULDER HAS ERODED. CALLER REQUESTS A LETTER STATING WHAT WILL BE DONE ABOUT IT. PLEASE ADDRESS THE LETTER TO JOHN BROWN AT THE SAME ADDRESS. LH
6/11/2003	18315 DAYTON PL N	Erosion	THE BANK OF THE OPEN DITCH IS COLLAPSING. SHE IS CONCERNED ABOUT CHILDREN PLAYING IN THE DITCH AND FEELS THIS IS A HAZARDOUS SITUATION.
7/11/2003	17212 AURORA AVE N	Erosion	THE OWNER OF THE SITE HAS DEPOSITED A LARGE PILE OF DIRT ON THE SITE. IT IS NOT COVERED, NOR DOES IT HAS A SILT BARRIER. HE SAID THERE IS A FOR SAL
11/18/2003	17602 DAYTON AVE N	Erosion	GRAVEL ERODED ON SIDE OF HOUSE CREATING DITCH
2/19/2004	17217 DAYTON AVE N	Erosion	BANK IN FRONT OF HOUSE IS ERODING. CUSTOMER WANTS TO KNOW WHOSE RESPONSIBILITY IT IS. IT LOOKS LIKE HOLES ARE FORMING AND THE HILLSIDE IS DRIFTING AW
4/30/2004	214 N 185TH ST	Erosion	THE CUSTOMER IS CONCERNED THAT HIS FAILING DRIVEWAY MAY BE CAUSED BY ADDITIONAL WATER RUNOFF FROM THE CITY STREET.
8/9/2004	17610 DAYTON AVE N	Erosion	CITIZEN REPORTS RESIDENT OF 17609 EVANSTON BUILT A TRENCH WITH A PIPE AND SHE BELIEVES IT CAUSED THE MUD SLIDE. SHE IS WORRIED ABOUT FURTHER EROSION.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
8/9/2004	15028 LINDEN AVE N	Erosion	FLOOD DAMAGE FROM FLOOD:WATER WASHED AWAY TOPSIL, CHIPS AND CAUSED RUTS. THE DITCH FROM THE INTERURBAN OVERFLOWED. CUSTOMER ALSO REQUEST INFO ON HOW T
8/23/2004	508 N GREENWOOD DR	Erosion	SEVERE EROSION ON THE EAST SIDE OF DAYTON JUST ABOVE THIS RESIDENCE. IT HAS UNDERMINED THE ASPHALT. THE CB'S BELOW THIS ARE FULLY IMPACTED WITH GRAVEL
8/27/2004	119 N 177TH ST	Erosion	RECENT FLOODING HAS WASHED AWAY DIRT AND GRAVEL ON THE SIDE OF THE ROADWAY AT THIS LOCATION (119 N 177TH ST). HE SAYS THAT SOON THE ROAD MAY "CAVE IN"
9/2/2004	515 N 172ND ST	Erosion	RAINWATER HAS DAMAGED / DESTROYED PART OF THE ROADWAY WHERE THE EDGE OF THE ROAD MEETS WITH CALLER'S DRIVEWAY, CREATED A GULLY. CALLER SAYS IF HE F
12/7/2004	16028 DAYTON AVE N	Erosion	THE GRAVEL IS WASHING AWAY FROM THE PAVEMENT EDGE FROM THE CALLER PROPERTY AND TO THE NORTH. PLEASE PLACE GRAVEL IN THESE RUTS.
1/8/2007	STONE AVE N	Erosion	CUSTOMER REPORTING THAT THE SHOULDER OF THE ROADWAY AT THE EDGE OF THE TRAFFIC CIRCLE IS STARTING TO ERODE AWAY. SHE THINKS THAT THE ROAD SURFACE NEED
1/30/2007	317 NW 176TH PL	Erosion	REQUESTING THAT THE CITY CLEAN UP (REMOVE DOWN TREES?) AND MITITGATE FUTURE EROSION PROBLEMS ALONG THE HILLSIDE BANK ALONG NW 176TH PL (EAST OF 6TH AV
2/16/2007	814 N 150TH ST	Erosion	THE SHOULDER IS WASHING AWAY AND CAUSING CONCERN REGARDING THE TREES FALLING. THIS HAS INCREASED IN THE PAST YEAR DRAMATICALLY.
9/2/2008	18529 PALATINE PL N	Erosion	A CONTRACTOR TOLD THE CUSTOMER THAT THE HOLE IN HER DRIVEWAY WAS BEING CAUSE BY CLOGGING IN THE DRAINAGE...POSSIBLY THE CATCH BASIN. SHE WOULD LIKE SO

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
2/1/2010	19324 PALATINE AVE N	Erosion	SHOULDER OF THE ROAD HAS ERODED IN A SEMI-CIRCLE SHAPE, ABOUT 18 INCHES TO 2 FEET LONG
4/27/2010	840 N 153RD PL	Erosion	Shoulder on south side of house needs grading.
3/14/2011	17510 1ST AVE NW	Erosion	LANDSLIDE / SLOPE EROSION ACROSS THE STREET FROM 17510 1ST AVE NW - PARTIALLY BLOCKING SOUTHBOUND LANE OF 1ST AVE NW
6/3/2011	704 N 165TH ST	Erosion	SHE LIVES ON THE CORNER OF 165TH AND FREMONT. THE ROCKERY IS CAUSING AN EROSION PROBLEM TO HER LANDSCAPE AND PROPERTY. THE ROCKERY IS TOO SHORT AND
10/9/2000	519 N 183RD ST	Flooding	STORM DRAIN GOES THROUGH, OR IS NEXT TO HIS PROPERTY, AND IS NOW FLOODING. MMM
10/23/2000	DAYTON AVE N	Flooding	YARDS BEING FLOODED. MMM
11/27/2000	513 N 183RD ST	Flooding	water flooding the site at the front and side.
12/27/2000	AURORA AVE N	flooding	There is water starting to flood the bus stop which is across from the safeway on Aurora. The Bus stop is located on the west side of Aurora near 155
8/22/2001	LINDEN AVE N	Flooding	OPERATOR #47 CALLED SAYS THE ROAD IS FLOODING AT THIS LOCATION. SOMEONE FROM THE CITY NEEDS TO GO OUT. AR
8/22/2001	DAYTON PL N	Flooding	THE CULVERT HAS FLOODED ON N 183RD ST AND THE ROADWAY AS WELL. CONCERNED ABOUT POSSIBLE FLOODING INTO THE HOUSE AND THEIR BASEMENT. AR
8/23/2001	18523 3RD PL NW	Flooding	HOUSE IS FLOODING WOULD LIKE SOME SANDBAGS TO HELP CONTROL THE WATER. AR
10/3/2001	327 NW 183RD ST	Flooding	Had concerns over the liability of a ditch that runs along her property. Would she be liable if someone fell in or since it is in the city right of w
11/14/2001	103 NW 188TH ST	Flooding	RESIDENT SAYS THERE IS FLOODING IN FRONT OF HIS HOUSE DUE TO WATER BACKUP.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/28/2001	LINDEN AVE N	Flooding	STEVE FROM RONALD WASTEWATER CALLED SAYS THERE IS A LARGE POOL OF WATER FORMING ON THE ROAD AT THIS LOCATION. ALSO SAYS THE DRAIN IN FRONT OF THIS LOC
11/28/2001	MIDVALE AVE N	Flooding	SAYS THE DRAIN HAS FLOODED CAR PORT AT THIS LOCATION. CONCERNED WILL FLOW INTO THE APT COMPLEX. SEE REQUEST #10098 FOR PREVIOUS INFO ON THIS LOCATION.
12/13/2001	MIDVALE AVE N	Flooding	
12/13/2001	14849 FREMONT PL N	Flooding	RESIDENT LIVES NEXT TO A SHORT PLAT THAT WAS BUILT AWHILE BACK. SAYS THE OWNER OF THE PROPERTY WAS SUPPOSED TO PUT IN A DRAIN FIELD ACROSS FROM PROPER
12/17/2001	18826 3RD AVE NW	Flooding	RESIDENT CALLED REGARDING THE CALVIN CHURCH AT THIS LOCATION SAYS THEY HAD SOME FLOODING OCCUR ON YESTERDAY THAT HAS SINCE RECEDED. MAIN ISSUE IS WHEN
12/17/2001	19303 1ST AVE NW	Flooding	Saturday 12/15/01 @ 2:03pm: Pam Cross resident at 19303 1st Ave NW left a message on the 1700 line reporting a 6" of water in her driveway. Says this
12/27/2001	124 N 155TH ST	Flooding	WATER RUN OFF ISSUE. SHE HAD 5-6 INCHES OF WATER IN HER BASEMENT LAST WEEK. SHE HAS BEEN IN THE HOUSE 12 YEARS. THIS WAS FIRST TIME. SHORELINE HAD PRE
1/7/2002	15604 1ST AVE NW	Flooding	CALLER HAS FLOODING IN HIS DRIVEWAY COMING FROM THE ROAD. SAYS THERE IS A LARGE AMOUNT GIVES THE APPEARANCE OF A LAKE. WOULD LIKE TO HAVE SOMEONE COME
3/11/2002	745 N 182ND ST	Flooding	THERE IS A VERY LARGE POND THAT IS OUT INTO THE ROADWAY ON N 182ND ST BETWEEN FREMONT AND LINDEN AVE N.
12/16/2002	17602 DAYTON AVE N	Flooding	CALLER HAS FLOODING ON N SIDE OF HOUSE SHE BELIEVES IS CAUSED BY SURFACE WATER OR THE SURFACE WATER PIPE THAT HAS AN EASEMENT ONTO HER PROPERTY.
12/16/2002	16517 CARLYLE HALL RD N	Flooding	FLOODING ON / NEAR CALLER'S PROPERTY

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
1/3/2003	LINDEN AVE N	Flooding	DRAINAGE/FLOODING PROBLEM ON LINDEN AVE N BEHIND "DESERET INDUSTRIES" CALLER SAYS ROAD FLOODS WHEN IT RAINS. CALLER THINKS THAT PIPE THAT RUNS UNDER S
1/9/2003	17512 AURORA AVE N	Flooding	- DANCE STUDIO AND HAWAIIAN GIFT SHOP ON AURORA....VM FORWARDED BY JOYCE NICHOLS: CUSTOMER STATES HE EXPERIENCED FLOODING AT HIS DANCE STUDIO WHERE WA
2/3/2003	LINDEN AVE N	Flooding	FLOODING/DRAIN PROBLEM ON LINDEN AVE N @ N 179TH ST. CALLER SAYS IT IS NEAR THE NORTH DRIVEWAY OF RONALD METHODIST CHURCH
7/24/2003	700 NW INNIS ARDEN WAY	Flooding	CALLED REGARDING THE SOCCER FIELD AT SHORVIEW PARK. SEEMS LIKE THE WATER MAIN BROKE AND HALF OF THE FIELD IS FLOODED.
10/20/2003	15604 1ST AVE NW	Flooding	CUSTOMER REPORTS SIDEWALK, AROUND TELEPHONE POLE AND HIS DRIVEWAY IS FLOODED.
10/20/2003	16517 CARLYLE HALL RD N	Flooding	FRONT YARD IS FLOODED
10/20/2003	920 N 167TH ST 1	Flooding	WATER ON ROAD
10/20/2003	AURORA AVE N	Flooding	WATER FLOODING UNDERHILLS
10/20/2003	AURORA AVE N	Flooding	POLICE DISPATCH REPORTS STANDING WATER
10/20/2003	519 N 183RD ST	Flooding	DRIVEWAY FLOODING
10/20/2003	519 N 183RD ST	Flooding	FLOODING
10/20/2003	STONE AVE N	Flooding	CUSTOMER REPORTS THAT ABOUT 2-3 HOUSES DOWN FROM HER BEHIND SAFEWAY THE YARD IS FLOODED WITH WATER
10/20/2003	STONE AVE N	Flooding	DON CALLED FOR ROAD CLOSED SIGNS
10/20/2003	745 N 182ND ST	Flooding	FLOODING
10/20/2003	MIDVALE AVE N	Flooding	APARTMENTS HAVE SEVERE STANDING WATER
10/20/2003	18110 MIDVALE AVE N	Flooding	FLOODING
10/20/2003	330 NW 183RD ST	Flooding	BACKYARD FLOODING
10/20/2003	1115 N 183RD ST 101	Flooding	DRIVEWAY IS FLOODING DUE TO SURFACE WATER

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
10/20/2003	18532 3RD PL NW	Flooding	FLOODING 3 INCHES OF WATER IN LAUNDRY ROOM AND BEDROOMS
10/20/2003	18502 3RD PL NW	Flooding	FLOODING - WATER GOING EAST ON 185TH.
10/20/2003	18516 6TH AVE NW	Flooding	FLOODING - BACKYARD AND CARPORT
10/20/2003	18523 3RD PL NW	Flooding	PROPERTY FLOODING
10/20/2003	15729 GREENWOOD AVE N	Flooding	FLOOD IN GARAGE
10/20/2003	6TH AVE NW	Flooding	FLOODING
10/20/2003	513 N 183RD ST	Flooding	FLOODING - ROAD TO BACK ON THE EASTSIDE OF THE PROPERTY. NOT ENTERING THE HOUSE AT THIS TIME.
10/20/2003	525 N 183RD ST	Flooding	FLOODING, CUSTOMER WOULD LIKE TO SPEAK TO SOMEONE ABOUT THIS PROBLEM AS IT'S ONGOING
10/20/2003	526 N 183RD ST	Flooding	CUSTOMER REPORTS FLOODING
10/21/2003	17602 DAYTON AVE N	Flooding	CALLER HAS FLOODING PREVIOUSLY ON N SIDE OF HOUSE AND SHE STILL BELIEVES FOLLDING AND EROSION IS CAUSED BY SURFACE WATER OR THE SURFACE WATER PIPE THA
10/21/2003	14920 WESTMINSTER WAY N 1A	Flooding	PARKING LOT IS FLOODED. HAS BEEN AN ON GOING PROBLEM BUT IT USUALLY RECEDES PRETTY QUICK. THE SYSTEM IS STILL BACKED UP AND DOESN'T SEEM TO BE GOING
10/21/2003	AURORA AVE N	Flooding	WATER HAS ALMOST REACHED THEIR ROLL UP DOORS IN THE BACK OF JOANNE FABRICS.
10/22/2003	17550 MIDVALE AVE N 1	Flooding	THIS CUSTOMER HAS CONCERNS THAT THE MINI STORAGE IS CAUSING FLOODING TO THE APARTMENTS, CAN A SURPRISE INSPECTION BE DONE ON THIS SITE TO ENSURE THAT
10/23/2003	15721 GREENWOOD AVE N	Flooding	CUSTOMER REPORTS HIS GARAGE AND BASEMENT WERE FLOODED DURING THE STORM ON 10/20/03 AND HE WOULD LIKE SOMEONE TO COME OUT AND TAKE A LOOK. CUSTOMER CAL
11/18/2003	16517 CARLYLE HALL RD N	Flooding	CUSTOMER CALLED VERY IRRATE. HE SAID HE IS SICK OF HEARING THAT WE ARE WORKING ON THE PROBLEM. HE WANTS IT FIXED. HE WOULD LIKE A CALL TO KNOW WHEN

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/18/2003	AURORA AVE N	Flooding	INTERSECTION FLOODING FROM 170TH - 175TH
11/18/2003	AURORA AVE N	Flooding	WATER SURROUNDING THE UNDERHILLS BUILDING AT THIS LOCATION
11/18/2003	519 N 183RD ST	Flooding	FLOODING IN FRONT YARD - NOT IN HOUSE AT THIS TIME
11/18/2003	LINDEN AVE N	Flooding	FLOODING IN CUSTOMER'S YARD
11/18/2003	MIDVALE AVE N	Flooding	APARTMENT COMPLEX IS FLOODING
11/18/2003	330 NW 183RD ST	Flooding	FLOODING AT RESIDENCE
11/18/2003	MIDVALE AVE N	Flooding	ROAD IN FRONT OF ANNEX IS FLOODING
11/18/2003	3RD AVE NW	Flooding	FLOODING WANT SANDBAGS AND HE TALKED WITH STEVE BURKETT LAST TIME
11/18/2003	AURORA AVE N	Flooding	FLOODING OVER ROADWAY
11/18/2003	DAYTON AVE N	Flooding	INTERSECTION FLOODING
11/18/2003	FREMONT AVE N	Flooding	INTERSECTION FLOODING
11/18/2003	17219 AURORA AVE N 101	Flooding	WATER OVER ROADWAY.
11/18/2003	420 NW 185TH ST	Flooding	CUSTOMER DRIVEWAY IS FLOODING AND WANTS SANDBAGS
11/18/2003	18520 6TH AVE NW	flooding	FLOODING IN HOUSE
11/18/2003	18515 3RD PL NW	Flooding	HOUSE FLOODING IN BACK OF HOUSE
12/3/2003	16128 EVANSTON AVE N	Flooding	A contact form has been submitted from the web site: Name: Amy Etelamaki Phone: 2062738361 or 2065425712 E-Mail: barklie@comcast.net
12/5/2003	17012 AURORA AVE N	Flooding	ACTION AUTO PARTS IS FLOODING, ACCORDING TO THE OWNER IT IS WORSE THAN IT EVER HAS BEEN BEFORE.
1/29/2004	15604 1ST AVE NW	Flooding	THE CALLER SAID HE WAS WORKING WITH BOB ON THIS PROBLEM BUT NO FILE WAS FOUND. HE REQUESTED WE OBSERVE HIS SITE TODAY DURING THE RAINFALL. HE SAID HIS

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
3/1/2004	18110 MIDVALE AVE N	Flooding	See attached image
3/1/2004	18520 6TH AVE NW	Flooding	See attached response letter
8/9/2004	N 160TH ST	Flooding	WATER ACROSS 1.5 LANES OF E/B TRAVEL
8/9/2004	519 N 183RD ST	Flooding	****VOICEMAIL CALL**** LOTS OF WATER
8/9/2004	17615 EVANSTON AVE N	Flooding	CUSTOMER CALLING ON BEHALF OF PARENTS. THIS IS THE 5TH TIME IN THE LAST FEW YEARS THEY HAVE FLOODED. FLOODING PROBLEMS HAS CAUSED EROSION IN THIER SO
8/9/2004	1153 N 165TH ST	Flooding	WATER FLOODED INTO BASEMENT
8/9/2004	15316 LINDEN AVE N	Flooding	SITE FLOODED
8/9/2004	1149 N 165TH ST	Flooding	BASEMENT FLOODED
8/9/2004	1301 N 165TH ST	Flooding	HIS SITE AND BASEMENT FLOODED.
8/9/2004	18200 MIDVALE AVE N	Flooding	FLOODING
8/9/2004	18523 3RD PL NW	Flooding	FLOODING AT THIS LOCATION
8/9/2004	915 N 167TH ST	Flooding	****VOICEMAIL CALL**** COMPLETELY FLOODED
8/9/2004	AURORA AVE N	Flooding	FLOODING ON AURORA AVE N @ N 155TH ST CALLER SAYS THE WATER IS ABOUT 6 INCHES DEEP
8/9/2004	17818 RONALD PL N	Flooding	4 INCHES OF WATER FLOODING PROPERTY (17818 RONALD PL N)
8/9/2004	17550 MIDVALE AVE N 1	Flooding	PARKING LOT NORTH OF CITY HALL FLOODING
8/9/2004	17616 EVANSTON AVE N	Flooding	ON-GOING FLOODING PROBLEMS IN THIS AREA. CITIZEN IS CONCERNED ABOUT FURTHER EROSION. HE REPORTS IT HAS ALREADY BLOWN OUT A FEEDER PIPE.
8/9/2004	420 NW 185TH ST	Flooding	SANDBAGS REQUESTED
8/9/2004	513 N 183RD ST	Flooding	NO REPORTING INFO

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
8/9/2004	16539 CARLYLE HALL RD N	Flooding	FRONT YARD IS FLOODED
8/9/2004	AURORA AVE N	Flooding	FLOODING AT THIS LOCATION
8/13/2004	1225 N 178TH ST B1	Flooding	CITIZEN REPORTS DAMAGE FROM FLOODING ON 8/6. SHE IS REPORTING NOW BECAUSE HER LANDLORD WILL NOT CLAIM RESPONSIBILITY FOR IT AND HER RENTER'S INSURANC
8/23/2004	15433 LINDEN AVE N	Flooding	HIS YARD IS COMPLETELY FLOODED
8/23/2004	STONE AVE N	Flooding	THE INTERSECTION IS COMPLETELY UNDER WATER. FIRE REQUESTED ROAD CLOSED SIGNS.
8/23/2004	330 NW 183RD ST	Flooding	THEIR BACKYARD WAS FLOODED
8/23/2004	1153 N 165TH ST	Flooding	LEFT MESSAGE ON 1700 LINE REPORTING WATER IN THEIR HOUSE AND ARE REQUESTING SAND BAGS.
8/23/2004	332 NW 183RD ST	Flooding	WATER FLOODING THE YARD
8/23/2004	3RD AVE NW	Flooding	CITIZEN WOULD LIKE THE DRAINS CHECKED FROM RICHMOND BEACH ROAD TO 175TH. HE SAID HIS DRIVEWAY/HOUSE AND CRAWLSPACE FLOODED.
8/23/2004	17542 FREMONT AVE N	Flooding	WATER FLOODED THE GARAGE AND CRAWLSPACE. HE SAID HE SEEMS TO BE GETTING WATER FROM TWO SYSTEMS. HE THINKS THERE IS A LARGE IMPACT FROM THE NEW DEVELOP
8/23/2004	420 NW 185TH ST	Flooding	THE BASEMENT HAS 2 FEET OF WATER AND WATER IS RUNNING ACROSS THE ROAD.
8/23/2004	513 N 183RD ST	Flooding	YARD IS FLOODED
8/23/2004	18520 6TH AVE NW	Flooding	THE CALLER WAS CALLING FOR THE CUST, (THEY ARE OUT OF TOWN) THEY HAD FLOODING IN THE BASEMENT. SHE REQUESTED WE DELIVER 25 SANDBAGS TO THE SITE. SO
8/24/2004	517 N 170TH CT	Flooding	FLOODING LAST SUNDAY 8/22/04 DRAIN CAN'T HOLD WATER. NEED HELP
9/2/2004	15020 LINDEN AVE N	Flooding	

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/2/2004	16526 AURORA AVE N	Flooding	THE CUST STATED THE BASEMENT OF THE MOTEL FLOODED LAST NIGHT APPROX 2AM.
11/2/2004	330 NW 183RD ST	Flooding	PROPERTY IS GETTING ALOT OF WATER.
11/2/2004	18523 3RD PL NW	Flooding	WATER IS FLOODING HIS PROPERTY. HE WANTS TO KNOW WHAT IS BEING DONE ABOUT IT.
11/2/2004	420 NW 185TH ST	Flooding	HIGH WATER LEVELS ON HIS PROPERTY.
11/2/2004	18520 6TH AVE NW	Flooding	CUSTOMER CALLED TO REPORT RISING WATER LEVELS ON HER PROPERTY.
10/2/2005	LINDEN AVE N	Flooding	THE POLICE REPORTED FLOODING THROUGHOUT THE WEST SIDE OF THE CITY.
10/2/2005	AURORA AVE N	Flooding	WATER IS FLOODING THE STREET AND FLOWING INTO THE CHURCH AGAIN CAN SOMEONE COME AND HELP.
10/3/2005	17625 LINDEN AVE N	Flooding	THE STREET IS FLOODED
10/3/2005	AURORA AVE N	Flooding	WATER FLOODING THE STREET.
10/3/2005	17818 AURORA AVE N STE A	Flooding	WATER DAMAGE TO HER SHOP. CONSIDERABLE MERCHANDISE DAMAGED.
10/3/2005	400 N 199TH ST	Flooding	CUSTOMER SAYS THAT ON SATURDAY, RAIN WATER FROM THE ENTIRE CUL-DE-SAC AND DAYTON AVE N RAN DOWN AND FLOODED CALLER'S GARAGE AND LAUNDRY ROOM.
10/3/2005	704 N 165TH ST	Flooding	THE CUST SAID THERE BASEMENT FLOODED.
10/3/2005	15430 LINDEN AVE N	Flooding	WATER FLOODED THE STREET AND THEN FLOODED THE BASEMENT OF THE CHURCH
10/3/2005	15430 LINDEN AVE N	Flooding	THE STREET ON 155TH FLOODED AGAIN WATER FLOWED INTO THE SUBJECT SITE AND BUILDING AGAIN.
10/3/2005	17542 FREMONT AVE N	Flooding	SITE FLOODING - NO HOUSE FLOODING
10/4/2005	15609 2ND AVE NW	Flooding	CUSTOMER SAYS THEY EXPERIENCED SOME DRAINAGE / FLOODING PROBLEMS ON 2ND AVE NW - HE WOULD LIKE TO TALK WITH SOMEONE ABOUT THE SITUATION, AND REQUESTIN

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
10/18/2005	17550 MIDVALE AVE N 1	Flooding	CLAIMANT STATES" TWO CATCH BASINS ON GRASS JUST NORTH OF 178TH GOT CLOGGED WITH HEAVY RAIN. POOL CROSSED STREET AND SPILLING INTO PARKING GARAGE ON SO
11/28/2005	904 N 155TH ST	Flooding	THE CUST IS THE PROPERTY MANAGER FOR THE DENNY'S SITE. SHE REPORTED THAT THE PARKING LOT HAD FLOODED AGAIN.
1/30/2006	15433 LINDEN AVE N	Flooding	CALLER SAYS THERE IS A DRAINAGE ISSUE ON WESTMINSTER WAY N, NEAR HIS HOUSE. CUSTOMER STATES HE HAS A LAKE ON HIS PROPERTY. NO WATER DAMAGE IN HOUSE A
1/30/2006	15269 FREMONT AVE N	Flooding	WATER ON FREMONT & 155TH IN THE ROW
1/30/2006	AURORA AVE N	Flooding	FLOODING AT THE SW CORNER OF THE THE INTERSECTION. APPROX 8INCHES OF WATER ON THE STREET.
1/30/2006	726 N 185TH ST	Flooding	CUSTOMER SAYS THEIR BASEMENT IS FLOODING.
2/10/2006	16720 LINDEN AVE N	Flooding	CALLER SAYS THAT HER PROPERTY FLOODED RECENTLY, AND WANTS TO SEE IF THE CITY CAN LOOK INTO DRAINAGE ISSUES ON THE STREET NEAR HER PROPERTY AT 16720 LI
5/17/2006	16048 AURORA AVE N	Flooding	EMPLOYEE AT "BROWN BEAR CAR WASH / 76 STATION" REPORTING WATER FLOODING OUT OF A CATCH BASIN, WHICH MAY BE RELATED TO THE WATER LEAK REPORTED EARLIER.
8/31/2006	15430 LINDEN AVE N	Flooding	Flooding damage to the Chirch in Seattle Linden Hall located at 15430 Linden Avenue N, Shoreline, assumed to be caused by Aurora Corridor Project Cons
9/5/2006	AURORA AVE N	Flooding	CUSTOMER REPORTS A LARGE WATER LEAK AT AURORA AVE N @ N 160TH ST, ON THE WEST SIDE OF THE STREET (SOUTHBOUND) - CUSTOMER THINKS THAT IF LEFT ON IT'S O
10/10/2006	17616 EVANSTON AVE N	Flooding	
11/6/2006	738 N 179TH ST	Flooding	CUSTOMER STATES THAT THE STREET IS STARTING FLOOD AND BECOME A "LAKE" ON THE NORTH SIDE OF N 179TH ST, NEAR 738 N 179TH ST. CUSTOMER STATES THAT 3 DRA

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/12/2006	AURORA AVE N	Flooding	SGT DIANA NEFF OF SPD REPORTS FLOODING ON AURORA FROM 172ND TO APPROX. 178TH. THE ENTIRE S/B RIGHT LANE IS FLOODED AND SHE IS CONCERNED ABOUT POTENTI
12/14/2006	AURORA AVE N	Flooding	OFC OSTLER REPORTING WATER OVER ROADWAY AT 175TH AND AURORA.
12/14/2006	AURORA AVE N	Flooding	OFC OSTLER REPORTING WATER OVER ROADWAY SOUTH OF 175TH AND AURORA.
12/14/2006	6TH AVE NW	Flooding	ROADWAY FLOODED
12/14/2006	DAYTON AVE N	Flooding	FLOODING ON NW RICHMOND BEACH ROAD BETWEEN DAYTON AVE N AND FREMONT AVE N
12/27/2006	FREMONT AVE N	Flooding	LARGE POND ACROSS THE 2 EAST BOUND LANES.
12/27/2006	17225 AURORA AVE N	Flooding	DEP. MANN REPORTED THE OUTSIDE SB LANE WAS UNDER WATER AND IT WAS MOVING TOWARD THE MIDDLE LAND.
12/27/2006	18317 1ST AVE NW	Flooding	THE CUST REPORTED WATER FLOODING HIS GARAGE. THERE IS A BASIN IN THE BACKYARD OF HIS NEIGHBOR, IT IS OVERFLOWING. HE REQUESTED SANDBAGS.
1/9/2007	124 N 155TH ST	Flooding	CUSTOMER SAID THAT SHE HAS 5 FEET OF WATER IN HER BASEMENT. I SPOKE WITH JERRY FROM SURFACE WATER WHO WAS IN THE OFFICE. JERRY MADE ARRANGMENTS TO H
2/15/2007	15430 LINDEN AVE N	Flooding	Flooding incident at their property and meeting hall at 15430 Linden Avenue N on December 26. Draft due February 23.
5/9/2007	225 NW 176TH PL	Flooding	Caller experienced minor flooding in basement this last november.
5/22/2007	17546 FREMONT AVE N	Flooding	
5/23/2007	17615 EVANSTON AVE N	Flooding	HE CALLED TO INFORM THE CITY THAT HIS STREET IS A LAKE AND THE WATER IS FLOWING OVER THE HILL DOWN TO DAYTON. HE SAID IT WAS NOT AS BAD AS BEFORE. HE
5/23/2007	17542 FREMONT AVE N	Flooding	HE CALLED TO INFORM THE CITY THAT DUE TO THE HEAVY RAIN THE STREETS ARE FLOODING.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
5/23/2007	17608 EVANSTON AVE N	Flooding	SHE SAID THE STREET IN FRONT OF HER HOUSE IS UNDER WATER. IT HAD BEEN 3 FT DEEP BUT IS NOW ONLY 12-15 INCHES.
5/23/2007	17828 MIDVALE AVE N	Flooding	THE CUST (VANGUARD STORAGE) CALLED TO INFORM THE CITY THAT THREE OF THERE ONSITE ALLEYS WERE FLOODING AND THAT 178TH BAND THE APTS TO SOUTH ARE FLOODE
5/23/2007	18545 PALATINE PL N	Flooding	THE CUST CALLED TO INFORM THE CITY HER BACKYARD WAS FLOODING.
5/23/2007	1301 N 165TH ST	Flooding	THE CUST CALLED TO INFORM THE CITY HIS YARD WAS FLOODING. HE HAD A SUMP PUMP BUT DID NOT THINK IT WOULD HOLD UP.
5/23/2007	17327 1ST AVE NW	Flooding	THE CUST CALLED TO INFORM THE CITY THAT HER GARAGE WAS FLOODING.
5/23/2007	18537 PALATINE PL N	Flooding	THE CUST CALLED TO INFORM THE CITY THAT HER BASEMENT WAS FLOODING.
7/9/2007	606 NW 185TH ST	Flooding	THERE IS STANDING WATER IN THIS YARD. CALLER FEELS IT MAY BREED MOSQUITOS.
12/3/2007	AURORA AVE N	Flooding	SGT. JOHANES- WATER OVER ROADWAY AT AURORA AND 172ND
12/3/2007	AURORA AVE N	Flooding	WATER IS COVERING 2 LANES. WATER ON ROAD SIGN BUT BARRICADE NOT THERE ANYMORE.
12/3/2007	1306 N 165TH ST	Flooding	WATER OVER ROADWAY
12/3/2007	15733 GREENWOOD AVE N	Flooding	HOUSE FLOODING.
12/3/2007	1301 N 165TH ST	Flooding	WATER OVER THE ROADWAY
12/3/2007	700 N 160TH ST	Flooding	FLOOD IN PARKING GARAGE.
12/3/2007	DAYTON AVE N	Flooding	WATER OVER THE ROADWAY DAYTON 183-185
12/3/2007	NW RICHMOND BEACH RD	Flooding	WATER OVER ROADWAY
12/3/2007	18520 6TH AVE NW	Flooding	HAS BEEN WORKING ON FLOODING SINCE 3AM AND IS LOOSING BATTLE PLEASE SEND HELP
12/3/2007	15551 PALATINE AVE N	Flooding	GARAGE AND BACKYARD FLOODING

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/3/2007	511 N 166TH ST	Flooding	RE: DIRT PILE HIS YARD IS BEING FLOODED 6INCHES IN YARD
12/3/2007	18012 DAYTON AVE N	Flooding	FLOODING DRIVEWAY INTO HOME - EOC#1009
12/3/2007	18012 DAYTON AVE N	Flooding	WATER ENTERING DRIVEWAY
12/3/2007	17544 MIDVALE AVE N	Flooding	THE BASEMENT OF CITY HALL HAS APPROX 4 INCHES OF WATER.
12/3/2007	MIDVALE AVE N	Flooding	BEING PUMPED`
12/3/2007	WHITMAN AVE N	Flooding	BEING PUMPED
12/3/2007	915 N 167TH ST	Flooding	WATER IN LAWN NEAR OIL TANK
12/3/2007	401 NW 175TH ST	Flooding	BOEING CREEK HAS RISEN AND IS AT FLOOD STAGE, TRAILS ARE FLOODED.
12/3/2007	513 N 183RD ST	Flooding	YARD COMPLETELY FLOODED.
12/3/2007	LINDEN AVE N	Flooding	SW CORNER FLOODING SITE-WATER NEAR FRONT PORCH
12/4/2007	STONE AVE N	Flooding	165TH & STONE, 2 INCHES DEEP ON 165TH, SHOULD CLOSE THE ROAD.
12/4/2007	732 N 150TH ST	Flooding	BASEMENT FLOODING IN HOME FROM STORM STEWER. - FIRE DEPT. VISITED.
12/4/2007	3RD AVE NW	Flooding	3RD AVE NW FROM 201ST TO RICHMOND BEACH RD, STANDING WATER ON ROADWAY.
12/4/2007	738 N 179TH ST	Flooding	STREET NEAR DRIVEWAY IS FLOODED
12/4/2007	3RD AVE NW	Flooding	FLOODING ON ROADWAY AT 3RD AVE. NORTH OF 185TH
12/4/2007	18041 3RD AVE NW	Flooding	BASEMENT IS FLOODING
12/4/2007	401 NW 175TH ST	Flooding	BOEING CREEK FACILITY AT FLOOD STAGE
12/4/2007	NW RICHMOND BEACH RD	Flooding	INTERSECTION FLOODING
12/4/2007	17608 EVANSTON AVE N	Flooding	WATER OVER ROADWAY
12/4/2007	132 NW 181ST ST	Flooding	BASEMENT FLOODING IN HOME. (1525 HRS UPDATE: HOMEOWNER IS GETTING WATER SUCKED OUT OF HOME WITH SHOP VAC. LOOKS LIKE WATER TABLE IS ABOVE CONCRETE - W
12/4/2007	17001 AURORA AVE N	Flooding	AURORA AVE N BETWEEN PARKERS AND SUBARU DEALER - 300' OF RIGHT LANE UNDER WATER, "PLEASE CONE OFF"
12/4/2007	19819 FREMONT AVE N	Flooding	FRONT YARD IS FLOODING.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/4/2007	15604 1ST AVE NW	Flooding	DRIVEWAY IS A LAKE, DRAIN TO A CATCH BASIN
12/4/2007	17828 MIDVALE AVE N	Flooding	SIX OR SEVEN BUILDINGS ABOUT TO BE FLOODED, HAS PUMP GOING BUT NOT KEEPING UP.
12/4/2007	1223 N 173RD ST	Flooding	NEEDS SANDBAGS; WATER RUNNING INTO GARAGE. *UPDATE: 1645 HRS, CALLED TO LET HIM KNOW STAND BAGS WERE AVAILABLE AT HAMLIN. DOES NOT NEED A VISIT.
12/4/2007	15528 GREENWOOD AVE N	Flooding	BASEMENT HAS A COUPLE OF INCHES OF WATER.
12/4/2007	1153 N 165TH ST	Flooding	WATER IN HOME, HIS & NEIGHBORS, GETTING WORSE.
12/4/2007	1153 N 165TH ST	Flooding	WATER IN HOME, HIS & NEIGHBORS, GETTING WORSE.
12/4/2007	119 N 177TH ST	Flooding	WATER COMING INTO BASEMENT, UNKNOWN SOURCE, BASEMENT ALMOST FLOODED
12/4/2007	17550 MIDVALE AVE N 1	Flooding	PUMP NEAR CITY HALL BASEMENT, PUMP IS NO LONGER WORKING BEHIND THEIR BUILDING
12/4/2007	331 N 200TH ST	Flooding	CALLER'S HOUSE FLOODED TODAY. HE TOOK PICTURES. WATER STILL FLOODING INTO CALLER'S HOUSE.
12/4/2007	348 NW 195TH ST	Flooding	BASEMENT IS STARTING TO FLOOD.
12/4/2007	526 N 183RD ST	Flooding	WATER IN BASEMENT(CRAWL SPACE). CRT HAS VISITED NUMEROUS TIMES. STILL HAVING DRAINAGE PROBLEMS
12/5/2007	18012 DAYTON AVE N	Flooding	STORM DRAIN OVERFLOWED RESULTING IN MORE THAN 1 FOOT WATER ON PROPERTY AND FLOOODING BASEMENT.
12/11/2007	601 NW 175TH ST	Flooding	List of trails that have been washed out in the recent flood event at Boeing Creek Park. Draft due December 18.
12/13/2007	125 N 177TH ST	Flooding	
12/13/2007	1301 N 169TH ST	Flooding	
12/13/2007	411 N 190TH ST	Flooding	
12/13/2007	510 N 180TH ST	Flooding	
12/28/2007	117 NW 173RD ST	Flooding	

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
1/7/2008	19105 3RD AVE NW	Flooding	CUSTOMER HAS WATER ENTERING HER BASEMENT. FLOODING HAS OCCURRED APPROXIMATELY TWICE IN THE LAST YEAR, ONE TIME BEING DURING THE DECEMBER STORM. CUSTOM
6/3/2008	AURORA AVE N	Flooding	ROADWAY FLOODING SOUTHBOUND AURORA @ 175TH ST
6/3/2008	FREMONT AVE N	Flooding	WATER OVER THE ROADWAY ON RICHMOND BEACH ROAD BETWEEN 3RD AVE NW AND FREMONT AVE N - SOUTH SIDE OF THE STREET
10/20/2008	N 175TH & I-5	Flooding	CLEARED FLOODED INTERSECTION AT 175TH ST @ I-5, NEAR NORTHBOUND ONRAMP.
11/6/2008	15433 LINDEN AVE N	Flooding	THE OPEN DITCH IN FRONT OF HER HOUSE IS BACKING UP.
10/19/2009	15433 LINDEN AVE N	Flooding	CUSTOMER CALLED TO REPORT THAT THEIR PROPERTY IS FLOODING.
10/21/2009	18340 3RD AVE NE	Flooding	CUSTOMER HAS HAD TWO FLOODINGS OF HIS DOWNSTAIRS ROOM. HE REQUESTS (THROUGH CUSTOMER COMMENT SURVEY LETTER FOR SR# 39381) THAT THE CITY INSTALL BERMS
10/26/2009	17500 MIDVALE AVE N	Flooding	MARC RESPONDED TO FLOODING ON SHORELINE STREETS: AURORA AVE N & 205TH I-5 & 175TH LINDEN AVE N & 155TH 155TH ST 8-10 AVE NE 195TH NE & 25TH AVE N
10/26/2009	109 NW 195TH ST	Flooding	STREET WAS RECENTLY PAVED AND SURFACE WATER IS FLOODING INTO CALLER'S DRIVEWAY. WATER IS NOT ENTERING THE HOUSE AT THIS TIME.
11/6/2009	N 175TH & I-5	Flooding	FLOODING UNDER THE OVERPASS.
11/6/2009	WESTMINSTER WAY N	Flooding	MAJOR ROAD FLOODING AT THIS LOCATION.
11/19/2009	351 NW RICHMOND BEACH RD	Flooding	CALLER IS THE OWNER OF THE APARTMENT BUILDING. SHE SAY THAT THE PARKING LOT OF THE RICHMOND BEACH CLINIC IS FLOODED AND RUNNING INTO HER PROPERTY. SHE

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/2/2009	124 N 155TH ST	Flooding	Her basement continues to flood. Saw a vactor truck out on her street but it wasn't there to help her. She would like us to do a better job with pre
9/10/2010	733 N 184TH ST	Flooding	CALLER STATES THAT WATER FROM THE STREET IS CAUSING DRAINAGE / FLOODING PROBLEMS FOR THIS PROPERTY (733 N 184TH ST) AND SOME PROPERTIES/EASEMENTS TO T
12/8/2010	N 175TH & I-5	Flooding	STANDING WATER/FLOODING AT THIS LOCATION.
12/8/2010	AURORA AVE N	Flooding	FLOODING/STANDING WATER AT THIS LOCATION.
12/8/2010	WESTMINSTER WAY N	Flooding	FLOODING/STANDING WATER AT THIS LOCATION.
12/13/2010	17550 FREMONT AVE N	Flooding	BASEMENT FLOODED DUE TO STORM DRAIN.
12/13/2010	17631 EVANSTON AVE N	Flooding	SURFACE WATER IS FLOODING THE BASEMENT TO THEIR HOME. THEY HAVE A SUMP PUMP. THE SITUATION IS CURRENTLY UNDER CONTROL, BUT WOULD LIKE SOMEONE TO COM
12/14/2010	124 N 155TH ST	Flooding	CALLER'S BASEMENT FLOODED LAST NIGHT - THIS HAS BEEN ADDRESSED BEFORE BY THE CITY UNDER A FEW OTHER SERVICE REQUESTS - IT'S UNCLEAR WHAT THE CAUSE OR
12/16/2010	700 N 160TH ST	Flooding	THE DRAINS ARE BACKING UP AND OVERFLOWING INTO THE PARKING GARAGE, ELEVATOR AND LOBBY.
12/23/2010	15433 LINDEN AVE N	Flooding	CUSTOMER IS EXPERIENCE HEAVY RAIN AND WATER IS BACKING UP IN FRONT OF THEIR PROPERTY.
3/14/2011	15433 LINDEN AVE N	Flooding	CALLER STATES THAT THEIR BACK YARD FLOODED BECAUSE OF A STREET DRAIN THAT WAS UP THE STREET AND BEHIND THE PROPERTY. SHE STATES THAT THE DRAIN MAY HAV
11/22/2011	741 N 184TH ST	Flooding	We have called ever year in November/ December since 2005 and no one comes until after we have had a flooding in our Neighbourhood. Every year we have
11/22/2011	AURORA AVE N	Flooding	WATER IS COVERING ROAD AT SB AURORA AND 155TH UNDER THE BRIDGE. IT IS THE Y OFF OF AURORA TO GO TO WESTMISTER WAY. IT IS UP TO THE AXLE ON MOST VEHICL

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/23/2011	FREMONT AVE N	Flooding	STANDING WATER ON 175TH NORTH SIDE OF SHOREWOOD HS BETWEEN FREMONT AND AURORA.
9/19/2000	16622 AURORA AVE N A	IDDE/Spill	WHEN I INSPECTED THE DRAINAGE FACILITY FOR OUR ANNUAL DRAINAGE INSPECTION I NOTICED AN UNUSUAL AMOUNT OF OIL IN THE CONTROL STRUCTURE.
2/22/2001	17544 MIDVALE AVE N	IDDE/Spill	THERE IS OIL LEAKING INTO THE DRAINAGE BEHIND OLYMPIC BOAT CENTER. THEY BELIEVE IT IS COMING FROM CITY USE CARS. THEY WANTED TO LET US KNOW ASAP SO TH
8/6/2001	17550 MIDVALE AVE N 1	IDDE/Spill	THERE IS SOME OIL IN A DITCH RUNNING ALONG RONALD PLACE.
1/18/2002	17250 10TH AVE NW	IDDE/Spill	POLLUTION IN THE CREEK, HIGHLY DISCOLORED. FAINT CHEMICAL ODOR, LIKE NATURAL GAS. IT IS FOAMY/FROTHING OF THE WATER IS OCCURING AT THE WEIRS.
3/29/2002	332 NW 200TH ST	IDDE/Spill	3/28/2002 15:30 WHILE TAKI AND I WERE GPS-ING WE STUMBLED UPON A CATCH BASIN WITH WHITE COLORED WATER. I FOLLOWED IT BACK AND SAW 2 GUYS CLEANING UP
4/11/2002	1110 N 175TH ST 206	IDDE/Spill	THERE IS A PAINT SPILL IN THE PARKING LOT. IT IS BEING WASHED INTO THE DRAINAGE SYSTEM.
5/2/2002	NW RICHMOND BEACH RD	IDDE/Spill	RECEIVED A MESSAGE @ 3:52PM FROM A RESIDENT. SAYS THE MAINTENANCE PERSON AT THE HIGHLAND SQUARE APTS IS DUMPING PAINT DOWN THE STORM DRAIN. WOULD LIKE
5/20/2002	508 N 178TH CT	IDDE/Spill	SHORELINE FIRE, BC RATHVON CALLED TO REPORT THAT A RESIDENT HAS DUMPED 2-3 GALLONS OF FUEL INTO THE STORM DRAIN. THIS IS AT INSIDE THE BOEING CREEK D
10/2/2002	2ND AVE NW	IDDE/Spill	WHITE SUBSTANCE IN DRAINAGE DITCH, POSSIBLY PAINT.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
10/23/2002	15201 AURORA AVE N	IDDE/Spill	McDONALD`S IS USING A DEGREASER ON PARKING LOT AND THEN WASHING IT DOWN. HAPPENS ABOUT 4 TIMES PER YEAR. CALL WAS REFERRED TO US VIA CRTEAM BY
3/13/2003	17700 NORTH PARK PL N 5	IDDE/Spill	CHRISTINE PRATT, SCL SPILL RESPONSE TEAM REPORTED A TRANSFORMER SPILLED OIL & PCB's INTO THE STORM DRAINAGE SYSTEM. THEY WERE NOT AT THE SITE YET.
6/5/2003	AURORA AVE N	IDDE/Spill	DISABLED VEHICLE ON AURORA HEADING SOUTHBOUND IS LEAKING VEHICLE FLUID INTO THE STORM DRAIN.
6/18/2003	16101 GREENWOOD AVE N	IDDE/Spill	CITIZEN REPORTS THE COMMUNITY COLLEGE IS DUMPING PHOTO CHEMICALS FROM THEIR LAB INTO THE DRAINS AND HAVE BEEN DOING SO FOR YEARS.
7/3/2003	15205 AURORA AVE N	IDDE/Spill	MADDY'S AUTOMOTIVE POURED THE NEW KIND OF ANTIFREEZE (ORANGE COLOR) THAT WAS POURED ONTO THE PARKING LOT EARLIER (AROUND NOON). IT HAS GONE ONTO CITY
10/9/2003	15201 AURORA AVE N	IDDE/Spill	CUSTOMER REPORTS MCDONALDS IS PRESSURE WASHING THEIR PARKING LOT RIGHT NOW WITH SOAP.
2/23/2004	18502 6TH AVE NW	IDDE/Spill	THERE APPEARS TO BE AN OIL BASE SUBSTANCE IN THE DITCH. THERE IS NOTHING STANDING, IT SMELLS THOUGH. THERE IS NOTHING THE PICK-UP, PLEASE LOOK AT IT
5/11/2004	AURORA AVE N	IDDE/Spill	76 STATION DAILY ROUTINE OF HOSING DOWN THEIR GASOLINE ISLANDS, THUS DISTRIBUTING GASOLINE AND OTHER PETROLEUM PRODUCTS INTO THE LOCAL STORM DRAINS AN
5/25/2004	540 N 169TH ST	IDDE/Spill	THE SUBJECT IS USING CLEANING SOLVENT ON HIS DRIVEWAY AND THEN WASHING IT DOWN. THE FLOW IS REACHING THE STORM DRAIN.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
6/19/2004	904 N 155TH ST	IDDE/Spill	POSSIBLE SEWAGE ENTERING THE STORM DRAIN SYSTEM. FOUL SMELLING WATER SERFACING AT THE BACK SIDE OF DENNY'S.
3/16/2005	WESTMINSTER WAY N	IDDE/Spill	DOT REPORTS 40-50 LBS OF FERTILIZER DUMPED FLOWING TOWARDS CATCH BASINS POTENTIALLY.
5/3/2005	AURORA AVE N	IDDE/Spill	SAFEWAY IS WASHING GREASY BAKERS RACKS WITH SOAP INTO CATCH BASINS IN FRONT OF THE STORE. CALLER FEARS WATER IS TOXIC. SAFEWAY SAID THEY'RE USING BIOD
7/13/2005	WESTMINSTER WAY N	IDDE/Spill	FIRE DISPATCH REQUESTING CRT ASSISTANCE IN CLEANUP OF A 5-6 GALLON FUEL SPILL LOCATED NEAR THE "SUPER CHINA BUFFET" AT 15523 WESTMINSTER WAY N. THEY M
12/27/2005	915 N 167TH ST	IDDE/Spill	CUSTOMER SAYS THAT A NEIGHBOR DUMPED OIL-BASED PAINT INTO A STORM DRAIN NEAR THEIR DRIVEWAY AT 915 N 167TH ST.
2/22/2006	18325 AURORA AVE N	IDDE/Spill	Fred Myer parking lot on North West side had a report of unknown white crystal substance spilled on the ground adjacent to CB, it was de-iceing salt.
3/13/2006	1ST AVE NW	IDDE/Spill	PROPERTY UP THE STREET BETWEEN 195TH AND 198TH ON 1ST NW HOSED DOWN PAINT THAT HAS TRAVELED DOWN THE STREET INTO STORM DRAINS. ALSO LEFT WHITE MARKING
5/12/2006	AURORA AVE N	IDDE/Spill	CUSTOMER REPORTS THAT A MEXICAN FOOD TRAILER IS DUMPING "RAW SEWAGE" INTO A CITY STORM DRAIN AT AURORA AVE N @ N 163RD ST.
9/15/2006	AURORA AVE N	IDDE/Spill	REPORT FROM THE AURORA PROJECT CONTRACTOR THAT "LA TRAILA" MEXICAN FOOD TRAILER IS DUMPING INTO THE STORM DRAIN BEHIND THE TRAILER.
9/27/2006	LINDEN AVE N	IDDE/Spill	WITNESSED A GUY DUMPING PAINT IN A CATCH BASIN DIRECTLY BEHIND FRED MEYER. PERSON IS WORKING ON A HOUSE ACROSS THE STREET FROM THE C/B.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
6/22/2007	117 NW 185TH ST	IDDE/Spill	STORM DRAIN AT THE END OF COMMUNAL DRIVEWAY, ON THE SOUTH SIDE OF 185TH ST - LOOKS LIKE THERE'S SOME OIL INSIDE IT. FROM THE DESCRIPTION OF THE PROBLE
12/7/2007	15201 AURORA AVE N	IDDE/Spill	CHAD, RONALD SEWER WOULD LIKE A SURFACE WATER REP TO LOOK AT THE DRAINAGE SYSTEM. IT APPEARS THAT SOMEONE IS DUMPING GREASE INTO THE CITY DRAINS SOMEW
2/11/2008	AURORA AVE N	IDDE/Spill	WHITE PAINT MAY HAVE BEEN DUMPED INTO A STORM DRAIN IN THE SOUTH PART OF THE SAFEWAY PARKING LOT NEAR THE CONSTRUCTION TRAILERS. (REFERRED TO US FROM
5/15/2008	619 NW RICHMOND BEACH RD A	IDDE/Spill	SPILL OF AN UNKNOWN PETROLEUM BASED FLUID INTO THE PARKING LOT AT 619 NW RICHMOND BEACH ROAD. SOME MAY BE GOING INTO A STORM DRAIN. CUSTOMER ASKING FO
11/6/2008	MIDVALE AVE N	IDDE/Spill	VEHICLE ACCIDENT WITH FLUID LEAKING INTO A STORM DRAIN @ MIDVALE AVE N @ N 175TH ST
11/7/2008	15201 AURORA AVE N	IDDE/Spill	CALLER NOTIFIED THE CITY THAT MCDONALDS IS DUMPING MOP WATER IN THE PARKING LOT AND THAT HE SAW AN OIL SPILL NEAR A CATCH BASIN. THE CALLER STATED THA
7/7/2009	16510 AURORA AVE N	IDDE/Spill	CARS ARE BEING WASHED AT THE 76 STATION AND SOAP IS RUNNING INTO THE CATCH BASIN
7/14/2009	18523 3RD PL NW	IDDE/Spill	SOMETHING HAS BEEN POURED ON THE STREET NEAR THE CATCH BASIN. IT APPEARS TO BE WET IN THE MORNING AND DRY IN THE AFTERNOON. BUT IT IS ALWAYS VISIBLE
10/12/2009	601 NW 175TH ST	IDDE/Spill	CUSTOMER REPORTED CONCERNS TO DEPARTMENT OF ECOLOGY: ON 10/11/2009, HE OBSERVED A RUST-ORANGE COLORED SUBSTANCE (POSSIBLY PAINT) IN THE STREAM AT BOEI
9/3/2010	3RD AVE NW	IDDE/Spill	CALLER SAYS THAT A CONTRACTOR DUMPED SOME "ROOF WATER" (FROM CLEANING GUTTERS) INTO A NEARBY DRAINAGE DITCH ON 3RD AVE NW, AT ONE OF THE FIRST HOUSES

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
2/19/2011	DAYTON AVE N	IDDE/Spill	THERE IS A WHITYE SUBSTANCE ON PANTERA POND, SHE HAS SEEN IT BEFORE AND WOULD LIKE TO HAVE IT TRACKED DOWN.
3/23/2011	DAYTON AVE N	IDDE/Spill	A resident whose property boarders Pantera Pond called to report a white milky substance in the water. They have spoken with Surface Water in the pas
3/28/2011	324 N 185TH ST	IDDE/Spill	WATER ENTERING THE POND IS WHITE.
5/31/2011	AURORA AVE N	IDDE/Spill	RECEIVED INTERNAL EMAIL:CAR WASHING IS OCCURRING WITH REGULARITY ON THE PAVED PARKING LOT IN ADDITION TO WASHING WITHIN THE BUILDING. NO COLLECTION SY
11/14/2000	16702 NORTH PARK AVE N	Ineffective drainage	THERE IS A LOW SPOT IN THE ROADWAY, WATER PONDS 1/2 WAY TO THE CENTER OF THE DRIVING LANE. THE WATER TAKES SEVERAL DAYS TO INFILTRATE INTO THE GROUND
2/8/2001	141 N 177TH ST	Ineffective drainage	WATER FROM THE ROADWAY IS FLOODING DOWN INTO THE FOUNDATION OF THIS RESIDENCE CAUSING DAMAGE.
3/29/2001	519 N 183RD ST	Ineffective drainage	CUSTOMER HAS DRAINAGE PROBLEMS. INFORMATION TRANSFERRED OVER FROM OLD CRT SYSTEM. REQUEST #25759-40932.
6/19/2001	315 NW 182ND ST	Ineffective drainage	6-18-01 Hello again, Still have drainage problems at 315 NW 182 and would like to know if a concrete basin could be installed to hook up with th
8/22/2001	1153 N 165TH ST	Ineffective drainage	THE PARK (DARNELL PARK) BEHIND THIS HOME HAS SOME MAJR RUN-OFF THAT IS FLOODING. ALSO SAYS THE HOUSES ON BOTH SIDES OF THE HOUSE ARE INCURRING SOME FL
10/17/2001	GREENWOOD AVE N	Ineffective drainage	CALLER STATED THAT WHEN IT RAINS, WATER RUNS ACROSS THE CRISTA PLAYFIELD, DOWN A GRADIENT, ALONG THE FENCE LINE, & RUNS ACROSS THE INTERSECTION OF 195

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
10/17/2001	16526 AURORA AVE N	Ineffective drainage	RESIDENT CALLED REGARDING THE SHORELINE MOTEL AT THIS LOCATION. SAYS THEY HAVE PUT NEW PAVEMENT DOWN AND ARE DIGGING DITCHES IN THE BACK SO THAT WATER
10/30/2001	18030 1ST AVE NW	Ineffective drainage	RESIDENT SAYS THE CATCHBASIN IN FRONT OF HER HOUSE IS TOO HIGH. WHEN IT RAINS WATER STAYS ON THE ROAD INSTEAD OF IN THE CB. WOULD LIKE TO HAVE THIS LO
11/14/2001	MIDVALE AVE N	Ineffective drainage	WATER FROM THE MAIN ROAD IS HEADING TOWARDS THE CARPORT AT THIS APT. NEED TO HAVE SOMEONE COME OUT TO TRY AND CLEAR THE WATER.
11/19/2001	AURORA AVE N	Ineffective drainage	SAYS THE CATCHBASIN GRATES ARE TOO HIGH AT THIS LOCATION. THEY ARE NOT CATCHING THE WATER PROPERLY AT THIS LOCATION. SAYS WATER IS FLOWING ON TO THE P
11/28/2001	17021 DAYTON AVE N	Ineffective drainage	THE WATER RUN-OFF FROM THE STREET IS COMING INTO THE DRIVEWAY AND FRONTYARD. CALLED OLLIE ON THE RADIO, AND HE SAID HE WILL GO CHECK IT OUT. OLLIE C
11/28/2001	1099 NW 167TH ST	Ineffective drainage	WOULD LIKE TO HAVE SOMEONE COME OUT AT LOOK AT A POSSIBLE SOLUTION TO THE WATER PROBLEM. SAYS THERE IS NO DRAIN AND WATER FROM THE ROAD FLOWS DOWN INT
11/29/2001	1235 N 172ND ST	Ineffective drainage	CUSTOMERS DRIVEWAY DRAIN BACKS UP AND PONDS. CALLER WANTS TO KNOW WHERE IT DRAINS TO. HE IS ONLY HOME DURING THE DAY ON MONDAY AND TUESDAYS AND WAS
12/4/2001	920 N 167TH ST 1	Ineffective drainage	SAYS WATER FLOWING FROM THE STREET IS NOT DRAINING PROPERLY AND IS FLOWING ONTO HER PROPERTY. WOULD LIKE TO HAVE THIS LOOKED AT TO SEE WHAT CAN BE DON
12/18/2001	17736 2ND AVE NW	Ineffective drainage	WATER IS LEAKING FROM THE GROUND AT THIS LOCATION.
1/2/2002	1133 N 166TH ST	Ineffective drainage	HER NEXT DOOR NEIGHBOR JUST WEST OF HER HAS JUST MADE IMPROVEMENTS ON THEIR PROPERTY. THE CALLER IS WORRIED ABOUT THE WATER THAT FLOWS FROM THE RAIN

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
1/8/2002	611 NW 182ND ST	Ineffective drainage	CALLER SAYS OVER THE LAST MONTH ON THE SOUTH SIDE OF HER PROPERTY (DRAINAGE EASEMENT) SHE SAYS WATER IS COLLECTING AND CAUSING A BACK UP. WOULD LIKE T
2/4/2002	16034 GREENWOOD AVE N	Ineffective drainage	SAYS THERE IS A DITCH IN FRONT OF THIS LOCATION (HER PARENTS HOUSE) THAT IS TOO NARROW. SAYS DITCH NEEDS TO BE WIDENED OR FILLED IN. CARS ARE RUNNING
2/13/2002	17021 DAYTON AVE N	Ineffective drainage	THE RUN OFF FROM THE NEIGHBORHOOD STREET IS COMING INTO THE FRONT YARD. THE HOUSE IS ON A SMALL SLOPE, JUST ENOUGH SO THAT THE RUN-OFF GOES ONTO THEI
11/21/2002	17115 FREMONT AVE N	Ineffective drainage	THE DRAIN TO THE SOUTH OF THIS PROPERTY IS NOT GETTING THE WATER FROM THE ROADWAY SINCE THE OVERLAY. CAN THIS BE CORREECTED?
12/10/2002	N 179TH PL	Ineffective drainage	CUSTOMER WAS WOKE UP BY ECONOVAC CLEANING DRAINS. CALLER SAID THEY DID NOT FIX THE PROBLEM BECAUSE THE RIVER FLOWING DOWN THE STREET IS STILL THERE. C
12/16/2002	915 N 167TH ST	Ineffective drainage	CALLER'S DRIVEWAY IS FULL OF WATER AS WELL AS BACK YARD. CALLER HAS BEEN DEALING WITH THIS DRAINAGE PROBLEM FOR 10 YEARS. CALLER SAID IT IS THE CITY'S
12/19/2002	17900 LINDEN AVE N B	Ineffective drainage	WATER RUNNING ENTIRE LENGTH OF PROPERTY STARTED AFTER LAST HEAVY RAIN
12/30/2002	16301 GREENWOOD AVE N	Ineffective drainage	LARGE PUDDLE ON THE NORTH END OF GREENWOOD AVE N @ CARLYLE HALL RD NW, CALLER THINKS THE PUDDLE IS CAUSED BY THE NEW CURBING AT THIS LOCATION. THE PUD
1/3/2003	18030 1ST AVE NW	Ineffective drainage	STANDING WATER IN FRONT OF DRIVEWAY WITH HEAVY RAIN IT POOLS AND IS 3-4 INCHES DEEP. CALLER BELIEVES CATCH BASIN IS TO HIGH AND NOT LEVEL WITH SURFACE
1/3/2003	DAYTON PL N	Ineffective drainage	CALLER SAID THE WRONG SIZED CULVERT IS IN DITCH WHICH CAUSES BACK UP. CALLER WAS TOLD BY NEIGHBORS THAT THIS WOULD BE FIXED BY THE CITY. CALLER IS CON

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
1/7/2003	15433 LINDEN AVE N	Ineffective drainage	THE WATER FROM THE STREET IS NOT MAKING IT INTO THE C/B IT HAS FOUND A LOWSPOT IN THE BERM AND IS FLOODING THE PROPERTY.
1/9/2003	N INNIS ARDEN WAY	Ineffective drainage	There is a sidewalk on Innis Arden way, bordering Shoreview park, which is constantly wet. When it it is cold enough, she says that the surface become
2/28/2003	735 N 184TH ST	Ineffective drainage	THERE IS A LARGE PUDDLE A THE END OF THE DRIVEWAY ACCESS. IT IS ABOUT 12' WIDE AND UP TO 30' LONG. IS THERE ANYTHING THAT THE CITY CAN DO TO ASSIST
3/20/2003	19122 2ND AVE NW	Ineffective drainage	DRAIN IN FRONT OF PROPERTY IS TO HIGH AND WATER IS PUDDLING
5/6/2003	15045 DAYTON AVE N	Ineffective drainage	WATER IS COLLECTING BETWEEN CUSTOMERS PROPERTY AND THE STREET. CUSTOMER WOULD LIKE A DITCH PUT IN TO DRAIN THE WATER.
7/28/2003	344 NW 185TH ST	Ineffective drainage	CEMENT DAM BUILT AT THIS LOCATION BLOCKING WATER DRAINAGE. THE DAM WAS JUST FINISHED THIS WEEK. DAM MAY POTENTIALLY CAUSE FLOODING PROBLEMS TO CUSTOME
8/21/2003	17915 DAYTON AVE N	Ineffective drainage	CUSTOMER WOULD LIKE TO KNOW IF THE CITY WILL INSTALL A BERM AT THE TOP OF HER DRIVEWAY. CUSTOMER SAID THERE IS A NATURAL SPRING THAT IS SENDING DIRT
9/2/2003	543 N 185TH PL	Ineffective drainage	CUSTOMER IS ON THE LOW SIDE OF THE STREET AND DURING A HEAVY RAIN WATER COMES DOWN HIS DRIVEWAY AND SIDEWALK AND PUDDLES. THIS HAS OCCURRED OFF AND O
9/24/2003	17216 3RD AVE NW	Ineffective drainage	Hello. We live at 17216 3rd Avenue NW. During the rainy season excessive water drains from the road. We are at the low end of hill. The run-off fr
10/16/2003	WESTMINSTER WAY N	Ineffective drainage	WATER IS DRAINING ON PROPERTY, CUSTOMER FEARS WITH HEAVY RAINS HER HOME WILL FLOOD

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/18/2003	16900 AURORA AVE N	Ineffective drainage	Virgil Slater came in to see Justin Knox about the drainage problem at this location. He said the city has known about this for over a year and they
3/22/2004	18555 LINDEN AVE N	Ineffective drainage	WATER AND SILT RUNS OFF THE STREET AND INTO GARAGE DURING HEAVY RAINS AND OVERWHELMS CURRENT DRAINAGE. PLEASE CALL THE CUSTOMER AND HE WILL SHOW YOU
7/14/2004	1ST AVE NW	Ineffective drainage	STEVE BURKETT RECEIVED THIS REQUEST AT ROTARY. HE WAS TOLD THAT A NEIGHBOR OF MR OLSON INQUIRED WITH THE CITY ABOUT FILLING IN HIS DITCH AND WAS TOLD
8/9/2004	N RICHMOND BEACH RD	Ineffective drainage	RICHMOND BEACH RD BETWEEN FREMONT AND DAYTON WATERFALL CASCADING DOWN A BANK ONTO THE ROAD.
8/12/2004	555 N 167TH ST	Ineffective drainage	THERE IS A STORM DRAIN IN FRONT OF CALLERS HOUSE. IT IS LOCATED IN THE GRAVEL SHOULDER BUT IS TOO HIGH AND NO SURFACE WATER GOES INTO IT. ON FRIDAY
8/13/2004	18203 6TH AVE NW	Ineffective drainage	SURFACE WATER RUNS OFF STREET AND INTO HER DRIVEWAY. IT FLOODS HER YARD AND SHE WOULD LIKE SOME ASPHALT OR A BERM TO SOVE THE PROBLEM.
8/23/2004	555 N 167TH ST	Ineffective drainage	BASEMENT FLOODED AGAIN 8/21/04. CUSTOMER INDICATES ROAD IS NOT SLANTED TOWARDS STORM DRAIN AND WATER BYPASSES STORM DRAIN AND IS DIRECTED TO CUSTOMER
9/22/2004	349 NW 177TH ST	Ineffective drainage	CITIZEN REPORTS CURB IN FRONT OF HOUSE IS DEGRADED AND NEEDS TO BE FIXED. WHEN IT RAINS WATER IS GOING DOWN INTO DRIVEWAY.
11/1/2004	18521 2ND AVE NW	Ineffective drainage	CUSTOMER CALLED ABOUT THE STORM DRAIN IN FRONT OF HER HOUSE. THE AREA AROUND IT IS SETTLED AND WATER POOLS TO THE NORTH OF THE BASIN. THE BASIN WAS
12/10/2004	511 N 166TH ST	Ineffective drainage	WATER FROM THE STREET IS FLOWING INTO THE YARD CREATING A POND. HE SAID THIS IS A GOOD DAY TO VIEW THE PROBLEM.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/16/2004	1016 NW 167TH ST	Ineffective drainage	WATER IS FLOWING INTO THE PROPERTY UNDER HEAVY RAIN CONDITIONS. NO PROPERTY DAMAGE IS OCCURING.
7/5/2005	105 N 200TH ST	Ineffective drainage	CALLER SAYS THERE IS SOME WATER FROM AN UNKNOWN SOURCE BUILDING AROUND A STORM DRAIN NEAR HIS PROPERTY. HE THINKS SOMETHING MAY BE LEAKING, OR THERE M
8/17/2005	348 NW 195TH ST	Ineffective drainage	CALLER SAYS RECENTLY CRUSHED ROCK WAS ADDED TO THE EDGE OF THE ROADWAY TO HELP WITH DRAINAGE ISSUES. HE SAYS THERE ARE STILL PUDDLES/POOLS OF WATER FO
10/3/2005	16323 LINDEN AVE N	Ineffective drainage	CUSTOMER RECEIVED WATER FROM ROADWAY DURING THE WEEKEND FLASH FLOODING. HE STATES THAT HE HAD 3"-4" THROUGHOUT THE BASEMENT OF THE RESIDENCE.
10/3/2005	14822 LINDEN AVE N	Ineffective drainage	CUSTOMER REPORTS THAT THERE IS A DRAINAGE PROBLEM ON THE STREET IN FRONT OF HIS PROPERTY. HE SAYS THAT IN THE RECENT RAIN STORM, WATER FLOWED FROM THE
10/6/2005	15028 LINDEN AVE N	Ineffective drainage	Has complained twice in 2004 about flooding from overflow of the ditch on the Interurban Trail and destructive flooding of her property below it (see
1/10/2006	15433 LINDEN AVE N	Ineffective drainage	CALLER SAYS THERE IS A DRAINAGE ISSUE ON WESTMINSTER WAY N, NEAR HIS HOUSE. HE SAYS A BERM WAS CREATED THAT PREVENTS WATER FROM ENTERING THE STORM DRA
1/17/2006	124 N 155TH ST	Ineffective drainage	THE CUST BELIEVES THE DRAINAGE PIPE THAT THE CITY INSTALLED ABOUT 5 YEARS AGO IS CAUSING HER SITE TO POND AND WHEN RAINING HEAVILY HER HOUSE TO FLOOD.
1/25/2006	16605 FREMONT AVE N	Ineffective drainage	CUSTOMER SAYS THAT THEIR DRIVEWAY SLOPES RADICALLY FROM THE STREET EDGE. SHE SAYS THAT SURFACE WATER FROM THE ROAD RUNS DOWN HER DRIVEWAY, AND SHE IS
1/31/2006	CARLYLE HALL RD N	Ineffective drainage	BLOCKED DRAINAGE FLOW.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
2/1/2006	502 N 167TH ST	Ineffective drainage	CALLER SAY'S SHE HAS STANDING WATER DURING LONG RAINS LIKE THIS PAST WEEKEND. SHE IS REQUESTING A DRAINAGE INSPECTION TO DETERMINE IF A C/B CAN BE IN
2/7/2006	15045 DAYTON AVE N	Ineffective drainage	Called Jerry Shuster to inform city of drainage problem at his driveway entrance.
10/11/2006	17541 STONE AVE N	Ineffective drainage	CUSTOMER REPORTING THAT THE ROAD HAS A LOW SPOT THAT DIRECTS WATER TWORDS HIS HOUSE AND CAUSES SOME FLOODING ISSUES IN THE YARD AND BASEMENT.
11/21/2006	15205 DAYTON AVE N	Ineffective drainage	CUSTOMER REQUESTING INVESTIGATION OF DRAINAGE PROBLEMS IN THE AREA NEAR 15205 DAYTON AVE N. CUSTOMER SATES THAT A NEIGHBOR HAS A "LAKE" OF WATER IN T
12/14/2006	915 N 167TH ST	Ineffective drainage	CUSTOMER REQUESTING SOME TYPE OF TEMPORARY SOLUTION FOR THE DRAINAGE PROBLEM IN FRONT OF 915 N 167TH ST. SHE STATES THAT THE RESIDENT OF THIS SITE IS
12/19/2006	15028 LINDEN AVE N	Ineffective drainage	Water from Interurban Trail entered her backyard on Thursday evening.
2/14/2007	518 N 195TH ST	Ineffective drainage	STORM DRAIN BY HIS SON'S PROPERTY IS RAISED UP 1 INCH TO 1.5 INCHES (BY DIRT / MUD) IT'S LOCATED ON THE WEST SIDE OF THE PROPERTY. IT'S CURRENTLY NOT
3/26/2007	15728 1ST AVE NW	Ineffective drainage	WHEN IT RAINS A LARGE PUDDLE FORMS OVER THE PARKING STRIP IMMEDIATELY NORTH OF THE DRIVEWAY.
4/12/2007	18326 DAYTON PL N	Ineffective drainage	REQUESTING DRAINAGE REPAIR FOR THE "DRIVEWAY SKIRT" (ACCORDING TO SOMEONE FROM THE ROADS CREW THAT WAS THERE ON ANOTHER PROJECT) - A PUDDLE OFTEN FORM
4/23/2007	15280 GREENWOOD AVE N	Ineffective drainage	SOMEONE RECENTLY INSTALLED A NEW SIDEWALK BY THE CORNER OF GREENWOOD AND 155TH ST. THERE WAS AN OPEN CULVERT COMING FROM EAST TO WEST, AND IT WAS "BUR

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
11/21/2007	FREMONT AVE N	Ineffective drainage	CONSTRUCTION JOB (PAVING) IS NOT COMPLETE, CONCERNED ABOUT POSSIBLE DRAINAGE PROBLEMS THAT THEY MAY BE CREATING
12/3/2007	14822 LINDEN AVE N	Ineffective drainage	WATER ENCROACHING HOUSE, WATER IN STREET BEING DIVERTED INTO DRIVEWAY. EOC#1011
12/4/2007	15433 LINDEN AVE N	Ineffective drainage	WATER FLOWING DOWN STREET AND INTO CALLER'S FRONT YARD.
12/4/2007	15604 1ST AVE NW	Ineffective drainage	DRIVEWAY IS A LAKE, DRAIN TO A CATCH BASIN
12/4/2007	511 N 166TH ST	Ineffective drainage	STREET DRAINAGE ISSUE AT 166TH AND DAYTON AVE N. NEW SIDEWALK ON DAYTON PART OF PROBLEM. CITY GRAVEL PILE BEEN WASHED AWAY. STANDING WATER IN YARDS BE
12/4/2007	717 N 165TH ST	Ineffective drainage	BASEMENT FLOODED - WATER FROM AURORA FLOWING INTO YARD.
12/14/2007	15703 2ND AVE NW	Ineffective drainage	CUSTOMER STATES THAT SURFACE WATER FROM THE ROAD FLOODS FROM 2ND AVE NW INTO HIS DRIVEWAY. HE SAYS THAT THE EXISTING CATCH BASIS ARE ONLY ON THE EAST
12/17/2007	505 N 166TH ST	Ineffective drainage	CUSTOMERS YARD FILLS WITH WATER DURING HEAVY RAINS. THE NEW SIDEWALK PROJECT HAS CREATED THIS. PLEASE REVIEW FOR A DRAINAGE REPAIR.
5/20/2009	502 N 170TH PL	Ineffective drainage	THE SIDEWALK PROJECT ON DAYTON PLACED ROCKS INSIDE OF THE DITCH AT THE CORNER OF DAYTON AVE N AND N 170TH STREET. THE CUSTOMER MAINTAINED THE DITCH P
8/31/2009	132 N 175TH ST	Ineffective drainage	There is a drainage problem in my backyard. Behind my property line is public land/green space. From that land water is draining onto my property. We
10/16/2009	745 N 182ND ST	Ineffective drainage	CALLER IS REQUESTING A BERM IN FRONT OF THE DRIVEWAY, TO DIRECT SURFACE WATER FROM THE STREET INTO A NEARBY STORM DRAIN, INSTEAD OF DOWN THE DRIVEWAY

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
10/26/2009	741 N 184TH ST	Ineffective drainage	DRAINAGE ISSUES FROM A NEARBY CATCH BASIN - POTENTIAL FLOODING COULD HAPPEN SOON TO CALLER'S SITE AND A NEIGHBORING SITE. IN THE PAST, THIS WAS AN ISS
1/7/2010	19811 3RD AVE NW	Ineffective drainage	CALLER IS CONCERNED WITH DRAINAGE IN FRONT OF HOME. ASKED FOR REVIEW AND POSSIBLE BERM.
2/17/2010	355 NW RICHMOND BEACH RD	Ineffective drainage	There is water pouring from a drain on their property and heading towards their business. It is flowing in the garden area.
4/19/2010	840 N 153RD PL	Ineffective drainage	"WATER COMES FROM THE STREET, DOWN THE DRIVEWAY AND LEAVES WATER IN THE GARAGE. 153RD GOES DOWNHILL AND WATER FROM WESTMINSTER WAY FLOWS IN FRONT OF H
7/22/2010	19010 3RD AVE NW	Ineffective drainage	CALLER REQUESTING THAT THE CITY FILL IN DITCHES ON BOTH SIDE OF THE N 191ST ST SIDE OF THE PROPERTY. CALLER STATES THAT THERE IS A CONSTANT/ONGOING PR
8/26/2010	220 NW 191ST ST	Ineffective drainage	CALLER STATES THAT THE DITCH NEXT TO HER PROPERTY (220 NW 191ST ST) USUALLY OVERFLOWS DURING HEAVY RAIN, AND WOULD LIKE TO SEE IF THIS CAN BE RESOLVED
12/22/2010	18520 6TH AVE NW	Ineffective drainage	CALLER REPORTS DRAINAGE ISSUES IN HER NEIGHBORHOOD
1/10/2011	339 N 200TH ST	Ineffective drainage	Caller requests review of surface water issues at property location. Currently ROW flows along shoulder then onto driveway and then into the owners g
1/12/2011	17846 4TH AVE NW	Ineffective drainage	DRAINAGE ISSUES IN FRONT OF CALLER'S HOUSE AT 17846 4TH AVE NW. HE STATES THAT THERE'S A "CHANNEL" FOR WATER ON EACH SIDE OF THE STREET, BUT SOME WATE
1/25/2011	136 N 200TH ST	Ineffective drainage	THE SITE DRIVEWAY ELEVATION ANGLES DOWN FROM THE STREET. DUE TO A COUPLE OF OVERLAYS ALONG 200TH, THE WATER NOW FLOWS DOWN HIS DRIVEWAY INTO HIS GA

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
3/11/2011	1065 NW 167TH ST	Ineffective drainage	LARGE PUDDLE FORMS IN CALLER'S DRIVEWAY, UNSURE OF THE CAUSE. (NO FLOODING ISSUES OTHERWISE) - SITE ADDRESS: 1065 NW 167TH ST
3/15/2011	3RD AVE NW	Ineffective drainage	CALLER REPORTING SOME CONCERNS WITH THE CATCH BASINS INSTALLED A FEW YEARS AGO BY THE CITY'S PROJECT. CALLER IS A UTILITY CONTRACTOR AND FAMILIAR WITH
4/21/2011	17211 10TH AVE NW	Ineffective drainage	Caller is concerned about culvert. Things appear to be reverse grade.
10/5/2011	17555 STONE AVE N	Ineffective drainage	THE ROW GETS VERY MUDDY WHEN IT RAINS AND IT DRAINS INTO HER YARD AND IT GETS VERY MUDDY. SPU WAS WORKING IN ROW.
4/11/2001	18502 3RD PL NW	Misc. Drainage	MR. BENDAGA CALLED TO REQUEST THAT SOMEONE GO OUT TO HIS PROPERTY AND INSPECT THE NEW CURB & SIDEWALK THAT WAS JUST PUT IN FOR HIS NEIGHBOR TO THE EAS
7/25/2001	1301 N 165TH ST	Misc. Drainage	THE CUSTOMER HAD RECIEVED A LETTER REGARDING A SMALL DRAINAGE PROJECT THAT WAS GOING TO TAKE PLACE IN FRON OF HIS HOUSE. THERE WERE THREE OPTIONS:
5/2/2002	16623 FREMONT AVE N	Misc. Drainage	PLEASE HAVE YOUR CREWS INSTALL DRAINAGE PERF SYSTEM PER ENGINEERING DRAWINGS AT RICHOND HIGHLANDS RECREATION CENTER
7/23/2002	AURORA AVE N	Misc. Drainage	HELEN AMES OF JOSHUA GREEN CORPORATION CALLED. MS. AMES IS THE PROPERTY MANAGER OF THE PROPERTY ON WHICH DENNY'S RESTRAUNT SETS. SHE SAYS THAT THE DIT
10/4/2002	17632 DAYTON AVE N	Misc. Drainage	CONCERNED ABOUT POSSIBLE FLOODING IN STORM DRAINS ON NEWLY PAVED STREET ACROSS FROM ST LUKES PLAY FIELD.
3/12/2003	STONE AVE N	Misc. Drainage	
3/12/2003	AURORA AVE N	Misc. Drainage	
3/12/2003	6TH AVE NW	Misc. Drainage	

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
3/12/2003	3RD PL NW	Misc. Drainage	
5/28/2003	420 NW 185TH ST	Misc. Drainage	THE NEIGHBOR TO EAST (SCOTT STIRKENS) INSTALLED A PIPE IN THE DITCH. ENCLOSED THE OPEN DITCH. THE SUBJECT WAS TOLD LAST YEAR NOT TO ENCLOSED THE DI
8/28/2003	3RD AVE NW	Misc. Drainage	Name: grant ripley Phone: 206.542.8863 E-Mail: ripley_12@hotmail.com Message: I live @ 18523 3rd place n.w & 185th n.w. There is a dr
9/11/2003	1202 N 173RD ST	Misc. Drainage	IN CALLER'S BACK YARD, THERE ARE TWO OPEN GRADE SORT OF DRAINAGE SYSTEM WITH A MAN-HOLE COVER THAT IS ABOUT 6-8' DEEP FOR STORM WATER. WATER ORIGINAT
9/17/2003	324 NW RICHMOND BEACH RD	Misc. Drainage	Name: Nancy Eckert Phone: 546-3201 E-Mail: neckert3@verizon.net Message: To David LaBelle Here's another e-mail. Would you give me
10/29/2003	220 NW 191ST ST	Misc. Drainage	WANTS DRAINAGE DITCH ENCLOSED
2/14/2004	920 N 167TH ST 1	Misc. Drainage	CUSTOMER CAME IN TO DISCUSS A BACKED UP DRAINAGE SYSTEM. HE IS CONTRACTOR TRYING TO FIX A CRAWL SPACE SUMP PUMP FOR RESIDENT AT 920 N 167TH ST. THE
3/18/2004	18818 FREMONT AVE N	Misc. Drainage	CUSTOMER WOULD LIKE THE DITCH IN FRONT OF HIS HOUSE FILLD IN.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
8/13/2004	400 N 199TH ST	Misc. Drainage	CALLER IS REPORTING A DRAINAGE SITUATION AT THIS LOCATION
8/20/2004	15724 GREENWOOD AVE N	Misc. Drainage	CUSTOMER IS INTERESTED IN PUTTING IN A ROCK POCKET AROUND THE CATCH BASIN
8/25/2004	N GREENWOOD DR	Misc. Drainage	A contact form has been submitted from the web site: Name: Carrie Higley-Krowka Phone: 206-546-1201 E-Mail: lcakrowka@msn.com Messag
9/30/2004	17550 MIDVALE AVE N 1	Misc. Drainage	CALLER IS OWNER'S AGENT QUESTIONS ABOUT PROPERTY TO THE NORTH, THEY HAVE A LOT OF IMPERVIOUS SURFACES THAT ARE TAPPED INTO UNDER CAPACITY SYSTEM. B
3/18/2005	15539 GREENWOOD AVE N	Misc. Drainage	CUSTOMER WOULD LIKE ALL DITCHES PIPED IN ON GREENWOOD AVE N FROM N 160TH TO N 155TH ST ON BOTH SIDES OF THE STREET.
4/22/2005	20010 5TH AVE NW	Misc. Drainage	MAILED ANON LETTER REPORTING CODE VIOLATIONS AT THIS ADDRESS.
4/27/2005	601 NW 175TH ST	Misc. Drainage	Four citizen (Steve Kellett - rep, Robyn Daly, Deyerle McNair, and Barbara Jans) letter of concern over the maintenance of Hidden Lake at Boeing Creek
7/27/2005	242 NW 196TH PL	Misc. Drainage	CUSTOMER WOULD LIKE TO HAVE THE DITCH FILLED IN.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
8/5/2005	1132 N 166TH ST	Misc. Drainage	CALLER SAYS THE RESIDENTS AT THIS LOCATION BROKE THROUGH SOME CURBING AND INSTALLED SOME TYPE OF DRAINAGE LINE TO DRAIN WATER OUT ONTO THE STREET.
10/3/2005	LINDEN AVE N	Misc. Drainage	
12/30/2005	16518 STONE AVE N	Misc. Drainage	Caller requested draiange ditch in from of this house be filled in. He says he has to mow it and he twisted his ankle last year.
5/22/2006	19010 3RD AVE NW	Misc. Drainage	THE SUBJECT IS ENCLOSING THE OPEN DITCH ALONG 3RD AVE NW. SHE SPOKE WITH CONTRACTOR AND THEY SAID THEY WERE WORKING FOR THE CITY.
10/2/2006	17216 3RD AVE NW	Misc. Drainage	Name:Nina McKenzie Address:17216 3rd Ave NW City:Shoreline State:WA Zip:98177 Neighborhood: Richmond Highlands Phone: E-Mail: nina.mckenzie@verizo
12/18/2006	MIDVALE AVE N	Misc. Drainage	Hot Spot Check Water in parking lot
5/2/2007	132 N 175TH ST	Misc. Drainage	Hello, I have a problem with my back yard that I am hoping you can help me with. Beyond our property line in the back yard is a stream on public land
5/9/2007	225 NW 176TH PL	Misc. Drainage	
12/3/2007	520 NW 175TH CT	Misc. Drainage	WANTS THE CITY TO CHECK THE TRASH RACK TO MAKE SURE IT IS NOT FULL
12/4/2007	222 N 171ST ST	Misc. Drainage	DONE
6/19/2008	18339 DAYTON PL N	Misc. Drainage	CALLER SAYS THAT THERE IS A DITCH IN FRONT OF HER HOUSE AND WAS WONDERING IF IT IS POSSIBLE TO GET IT FILLED. IT IS PART OF THE DRAINAGE. SHE SAYS THA
9/5/2008	110 NW 183RD ST	Misc. Drainage	CONCERNED ABOUT AN OPEN DRAINAGE "CISTERN" IN THE BACK YARD AT THIS PROPERTY, IT'S 5 FEET ACROSS, 3 TO 4 FEET DEEP, AND HAS A 10 INCH CONDUIT LEADING

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
1/15/2009	FREMONT AVE N	Misc. Drainage	REPORT FROM OFF-DUTY RIGHT OF WAY INSPECTOR: POSSIBLE ILLEGAL RIGHT-OF-WAY WORK, IT APPEARS THAT SOMEONE MAY BE ATTEMPTING TO CONNECT A PIPE TO THE ST
10/1/2009	14912 NORTH PARK AVE N	Misc. Drainage	Could you create a Hansen record for this drainage issue? A resident came in on 9/29 around 10:00 AM to ask for assistance. Eric and I will go look a
6/15/2010	17300 FREMONT AVE N	Misc. Drainage	AES wants to test the aquifer at shorewood by pumping aquifer at 45 gpm (6CFS) into city storm drain system.
12/9/2010	16300 AURORA AVE N A	Misc. Drainage	
7/26/2011	725 NW INNIS ARDEN WAY	Misc. Drainage	Caller is having groundwater problems and asked for a site visit.
8/1/2011	16623 FREMONT AVE N	Misc. Drainage	Eric-- I am the homeowner at 16623 Fremont Ave N. I was referred to you by the Shoreline City Hall. Stormwater runoff flowing southward down Fremo
6/7/2002	6TH AVE NW	Pond capacity	WAS WONDERING ABOUT TRIMMING THE VEGETATION BACK AT THE NORTH POND.
10/20/2003	N RICHMOND BEACH RD	Pond capacity	CRISTA POND ON CRISTA MINISTRIES PROPERTY WATER IS HIGH, DRAINLINES ARE PLUGGED. THERE IS WATER ABOVE THE TRAIL AROUND THE PERIMETER.
8/20/2004	6TH AVE NW	Pond capacity	From: O'Neil, Mike Sent: Tuesday, August 10, 2004 9:47 AM To: Althauser, Don Subject: Boeing Creek Pond Don Tim Nordin, a

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
12/4/2007	350 N 190TH ST	Pond capacity	RETENTION POND ON SOUTH SIDE OF PROPERTY IS FILLING QUICKLY AND IS CONCERNED THAT IT WILL SPILL TOWARD HOUSING AT CHRISTWOOD.
8/22/2001	MIDVALE AVE N	Sewer backup	BUILDING IS FLOODING WITH WATER AND SAYS IT'S ABOUT KNEE DEEP. THIS IS DUE TO THEIR SEWER SYSTEM BEING BACKED UP. SAYS IT IS BAD AND NEEDS SOMEONE TO
3/6/2006	127 NW 177TH LN	Slope	CUSTOMER IS REQUESTING THAT THE CITY LOOK AT THE SLOPE ON THE SIDE OF HIS PROPERTY THAT FACES 1ST AVE NW TO SEE IF A RETAINING WALL COULD BE INSTALLED
3/29/2011	343 NW 177TH ST	Slope	THE NEIGHBORING PROPERTY IS UNDER CORRECTIVE ACTION (CODE ENFORCEMENT) FOR ALTERING A STEEP SLOPE. THE STOP AT THIS SITE IS TO LET THEM KNOW THAT WORK
1/12/2006	17609 EVANSTON AVE N	Slope Issue	STEEP SLOPE BETWEEN EVANSTON AVE N AND DAYTON AVE N
11/7/2000	LINDEN AVE N	Private issue	THE NEIGHBORS TO THE S OF HER HAVE PUT IN A 15" PLASTIC PIPE IN FRONT OF HER HOUSE. IT COMES UP ABOVE THE GROUND LEVEL AND WATER IS NOT DRAINING PROP
12/4/2000	15329 LINDEN AVE N	Private issue	SHORT PLAT BEING DONE AT THIS ADDRESS. A SIDEWALK WILL BE PUT IN FRONT OF THE HOUSE. THE CALLER HAD A PROBLEM WITH WATER RUNNING DOWN HIS DRIVEWAY FR
2/12/2001	14547 WHITMAN AVE N	Private issue	CUSTOMER IS CURRENTLY WORKING ON A 14 UNIT DEVELOPMENT FOUR HOUSES FROM THE AFOREMENTIONED SITE. WHEN PUTTING IN A STORM DRAIN THEY RAN INTO A LARGE B
3/14/2001	132 N 175TH ST	Private issue	WOULD LIKE A CALL REGARDING RUN OFF FROM ANOTHER PERSONS PROPERTY THAT IS COMING ONTO HER PROPERTY. IT IS CAUSING PUDDLING, SWAMP, ENTIRE BACKYARD IS
1/27/2006	110 N 195TH CT	Private issue	CUSTOMER SAYS THE OWNER OF 110 N 195TH CT IS MAKING CHANGES TO A STORM DRAIN ON HIS PROPERTY, AND IS CONCERNED ABOUT POSSIBLE FLOODING OF HIS PROPERTY

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
7/26/2007	606 NW 185TH ST	Private issue	CALLER SAYS THEIR NEIGHBORS YARD IS FLOODED WITH WATER AND THERE IS LOTS OF GARBAGE ALL OVER THE YARD AS WELL. SHE THINKS THE HOUSE MAY BE VACANT.
12/4/2007	218 NW 198TH ST	Private issue	IN A RENTAL HOME - REQUESTING SOMEONE COVER HOUSE WITH A TARP - ROOF IS LEAKING.
9/11/2009	15201 AURORA AVE N	Private issue	CUSTOMER DROPPED KEYS IN A STORM DRAIN AT MCDONALDS PARKING LOT, REQUESTING ASSISTANCE IN REMOVING THEM
5/14/2010	18019 4TH AVE NW	Private issue	Caller requested a site visit to talk about private property water issues.
12/4/2000	19310 2ND AVE NW	Sinkhole	STEVE WHALEN CALLED TO REPORT A DEPRESSION IN THE ROADWAY JUST SOUTH OF THE MANHOLE IN FRONT OF HIS HOUSE. IT SEAMS TO BE SINKING MORE AND MORE AND H
12/12/2000	2ND AVE NW	Sinkhole	2ND NW, JUST N OF 193RD. SINKHOLE FORMING IN CENTER OF STREET. LH
1/19/2001	16539 CARLYLE HALL RD N	Sinkhole	SINKHOLE ON WESTSIDE OF STREET ABOUT 30 FEET FROM THE STOP SIGN. LH
3/22/2001	19353 2ND AVE NW	Sinkhole	LARGE HOLE IN SIDEWALK COMING OFF 3RD AND GOING TOWARD 195TH. HE THINKS THERE MIGHT BE AN OLD GASLINE TORN UP. THE HOLE IS IN HIS WHEEL CHAIR ROUTE.
8/3/2001	17250 10TH AVE NW	Sinkhole	A WHILE BACK THERE WAS SOME UNDER CUTTING FROM THE DRAINAGE IN FRONT OF HIS HOUSE. THE CITY CAME OUT AND ASPHALTED THE ROAD. SAYS NOW THERE IS MORE UN
12/3/2001	FREMONT AVE N	Sinkhole	SAYS A LARGE SINKHOLE IS DEVELOPING AT THIS LOCATION. SAYS IT IS APPROX. 2FEET LONG AND 1 FOOT WIDE. SINKHOLE NEEDS TO BE FILLED IN.
4/8/2002	111 N 175TH ST	Sinkhole	IN THE PARKING STRIP DIRECTLY IN IN FRONT OF N 111 AND 119 N 175TH IS A SINKHOLE. THE CUSTOMER HAD A FAMILY MEMBER FALL UP TO HER KNEE IN THE HOLE TH

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
4/29/2002	AURORA AVE N	Sinkhole	OFF. SOUZSA REPORTED A NEW SINKHOLE HAD FORMED JUST NORTH OF THE PREVIOUS PATCH. HE REQUESTED LANE CLOSURE SIGNS.
6/24/2002	510 N 169TH ST	Sinkhole	CITIZEN LEFT MESSAGE ON 1700 LINE REPORTING A DEPRESSION IN THE ROADWAY THAT JUST OPENED UP. THE HOLE IN THE ASPHALT IS ABOUT 12 INCHES IN DIAMETER B
12/2/2002	LINDEN AVE N	Sinkhole	CALLER HAS 2 ITEMS TO BE ADDRESSED 1)SINK HOLE NEEDS TO BE FILLED AT MIDDLE OF BLOCK ON LINDEN @170TH 2) 3 BIG POTHOLES WHERE SHOULDER & PAVEMENT END
12/19/2002	16326 LINDEN AVE N	Sinkhole	SINKHOLE ON NORTH SIDE OF 16326 LINDEN AVE N, BY FIRE HYDRANT
10/21/2003	419 NW 185TH ST	Sinkhole	CUSTOMER REPORTS THERE IS AN 8X8FT HOLE IN THE ROAD. KIM FROM ROADS WAS AT THIS LOCATION AND REPORTED IT IS A LARGE PUDDLE ON THE SHOULDER AND A WORK
12/3/2003	16012 DAYTON AVE N	Sinkhole	CUSTOMER REPORTS THAT A TRENCH WAS DUG BY THE CITY AND NOW IT'S CREATING A BIG HOLE IN FRONT OF HER DRIVEWAY
12/3/2003	GREENWOOD AVE N	Sinkhole	CUSTOMER REPORTS LARGE HOLE POSSIBLE UTILITY FAILURE HEADING NORTH RIGHT BEFORE YOU GET TO 160TH ON THE RIGHT SIDE OF THE ROAD.
7/14/2004	857 N 145TH LN	Sinkhole	SINKHOLE NEXT TO A CB NEAR 14517 WHITMAN
7/14/2004	WHITMAN AVE N	Sinkhole	SINKHOLE FORMING ON NE CORNER OF C/B. EST 3 BAGS OF COLD MIX TO FILL. PLEASE FILL AND REFER TO ROADS FOR PERMANENT REPAIR.
8/4/2005	15538 MIDVALE AVE N	Sinkhole	POTHOLE / SINKHOLE FORMING IN FRONT OF THIS ADDRESS
12/19/2005	MIDVALE AVE N	Sinkhole	CUSTOMER IS REPORTING A POSSIBLE POTHOLE OR SINKHOLE FORMING AT MIDVALE AVE N @ N 180TH ST.
12/29/2005	15038 DAYTON AVE N	Sinkhole	SINKHOLE IN FRONT OF NEIGHBOR'S HOUSE, NEXT TO CALLER'S DRIVEWAY AT 15308 DAYTON AVE N. 6 FEET BY 4 FEET, AND 1 FOOT DEEP AT THIS TIME.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
2/6/2006	15538 GREENWOOD AVE N	Sinkhole	CUSTOMER SAYS THAT A SINKHOLE IS FORMING AT A DRAIN NEAR THE EASEMENT TO THE SOUTH OF HER PROPERTY (NEAR THE STREET).
5/2/2006	18020 8TH AVE NW	Sinkhole	HOLE IN THE PAVEMENT THAT OPENS INTO A SMALL CAVERN. HE CAN SEE PIPES.
5/21/2006	510 N 169TH ST	Sinkhole	CUSTOMER STATED THAT THERE IS A SMALL SINK HOLE DEVELOPING IN THE SAME LOCATION OF A VERY SIGNIFICANT SINK HOLE A COUPLE YEARS BACK.
6/24/2006	17514 1ST AVE NW	Sinkhole	A SINKHOLE HAS FORMED NEXT TO A CATCH BASIN. THE HOLE IS APPROX 30INCHES DEEP AND 18x18INCHES DIA. AT THE SURFACE.
12/27/2006	AURORA AVE N	Sinkhole	CUSTOMER WENT INTO POTHOLE THAT APPEARED TO BE WASHED AWAY ASPHALT THAT WAS AROUND A PIPE IN THE ROAD THAT DAMAGED HIS VEHICLE. HE STATED CAR HAD TO
5/14/2007	19310 2ND AVE NW	Sinkhole	THERE IS AN OPEN HOLE IN THE ROAD IN FRONT OF THIS ADDRESS.
5/19/2007	734 N 182ND ST	Sinkhole	THERE IS A LARGE SINKHOLE IN THE ROAD APPROX 1.5 x 2.5, 5 INCHES DEEP.
6/20/2007	16549 AURORA AVE N	Sinkhole	25 FOOT DEEP SINKHOLE FORMING IN THE PARKING LOT AT THE OLD COUNTRY BUFFET, 16549 AURORA AVE N. I EXPLAINED TO THE CALLER THAT THIS IS A PRIVATE ISSUE
12/5/2007	17510 1ST AVE NW	Sinkhole	SINKHOLE FORMING ON 1ST AVE NW NEAR NEIGHBORING PROPERTY - ONE IS 2 FEET ACROSS AND MAYBE 1 FOOT DEEP OTHER LOOKS LIKE THE DRIVEWAY IS SINKING
12/20/2007	16350 AURORA AVE N	Sinkhole	SINKHOLE FORMING IN THIS AREA BEHIND "AQUA QUIP" REAR PARKING LOT, APPROX 3' INTO INTERURBAN TRAIL.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
7/22/2008	16034 GREENWOOD AVE N	Sinkhole	I noticed a sink hole forming in the asphalt side walk in front of the house. The hole is on the house side of the walk way, near one of the cinder bl
8/5/2008	19310 2ND AVE NW	Sinkhole	HOLE IN THE ROAD PAVEMENT ABOUT 1 FOOT IN DIAMETER, AT LEAST 1 FOOT DEEP.
8/25/2008	542 N 170TH PL	Sinkhole	IN FRONT OF CALLERS HOUSE, WATER PRESSURE HAS CREATED A HOLE IN THE GROUND. YOU CAN NOW SEE UNDER THE STREET.
9/12/2008	1ST AVE NW	Sinkhole	TWO HOLES IN THE SHOULDER OF THE ROAD, MAY BE CONNECTED WITH THE SEWER OR WATER LINES UNDER THEM.
1/7/2009	FREMONT AVE N	Sinkhole	SINKHOLE FORMING, APPROX 3 FEET DEEP, IN THE CENTER OF THE ROADWAY ON N 182ND ST, EAST OF FREMONT AVE N.
2/3/2009	16324 FREMONT AVE N	Sinkhole	HOLE IN THE ROAD, 3' X 1.5'
2/18/2009	16324 FREMONT AVE N	Sinkhole	SINKHOLE REPORTED @ 16300 BLOCK OF FREMONT AVE N, ADDRESS 16324 FREMONT AVE N, APPROXIMATELY 18 INCHES BY 18 INCHES. OFFICER PLACED A CONE NEAR IT AND
3/10/2009	16300 AURORA AVE N A	Sinkhole	SINKHOLE, 20' SOUTH OF THE UTILITY POLE BEHIND THIS PROPERTY.
6/12/2009	16324 FREMONT AVE N	Sinkhole	CLEANSCAPES DRIVER REPORTING A LARGE POTHOLE / SINKHOLE (DRIVER LEFT A CONE INSIDE IT) IN FRONT 16324 FREMONT AVE N.
10/27/2009	724 N 182ND ST	Sinkhole	OBSERVED AT THE SITE OF A ROADS REPAIR SQUARE CUT, A SINKHOLE HAS FORMED AND THE OPENING IS APPROX 1.5x2SF, THE DEPTH IS APPROX 6+FT. CALLED DAVID LAB
1/19/2010	801 NW 175TH ST	Sinkhole	4:25pm: The resident of 801 NW 175th St. reported a sinkhole had formed just off the street and requested a response.

Appendix B. Summary table of service calls between 2000 and 2011 sorted by type of problem
Boeing Creek Basin Plan

Date	Address	Type of Problem	Comments
8/23/2010	915 N 167TH ST	Sinkhole	CALLER STATES THAT THERE'S A HOLE NEXT TO ONE OF THE NEWLY INSTALLED DRAINS IN THE DRAINAGE FIELD THAT THE CITY RECENTLY INSTALLED.
1/27/2011	137 NW 181ST ST	Sinkhole	Caller is requesting that the City investigate a sinkhole in his back yard near a stormwater line.
1/31/2011	515 N 190TH ST	Sinkhole	POTHOLE ON N 190TH ST NEAR "CRISTA LANE" (APPROX ADDRESS: 515 N 190TH ST) - CALLER STATES IT'S ABOUT 3 FEET ACROSS
4/29/2011	132 N 155TH ST	Sinkhole	SINKHOLE IN THE CENTER OF DRIVEWAY APRON ON R.O.W PROPERTY. (LOCATION: 132 NW 155TH ST, REFERRED TO PW ROADS FOR PERMANENT REPAIR; ROB S. USED 5 BAGS
5/4/2011	16515 LINDEN AVE N	Sinkhole	SINKHOLE DEVELOPING AT LINDEN AVE N @ N 165TH ST, ABOUT 30 FEET SOUTH OF THE DRIVEWAY AT 16515 LINDEN AVE N, BY THE EDGE OF THE ROAD.
6/3/2011	DAYTON AVE N	Sinkhole	THERE IS A DEEP POTHOLE ON DAYTON AVE N SOUTH OF 200TH. IT IS THE SIZE OF A MANHOLE COVER. IT IS 5 INCHES DEEP.
6/8/2011	16515 LINDEN AVE N	Sinkhole	NEAR THE ROAD, IN FRONT OF THE HOUSE, BY THE FENCE, IS A SINKHOLE OF SORTS AND KIDS ARE TRIPPING IN IT.
1/26/2012	510 N 169TH ST	Sinkhole	THERE IS A 2' SINK HOLE IN FRONT OF HER HOME. IT IS USUALLY 8' X 10'. WE HAVE REPAIRED THIS SINK HOLE BEFORE.

APPENDIX C. WETLAND RATING FORMS

WETLAND RATING FORM – WESTERN WASHINGTON
Version 2 – Updated July 2006 to increase accuracy and reproducibility among users
Updated Oct 2008 with the new WDFW definitions for priority habitats

Name of wetland (if known): Confluence Wetland Date of site visit: 9/19/2012

Rated by: H. Mortensen Trained by Ecology? Yes ☒ No ☐ Date of Training 5/2005

SEC: 12 TWNSHP: 23N RNGE: 3E Is S/T/R in Appendix D? Yes ☐ No ☒

SUMMARY OF RATING

Category based on FUNCTIONS provided by wetland

I ☐ II ☐ III ☒ IV ☐

Category I = Score ≥70
Category II = Score 51-69
Category III = Score 30-50
Category IV = Score < 30

Score for Water Quality Functions	3
Score for Hydrologic Functions	10
Score for Habitat Functions	17
TOTAL score for functions	**30**

Category based on SPECIAL CHARACTERISTICS of wetland

I ☐ II ☐ Does not Apply ☒

Final Category (choose the "highest" category from above) **III**

Check the appropriate type and class of wetland being rated.

Wetland Type		Wetland Class	
Estuarine		**Depressional**	
Natural Heritage Wetland		**Riverine**	
Bog		**Lake-fringe**	
Mature Forest		**Slope**	**X**
Old Growth Forest		**Flats**	
Coastal Lagoon		**Freshwater Tidal**	
Interdunal			
None of the above	**X**	Check if unit has multiple HGM classes present	

Does the wetland unit being rated meet any of the criteria below?

If you answer YES to any of the questions below you will need to protect the wetland according to the regulations regarding the special characteristics found in the wetland.

Check List for Wetlands That May Need Additional Protection (in addition to the protection recommended for its category)	YES	NO
SP1. *Has the wetland unit been documented as a habitat for any Federally listed Threatened or Endangered **animal** or **plant** species (T/E species)?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state or federal database.		X*
SP2. *Has the wetland unit been documented as habitat for any State listed Threatened or Endangered **animal** species?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state database. Note: Wetlands with State listed plant species are categorized as Category I Natural Heritage Wetlands (see p. 19 of data form).		X*
SP3. *Does the wetland unit contain individuals of Priority species listed by the WDFW for the state?*		X*
SP4. *Does the wetland unit have a local significance in addition to its functions*? For example, the wetland has been identified in the Shoreline Master Program, the Critical Areas Ordinance, or in a local management plan as having special significance.		X

***The study area was reviewed for the presence of endangered, threatened, and priority species using WDFW online Priority Habitat and Species Data, PHS on the Web (http://wdfw.wa.gov/mapping/phs/).**

To complete the next part of the data sheet you will need to determine the Hydrogeomorphic Class of the wetland being rated.

The hydrogeomorphic classification groups wetlands into those that function in similar ways. Classifying the wetland first simplifies the questions needed to answer how it functions. The Hydrogeomorphic Class of a wetland can be determined using the key below. See p. 24 for more detailed instructions on classifying wetlands.

Classification of Wetland Units in Western Washington

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in Questions 1-7 apply, and go to Question 8.

1. Are the water levels in the wetland unit usually controlled by tides (i.e. except during floods)?

☒ NO – go to 2 ☐ **YES** – the wetland class is **Tidal Fringe**

If yes, is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)? **YES – Freshwater Tidal Fringe NO – Saltwater Tidal Fringe (Estuarine)**

*If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is rated as an **Estuarine** wetland.* Wetlands that were called estuarine in the first and second editions of the rating system are called Salt Water Tidal Fringe in the Hydrogeomorphic Classification. Estuarine wetlands were categorized separately in the earlier editions, and this separation is being kept in this revision. To maintain consistency between editions, the term "Estuarine" wetland is kept. Please note, however, that the characteristics that define Category I and II estuarine wetlands have changed (see p.).

2. The entire wetland unit is flat and precipitation is only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit

☒ NO – go to 3 ☐ **YES** – The wetland class is **Flats**

If your wetland can be classified as a "Flats" wetland, use the form for **Depressional** wetlands.

3. Does the entire wetland unit **meet both** of the following criteria?

☐ The vegetated part of the wetland is on the shores of a body of open water (without any vegetation on the surface) at least 20 acres (8 ha) in size;

☐ At least 30% of the open water area is deeper than 6.6 ft (2 m)?

☒ NO – go to 4 ☐ **YES –** The wetland class is **Lake-fringe (Lacustrine Fringe)**

4. Does the entire wetland unit **meet all** of the following criteria?

☒ The wetland is on a slope (*slope can be very gradual*),

☒ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.

☒ The water leaves the wetland **without being impounded**?

NOTE: *Surface water does not pond in these types of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3ft diameter and less than a foot deep).*

☐ NO – go to 5 ☒ **YES –** The wetland class is **Slope**

5. Does the entire wetland unit **meet all** of the following criteria?

☐ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river.

☐ The overbank flooding occurs at least once every two years

NOTE: The riverine unit can contain depressions that are filled with water when the river is not flooding.

☐ NO - go to 6 ☐ **YES** – The wetland class is **Riverine**

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year. *This means that any outlet, if present, is higher than the interior of the wetland.*

☐ NO – go to 7 ☐ **YES –** The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding. The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☐ NO – go to 8 ☐ **YES –** The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within your wetland. NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the class listed in column 2 is less than 10% of the unit, classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	*HGM Class to Use in Rating*
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake-fringe	Lake-fringe
Depressional + Riverine along stream within boundary	Depressional
Depressional + Lake-fringe	Depressional
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE under wetlands with special characteristics

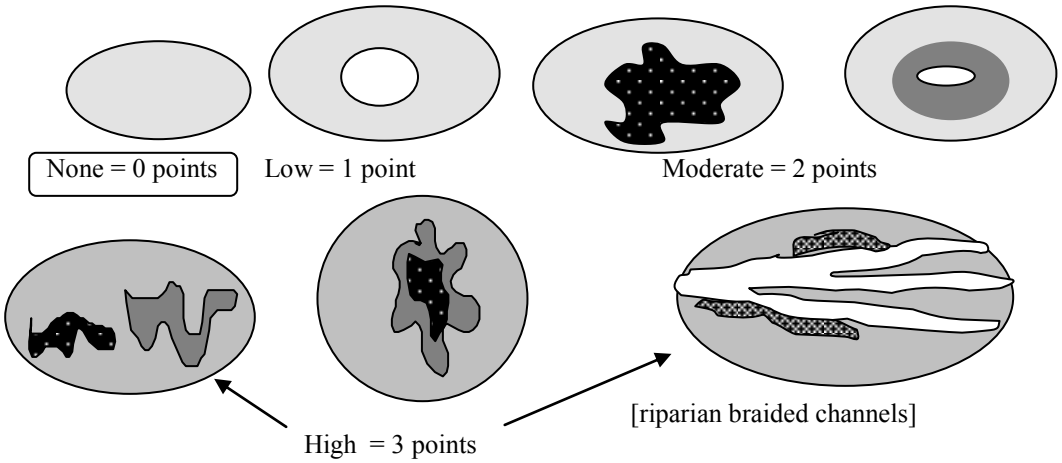
If you are unable still to determine which of the above criteria apply to your wetland, or you have more than 2 HGM classes within a wetland boundary, classify the wetland as **Depressional** for the rating.

S	Slope Wetlands	Points
	WATER QUALITY FUNCTIONS - Indicators that wetland functions to improve water quality	
S	**S 1. Does the wetland have the potential to improve water quality?**	*(see p. 64)*
S	S 1.1 Characteristics of average slope of wetland: Slope is1% or less *(a 1% slope has a 1 foot vertical drop in elevation horizontal distance) for every 100 ft* ..... points = 3 Slope is 1% - 2% ..... points = 2 Slope is 2% - 5% ..... points = 1 Slope is greater than 5% ..... points = 0	0
S	S 1.2 The soil 2 inches below the surface (or duff layer) is clay or organic *(use NRCS definitions)*. YES = 3 points NO = 0 points	0
S	S 1.3 Characteristics of the vegetation in the wetland that trap sediments and pollutants: *Choose the points appropriate for the description that best fits the vegetation in the wetland. Dense vegetation means you have trouble seeing the soil surface. Dense vegetation means you have trouble seeing the soil surface (>75% cover) and uncut means not grazed or mowed and plants are higher than 6 inches.* Dense, ungrazed, herbaceous vegetation > 90% of the wetland area ..... points = 6 Dense, ungrazed, herbaceous vegetation > 1/2 of area ..... points = 3 Dense, woody, vegetation > ½ of area ..... points = 2 Dense, ungrazed, herbaceous vegetation > 1/4 of area ..... points = 1 Does not meet any of the criteria above for vegetation ..... points = 0	3
S	**Total for S 1** *Add the points in the boxes above*	3
S	**S 2. Does the wetland have the opportunity to improve water quality?** ***(see p. 67)*** Answer YES if you know or believe there are pollutants in groundwater or surface water coming into the wetland that would otherwise reduce water quality in streams, lakes or groundwater downgradient from the wetland? *Note which of the following conditions provide the sources of pollutants.A unit may have pollutants coming from several sources, but any single source would qualify as opportunity.* ☐ Grazing in the wetland or within 150 ft ☐ Untreated stormwater discharges to wetland ☐ Tilled fields, logging or orchards within 150 ft of wetland ☐ A stream or culvert discharges into wetland that drains developed areas, residential areas, farmed fields, roads, or clear-cut logging ☐ Residential, urban areas, or golf courses are within 150 ft upslope of wetland ☐ Other_____ **YES** multiplier is **2** **NO** multiplier is **1**	multiplier 1
S	**TOTAL - Water Quality Functions** Multiply the score from S 1 by S 2 ***Add score to table on p. 1***	**3**

S	Slope Wetlands	Points
	HYDROLOGIC FUNCTIONS - Indicators that wetland functions to reduce flooding and stream erosion	
	S 3. Does the wetland have the potential to reduce flooding and erosion?	***(see p. 68)***
S	S 3.1 Characteristics of vegetation that reduce the velocity of surface flows during storms. *Choose the points appropriate for the description that best fit conditions in the wetland. (stems of plants should be thick enough (usually > 1/8in), or dense enough, to remain erect during surface flows)* Dense, uncut, **rigid** vegetation covers > 90% of the area of the wetland. ..... points = 6 Dense, uncut, **rigid** vegetation > 1/2 area of wetland ..... points = 3 Dense, uncut, **rigid** vegetation > 1/4 area ..... points = 1 More than 1/4 of area is grazed, mowed, tilled or vegetation is not rigid ..... points = 0	3
S	S 3.2 Characteristics of slope wetland that holds back small amounts of flood flows: The slope wetland has small surface depressions that can retain water over at least 10% of its area. YES points = 2 NO points = 0	2
S	**Total for S 3** *Add the points in the boxes above*	5
S	**S 4. Does the wetland have the opportunity to reduce flooding and erosion?** ***(see p. 70)*** Is the wetland in a landscape position where the reduction in water velocity it provides helps protect downstream property and aquatic resources from flooding or excessive and/or erosive flows? *Note which of the following conditions apply.* ☒ Wetland has surface runoff that drains to a river or stream that has flooding problems ☐ Other_____ *(Answer NO if the major source of water to the wetland is controlled by a reservoir or the wetland is tidal fringe along the sides of a dike)* **YES** multiplier is **2** **NO** multiplier is **1**	multiplier 2
S	**TOTAL - Hydrologic Functions** Multiply the score from S 3 by S 4 ***Add score to table on p. 1***	**10**

Comments

These questions apply to wetlands of all HGM classes. **HABITAT FUNCTIONS - Indicators that wetland functions to provide important habitat**	
H 1. Does the wetland have the potential to provide habitat for many species?	
H 1.1 Vegetation structure ***(see p. 72)*** *Check the types of vegetation classes present (as defined by Cowardin) if the class is ¼ acre or covers more than 10% of the area of the wetland if unit smaller than 2.5 acres.* ☐ Aquatic bed ☐ Emergent plants ☒ Scrub/shrub (areas where shrubs have >30% cover) ☐ Forested (areas where trees have >30% cover) ☐ Forested areas have 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the forested polygon *Add the number of vegetation types that qualify. If you have:* 4 structures or more ..... points = 4 3 structures ..... points = 2 2 structures ..... points = 1 1 structure ..... points = 0	0
H 1.2. Hydroperiods ***(see p. 73)*** *Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ acre to count. (see text for descriptions of hydroperiods)* ☐ Permanently flooded or inundated ☐ Seasonally flooded or inundated ☐ Occasionally flooded or inundated ☒ Saturated only ☒ Permanently flowing stream or river in, or adjacent to, the wetland ☐ Seasonally flowing stream in, or adjacent to, the wetland ☐ ***Lake-fringe wetland* = 2 points** ☐ ***Freshwater tidal wetland* = 2 points** 4 or more types present ..... points = 3 3 types present ..... points = 2 2 types present ..... points = 1 1 types present……points = 0	1
H 1.3. Richness of Plant Species ***(see p. 75)*** Count the number of plant species in the wetland that cover at least 10 ft^2. (*different patches of the same species can be combined to meet the size threshold)* *You do not have to name the species.* *Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle* *List species below if you want to:* If you counted: > 19 species ..... points = 2 5 - 19 species ..... points = 1 < 5 species ..... points = 0	1

H 1.4. Interspersion of habitats ***(see p. 76)*** Decide from the diagrams below whether interspersion between Cowardin vegetation classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, medium, low, or none.  None = 0 points Low = 1 point Moderate = 2 points High = 3 points [riparian braided channels] NOTE: If you have four or more vegetation types or three vegetation types and open water the rating is always "high".	0
H 1.5. Special Habitat Features: ***(see p. 77)*** *Check the habitat features that are present in the wetland. The number of checks is the number of points you put into the next column.* ☒ Large, downed, woody debris within the wetland (>4in. diameter and 6 ft long). ☐ Standing snags (diameter at the bottom > 4 inches) in the wetland ☒ Undercut banks are present for at least 6.6 ft (2m) and/or overhanging vegetation extends at least 3.3 ft (1m) over a stream for at least 33 ft (10m) ☐ Stable steep banks of fine material that might be used by beaver or muskrat for denning (>30degree slope) OR signs of recent beaver activity are present ☐ At least ¼ acre of thin-stemmed persistent vegetation or woody branches are present in areas that are permanently or seasonally inundated.*(structures for egg-laying by amphibians)* ☒ Invasive plants cover less than 25% of the wetland area in each stratum of plants *Note: The 20% stated in early printings of the manual on page 78 is an error.*	3
H 1. TOTAL Score - potential for providing habitat *Add the scores from H1.1, H1.2, H1.3, H1.4, H1.5*	5

H 2. Does the wetland have the opportunity to provide habitat for many species?	
H 2.1 Buffers ***(see p. 80)*** *Choose the description that best represents condition of buffer of wetland. The highest scoring criterion that applies to the wetland is to be used in the rating. See text for definition of "undisturbed."* ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% of circumference. No developed areas within undisturbed part of buffer. (relatively undisturbed also means no-grazing) ..... Points = 5 ☒ ..... 100 m (330 ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 50% circumference..... Points = 4 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% circumference..... Points = 4 ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 25% circumference..... Points = 3 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water for > 50% circumference. ..... Points = 3 **If buffer does not meet any of the criteria above** ☐ No paved areas (except paved trails) or buildings within 25 m (80ft) of wetland > 95% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ No paved areas or buildings within 50m of wetland for >50% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ Heavy grazing in buffer. ..... Points = 1 ☐ Vegetated buffers are <2m wide (6.6ft) for more than 95% of the circumference (e.g. tilled fields, paving, basalt bedrock extend to edge of wetland ..... Points = 0 ☐ Buffer does not meet any of the criteria above……...Points = 1	4
H 2.2 Corridors and Connections ***(see p. 81)*** H 2.2.1 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 150 ft wide, has at least 30% cover of shrubs, forest or native undisturbed prairie, that connects to estuaries, other wetlands or undisturbed uplands that are at least 250 acres in size? (*dams in riparian corridors*, *heavily used gravel roads*, *paved roads, are considered breaks in the corridor*). YES = **4 points** (*go to H 2.3*) **NO** = go to H 2.2.2 H 2.2.2 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 50ft wide, has at least 30% cover of shrubs or forest, and connects to estuaries, other wetlands or undisturbed uplands that are at least 25 acres in size? **OR** a **Lake-fringe** wetland, if it does not have an undisturbed corridor as in the question above? YES = **2 points** (*go to H 2.3*) **NO** = H 2.2.3 H 2.2.3 Is the wetland: within 5 mi (8km) of a brackish or salt water estuary OR within 3 mi of a large field or pasture (>40 acres) OR within 1 mi of a lake greater than 20 acres? YES = **1 point** NO = **0 points**	2

H 2.3 Near or adjacent to other priority habitats listed by WDFW ***(see new and complete descriptions of WDFW priority habitats, and the counties in which they can be found, in the PHS report http://wdfw.wa.gov/hab/phslist.htm)*** Which of the following priority habitats are within 330ft (100m) of the wetland? *(NOTE: the connections do not have to be relatively undisturbed)* ☐ **Aspen Stands:** Pure or mixed stands of aspen greater than 0.4 ha (1 acres). ☐ **Biodiversity Areas and Corridors:** Areas of habitat that are relatively important to various species of native fish and wildlife (*full description in WDFW PHS report p. 152*) ☐ **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock. ☒ **Old-growth/Mature forests:** (Old-growth west of Cascade crest) Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 20 trees/ha (8 trees/acre) > 81 cm (32 in) dbh or > 200 years of age. (Mature forests.) Stands with average diameters exceeding 53 cm (21 in) dbh; crown cover may be less that 100%; crown cover may be less that 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80 - 200 years old west of the Cascade crest. ☐ **Oregon white Oak:** Woodlands Stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158.)* ☒ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other. ☐ **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161*) ☒ **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources. ☐ **Nearshore:** Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. *(full descriptions of habitats and the definition of relatively undisturbed are in WDFW report: pp. 167-169 and glossary in Appendix A.)* ☐ **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human. ☐ **Cliffs:** Greater than 7.6 m (25 ft) high and occurring below 5000 ft. ☐ **Talus:** Homogenous areas of rock rubble ranging in average size 0.15 - 2.0 m (0.5 - 6.5 ft), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs. ☒ **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of >51 cm (20 in) in western Washington and are > 2 m (6.5 ft) in height. Priority logs are > 30cm (12 in) in diameter at the largest end, and > 6m (20 ft) long. If wetland has **3 or more** priority habitats = **4 points** If wetland has **2** priority habitats = **3 points** If wetland has **1** priority habitat **= 1 point** No habitats = **0 points** *Note: All vegetated wetland are by definition a priority habitat but are not included in this list. Nearby wetlands are addressed in question H2.4.*	4

H 2.4 Wetland Landscape *(choose the **one** description of the landscape around the wetland that best fits)* ***(see p. 84)*** There are at least 3 other wetlands within ½ mile, and the connections between them are relatively undisturbed (light grazing between wetlands OK, as is lake shore with some boating, but connections should NOT be bisected by paved roads, fill, fields, or other development. ..... points = 5 The wetland is Lake-fringe on a lake with little disturbance and there are 3 other lake-fringe wetlands within ½ mile ..... points = 5 There are at least 3 other wetlands within ½ mile, BUT the connections between them are disturbed ..... points = 3 The wetland is Lake-fringe on a lake **with** disturbance and there are 3 other lake-fringe wetland within ½ mile ..... points = 3 There is at least 1 wetland within ½ mile. ..... points = 2 There are no wetlands within ½ mile. ..... points = 0	2
H 2. TOTAL Score - opportunity for providing habitat *Add the scores from H2.1, H2.2, H2.3, H2.4*	12
TOTAL for H1 from page 14	5
Total Score for Habitat Functions – add the points for H 1, H 2 and record the result on p. 1	17

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Please determine if the wetland meets the attributes described below and circle the appropriate Category.

Wetland Type *Check off any criteria that apply to the wetland. Circle the Category when the appropriate criteria are met.*	**Category**
SC 1.0 Estuarine wetlands (*see p. 86)* Does the wetland unit meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt. YES = Go to SC 1.1 NO ☒	
SC 1.1 Is the wetland unit within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-151? ☐YES = Category I ☐NO = go to SC 1.2	**Cat. I**
SC 1.2 Is the wetland unit at least 1 acre in size and meets at least two of the following three conditions? ☐YES = Category I ☐NO = Category II ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. If the non-native Spartina spp. are the only species that cover more than 10% of the wetland, then the wetland should be given a dual rating (I/II) The are aof Spartina would be rated a Category II while the relatively undisturbed upper marsh with native species would be a Category I. Do not, however, exclude the area of Spartina in determining the size threshold of 1 acre. ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed wetland. ☐ The wetland has at least 2 or the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands.	**Cat. I** **Cat. II** **Dual rating I/II**

SC 2.0 Natural Heritage Wetlands ***(see p. 87)*** Natural Heritage wetlands have been identified by the Washington Natural Heritage Program/DNR as either high quality undisturbed wetlands or wetlands that support state Threatened, Endangered, or Sensitive plant species. SC 2.1 Is the wetland being rated in a Section/Township/Range that contains a Natural Heritage wetland? *(this question is used to screen out most sites before you need to contact WNHP/DNR)* S/T/R information from Appendix D ☐ or accessed from WNHP/DNR web site ☐ YES☐ – contact WNHP/DNR (see p. 79) and go to SC 2.2 NO ☒ SC 2.2 Has DNR identified the wetland as a high quality undisturbed wetland or as or as a site with state threatened or endangered plant species? YES = Category I NO ☐ Not a Heritage Wetland	**Cat. I**
SC 3.0 Bogs ***(see p. 87)*** Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below to identify if the wetland is a bog. If you answer yes, you will still need to rate the wetland based on its functions.* 1. Does the wetland have organic soils horizons (i.e. layers of organic soil), either peats or mucks, that compose 16" or more of the first 32 inches of the soil profile? (See Appendix B for a field key to identify organic soils.) Yes - go to Q.3 NO - go to Q.2 2. Does the wetland have organic soils, either peats or mucks, that are less than 16 inches deep over bedrock or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? Yes - go to Q.3 NO ☒ is not a bog for purpose of rating 3. Does the wetland have more than 70% cover of mosses at ground level, AND other plants, if present, consist of the "bog" species listed in Table 3 as a significant component of the vegetation (more than 30% of the total shrub and herbaceous cover consists species in Table 3)? Yes – Is a bog for purpose of rating NO - go to Q.4 *NOTE: If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16" deep. If the pH is less than 5.0 and the "bog" plant species in Table 3 are present, the wetland is a bog.* 4. Is the wetland forested (>30% cover) with sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Englemann's spruce, or western white pine, WITH any of the species (or combination of species) on the bog species plant list in Table 3 as a significant component of the ground cover (*>30% coverage of the total shrub/herbaceous* cover)? YES = Category I NO ☐ is not a bog for purpose of rating	**Cat. I**

SC 4.0 Forested Wetlands *(see p. 90)*	
Does the wetland have at least 1 acre of forest that meet one of these criteria for the Department of Fish and Wildlife's forests as priority habitats? *If you answer yes you will still need to rate the wetland based on its functions.*	
☐ Old growth forests: (west of Cascade crest) Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/acre (20 trees/hectare) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 inches (81 cm) or more. *Note: The criterion for dbh is based on measurements for upland forests. Two hundred year old trees in wetlands will often have a smaller dbh because their growth rates are often slower. The DFW criterion is and "OR" so old-growth forests do not necessarily have to have trees of this diameter.*	
☐ Mature forests: (west of the Cascade crest) Stands where the largest trees are 80-200 years old OR have average diameters (dbh) exceeding 21 in (53 cm); crown cover may be less than 100%; decay, decadence, numbers of snags, and quanitity of large downed material is generally less than that found in old-growth	
YES = Category 1 NO ☒ not a forested wetland with special characteristics	**Cat. I**
SC 5.0 Wetlands in Coastal Lagoons (see p. 91)	
Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?	
☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks.	
☐ The lagoon in which the wetland is located contains surgace water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon (*needs to be measured near the bottom*)	
YES – Go to SC 5.1 NO ☒ not a wetland in a coastal lagoon	**Cat. I**
SC 5.1 Does the wetland meet all of the following three conditions?	
☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of invasive plant species (see list of invasive species on p. 74).	
☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland.	
☐The wetalnd is larger than 1/10 acre (4350 square feet)	
YES = Category I NO = Category II	**Cat. II**

SC 6.0 Interdunal Wetlands (see p. 93) Is the wetalnd unit west of the 1889 line (also called the Westarn Boundary of Upland Ownership or WBUO)? YES – go to SC 6.1 NO ☒ not an interdunal wetland for rating *If you answer yes you will still need to rate the wetland based on its functions.* In practical terms that means the following geographic areas: – Long Beach Peninsula – lands west of SR 103 – Grayland-Westport – lands west of SR 105 – Ocean Shores-Copalis – lands west of SR 115 and SR 109 SC 6.1 Is the wetland 1 acre or larger, or is it in a mosaic of wetlands that is 1 acre or larger? YES = Category II NO – go to SC 6.2 SC 6.2 Is the unit between 0.1 and 1 acre, or is it in a mosaic of wetlands that is between 0.1 and 1 acre? YES = Category III	**Cat. II** **Cat. III**
Category of wetland based on Special Characteristics *Choose the "highest" rating if wetland falls into several categorie, and record on p. 1 .* If you answered NO for all types enter "Not Applicable" on p.1.	NA

Wetland name or number ___Hillwood Park Wetland___

WETLAND RATING FORM – WESTERN WASHINGTON
Version 2 – Updated July 2006 to increase accuracy and reproducibility among users
Updated Oct 2008 with the new WDFW definitions for priority habitats

Name of wetland (if known): Hillwood Park Wetland Date of site visit: 10/10/12

Rated by: H. Mortensen Trained by Ecology? Yes ☒ No ☐ Date of Training 5/2005

SEC: 1 TWNSHP: 26N RNGE: 3E Is S/T/R in Appendix D? Yes ☐ No ☒

SUMMARY OF RATING

Category based on FUNCTIONS provided by wetland

I ☐ II ☐ III ☐ IV ☒

Category I = Score ≥70
Category II = Score 51-69
Category III = Score 30-50
Category IV = Score < 30

Score for Water Quality Functions	4
Score for Hydrologic Functions	4
Score for Habitat Functions	8
TOTAL score for functions	**16**

Category based on SPECIAL CHARACTERISTICS of wetland

I ☐ II ☐ Does not Apply ☒

Final Category (choose the "highest" category from above) **IV**

Check the appropriate type and class of wetland being rated.

Wetland Type		Wetland Class	
Estuarine		**Depressional**	**X**
Natural Heritage Wetland		**Riverine**	
Bog		**Lake-fringe**	
Mature Forest		**Slope**	
Old Growth Forest		**Flats**	
Coastal Lagoon		**Freshwater Tidal**	
Interdunal			
None of the above	**X**	Check if unit has multiple HGM classes present	**X**

Does the wetland unit being rated meet any of the criteria below?

If you answer YES to any of the questions below you will need to protect the wetland according to the regulations regarding the special characteristics found in the wetland.

Check List for Wetlands That May Need Additional Protection (in addition to the protection recommended for its category)	YES	NO
SP1. *Has the wetland unit been documented as a habitat for any Federally listed Threatened or Endangered **animal** or **plant** species (T/E species)?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state or federal database.		X*
SP2. *Has the wetland unit been documented as habitat for any State listed Threatened or Endangered **animal** species?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state database. Note: Wetlands with State listed plant species are categorized as Category I Natural Heritage Wetlands (see p. 19 of data form).		X*
SP3. *Does the wetland unit contain individuals of Priority species listed by the WDFW for the state?*		X*
SP4. *Does the wetland unit have a local significance in addition to its functions*? For example, the wetland has been identified in the Shoreline Master Program, the Critical Areas Ordinance, or in a local management plan as having special significance.		X

***The study area was reviewed for the presence of endangered, threatened, and priority species using WDFW online Priority Habitat and Species Data, PHS on the Web (http://wdfw.wa.gov/mapping/phs/).**

To complete the next part of the data sheet you will need to determine the Hydrogeomorphic Class of the wetland being rated.

The hydrogeomorphic classification groups wetlands into those that function in similar ways. Classifying the wetland first simplifies the questions needed to answer how it functions. The Hydrogeomorphic Class of a wetland can be determined using the key below. See p. 24 for more detailed instructions on classifying wetlands.

Classification of Wetland Units in Western Washington

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in Questions 1-7 apply, and go to Question 8.

1. Are the water levels in the wetland unit usually controlled by tides (i.e. except during floods)?

☒ NO – go to 2 ☐ **YES** – the wetland class is **Tidal Fringe**

If yes, is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)? **YES – Freshwater Tidal Fringe NO – Saltwater Tidal Fringe (Estuarine)**

*If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is rated as an **Estuarine** wetland.* Wetlands that were called estuarine in the first and second editions of the rating system are called Salt Water Tidal Fringe in the Hydrogeomorphic Classification. Estuarine wetlands were categorized separately in the earlier editions, and this separation is being kept in this revision. To maintain consistency between editions, the term "Estuarine" wetland is kept. Please note, however, that the characteristics that define Category I and II estuarine wetlands have changed (see p.).

2. The entire wetland unit is flat and precipitation is only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit

☒ NO – go to 3 ☐ **YES** – The wetland class is **Flats**

If your wetland can be classified as a "Flats" wetland, use the form for **Depressional** wetlands.

3. Does the entire wetland unit **meet both** of the following criteria?

☐ The vegetated part of the wetland is on the shores of a body of open water (without any vegetation on the surface) at least 20 acres (8 ha) in size;

☐ At least 30% of the open water area is deeper than 6.6 ft (2 m)?

☒ NO – go to 4 ☐ **YES –** The wetland class is **Lake-fringe (Lacustrine Fringe)**

4. Does the entire wetland unit **meet all** of the following criteria?

☒ The wetland is on a slope (*slope can be very gradual*),

☒ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.

☐ The water leaves the wetland **without being impounded**?

NOTE: *Surface water does not pond in these types of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3ft diameter and less than a foot deep).*

☒ NO – go to 5 ☐ **YES –** The wetland class is **Slope**

5. Does the entire wetland unit **meet all** of the following criteria?

☐ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river.

☐ The overbank flooding occurs at least once every two years

NOTE: The riverine unit can contain depressions that are filled with water when the river is not flooding.

☒ NO - go to 6 ☐ **YES** – The wetland class is **Riverine**

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year. *This means that any outlet, if present, is higher than the interior of the wetland.*

☒ NO – go to 7 ☐ **YES –** The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding. The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☒ NO – go to 8 ☐ **YES –** The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within your wetland. NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the class listed in column 2 is less than 10% of the unit, classify the wetland using the class that represents more than 90% of the total area.

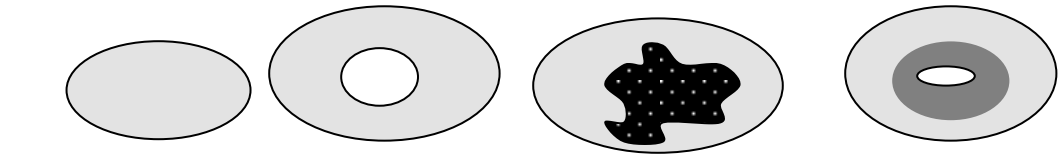
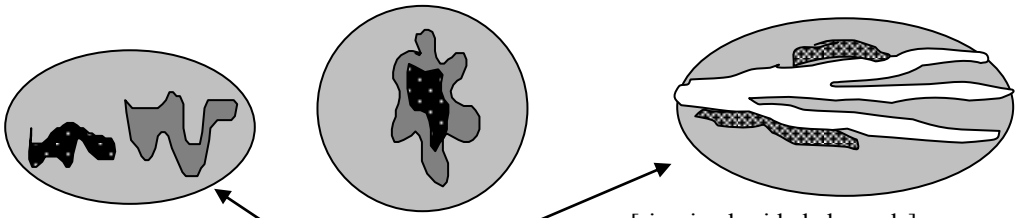
HGM classes within the wetland unit being rated	*HGM Class to Use in Rating*
~~Slope + Riverine~~	Riverine
Slope + Depressional	**Depressional**
Slope + Lake-fringe	Lake-fringe
Depressional + Riverine along stream within boundary	Depressional
Depressional + Lake-fringe	Depressional
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE under wetlands with special characteristics

If you are unable still to determine which of the above criteria apply to your wetland, or you have more than 2 HGM classes within a wetland boundary, classify the wetland as **Depressional** for the rating.

D	Depressional and Flats Wetlands	Points
	WATER QUALITY FUNCTIONS - Indicators that wetland functions to improve water quality	
D	**D 1. Does the wetland have the potential to improve water quality?**	***(see p. 38)***
D	D 1.1 Characteristics of surface water flows out of the wetland: Unit is a depression with no surface water leaving it (no outlet)..... points = 3 Unit has an intermittently flowing, or highly constricted permanently flowing outlet..... points = 2 Unit has an unconstricted, or slightly constricted, surface outlet *(permanently flowing)*. points = 1 Unit is a "flat" depression (Q.7 on key), or in the Flats class, with permanent surface outflow **and no obvious natural outlet**, and/or outlet is a man-made ditch ..... points = 1 (*If ditch is not permanently flowing treat unit as "intermittently flowing")*	2
D	D 1.2 The soil 2 inches below the surface (or duff layer) is clay or organic (*use NRCS definitions*). YES points = 4 NO points = 0	0
D	D 1.3 Characteristics of persistent vegetation (emergent, shrub, and/or forest Cowardin class): Wetland has persistent, ungrazed, vegetation > = 95% of area ..... points = 5 Wetland has persistent, ungrazed, vegetation > = 1/2 of area ..... points = 3 Wetland has persistent, ungrazed vegetation > = 1/10 of area ..... points = 1 Wetland has persistent, ungrazed vegetation <1/10 of area..... points = 0	0 (grass is mowed = grazed)
D	D1.4 Characteristics of seasonal ponding or inundation. *This is the area of the wetland unit that is ponded for at least 2 months, but dries out sometime during the year. Do not count the area that is permanently ponded. Estimate area as the average condition 5 out of 10 yrs.* Area seasonally ponded is > ½ total area of wetland..... points = 4 Area seasonally ponded is > ¼ total area of wetland..... points = 2 Area seasonally ponded is < ¼ total area of wetland..... points = 0 NOTE: *See text for indicators of seasonal and permanent inundation.*	0
D	**Total for D 1** *Add the points in the boxes above*	2
D	**D 2. Does the wetland unit have the opportunity to improve water quality?** Answer YES if you know or believe there are pollutants in groundwater or surface water coming into the wetland that would otherwise reduce water quality in streams, lakes or groundwater downgradient from the wetland? *Note which of the following conditions provide the sources of pollutants. A unit may have pollutants coming from several sources, but any single source would qualify as opportunity.* ☐ Grazing in the wetland or within 150 ft ☒ Untreated stormwater discharges to wetland ☐ Tilled fields or orchards within 150 ft of wetland ☒ A stream or culvert discharges into wetland that drains developed areas, residential areas, farmed fields, roads, or clear-cut logging ☒ Residential, urban areas, golf courses are within 150 ft of wetland ☐ Wetland is fed by groundwater high in phosphorus or nitrogen ☐ Other_____ **YES** multiply score in D 1. **by 2** **NO** multiply score in D 1. **by 1**	***(see p. 44)*** multiplier 2
D	**TOTAL - Water Quality Functions** Multiply the score from D1 by D2 ***Add score to table on p. 1***	**4**

D	**Depresssional and Flats Wetlands**	
	HYDROLOGIC FUNCTIONS - Indicators that wetland functions to reduce flooding and stream degradation	
	D 3. Does the wetland have the potential to reduce flooding and erosion?	***(see p. 46)***
D	D 3.1 Characteristics of surface water flows out of the wetland unit Unit is a depression with no surface water leaving it (no outlet)..... points = 4 Unit has an intermittently flowing, or highly constricted permanently flowing outlet..... points = 2 Unit has an unconstricted, or slightly constricted, surface outlet *(permanently flowing)*. points = 1 Unit is a "flat" depression (Q.7 on key), or in the Flats class, with permanent surface outflow **and no obvious natural outlet**, and/or outlet is a man-made ditch ..... points = 1 (*If ditch is not permanently flowing treat unit as "intermittently flowing")* Unit has an unconstricted, or slightly constricted, surface outlet (*permanently flowing*). points = 0	2
D	D 3.2 Depth of storage during wet periods *Estimate the height of ponding above the bottom of the outlet For units with no outlet measure from the surface of permanent water or deepest part (if dry).* Marks of ponding are at least 3 ft or more above the surface or bottom of outlet..... points = 7 The wetland is a "headwater" wetland" ..... points = 5 Marks of ponding between 2 ft to < 3 ft from surface or bottom of outlet..... points = 5 Marks are at least 0.5 ft to < 2 ft from surface or bottom of outlet ..... points = 3 Unit is flat (yes to Q.2 or Q.7 on key) but has small depressions on the surface that trap water ..... points = 1 Marks of ponding less than 0.5 ft..... points = 0	0
D	D 3.3 Contribution of wetland unit to storage in the watershed *Estimate the ratio of the area of upstream basin contributing surface water to the wetland to the area of the wetland unit itself.* The area of the basin is less than 10 times the area of the unit ..... points = 5 The area of the basin is 10 to 100 times the area of the unit ..... points = 3 The area of the basin is more than 100 times the area of the unit ..... points = 0 Entire unit is in the FLATS class ..... points = 5	0
D	**Total for D 3** *Add the points in the boxes above*	2
D	**D 4. Does the wetland unit have the opportunity to reduce flooding and erosion?** Answer YES if the unit is in a location in the watershed where the flood storage, or reduction in water velocity, it provides helps protect downstream property and aquatic resources from flooding or excessive and/or erosive flows. Answer NO if the water coming into the wetland is controlled by a structure such as flood gate, tide gate, flap valve, reservoir etc. OR you estimate that more than 90% of the water in the wetland is from groundwater in areas where damaging groundwater flooding does not occur. *Note which of the following conditions apply.* ☒ Wetland is in a headwater of a river or stream that has flooding problems ☒ Wetland drains to a river or stream that has flooding problems ☐ Wetland has no outlet and impounds surface runoff water that might otherwise flow into a river or stream that has flooding problems ☐ Other _____ ☒ **YES** multiplier is **2** ☐ **NO** multiplier is **1**	*(see p. 49)* multiplier 2
D	**TOTAL - Hydrologic Functions** Multiply the score from D 3 by D 4 ***Add score to table on p. 1***	**4**

These questions apply to wetlands of all HGM classes. **HABITAT FUNCTIONS - Indicators that wetland functions to provide important habitat**	
H 1. Does the wetland have the potential to provide habitat for many species?	
H 1.1 Vegetation structure ***(see p. 72)*** *Check the types of vegetation classes present (as defined by Cowardin) if the class is ¼ acre or covers more than 10% of the area of the wetland if unit smaller than 2.5 acres.* ☐ Aquatic bed ☒ Emergent plants ☐ Scrub/shrub (areas where shrubs have >30% cover) ☐ Forested (areas where trees have >30% cover) ☐ Forested areas have 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the forested polygon *Add the number of vegetation types that qualify. If you have:* 4 structures or more ..... points = 4 3 structures ..... points = 2 2 structures ..... points = 1 1 structure ..... points = 0	0
H 1.2. Hydroperiods ***(see p. 73)*** *Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ acre to count. (see text for descriptions of hydroperiods)* ☐ Permanently flooded or inundated — 4 or more types present ..... points = 3 ☒ Seasonally flooded or inundated — 3 types present ..... points = 2 ☐ Occasionally flooded or inundated — 2 types present ..... points = 1 ☒ Saturated only — 1 types present……points = 0 ☐ Permanently flowing stream or river in, or adjacent to, the wetland ☐ Seasonally flowing stream in, or adjacent to, the wetland ☐ ***Lake-fringe wetland* = 2 points** ☐ ***Freshwater tidal wetland* = 2 points**	1
H 1.3. Richness of Plant Species ***(see p. 75)*** Count the number of plant species in the wetland that cover at least 10 ft^2. (*different patches of the same species can be combined to meet the size threshold)* *You do not have to name the species.* *Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle* If you counted: *List species below if you want to:* > 19 species ..... points = 2 5 - 19 species ..... points = 1 < 5 species ..... points = 0	1

H 1.4. Interspersion of habitats ***(see p. 76)*** Decide from the diagrams below whether interspersion between Cowardin vegetation classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, medium, low, or none.  None = 0 points Low = 1 point Moderate = 2 points  [riparian braided channels] High = 3 points NOTE: If you have four or more vegetation types or three vegetation types and open water the rating is always "high".	0
H 1.5. Special Habitat Features: ***(see p. 77)*** *Check the habitat features that are present in the wetland. The number of checks is the number of points you put into the next column.* ☒ Large, downed, woody debris within the wetland (>4in. diameter and 6 ft long). ☒ Standing snags (diameter at the bottom > 4 inches) in the wetland ☐ Undercut banks are present for at least 6.6 ft (2m) and/or overhanging vegetation extends at least 3.3 ft (1m) over a stream for at least 33 ft (10m) ☐ Stable steep banks of fine material that might be used by beaver or muskrat for denning (>30degree slope) OR signs of recent beaver activity are present ☐ At least ¼ acre of thin-stemmed persistent vegetation or woody branches are present in areas that are permanently or seasonally inundated.*(structures for egg-laying by amphibians)* ☒ Invasive plants cover less than 25% of the wetland area in each stratum of plants *Note: The 20% stated in early printings of the manual on page 78 is an error.*	3
H 1. TOTAL Score - potential for providing habitat *Add the scores from H1.1, H1.2, H1.3, H1.4, H1.5*	5

Comments:

H 2. Does the wetland have the opportunity to provide habitat for many species?	
H 2.1 Buffers ***(see p. 80)*** *Choose the description that best represents condition of buffer of wetland. The highest scoring criterion that applies to the wetland is to be used in the rating. See text for definition of "undisturbed."* ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% of circumference. No developed areas within undisturbed part of buffer. (relatively undisturbed also means no-grazing) ..... Points = 5 ☐ ..... 100 m (330 ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 50% circumference. ..... Points = 4 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% circumference ..... Points = 4 ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 25% circumference ..... Points = 3 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water for > 50% circumference. ..... Points = 3 **If buffer does not meet any of the criteria above** ☐ No paved areas (except paved trails) or buildings within 25 m (80ft) of wetland > 95% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ No paved areas or buildings within 50m of wetland for >50% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ Heavy grazing in buffer. ..... Points = 1 ☐ Vegetated buffers are <2m wide (6.6ft) for more than 95% of the circumference (e.g. tilled fields, paving, basalt bedrock extend to edge of wetland ..... Points = 0 ☒ Buffer does not meet any of the criteria above..... Points = 1	1
H 2.2 Corridors and Connections ***(see p. 81)*** H 2.2.1 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 150 ft wide, has at least 30% cover of shrubs, forest or native undisturbed prairie, that connects to estuaries, other wetlands or undisturbed uplands that are at least 250 acres in size? (*dams in riparian corridors*, *heavily used gravel roads*, *paved roads, are considered breaks in the corridor*). YES = **4 points** (*go to H 2.3*) **NO** = go to H 2.2.2 H 2.2.2 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 50ft wide, has at least 30% cover of shrubs or forest, and connects to estuaries, other wetlands or undisturbed uplands that are at least 25 acres in size? **OR** a **Lake-fringe** wetland, if it does not have an undisturbed corridor as in the question above? YES = **2 points** (*go to H 2.3*) **NO** = H 2.2.3 H 2.2.3 Is the wetland: within 5 mi (8km) of a brackish or salt water estuary OR within 3 mi of a large field or pasture (>40 acres) OR within 1 mi of a lake greater than 20 acres? YES = **1 point** NO = **0 points**	0

H 2.3 Near or adjacent to other priority habitats listed by WDFW ***(see new and complete descriptions of WDFW priority habitats, and the counties in which they can be found, in the PHS report http://wdfw.wa.gov/hab/phslist.htm)*** Which of the following priority habitats are within 330ft (100m) of the wetland? *(NOTE: the connections do not have to be relatively undisturbed)* ☐ **Aspen Stands:** Pure or mixed stands of aspen greater than 0.4 ha (1 acres). ☐ **Biodiversity Areas and Corridors:** Areas of habitat that are relatively important to various species of native fish and wildlife (*full description in WDFW PHS report p. 152*) ☐ **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock. ☐ **Old-growth/Mature forests:** (Old-growth west of Cascade crest) Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 20 trees/ha (8 trees/acre) > 81 cm (32 in) dbh or > 200 years of age. (Mature forests.) Stands with average diameters exceeding 53 cm (21 in) dbh; crown cover may be less that 100%; crown cover may be less that 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80 - 200 years old west of the Cascade crest. ☐ **Oregon white Oak:** Woodlands Stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158.)* ☐ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other. ☐ **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161*) ☐ **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources. ☐ **Nearshore:** Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. *(full descriptions of habitats and the definition of relatively undisturbed are in WDFW report: pp. 167-169 and glossary in Appendix A.)* ☐ **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human. ☐ **Cliffs:** Greater than 7.6 m (25 ft) high and occurring below 5000 ft. ☐ **Talus:** Homogenous areas of rock rubble ranging in average size 0.15 - 2.0 m (0.5 - 6.5 ft), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs. ☐ **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of >51 cm (20 in) in western Washington and are > 2 m (6.5 ft) in height. Priority logs are > 30cm (12 in) in diameter at the largest end, and > 6m (20 ft) long. If wetland has **3 or more** priority habitats **= 4 points** If wetland has **2** priority habitats = **3 points** If wetland has **1** priority habitat **= 1 point** No habitats = **0 points** *Note: All vegetated wetland are by definition a priority habitat but are not included in this list. Nearby wetlands are addressed in question H2.4.*	0

H 2.4 Wetland Landscape *(choose the **one** description of the landscape around the wetland that best fits)* ***(see p. 84)*** There are at least 3 other wetlands within ½ mile, and the connections between them are relatively undisturbed (light grazing between wetlands OK, as is lake shore with some boating, but connections should NOT be bisected by paved roads, fill, fields, or other development. ..... points = 5 The wetland is Lake-fringe on a lake with little disturbance and there are 3 other lake-fringe wetlands within ½ mile ..... points = 5 There are at least 3 other wetlands within ½ mile, BUT the connections between them are disturbed ..... points = 3 The wetland is Lake-fringe on a lake **with** disturbance and there are 3 other lake-fringe wetland within ½ mile ..... points = 3 There is at least 1 wetland within ½ mile. ..... points = 2 There are no wetlands within ½ mile. ..... points = 0	2
H 2. TOTAL Score - opportunity for providing habitat *Add the scores from H2.1, H2.2, H2.3, H2.4*	3
TOTAL for H1 from page 14	5
Total Score for Habitat Functions – add the points for H 1, H 2 and record the result on p. 1	8

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Please determine if the wetland meets the attributes described below and circle the appropriate Category.

Wetland Type *Check off any criteria that apply to the wetland. Circle the Category when the appropriate criteria are met.*	**Category**
SC 1.0 Estuarine wetlands (*see p. 86)* Does the wetland unit meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt. YES = Go to SC 1.1 NO ☒	
SC 1.1 Is the wetland unit within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-151? ☐YES = Category I ☐NO = go to SC 1.2	**Cat. I**
SC 1.2 Is the wetland unit at least 1 acre in size and meets at least two of the following three conditions? ☐YES = Category I ☐NO = Category II ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. If the non-native Spartina spp. are the only species that cover more than 10% of the wetland, then the wetland should be given a dual rating (I/II) The are aof Spartina would be rated a Category II while the relatively undisturbed upper marsh with native species would be a Category I. Do not, however, exclude the area of Spartina in determining the size threshold of 1 acre. ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed wetland. ☐ The wetland has at least 2 or the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands.	**Cat. I** **Cat. II** **Dual rating I/II**

SC 2.0 Natural Heritage Wetlands ***(see p. 87)***

Natural Heritage wetlands have been identified by the Washington Natural Heritage Program/DNR as either high quality undisturbed wetlands or wetlands that support state Threatened, Endangered, or Sensitive plant species.

SC 2.1 Is the wetland being rated in a Section/Township/Range that contains a Natural Heritage wetland? *(this question is used to screen out most sites before you need to contact WNHP/DNR)*

S/T/R information from Appendix D ☐ or accessed from WNHP/DNR web site ☐

YES☐ – contact WNHP/DNR (see p. 79) and go to SC 2.2 NO ☒

SC 2.2 Has DNR identified the wetland as a high quality undisturbed wetland or as or as a site with state threatened or endangered plant species?

YES = Category I NO ☒ Not a Heritage Wetland

SC 3.0 Bogs ***(see p. 87)***

Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below to identify if the wetland is a bog. If you answer yes, you will still need to rate the wetland based on its functions.*

1. Does the wetland have organic soils horizons (i.e. layers of organic soil), either peats or mucks, that compose 16" or more of the first 32 inches of the soil profile? (See Appendix B for a field key to identify organic soils.)
   Yes - go to Q.3 NO - go to Q.2
2. Does the wetland have organic soils, either peats or mucks, that are less than 16 inches deep over bedrock or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond?
   Yes - go to Q.3 NO ☒ is not a bog for purpose of rating
3. Does the wetland have more than 70% cover of mosses at ground level, AND other plants, if present, consist of the "bog" species listed in Table 3 as a significant component of the vegetation (more than 30% of the total shrub and herbaceous cover consists species in Table 3)?
   Yes – Is a bog for purpose of rating NO - go to Q.4
   NOTE: If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16" deep. If the pH is less than 5.0 and the "bog" plant species in Table 3 are present, the wetland is a bog.
4. Is the wetland forested (>30% cover) with sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Englemann's spruce, or western white pine, WITH any of the species (or combination of species) on the bog species plant list in Table 3 as a significant component of the ground cover (*>30% coverage of the total shrub/herbaceous* cover)?
   YES = Category I NO ☒ is not a bog for purpose of rating

SC 4.0 Forested Wetlands *(see p. 90)*

Does the wetland have at least 1 acre of forest that meet one of these criteria for the Department of Fish and Wildlife's forests as priority habitats? *If you answer yes you will still need to rate the wetland based on its functions.*

☐ Old growth forests: (west of Cascade crest) Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/acre (20 trees/hectare) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 inches (81 cm) or more.
Note: The criterion for dbh is based on measurements for upland forests. Two hundred year old trees in wetlands will often have a smaller dbh because their growth rates are often slower. The DFW criterion is and "OR" so old-growth forests do not necessarily have to have trees of this diameter.

☐ Mature forests: (west of the Cascade crest) Stands where the largest trees are 80-200 years old OR have average diameters (dbh) exceeding 21 in (53 cm); crown cover may be less than 100%; decay, decadence, numbers of snags, and quanitity of large downed material is generally less than that found in old-growth

YES = Category 1 NO ☒ not a forested wetland with special characteristics

SC 5.0 Wetlands in Coastal Lagoons (see p. 91)

Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?

☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks.

☐ The lagoon in which the wetland is located contains surgace water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon (*needs to be measured near the bottom*)

YES – Go to SC 5.1 NO ☒ not a wetland in a coastal lagoon

Cat. I

SC 5.1 Does the wetland meet all of the following three conditions?

☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of invasive plant species (see list of invasive species on p. 74).

☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland.

☐ The wetalnd is larger than 1/10 acre (4350 square feet)

Cat. II

YES = Category I NO = Category II

SC 6.0 Interdunal Wetlands (see p. 93) Is the wetland unit west of the 1889 line (also called the Westarn Boundary of Upland Ownership or WBUO)? YES – go to SC 6.1 NO ☒ not an interdunal wetland for rating *If you answer yes you will still need to rate the wetland based on its functions.* In practical terms that means the following geographic areas: – Long Beach Peninsula – lands west of SR 103 – Grayland-Westport – lands west of SR 105 – Ocean Shores-Copalis – lands west of SR 115 and SR 109 SC 6.1 Is the wetland 1 acre or larger, or is it in a mosaic of wetlands that is 1 acre or larger? YES = Category II NO – go to SC 6.2 SC 6.2 Is the unit between 0.1 and 1 acre, or is it in a mosaic of wetlands that is between 0.1 and 1 acre? YES = Category III	**Cat. II** **Cat. III**
Category of wetland based on Special Characteristics *Choose the "highest" rating if wetland falls into several categorie, and record on p. 1 .* If you answered NO for all types enter "Not Applicable" on p.1.	**NA**

WETLAND RATING FORM – WESTERN WASHINGTON
Version 2 – Updated July 2006 to increase accuracy and reproducibility among users
Updated Oct 2008 with the new WDFW definitions for priority habitats

Name of wetland (if known): Happy Valley Slope Wetland Date of site visit: 12/21/11

Rated by: H. Mortensen Trained by Ecology? Yes ☒ No ☐ Date of Training 5/2005

SEC: 13 TWNSHP: 23N RNGE: 3E Is S/T/R in Appendix D? Yes ☐ No ☒

SUMMARY OF RATING

Category based on FUNCTIONS provided by wetland

I ☐ II ☐ III ☒ IV ☐

Category I = Score ≥70
Category II = Score 51-69
Category III = Score 30-50
Category IV = Score < 30

Score for Water Quality Functions	14
Score for Hydrologic Functions	16
Score for Habitat Functions	19
TOTAL score for functions	**39**

Category based on SPECIAL CHARACTERISTICS of wetland

I ☐ II ☐ Does not Apply ☒

Final Category (choose the "highest" category from above) **III**

Check the appropriate type and class of wetland being rated.

Wetland Type		Wetland Class	
Estuarine		**Depressional**	
Natural Heritage Wetland		**Riverine**	
Bog		**Lake-fringe**	
Mature Forest		**Slope**	**X**
Old Growth Forest		**Flats**	
Coastal Lagoon		**Freshwater Tidal**	
Interdunal			
None of the above	**X**	Check if unit has multiple HGM classes present	

Does the wetland unit being rated meet any of the criteria below?

If you answer YES to any of the questions below you will need to protect the wetland according to the regulations regarding the special characteristics found in the wetland.

Check List for Wetlands That May Need Additional Protection (in addition to the protection recommended for its category)	YES	NO
SP1. *Has the wetland unit been documented as a habitat for any Federally listed Threatened or Endangered **animal** or **plant** species (T/E species)?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state or federal database.		X*
SP2. *Has the wetland unit been documented as habitat for any State listed Threatened or Endangered **animal** species?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state database. Note: Wetlands with State listed plant species are categorized as Category I Natural Heritage Wetlands (see p. 19 of data form).		X*
SP3. *Does the wetland unit contain individuals of Priority species listed by the WDFW for the state?*		X*
SP4. *Does the wetland unit have a local significance in addition to its functions*? For example, the wetland has been identified in the Shoreline Master Program, the Critical Areas Ordinance, or in a local management plan as having special significance.		X

***The study area was reviewed for the presence of endangered, threatened, and priority species using WDFW online Priority Habitat and Species Data, PHS on the Web (http://wdfw.wa.gov/mapping/phs/).**

To complete the next part of the data sheet you will need to determine the Hydrogeomorphic Class of the wetland being rated.

The hydrogeomorphic classification groups wetlands into those that function in similar ways. Classifying the wetland first simplifies the questions needed to answer how it functions. The Hydrogeomorphic Class of a wetland can be determined using the key below. See p. 24 for more detailed instructions on classifying wetlands.

Classification of Wetland Units in Western Washington

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in Questions 1-7 apply, and go to Question 8.

1. Are the water levels in the wetland unit usually controlled by tides (i.e. except during floods)?

☒ NO – go to 2 ☐ **YES** – the wetland class is **Tidal Fringe**

If yes, is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)? **YES – Freshwater Tidal Fringe NO – Saltwater Tidal Fringe (Estuarine)**

*If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is rated as an **Estuarine** wetland.* Wetlands that were called estuarine in the first and second editions of the rating system are called Salt Water Tidal Fringe in the Hydrogeomorphic Classification. Estuarine wetlands were categorized separately in the earlier editions, and this separation is being kept in this revision. To maintain consistency between editions, the term "Estuarine" wetland is kept. Please note, however, that the characteristics that define Category I and II estuarine wetlands have changed (see p.).

2. The entire wetland unit is flat and precipitation is only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit

☒ NO – go to 3 ☐ **YES** – The wetland class is **Flats**

If your wetland can be classified as a "Flats" wetland, use the form for **Depressional** wetlands.

3. Does the entire wetland unit **meet both** of the following criteria?

☐ The vegetated part of the wetland is on the shores of a body of open water (without any vegetation on the surface) at least 20 acres (8 ha) in size;

☐ At least 30% of the open water area is deeper than 6.6 ft (2 m)?

☒ NO – go to 4 ☐ **YES –** The wetland class is **Lake-fringe (Lacustrine Fringe)**

4. Does the entire wetland unit **meet all** of the following criteria?

☒ The wetland is on a slope (*slope can be very gradual*),

☒ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.

☒ The water leaves the wetland **without being impounded**?

NOTE: *Surface water does not pond in these types of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3ft diameter and less than a foot deep).*

☐ NO – go to 5 ☒ **YES –** The wetland class is **Slope**

5. Does the entire wetland unit **meet all** of the following criteria?

☐ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river.

☐ The overbank flooding occurs at least once every two years

NOTE: The riverine unit can contain depressions that are filled with water when the river is not flooding.

☐ NO - go to 6 ☐ **YES** – The wetland class is **Riverine**

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year. *This means that any outlet, if present, is higher than the interior of the wetland.*

☐ NO – go to 7 ☐ **YES –** The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding. The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☐ NO – go to 8 ☐ **YES –** The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within your wetland. NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the class listed in column 2 is less than 10% of the unit, classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	*HGM Class to Use in Rating*
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake-fringe	Lake-fringe
Depressional + Riverine along stream within boundary	Depressional
Depressional + Lake-fringe	Depressional
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE under wetlands with special characteristics

If you are unable still to determine which of the above criteria apply to your wetland, or you have more than 2 HGM classes within a wetland boundary, classify the wetland as **Depressional** for the rating.

S	Slope Wetlands	Points
	WATER QUALITY FUNCTIONS - Indicators that wetland functions to improve water quality	
S	**S 1. Does the wetland have the <u>potential</u> to improve water quality?**	***(see p. 64)***
S	S 1.1 Characteristics of average slope of wetland: Slope is1% or less *(a 1% slope has a 1 foot vertical drop in elevation horizontal distance) for every 100 ft* ..... points = 3 Slope is 1% - 2% ..... points = 2 (Slope is 2% - 5% ..... points = 1) Slope is greater than 5% ..... points = 0	1
S	S 1.2 The soil 2 inches below the surface (or duff layer) is clay or organic *(use NRCS definitions)*. YES = 3 points (NO = 0 points)	0
S	S 1.3 Characteristics of the vegetation in the wetland that trap sediments and pollutants: *Choose the points appropriate for the description that best fits the vegetation in the wetland. Dense vegetation means you have trouble seeing the soil surface. Dense vegetation means you have trouble seeing the soil surface (>75% cover) and uncut means not grazed or mowed and plants are higher than 6 inches.* (Dense, ungrazed, herbaceous vegetation > 90% of the wetland area ..... points = 6) Dense, ungrazed, herbaceous vegetation > 1/2 of area ..... points = 3 Dense, woody, vegetation > ½ of area ..... points = 2 Dense, ungrazed, herbaceous vegetation > 1/4 of area ..... points = 1 Does not meet any of the criteria above for vegetation ..... points = 0	6
S	**Total for S 1** *Add the points in the boxes above*	7
S	**S 2. Does the wetland have the <u>opportunity</u> to improve water quality? *(see p. 67)*** Answer YES if you know or believe there are pollutants in groundwater or surface water coming into the wetland that would otherwise reduce water quality in streams, lakes or groundwater downgradient from the wetland? *Note which of the following conditions provide the sources of pollutants.A unit may have pollutants coming from several sources, but any single source would qualify as opportunity.* ☐ Grazing in the wetland or within 150 ft ☐ Untreated stormwater discharges to wetland ☐ Tilled fields, logging or orchards within 150 ft of wetland ☒ A stream or culvert discharges into wetland that drains developed areas, residential areas, farmed fields, roads, or clear-cut logging ☒ Residential, urban areas, or golf courses are within 150 ft upslope of wetland ☐ Other _____ (**YES** multiplier is **2**) **NO** multiplier is **1**	multiplier <u>2</u>
S	**<u>TOTAL</u> - Water Quality Functions** Multiply the score from S 1 by S 2 ***Add score to table on p. 1***	**14**

S	Slope Wetlands	Points
	HYDROLOGIC FUNCTIONS - Indicators that wetland functions to reduce flooding and stream erosion	
	S 3. Does the wetland have the potential to reduce flooding and erosion?	***(see p. 68)***
S	S 3.1 Characteristics of vegetation that reduce the velocity of surface flows during storms. *Choose the points appropriate for the description that best fit conditions in the wetland. (stems of plants should be thick enough (usually > 1/8in), or dense enough, to remain erect during surface flows)* (Dense, uncut, **rigid** vegetation covers > 90% of the area of the wetland. ..... points = 6) Dense, uncut, **rigid** vegetation > 1/2 area of wetland ..... points = 3 Dense, uncut, **rigid** vegetation > 1/4 area ..... points = 1 More than 1/4 of area is grazed, mowed, tilled or vegetation is not rigid ..... points = 0	6
S	S 3.2 Characteristics of slope wetland that holds back small amounts of flood flows: The slope wetland has small surface depressions that can retain water over at least 10% of its area. (YES points = 2) NO points = 0	2
S	**Total for S 3** *Add the points in the boxes above*	8
S	**S 4. Does the wetland have the opportunity to reduce flooding and erosion?** ***(see p. 70)*** Is the wetland in a landscape position where the reduction in water velocity it provides helps protect downstream property and aquatic resources from flooding or excessive and/or erosive flows? *Note which of the following conditions apply.* ☒ Wetland has surface runoff that drains to a river or stream that has flooding problems ☐ Other_____ *(Answer NO if the major source of water to the wetland is controlled by a reservoir or the wetland is tidal fringe along the sides of a dike)* **YES** multiplier is **2** **NO** multiplier is **1**	multiplier 2
S	**TOTAL - Hydrologic Functions** Multiply the score from S 3 by S 4 ***Add score to table on p. 1***	**16**

Comments

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that wetland functions to provide important habitat

H 1. Does the wetland have the potential to provide habitat for many species?

H 1.1 Vegetation structure ***(see p. 72)***

Check the types of vegetation classes present (as defined by Cowardin) if the class is ¼ acre or covers more than 10% of the area of the wetland if unit smaller than 2.5 acres.

- ☐ Aquatic bed
- ☐ Emergent plants
- ☒ Scrub/shrub (areas where shrubs have >30% cover)
- ☐ Forested (areas where trees have >30% cover)
- ☐ Forested areas have 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the forested polygon

Add the number of vegetation types that qualify. If you have:

4 structures or more ..... points = 4
3 structures ..... points = 2
2 structures ..... points = 1
[1 structure ..... points = 0]

Ravine is forested but only a few trees are rooted in the wetland

0

H 1.2. Hydroperiods ***(see p. 73)***

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ acre to count. (see text for descriptions of hydroperiods)

- ☐ Permanently flooded or inundated
- ☐ Seasonally flooded or inundated
- ☐ Occasionally flooded or inundated
- ☒ Saturated only
- ☐ Permanently flowing stream or river in, or adjacent to, the wetland
- ☒ Seasonally flowing stream in, or adjacent to, the wetland
- ☐ ***Lake-fringe wetland* = 2 points**
- ☐ ***Freshwater tidal wetland* = 2 points**

4 or more types present ..... points = 3
3 types present ..... points = 2
[2 types present ..... points = 1]
1 types present……points = 0

1

H 1.3. Richness of Plant Species ***(see p. 75)***

Count the number of plant species in the wetland that cover at least 10 ft^2. (*different patches of the same species can be combined to meet the size threshold)*

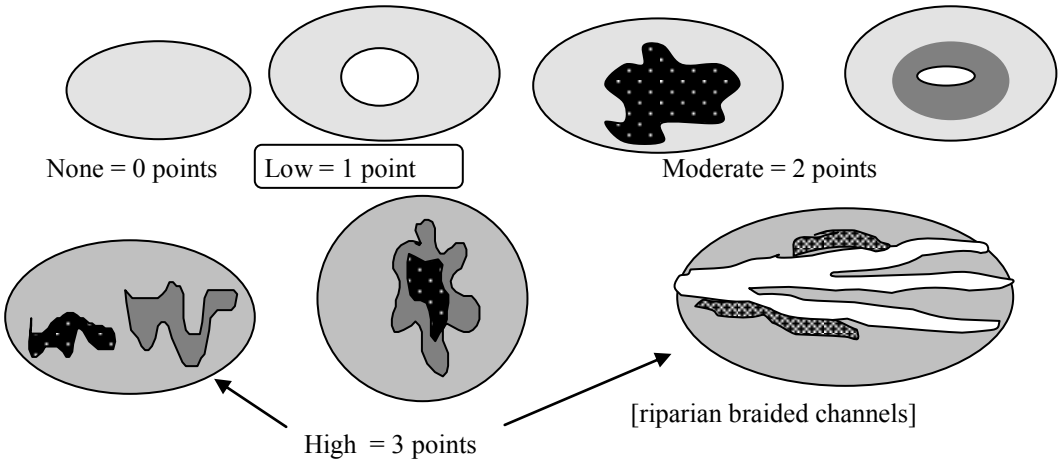
You do not have to name the species.

Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle

If you counted:
> 19 species ..... points = 2
[5 - 19 species ..... points = 1]
< 5 species ..... points = 0

List species below if you want to:

1

H 1.4. Interspersion of habitats ***(see p. 76)*** Decide from the diagrams below whether interspersion between Cowardin vegetation classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, medium, low, or none.  None = 0 points Low = 1 point Moderate = 2 points High = 3 points [riparian braided channels] NOTE: If you have four or more vegetation types or three vegetation types and open water the rating is always "high".	1
H 1.5. Special Habitat Features: ***(see p. 77)*** *Check the habitat features that are present in the wetland. The number of checks is the number of points you put into the next column.* ☒ Large, downed, woody debris within the wetland (>4in. diameter and 6 ft long). ☒ Standing snags (diameter at the bottom > 4 inches) in the wetland ☒ Undercut banks are present for at least 6.6 ft (2m) and/or overhanging vegetation extends at least 3.3 ft (1m) over a stream for at least 33 ft (10m) ☐ Stable steep banks of fine material that might be used by beaver or muskrat for denning (>30degree slope) OR signs of recent beaver activity are present ☐ At least ¼ acre of thin-stemmed persistent vegetation or woody branches are present in areas that are permanently or seasonally inundated.*(structures for egg-laying by amphibians)* ☒ Invasive plants cover less than 25% of the wetland area in each stratum of plants *Note: The 20% stated in early printings of the manual on page 78 is an error.*	4
H 1. TOTAL Score - potential for providing habitat *Add the scores from H1.1, H1.2, H1.3, H1.4, H1.5*	7

H 2. Does the wetland have the opportunity to provide habitat for many species?	
H 2.1 Buffers ***(see p. 80)*** *Choose the description that best represents condition of buffer of wetland. The highest scoring criterion that applies to the wetland is to be used in the rating. See text for definition of "undisturbed."* ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% of circumference. No developed areas within undisturbed part of buffer. (relatively undisturbed also means no-grazing) ..... Points = 5 ☒ ..... 100 m (330 ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 50% circumference..... Points = 4 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% circumference..... Points = 4 ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 25% circumference..... Points = 3 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water for > 50% circumference. ..... Points = 3 **If buffer does not meet any of the criteria above** ☐ No paved areas (except paved trails) or buildings within 25 m (80ft) of wetland > 95% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ No paved areas or buildings within 50m of wetland for >50% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ Heavy grazing in buffer. ..... Points = 1 ☐ Vegetated buffers are <2m wide (6.6ft) for more than 95% of the circumference (e.g. tilled fields, paving, basalt bedrock extend to edge of wetland ..... Points = 0 ☐ Buffer does not meet any of the criteria above……...Points = 1	4
H 2.2 Corridors and Connections ***(see p. 81)*** H 2.2.1 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 150 ft wide, has at least 30% cover of shrubs, forest or native undisturbed prairie, that connects to estuaries, other wetlands or undisturbed uplands that are at least 250 acres in size? (*dams in riparian corridors*, *heavily used gravel roads*, *paved roads, are considered breaks in the corridor*). YES = **4 points** (*go to H 2.3*) **NO** = go to H 2.2.2 H 2.2.2 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 50ft wide, has at least 30% cover of shrubs or forest, and connects to estuaries, other wetlands or undisturbed uplands that are at least 25 acres in size? **OR** a **Lake-fringe** wetland, if it does not have an undisturbed corridor as in the question above? YES = **2 points** (*go to H 2.3*) **NO** = H 2.2.3 H 2.2.3 Is the wetland: within 5 mi (8km) of a brackish or salt water estuary OR within 3 mi of a large field or pasture (>40 acres) OR within 1 mi of a lake greater than 20 acres? YES = **1 point** NO = **0 points**	2

H 2.3 Near or adjacent to other priority habitats listed by WDFW ***(see new and complete descriptions of WDFW priority habitats, and the counties in which they can be found, in the PHS report http://wdfw.wa.gov/hab/phslist.htm)***

Which of the following priority habitats are within 330ft (100m) of the wetland?
(NOTE: the connections do not have to be relatively undisturbed)

☐ **Aspen Stands:** Pure or mixed stands of aspen greater than 0.4 ha (1 acres).

☒ **Biodiversity Areas and Corridors:** Areas of habitat that are relatively important to various species of native fish and wildlife (*full description in WDFW PHS report p. 152*)

☐ **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock.

☐ **Old-growth/Mature forests:** (Old-growth west of Cascade crest) Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 20 trees/ha (8 trees/acre) > 81 cm (32 in) dbh or > 200 years of age. (Mature forests.) Stands with average diameters exceeding 53 cm (21 in) dbh; crown cover may be less that 100%; crown cover may be less that 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80 - 200 years old west of the Cascade crest.

☐ **Oregon white Oak:** Woodlands Stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158.)*

☒ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.

☐ **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161*)

☒ **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

☐ **Nearshore:** Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. *(full descriptions of habitats and the definition of relatively undisturbed are in WDFW report: pp. 167-169 and glossary in Appendix A.)*

☐ **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.

☐ **Cliffs:** Greater than 7.6 m (25 ft) high and occurring below 5000 ft.

☐ **Talus:** Homogenous areas of rock rubble ranging in average size 0.15 - 2.0 m (0.5 - 6.5 ft), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.

☒ **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of >51 cm (20 in) in western Washington and are > 2 m (6.5 ft) in height. Priority logs are > 30cm (12 in) in diameter at the largest end, and > 6m (20 ft) long.

If wetland has **3 or more** priority habitats = **4 points**
If wetland has **2** priority habitats = **3 points**
If wetland has **1** priority habitat **= 1 point**
No habitats = **0 points**

Note: All vegetated wetland are by definition a priority habitat but are not included in this list. Nearby wetlands are addressed in question H2.4.

4

H 2.4 Wetland Landscape *(choose the **one** description of the landscape around the wetland that best fits)* ***(see p. 84)*** There are at least 3 other wetlands within ½ mile, and the connections between them are relatively undisturbed (light grazing between wetlands OK, as is lake shore with some boating, but connections should NOT be bisected by paved roads, fill, fields, or other development. ..... points = 5 The wetland is Lake-fringe on a lake with little disturbance and there are 3 other lake-fringe wetlands within ½ mile ..... points = 5 There are at least 3 other wetlands within ½ mile, BUT the connections between them are disturbed ..... points = 3 The wetland is Lake-fringe on a lake **with** disturbance and there are 3 other lake-fringe wetland within ½ mile ..... points = 3 There is at least 1 wetland within ½ mile. ..... points = 2 There are no wetlands within ½ mile. ..... points = 0	2
H 2. TOTAL Score - opportunity for providing habitat *Add the scores from H2.1, H2.2, H2.3, H2.4*	12
TOTAL for H1 from page 14	7
Total Score for Habitat Functions – add the points for H 1, H 2 and record the result on p. 1	19

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Please determine if the wetland meets the attributes described below and circle the appropriate Category.

Wetland Type *Check off any criteria that apply to the wetland. Circle the Category when the appropriate criteria are met.*	**Category**
SC 1.0 Estuarine wetlands (*see p. 86)* Does the wetland unit meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt. YES = Go to SC 1.1 NO ☒	
SC 1.1 Is the wetland unit within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-151? ☐YES = Category I ☐NO = go to SC 1.2	**Cat. I**
SC 1.2 Is the wetland unit at least 1 acre in size and meets at least two of the following three conditions? ☐YES = Category I ☐NO = Category II ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. If the non-native Spartina spp. are the only species that cover more than 10% of the wetland, then the wetland should be given a dual rating (I/II) The are aof Spartina would be rated a Category II while the relatively undisturbed upper marsh with native species would be a Category I. Do not, however, exclude the area of Spartina in determining the size threshold of 1 acre. ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed wetland. ☐ The wetland has at least 2 or the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands.	**Cat. I** **Cat. II** **Dual rating I/II**

SC 2.0 Natural Heritage Wetlands ***(see p. 87)*** Natural Heritage wetlands have been identified by the Washington Natural Heritage Program/DNR as either high quality undisturbed wetlands or wetlands that support state Threatened, Endangered, or Sensitive plant species. SC 2.1 Is the wetland being rated in a Section/Township/Range that contains a Natural Heritage wetland? *(this question is used to screen out most sites before you need to contact WNHP/DNR)* S/T/R information from Appendix D ☐ or accessed from WNHP/DNR web site ☐ YES☐ – contact WNHP/DNR (see p. 79) and go to SC 2.2 NO ☒ SC 2.2 Has DNR identified the wetland as a high quality undisturbed wetland or as or as a site with state threatened or endangered plant species? YES = Category I NO ☐ Not a Heritage Wetland	**Cat. I**
SC 3.0 Bogs ***(see p. 87)*** Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below to identify if the wetland is a bog. If you answer yes, you will still need to rate the wetland based on its functions.* 1. Does the wetland have organic soils horizons (i.e. layers of organic soil), either peats or mucks, that compose 16" or more of the first 32 inches of the soil profile? (See Appendix B for a field key to identify organic soils.) Yes - go to Q.3 NO - go to Q.2 2. Does the wetland have organic soils, either peats or mucks, that are less than 16 inches deep over bedrock or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? Yes - go to Q.3 NO ☒ is not a bog for purpose of rating 3. Does the wetland have more than 70% cover of mosses at ground level, AND other plants, if present, consist of the "bog" species listed in Table 3 as a significant component of the vegetation (more than 30% of the total shrub and herbaceous cover consists species in Table 3)? Yes – Is a bog for purpose of rating NO - go to Q.4 *NOTE: If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16" deep. If the pH is less than 5.0 and the "bog" plant species in Table 3 are present, the wetland is a bog.* 4. Is the wetland forested (>30% cover) with sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Englemann's spruce, or western white pine, WITH any of the species (or combination of species) on the bog species plant list in Table 3 as a significant component of the ground cover (*>30% coverage of the total shrub/herbaceous* cover)? YES = Category I NO ☐ is not a bog for purpose of rating	**Cat. I**

SC 4.0 Forested Wetlands *(see p. 90)*	
Does the wetland have at least 1 acre of forest that meet one of these criteria for the Department of Fish and Wildlife's forests as priority habitats? *If you answer yes you will still need to rate the wetland based on its functions.*	
☐ Old growth forests: (west of Cascade crest) Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/acre (20 trees/hectare) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 inches (81 cm) or more. *Note: The criterion for dbh is based on measurements for upland forests. Two hundred year old trees in wetlands will often have a smaller dbh because their growth rates are often slower. The DFW criterion is and "OR" so old-growth forests do not necessarily have to have trees of this diameter.*	
☐ Mature forests: (west of the Cascade crest) Stands where the largest trees are 80-200 years old OR have average diameters (dbh) exceeding 21 in (53 cm); crown cover may be less than 100%; decay, decadence, numbers of snags, and quanitity of large downed material is generally less than that found in old-growth	
YES = Category 1 NO ☒ not a forested wetland with special characteristics	**Cat. I**
SC 5.0 Wetlands in Coastal Lagoons (see p. 91)	
Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?	
☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks.	
☐ The lagoon in which the wetland is located contains surgace water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon (*needs to be measured near the bottom*)	
YES – Go to SC 5.1 NO ☒ not a wetland in a coastal lagoon	**Cat. I**
SC 5.1 Does the wetland meet all of the following three conditions?	
☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of invasive plant species (see list of invasive species on p. 74).	
☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland.	
☐The wetalnd is larger than 1/10 acre (4350 square feet)	
YES = Category I NO = Category II	**Cat. II**

SC 6.0 Interdunal Wetlands (see p. 93) Is the wetalnd unit west of the 1889 line (also called the Westarn Boundary of Upland Ownership or WBUO)? YES – go to SC 6.1 NO ☒ not an interdunal wetland for rating *If you answer yes you will still need to rate the wetland based on its functions.* In practical terms that means the following geographic areas: – Long Beach Peninsula – lands west of SR 103 – Grayland-Westport – lands west of SR 105 – Ocean Shores-Copalis – lands west of SR 115 and SR 109 SC 6.1 Is the wetland 1 acre or larger, or is it in a mosaic of wetlands that is 1 acre or larger? YES = Category II NO – go to SC 6.2 SC 6.2 Is the unit between 0.1 and 1 acre, or is it in a mosaic of wetlands that is between 0.1 and 1 acre? YES = Category III	**Cat. II** **Cat. III**
Category of wetland based on Special Characteristics *Choose the "highest" rating if wetland falls into several categorie, and record on p. 1 .* If you answered NO for all types enter "Not Applicable" on p.1.	NA

Wetland name or number _____

WETLAND RATING FORM – WESTERN WASHINGTON
Version 2 – Updated July 2006 to increase accuracy and reproducibility among users
Updated Oct 2008 with the new WDFW definitions for priority habitats

Name of wetland (if known): Hidden Lake Date of site visit: 9/20/12

Rated by: H. Mortensen Trained by Ecology? Yes ☒ No ☐ Date of Training May 2005

SEC: 12 TWNSHP: 26N RNGE: 3E Is S/T/R in Appendix D? Yes ☐ No ☒

SUMMARY OF RATING

Category based on FUNCTIONS provided by wetland

I ☐ II ☐ III ☒ IV ☐

Category I = Score ≥70
Category II = Score 51-69
Category III = Score 30-50
Category IV = Score < 30

Score for Water Quality Functions	16
Score for Hydrologic Functions	8
Score for Habitat Functions	19
TOTAL score for functions	**43**

Category based on SPECIAL CHARACTERISTICS of wetland

I ☐ II ☐ Does not Apply ☒

Final Category (choose the "highest" category from above) **III**

Check the appropriate type and class of wetland being rated.

Wetland Type		Wetland Class	
Estuarine		**Depressional**	**X**
Natural Heritage Wetland		**Riverine**	
Bog		**Lake-fringe**	
Mature Forest		**Slope**	
Old Growth Forest		**Flats**	
Coastal Lagoon		**Freshwater Tidal**	
Interdunal			
None of the above	**X**	Check if unit has multiple HGM classes present	

Does the wetland unit being rated meet any of the criteria below?

If you answer YES to any of the questions below you will need to protect the wetland according to the regulations regarding the special characteristics found in the wetland.

Check List for Wetlands That May Need Additional Protection (in addition to the protection recommended for its category)	YES	NO
SP1. *Has the wetland unit been documented as a habitat for any Federally listed Threatened or Endangered* ***animal*** *or* ***plant*** *species (T/E species)?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state or federal database.		X*
SP2. *Has the wetland unit been documented as habitat for any State listed Threatened or Endangered* ***animal*** *species?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state database. Note: Wetlands with State listed plant species are categorized as Category I Natural Heritage Wetlands (see p. 19 of data form).		X*
SP3. *Does the wetland unit contain individuals of Priority species listed by the WDFW for the state?* **(Resident Cutthroat)**	X*	
SP4. *Does the wetland unit have a local significance in addition to its functions*? For example, the wetland has been identified in the Shoreline Master Program, the Critical Areas Ordinance, or in a local management plan as having special significance.		X

***The study area was reviewed for the presence of endangered, threatened, and priority species using WDFW online Priority Habitat and Species Data, PHS on the Web (http://wdfw.wa.gov/mapping/phs/).**

To complete the next part of the data sheet you will need to determine the Hydrogeomorphic Class of the wetland being rated.

The hydrogeomorphic classification groups wetlands into those that function in similar ways. Classifying the wetland first simplifies the questions needed to answer how it functions. The Hydrogeomorphic Class of a wetland can be determined using the key below. See p. 24 for more detailed instructions on classifying wetlands.

Classification of Wetland Units in Western Washington

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in Questions 1-7 apply, and go to Question 8.

1. Are the water levels in the wetland unit usually controlled by tides (i.e. except during floods)?

☒ NO – go to 2 ☐ **YES** – the wetland class is **Tidal Fringe**

If yes, is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)? **YES – Freshwater Tidal Fringe NO – Saltwater Tidal Fringe (Estuarine)**

*If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is rated as an **Estuarine** wetland.* Wetlands that were called estuarine in the first and second editions of the rating system are called Salt Water Tidal Fringe in the Hydrogeomorphic Classification. Estuarine wetlands were categorized separately in the earlier editions, and this separation is being kept in this revision. To maintain consistency between editions, the term "Estuarine" wetland is kept. Please note, however, that the characteristics that define Category I and II estuarine wetlands have changed (see p.).

2. The entire wetland unit is flat and precipitation is only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit

☒ NO – go to 3 ☐ **YES** – The wetland class is **Flats**

If your wetland can be classified as a "Flats" wetland, use the form for **Depressional** wetlands.

3. Does the entire wetland unit **meet both** of the following criteria?

☐ The vegetated part of the wetland is on the shores of a body of open water (without any vegetation on the surface) at least 20 acres (8 ha) in size;

☒ At least 30% of the open water area is deeper than 6.6 ft (2 m)?

☒ NO – go to 4 ☐ **YES –** The wetland class is **Lake-fringe (Lacustrine Fringe)**

4. Does the entire wetland unit **meet all** of the following criteria?

☐ The wetland is on a slope (*slope can be very gradual*),

☐ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.

☐ The water leaves the wetland **without being impounded**?

NOTE: *Surface water does not pond in these types of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3ft diameter and less than a foot deep).*

☒ NO – go to 5 ☐ **YES –** The wetland class is **Slope**

5. Does the entire wetland unit **meet all** of the following criteria?

☒ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river.

☒ The overbank flooding occurs at least once every two years

NOTE: The riverine unit can contain depressions that are filled with water when the river is not flooding.

☐ NO - go to 6 ☒ **YES** – The wetland class is **Riverine**

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year. *This means that any outlet, if present, is higher than the interior of the wetland.*

☐ NO – go to 7 ☐ **YES –** The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding. The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☐ NO – go to 8 ☐ **YES –** The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within your wetland. NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the class listed in column 2 is less than 10% of the unit, classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	*HGM Class to Use in Rating*
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake-fringe	Lake-fringe
Depressional + Riverine along stream within boundary	Depressional
Depressional + Lake-fringe	Depressional
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE under wetlands with special characteristics

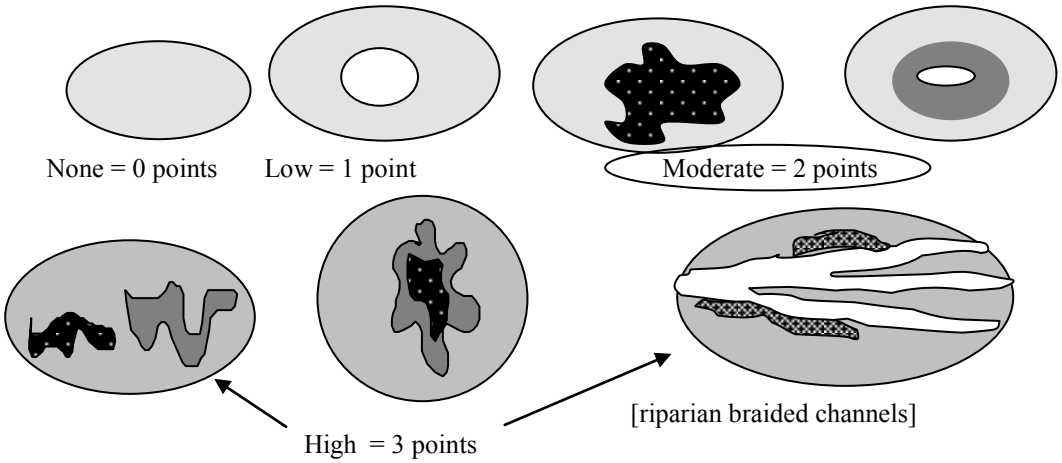
If you are unable still to determine which of the above criteria apply to your wetland, or you have more than 2 HGM classes within a wetland boundary, classify the wetland as **Depressional** for the rating.

R	Riverine and Freshwater Tidal Fringe Wetlands	Points
	WATER QUALITY FUNCTIONS - Indicators that wetland functions to improve water quality	
R	**R 1. Does the wetland have the potential to improve water quality?**	*(see p. 52)*
R	R 1.1 Area of surface depressions within the riverine wetland that can trap sediments during a flooding event: Depressions cover >3/4 area of wetland ..... points = 8 Depressions cover > 1/2 area of wetland ..... points = 4 Depressions present but cover < 1/2 area of wetland ..... points = 2 No depressions present ..... points = 0	8
R	R 1.2 Characteristics of the vegetation in the wetland (areas with > 90% cover at person height): Forest or shrub > 2/3 the area of the wetland ..... points = 8 Forest or shrub > 1/3 area of the wetland ..... points = 6 Ungrazed, emergent plants > 2/3 area of wetland ..... points = 6 Ungrazed emergent plants > 1/3 area of wetland ..... points = 3 Forest, shrub, and ungrazed emergent < 1/3 area of wetland ..... points = 0	0
R	**Total for R 1** *Add the points in the boxes above*	8
R	**R 2. Does the wetland have the opportunity to improve water quality?** *(see p. 53)* Answer YES if you know or believe there are pollutants in groundwater or surface water coming into the wetland that would otherwise reduce water quality in streams, lakes or groundwater downgradient from the wetland? *Note which of the following conditions provide the sources of pollutants.* ☐ Grazing in the wetland or within 150 ft ☐ Untreated stormwater discharges to wetland ☐ Tilled fields or orchards within 150 ft of wetland ☐ A stream or culvert discharges into wetland that drains developed areas, residential areas, farmed fields, roads, or clear-cut logging ☒ Residential, urban areas, golf courses are within 150 ft of wetland ☐ The river or stream linked to the wetland has a contributing basin where human activities have raised levels of sediment, toxic compounds or nutrients in the river water above standards for water quality ☐ Other_____ **YES** multiplier is **2** **NO** multiplier is **1**	multiplier 2
R	**TOTAL - Water Quality Functions** Multiply the score from R 1 by R 2 ***Add score to table on p. 1***	**16**

Comments

R	**Riverine and Freshwater Tidal Fringe Wetlands**	
	HYDROLOGIC FUNCTIONS - Indicators that wetland functions to reduce flooding and stream erosion	
	R 3. Does the wetland have the <u>potential</u> to reduce flooding and erosion?	***(see p. 54)***
R	R 3.1 Characteristics of the overbank storage the wetland provides: *Estimate the average width of the wetland perpendicular to the direction of the flow and the width of the stream or river channel (distance between banks). Calculate the ratio: (width of wetland)/(width of stream).* If the ratio is more than 20 ..... points = 9 If the ratio is between 10 – 20 ..... points = 6 If the ratio is 5- <10 ..... points = 4 If the ratio is 1- <5 ..... points = 2 If the ratio is < 1 ..... points = 1	4
R	R 3.2 Characteristics of vegetation that slow down water velocities during floods: *Treat large woody debris as "forest or shrub". Choose the points appropriate for the best description.* (polygons need to have >90% cover at person height NOT Cowardin classes) Forest or shrub for >1/3 area OR Emergent plants > 2/3 area ..... points = 7 Forest or shrub for > 1/10 area OR Emergent plants > 1/3 area ..... points = 4 Vegetation does not meet above criteria ..... points = 0	0
R	**Total for R 3** *Add the points in the boxes above*	4
R	**R 4. Does the wetland have the <u>opportunity</u> to reduce flooding and erosion? *(see p. 57)*** Answer YES if the wetland is in a location in the watershed where the flood storage, or reduction in water velocity, it provides helps protect downstream property and aquatic resources from flooding or excessive and/or erosive flows. *Note which of the following conditions apply.* ☒ There are human structures and activities downstream (roads, buildings, bridges, farms) that can be damaged by flooding. ☒ There are natural resources downstream (e.g. salmon redds) that can be damaged by flooding ☐ Other_____ *(Answer NO if the major source of water to the wetland is controlled by a reservoir or the wetland is tidal fringe along the sides of a dike)* **YES** multiplier is **2** **NO** multiplier is **1**	multiplier 2
R	**TOTAL - Hydrologic Functions** Multiply the score from R 3 by R 4 ***Add score to table on p. 1***	8

These questions apply to wetlands of all HGM classes. **HABITAT FUNCTIONS - Indicators that wetland functions to provide important habitat**	
H 1. Does the wetland have the potential to provide habitat for many species?	
H 1.1 Vegetation structure ***(see p. 72)*** *Check the types of vegetation classes present (as defined by Cowardin) if the class is ¼ acre or covers more than 10% of the area of the wetland if unit smaller than 2.5 acres.* ☒ Aquatic bed ☐ Emergent plants ☒ Scrub/shrub (areas where shrubs have >30% cover) ☐ Forested (areas where trees have >30% cover) ☐ Forested areas have 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the forested polygon *Add the number of vegetation types that qualify. If you have:* 4 structures or more ..... points = 4 3 structures ..... points = 2 2 structures ..... points = 1 1 structure ..... points = 0	1
H 1.2. Hydroperiods ***(see p. 73)*** *Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ acre to count. (see text for descriptions of hydroperiods)* ☒ Permanently flooded or inundated — 4 or more types present ..... points = 3 ☐ Seasonally flooded or inundated — 3 types present ..... points = 2 ☐ Occasionally flooded or inundated — 2 types present ..... points = 1 ☐ Saturated only — 1 types present……points = 0 ☒ Permanently flowing stream or river in, or adjacent to, the wetland ☐ Seasonally flowing stream in, or adjacent to, the wetland ☐ ***Lake-fringe wetland* = 2 points** ☐ ***Freshwater tidal wetland* = 2 points**	1
H 1.3. Richness of Plant Species ***(see p. 75)*** Count the number of plant species in the wetland that cover at least 10 ft^2. (*different patches of the same species can be combined to meet the size threshold)* *You do not have to name the species.* *Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle* If you counted: > 19 species ..... points = 2 *List species below if you want to:* 5 - 19 species ..... points = 1 < 5 species ..... points = 0	1

H 1.4. Interspersion of habitats ***(see p. 76)*** Decide from the diagrams below whether interspersion between Cowardin vegetation classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, medium, low, or none.  NOTE: If you have four or more vegetation types or three vegetation types and open water the rating is always "high".	2
H 1.5. Special Habitat Features: ***(see p. 77)*** *Check the habitat features that are present in the wetland. The number of checks is the number of points you put into the next column.* ☒ Large, downed, woody debris within the wetland (>4in. diameter and 6 ft long). ☐ Standing snags (diameter at the bottom > 4 inches) in the wetland ☒ Undercut banks are present for at least 6.6 ft (2m) and/or overhanging vegetation extends at least 3.3 ft (1m) over a stream for at least 33 ft (10m) ☒ Stable steep banks of fine material that might be used by beaver or muskrat for denning (>30degree slope) OR signs of recent beaver activity are present ☐ At least ¼ acre of thin-stemmed persistent vegetation or woody branches are present in areas that are permanently or seasonally inundated.*(structures for egg-laying by amphibians)* ☐ Invasive plants cover less than 25% of the wetland area in each stratum of plants *Note: The 20% stated in early printings of the manual on page 78 is an error.*	3
H 1. TOTAL Score - potential for providing habitat *Add the scores from H1.1, H1.2, H1.3, H1.4, H1.5*	8

H 2. Does the wetland have the opportunity to provide habitat for many species?	
H 2.1 Buffers ***(see p. 80)*** *Choose the description that best represents condition of buffer of wetland. The highest scoring criterion that applies to the wetland is to be used in the rating. See text for definition of "undisturbed."* ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% of circumference. No developed areas within undisturbed part of buffer. (relatively undisturbed also means no-grazing) ..... Points = 5 ☐ ..... 100 m (330 ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 50% circumference. ..... Points = 4 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% circumference ..... Points = 4 ☒ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 25% circumference ..... Points = 3 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water for > 50% circumference. ..... Points = 3 **If buffer does not meet any of the criteria above** ☐ No paved areas (except paved trails) or buildings within 25 m (80ft) of wetland > 95% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ No paved areas or buildings within 50m of wetland for >50% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ Heavy grazing in buffer. ..... Points = 1 ☐ Vegetated buffers are <2m wide (6.6ft) for more than 95% of the circumference (e.g. tilled fields, paving, basalt bedrock extend to edge of wetland ..... Points = 0 ☐ Buffer does not meet any of the criteria above……...Points = 1	3
H 2.2 Corridors and Connections ***(see p. 81)*** H 2.2.1 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 150 ft wide, has at least 30% cover of shrubs, forest or native undisturbed prairie, that connects to estuaries, other wetlands or undisturbed uplands that are at least 250 acres in size? (*dams in riparian corridors*, *heavily used gravel roads*, *paved roads, are considered breaks in the corridor*). YES = **4 points** (*go to H 2.3*) **NO** = go to H 2.2.2 H 2.2.2 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 50ft wide, has at least 30% cover of shrubs or forest, and connects to estuaries, other wetlands or undisturbed uplands that are at least 25 acres in size? **OR** a **Lake-fringe** wetland, if it does not have an undisturbed corridor as in the question above? YES = **2 points** (*go to H 2.3*) **NO** = H 2.2.3 H 2.2.3 Is the wetland: within 5 mi (8km) of a brackish or salt water estuary OR within 3 mi of a large field or pasture (>40 acres) OR within 1 mi of a lake greater than 20 acres? YES = **1 point** NO = **0 points**	2

H 2.3 Near or adjacent to other priority habitats listed by WDFW ***(see new and complete descriptions of WDFW priority habitats, and the counties in which they can be found, in the PHS report http://wdfw.wa.gov/hab/phslist.htm)***

Which of the following priority habitats are within 330ft (100m) of the wetland?
(NOTE: the connections do not have to be relatively undisturbed)

☐ **Aspen Stands:** Pure or mixed stands of aspen greater than 0.4 ha (1 acres).

☒ **Biodiversity Areas and Corridors:** Areas of habitat that are relatively important to various species of native fish and wildlife (*full description in WDFW PHS report p. 152*)

☐ **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock.

☒ **Old-growth/Mature forests:** (Old-growth west of Cascade crest) Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 20 trees/ha (8 trees/acre) > 81 cm (32 in) dbh or > 200 years of age. (Mature forests.) Stands with average diameters exceeding 53 cm (21 in) dbh; crown cover may be less that 100%; crown cover may be less that 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80 - 200 years old west of the Cascade crest.

☐ **Oregon white Oak:** Woodlands Stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158.)*

☒ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.

☐ **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161*)

☒ **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

☐ **Nearshore:** Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. *(full descriptions of habitats and the definition of relatively undisturbed are in WDFW report: pp. 167-169 and glossary in Appendix A.)*

☐ **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.

☐ **Cliffs:** Greater than 7.6 m (25 ft) high and occurring below 5000 ft.

☐ **Talus:** Homogenous areas of rock rubble ranging in average size 0.15 - 2.0 m (0.5 - 6.5 ft), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.

☒ **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of >51 cm (20 in) in western Washington and are > 2 m (6.5 ft) in height. Priority logs are > 30cm (12 in) in diameter at the largest end, and > 6m (20 ft) long.

If wetland has **3 or more** priority habitats **= 4 points**
If wetland has **2** priority habitats = **3 points**
If wetland has **1** priority habitat **= 1 point**
No habitats = **0 points**

Note: All vegetated wetland are by definition a priority habitat but are not included in this list. Nearby wetlands are addressed in question H2.4.

4

H 2.4 Wetland Landscape *(choose the **one** description of the landscape around the wetland that best fits)* ***(see p. 84)*** There are at least 3 other wetlands within ½ mile, and the connections between them are relatively undisturbed (light grazing between wetlands OK, as is lake shore with some boating, but connections should NOT be bisected by paved roads, fill, fields, or other development. ..... points = 5 The wetland is Lake-fringe on a lake with little disturbance and there are 3 other lake-fringe wetlands within ½ mile ..... points = 5 There are at least 3 other wetlands within ½ mile, BUT the connections between them are disturbed ..... points = 3 The wetland is Lake-fringe on a lake **with** disturbance and there are 3 other lake-fringe wetland within ½ mile ..... points = 3 There is at least 1 wetland within ½ mile. ..... points = 2 There are no wetlands within ½ mile. ..... points = 0	2
H 2. TOTAL Score - opportunity for providing habitat *Add the scores from H2.1, H2.2, H2.3, H2.4*	11
TOTAL for H1 from page 14	8
Total Score for Habitat Functions – add the points for H 1, H 2 and record the result on p. 1	19

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Please determine if the wetland meets the attributes described below and circle the appropriate Category.

Wetland Type *Check off any criteria that apply to the wetland. Circle the Category when the appropriate criteria are met.*	**Category**
SC 1.0 Estuarine wetlands (*see p. 86)* Does the wetland unit meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt. YES = Go to SC 1.1 NO ☒	
SC 1.1 Is the wetland unit within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-151? ☐YES = Category I ☐NO = go to SC 1.2	**Cat. I**
SC 1.2 Is the wetland unit at least 1 acre in size and meets at least two of the following three conditions? ☐YES = Category I ☐NO = Category II ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. If the non-native Spartina spp. are the only species that cover more than 10% of the wetland, then the wetland should be given a dual rating (I/II) The are aof Spartina would be rated a Category II while the relatively undisturbed upper marsh with native species would be a Category I. Do not, however, exclude the area of Spartina in determining the size threshold of 1 acre. ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed wetland. ☐ The wetland has at least 2 or the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands.	**Cat. I** **Cat. II** **Dual rating I/II**

SC 2.0 Natural Heritage Wetlands ***(see p. 87)*** Natural Heritage wetlands have been identified by the Washington Natural Heritage Program/DNR as either high quality undisturbed wetlands or wetlands that support state Threatened, Endangered, or Sensitive plant species. SC 2.1 Is the wetland being rated in a Section/Township/Range that contains a Natural Heritage wetland? *(this question is used to screen out most sites before you need to contact WNHP/DNR)* S/T/R information from Appendix D ☐ or accessed from WNHP/DNR web site ☐ YES☐ – contact WNHP/DNR (see p. 79) and go to SC 2.2 NO ☒ SC 2.2 Has DNR identified the wetland as a high quality undisturbed wetland or as or as a site with state threatened or endangered plant species? YES = Category I NO ☐ Not a Heritage Wetland	**Cat. I**
SC 3.0 Bogs ***(see p. 87)*** Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below to identify if the wetland is a bog. If you answer yes, you will still need to rate the wetland based on its functions.* 1. Does the wetland have organic soils horizons (i.e. layers of organic soil), either peats or mucks, that compose 16" or more of the first 32 inches of the soil profile? (See Appendix B for a field key to identify organic soils.) Yes - go to Q.3 NO - go to Q.2 2. Does the wetland have organic soils, either peats or mucks, that are less than 16 inches deep over bedrock or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? Yes - go to Q.3 NO ☒ is not a bog for purpose of rating 3. Does the wetland have more than 70% cover of mosses at ground level, AND other plants, if present, consist of the "bog" species listed in Table 3 as a significant component of the vegetation (more than 30% of the total shrub and herbaceous cover consists species in Table 3)? Yes – Is a bog for purpose of rating NO - go to Q.4 *NOTE: If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16" deep. If the pH is less than 5.0 and the "bog" plant species in Table 3 are present, the wetland is a bog.* 4. Is the wetland forested (>30% cover) with sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Englemann's spruce, or western white pine, WITH any of the species (or combination of species) on the bog species plant list in Table 3 as a significant component of the ground cover (*>30% coverage of the total shrub/herbaceous* cover)? YES = Category I NO ☐ is not a bog for purpose of rating	**Cat. I**

SC 4.0 Forested Wetlands *(see p. 90)*	
Does the wetland have at least 1 acre of forest that meet one of these criteria for the Department of Fish and Wildlife's forests as priority habitats? *If you answer yes you will still need to rate the wetland based on its functions.*	
☐ Old growth forests: (west of Cascade crest) Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/acre (20 trees/hectare) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 inches (81 cm) or more. *Note: The criterion for dbh is based on measurements for upland forests. Two hundred year old trees in wetlands will often have a smaller dbh because their growth rates are often slower. The DFW criterion is and "OR" so old-growth forests do not necessarily have to have trees of this diameter.*	
☐ Mature forests: (west of the Cascade crest) Stands where the largest trees are 80-200 years old OR have average diameters (dbh) exceeding 21 in (53 cm); crown cover may be less than 100%; decay, decadence, numbers of snags, and quanitity of large downed material is generally less than that found in old-growth	
YES = Category 1 NO ☒ not a forested wetland with special characteristics	**Cat. I**
SC 5.0 Wetlands in Coastal Lagoons (see p. 91)	
Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?	
☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks.	
☐ The lagoon in which the wetland is located contains surgace water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon (*needs to be measured near the bottom*)	
YES – Go to SC 5.1 NO ☒ not a wetland in a coastal lagoon	**Cat. I**
SC 5.1 Does the wetland meet all of the following three conditions?	
☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of invasive plant species (see list of invasive species on p. 74).	
☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland.	
☐The wetalnd is larger than 1/10 acre (4350 square feet)	
YES = Category I NO = Category II	**Cat. II**

SC 6.0 Interdunal Wetlands (see p. 93) Is the wetalnd unit west of the 1889 line (also called the Westarn Boundary of Upland Ownership or WBUO)? YES – go to SC 6.1 NO ☒ not an interdunal wetland for rating *If you answer yes you will still need to rate the wetland based on its functions.* In practical terms that means the following geographic areas: – Long Beach Peninsula – lands west of SR 103 – Grayland-Westport – lands west of SR 105 – Ocean Shores-Copalis – lands west of SR 115 and SR 109 SC 6.1 Is the wetland 1 acre or larger, or is it in a mosaic of wetlands that is 1 acre or larger? YES = Category II NO – go to SC 6.2 SC 6.2 Is the unit between 0.1 and 1 acre, or is it in a mosaic of wetlands that is between 0.1 and 1 acre? YES = Category III	**Cat. II** **Cat. III**
Category of wetland based on Special Characteristics *Choose the "highest" rating if wetland falls into several categorie, and record on p. 1 .* If you answered NO for all types enter "Not Applicable" on p.1.	NA

WETLAND RATING FORM – WESTERN WASHINGTON
Version 2 – Updated July 2006 to increase accuracy and reproducibility among users
Updated Oct 2008 with the new WDFW definitions for priority habitats

Name of wetland (if known): Highland Terrace Slope Wetland Date of site visit: 12/21/11

Rated by: H. Mortensen Trained by Ecology? Yes ☒ No ☐ Date of Training 5/2005

SEC: 13 TWNSHP: 23N RNGE: 3E Is S/T/R in Appendix D? Yes ☐ No ☒

SUMMARY OF RATING

Category based on FUNCTIONS provided by wetland

I ☐ II ☐ III ☒ IV ☐

Category I = Score ≥70
Category II = Score 51-69
Category III = Score 30-50
Category IV = Score < 30

Score for Water Quality Functions	14
Score for Hydrologic Functions	16
Score for Habitat Functions	19
TOTAL score for functions	**39**

Category based on SPECIAL CHARACTERISTICS of wetland

I ☐ II ☐ Does not Apply ☒

Final Category (choose the "highest" category from above) **III**

Check the appropriate type and class of wetland being rated.

Wetland Type		Wetland Class	
Estuarine		**Depressional**	
Natural Heritage Wetland		**Riverine**	
Bog		**Lake-fringe**	
Mature Forest		**Slope**	**X**
Old Growth Forest		**Flats**	
Coastal Lagoon		**Freshwater Tidal**	
Interdunal			
None of the above	**X**	Check if unit has multiple HGM classes present	

Does the wetland unit being rated meet any of the criteria below?

If you answer YES to any of the questions below you will need to protect the wetland according to the regulations regarding the special characteristics found in the wetland.

Check List for Wetlands That May Need Additional Protection (in addition to the protection recommended for its category)	YES	NO
SP1. *Has the wetland unit been documented as a habitat for any Federally listed Threatened or Endangered* ***animal*** *or* ***plant*** *species (T/E species)?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state or federal database.		X*
SP2. *Has the wetland unit been documented as habitat for any State listed Threatened or Endangered* ***animal*** *species?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state database. Note: Wetlands with State listed plant species are categorized as Category I Natural Heritage Wetlands (see p. 19 of data form).		X*
SP3. *Does the wetland unit contain individuals of Priority species listed by the WDFW for the state?*		X*
SP4. *Does the wetland unit have a local significance in addition to its functions*? For example, the wetland has been identified in the Shoreline Master Program, the Critical Areas Ordinance, or in a local management plan as having special significance.		X

***The study area was reviewed for the presence of endangered, threatened, and priority species using WDFW online Priority Habitat and Species Data, PHS on the Web (http://wdfw.wa.gov/mapping/phs/).**

To complete the next part of the data sheet you will need to determine the Hydrogeomorphic Class of the wetland being rated.

The hydrogeomorphic classification groups wetlands into those that function in similar ways. Classifying the wetland first simplifies the questions needed to answer how it functions. The Hydrogeomorphic Class of a wetland can be determined using the key below. See p. 24 for more detailed instructions on classifying wetlands.

Classification of Wetland Units in Western Washington

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in Questions 1-7 apply, and go to Question 8.

1. Are the water levels in the wetland unit usually controlled by tides (i.e. except during floods)?

☒ NO – go to 2 ☐ **YES** – the wetland class is **Tidal Fringe**

If yes, is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)? **YES – Freshwater Tidal Fringe NO – Saltwater Tidal Fringe (Estuarine)**

*If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is rated as an **Estuarine** wetland.* Wetlands that were called estuarine in the first and second editions of the rating system are called Salt Water Tidal Fringe in the Hydrogeomorphic Classification. Estuarine wetlands were categorized separately in the earlier editions, and this separation is being kept in this revision. To maintain consistency between editions, the term "Estuarine" wetland is kept. Please note, however, that the characteristics that define Category I and II estuarine wetlands have changed (see p.).

2. The entire wetland unit is flat and precipitation is only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit

☒ NO – go to 3 ☐ **YES** – The wetland class is **Flats**

If your wetland can be classified as a "Flats" wetland, use the form for **Depressional** wetlands.

3. Does the entire wetland unit **meet both** of the following criteria?

☐ The vegetated part of the wetland is on the shores of a body of open water (without any vegetation on the surface) at least 20 acres (8 ha) in size;

☐ At least 30% of the open water area is deeper than 6.6 ft (2 m)?

☒ NO – go to 4 ☐ **YES –** The wetland class is **Lake-fringe (Lacustrine Fringe)**

4. Does the entire wetland unit **meet all** of the following criteria?

☒ The wetland is on a slope (*slope can be very gradual*),

☒ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.

☒ The water leaves the wetland **without being impounded**?

NOTE: *Surface water does not pond in these types of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3ft diameter and less than a foot deep).*

☐ NO – go to 5 ☒ **YES –** The wetland class is **Slope**

5. Does the entire wetland unit **meet all** of the following criteria?

☐ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river.

☐ The overbank flooding occurs at least once every two years

NOTE: The riverine unit can contain depressions that are filled with water when the river is not flooding.

☐ NO - go to 6 ☐ **YES** – The wetland class is **Riverine**

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year. *This means that any outlet, if present, is higher than the interior of the wetland.*

☐ NO – go to 7 ☐ **YES –** The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding. The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☐ NO – go to 8 ☐ **YES –** The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within your wetland. NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the class listed in column 2 is less than 10% of the unit, classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	*HGM Class to Use in Rating*
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake-fringe	Lake-fringe
Depressional + Riverine along stream within boundary	Depressional
Depressional + Lake-fringe	Depressional
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE under wetlands with special characteristics

If you are unable still to determine which of the above criteria apply to your wetland, or you have more than 2 HGM classes within a wetland boundary, classify the wetland as **Depressional** for the rating.

S	Slope Wetlands	Points
	WATER QUALITY FUNCTIONS - Indicators that wetland functions to improve water quality	
S	**S 1. Does the wetland have the <u>potential</u> to improve water quality?**	***(see p. 64)***
S	S 1.1 Characteristics of average slope of wetland: Slope is1% or less *(a 1% slope has a 1 foot vertical drop in elevation horizontal distance) for every 100 ft* ..... points = 3 Slope is 1% - 2% ..... points = 2 (Slope is 2% - 5% ..... points = 1) Slope is greater than 5% ..... points = 0	1
S	S 1.2 The soil 2 inches below the surface (or duff layer) is clay or organic *(use NRCS definitions)*. YES = 3 points (NO = 0 points)	0
S	S 1.3 Characteristics of the vegetation in the wetland that trap sediments and pollutants: *Choose the points appropriate for the description that best fits the vegetation in the wetland. Dense vegetation means you have trouble seeing the soil surface. Dense vegetation means you have trouble seeing the soil surface (>75% cover) and uncut means not grazed or mowed and plants are higher than 6 inches.* (Dense, ungrazed, herbaceous vegetation > 90% of the wetland area ..... points = 6) Dense, ungrazed, herbaceous vegetation > 1/2 of area ..... points = 3 Dense, woody, vegetation > ½ of area ..... points = 2 Dense, ungrazed, herbaceous vegetation > 1/4 of area ..... points = 1 Does not meet any of the criteria above for vegetation ..... points = 0	6
S	**Total for S 1** *Add the points in the boxes above*	7
S	**S 2. Does the wetland have the <u>opportunity</u> to improve water quality? *(see p. 67)*** Answer YES if you know or believe there are pollutants in groundwater or surface water coming into the wetland that would otherwise reduce water quality in streams, lakes or groundwater downgradient from the wetland? *Note which of the following conditions provide the sources of pollutants.A unit may have pollutants coming from several sources, but any single source would qualify as opportunity.* ☐ Grazing in the wetland or within 150 ft ☐ Untreated stormwater discharges to wetland ☐ Tilled fields, logging or orchards within 150 ft of wetland ☒ A stream or culvert discharges into wetland that drains developed areas, residential areas, farmed fields, roads, or clear-cut logging ☒ Residential, urban areas, or golf courses are within 150 ft upslope of wetland ☐ Other _____ (**YES** multiplier is **2**) **NO** multiplier is **1**	multiplier <u>2</u>
S	**<u>TOTAL</u> - Water Quality Functions** Multiply the score from S 1 by S 2 ***Add score to table on p. 1***	**14**

S	Slope Wetlands	Points
	HYDROLOGIC FUNCTIONS - Indicators that wetland functions to reduce flooding and stream erosion	
	S 3. Does the wetland have the potential to reduce flooding and erosion?	***(see p. 68)***
S	S 3.1 Characteristics of vegetation that reduce the velocity of surface flows during storms. *Choose the points appropriate for the description that best fit conditions in the wetland. (stems of plants should be thick enough (usually > 1/8in), or dense enough, to remain erect during surface flows)* (Dense, uncut, **rigid** vegetation covers > 90% of the area of the wetland. ..... points = 6) Dense, uncut, **rigid** vegetation > 1/2 area of wetland ..... points = 3 Dense, uncut, **rigid** vegetation > 1/4 area ..... points = 1 More than 1/4 of area is grazed, mowed, tilled or vegetation is not rigid ..... points = 0	6
S	S 3.2 Characteristics of slope wetland that holds back small amounts of flood flows: The slope wetland has small surface depressions that can retain water over at least 10% of its area. (YES points = 2) NO points = 0	2
S	**Total for S 3** *Add the points in the boxes above*	8
S	**S 4. Does the wetland have the opportunity to reduce flooding and erosion?** ***(see p. 70)*** Is the wetland in a landscape position where the reduction in water velocity it provides helps protect downstream property and aquatic resources from flooding or excessive and/or erosive flows? *Note which of the following conditions apply.* ☒ Wetland has surface runoff that drains to a river or stream that has flooding problems ☐ Other_____ *(Answer NO if the major source of water to the wetland is controlled by a reservoir or the wetland is tidal fringe along the sides of a dike)* **YES** multiplier is **2** **NO** multiplier is **1**	multiplier 2
S	**TOTAL - Hydrologic Functions** Multiply the score from S 3 by S 4 ***Add score to table on p. 1***	**16**

Comments

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that wetland functions to provide important habitat

H 1. Does the wetland have the potential to provide habitat for many species?

H 1.1 Vegetation structure ***(see p. 72)***

Check the types of vegetation classes present (as defined by Cowardin) if the class is ¼ acre or covers more than 10% of the area of the wetland if unit smaller than 2.5 acres.

- ☐ Aquatic bed
- ☐ Emergent plants
- ☒ Scrub/shrub (areas where shrubs have >30% cover)
- ☐ Forested (areas where trees have >30% cover)
- ☐ Forested areas have 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the forested polygon

Add the number of vegetation types that qualify. If you have:

4 structures or more ..... points = 4
3 structures ..... points = 2
2 structures ..... points = 1
[1 structure ..... points = 0]

Ravine is forested but only a few trees are rooted in the wetland

0

H 1.2. Hydroperiods ***(see p. 73)***

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ acre to count. (see text for descriptions of hydroperiods)

- ☐ Permanently flooded or inundated
- ☐ Seasonally flooded or inundated
- ☐ Occasionally flooded or inundated
- ☒ Saturated only
- ☐ Permanently flowing stream or river in, or adjacent to, the wetland
- ☒ Seasonally flowing stream in, or adjacent to, the wetland
- ☐ ***Lake-fringe wetland* = 2 points**
- ☐ ***Freshwater tidal wetland* = 2 points**

4 or more types present ..... points = 3
3 types present ..... points = 2
[2 types present ..... points = 1]
1 types present……points = 0

1

H 1.3. Richness of Plant Species ***(see p. 75)***

Count the number of plant species in the wetland that cover at least 10 ft^2. (*different patches of the same species can be combined to meet the size threshold)*

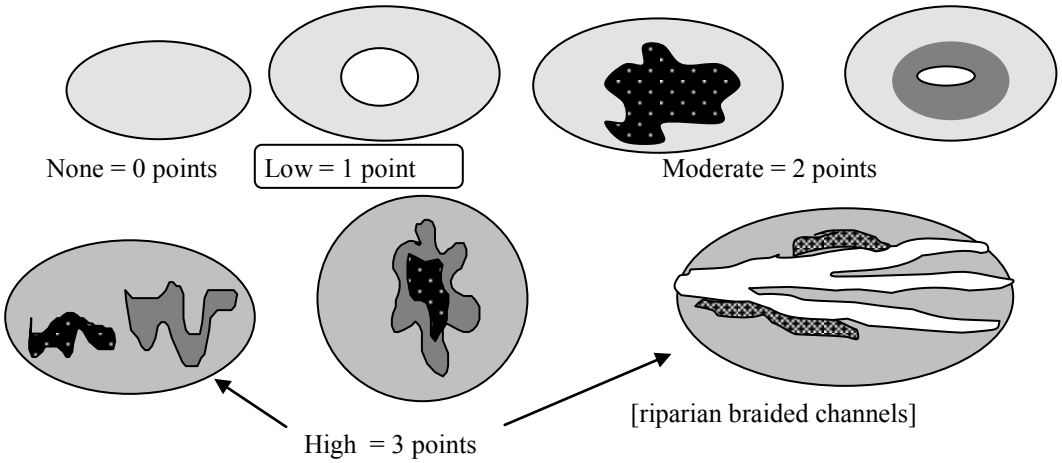
You do not have to name the species.

Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle

If you counted:
> 19 species ..... points = 2
[5 - 19 species ..... points = 1]
< 5 species ..... points = 0

List species below if you want to:

1

H 1.4. Interspersion of habitats ***(see p. 76)*** Decide from the diagrams below whether interspersion between Cowardin vegetation classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, medium, low, or none.  None = 0 points Low = 1 point Moderate = 2 points High = 3 points [riparian braided channels] NOTE: If you have four or more vegetation types or three vegetation types and open water the rating is always "high".	1
H 1.5. Special Habitat Features: ***(see p. 77)*** *Check the habitat features that are present in the wetland. The number of checks is the number of points you put into the next column.* ☒ Large, downed, woody debris within the wetland (>4in. diameter and 6 ft long). ☒ Standing snags (diameter at the bottom > 4 inches) in the wetland ☒ Undercut banks are present for at least 6.6 ft (2m) and/or overhanging vegetation extends at least 3.3 ft (1m) over a stream for at least 33 ft (10m) ☐ Stable steep banks of fine material that might be used by beaver or muskrat for denning (>30degree slope) OR signs of recent beaver activity are present ☐ At least ¼ acre of thin-stemmed persistent vegetation or woody branches are present in areas that are permanently or seasonally inundated.*(structures for egg-laying by amphibians)* ☒ Invasive plants cover less than 25% of the wetland area in each stratum of plants *Note: The 20% stated in early printings of the manual on page 78 is an error.*	4
H 1. TOTAL Score - potential for providing habitat *Add the scores from H1.1, H1.2, H1.3, H1.4, H1.5*	7

H 2. Does the wetland have the opportunity to provide habitat for many species?	
H 2.1 Buffers ***(see p. 80)*** *Choose the description that best represents condition of buffer of wetland. The highest scoring criterion that applies to the wetland is to be used in the rating. See text for definition of "undisturbed."* ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% of circumference. No developed areas within undisturbed part of buffer. (relatively undisturbed also means no-grazing) ..... Points = 5 ☒ ..... 100 m (330 ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 50% circumference..... Points = 4 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water >95% circumference..... Points = 4 ☐ ..... 100 m (330ft) of relatively undisturbed vegetated areas, rocky areas, or open water > 25% circumference..... Points = 3 ☐ ..... 50 m (170ft) of relatively undisturbed vegetated areas, rocky areas, or open water for > 50% circumference. ..... Points = 3 **If buffer does not meet any of the criteria above** ☐ No paved areas (except paved trails) or buildings within 25 m (80ft) of wetland > 95% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ No paved areas or buildings within 50m of wetland for >50% circumference. Light to moderate grazing, or lawns are OK. ..... Points = 2 ☐ Heavy grazing in buffer. ..... Points = 1 ☐ Vegetated buffers are <2m wide (6.6ft) for more than 95% of the circumference (e.g. tilled fields, paving, basalt bedrock extend to edge of wetland ..... Points = 0 ☐ Buffer does not meet any of the criteria above……...Points = 1	4
H 2.2 Corridors and Connections ***(see p. 81)*** H 2.2.1 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 150 ft wide, has at least 30% cover of shrubs, forest or native undisturbed prairie, that connects to estuaries, other wetlands or undisturbed uplands that are at least 250 acres in size? (*dams in riparian corridors*, *heavily used gravel roads*, *paved roads, are considered breaks in the corridor*). YES = **4 points** (*go to H 2.3*) **NO** = go to H 2.2.2 H 2.2.2 Is the wetland part of a relatively undisturbed and unbroken vegetated corridor (either riparian or upland) that is at least 50ft wide, has at least 30% cover of shrubs or forest, and connects to estuaries, other wetlands or undisturbed uplands that are at least 25 acres in size? **OR** a **Lake-fringe** wetland, if it does not have an undisturbed corridor as in the question above? YES = **2 points** (*go to H 2.3*) **NO** = H 2.2.3 H 2.2.3 Is the wetland: within 5 mi (8km) of a brackish or salt water estuary OR within 3 mi of a large field or pasture (>40 acres) OR within 1 mi of a lake greater than 20 acres? YES = **1 point** NO = **0 points**	2

H 2.3 Near or adjacent to other priority habitats listed by WDFW ***(see new and complete descriptions of WDFW priority habitats, and the counties in which they can be found, in the PHS report http://wdfw.wa.gov/hab/phslist.htm)***

Which of the following priority habitats are within 330ft (100m) of the wetland?
(NOTE: the connections do not have to be relatively undisturbed)

☐ **Aspen Stands:** Pure or mixed stands of aspen greater than 0.4 ha (1 acres).

☒ **Biodiversity Areas and Corridors:** Areas of habitat that are relatively important to various species of native fish and wildlife (*full description in WDFW PHS report p. 152*)

☐ **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock.

☐ **Old-growth/Mature forests:** (Old-growth west of Cascade crest) Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 20 trees/ha (8 trees/acre) > 81 cm (32 in) dbh or > 200 years of age. (Mature forests.) Stands with average diameters exceeding 53 cm (21 in) dbh; crown cover may be less that 100%; crown cover may be less that 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80 - 200 years old west of the Cascade crest.

☐ **Oregon white Oak:** Woodlands Stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158.)*

☒ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.

☐ **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161*)

☒ **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

☐ **Nearshore:** Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. *(full descriptions of habitats and the definition of relatively undisturbed are in WDFW report: pp. 167-169 and glossary in Appendix A.)*

☐ **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.

☐ **Cliffs:** Greater than 7.6 m (25 ft) high and occurring below 5000 ft.

☐ **Talus:** Homogenous areas of rock rubble ranging in average size 0.15 - 2.0 m (0.5 - 6.5 ft), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.

☒ **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of >51 cm (20 in) in western Washington and are > 2 m (6.5 ft) in height. Priority logs are > 30cm (12 in) in diameter at the largest end, and > 6m (20 ft) long.

If wetland has **3 or more** priority habitats = **4 points**
If wetland has **2** priority habitats = **3 points**
If wetland has **1** priority habitat **= 1 point**
No habitats = **0 points**

Note: All vegetated wetland are by definition a priority habitat but are not included in this list. Nearby wetlands are addressed in question H2.4.

4

H 2.4 Wetland Landscape *(choose the **one** description of the landscape around the wetland that best fits)* ***(see p. 84)*** There are at least 3 other wetlands within ½ mile, and the connections between them are relatively undisturbed (light grazing between wetlands OK, as is lake shore with some boating, but connections should NOT be bisected by paved roads, fill, fields, or other development. ..... points = 5 The wetland is Lake-fringe on a lake with little disturbance and there are 3 other lake-fringe wetlands within ½ mile ..... points = 5 There are at least 3 other wetlands within ½ mile, BUT the connections between them are disturbed ..... points = 3 The wetland is Lake-fringe on a lake **with** disturbance and there are 3 other lake-fringe wetland within ½ mile ..... points = 3 There is at least 1 wetland within ½ mile. ..... points = 2 There are no wetlands within ½ mile. ..... points = 0	2
H 2. TOTAL Score - opportunity for providing habitat *Add the scores from H2.1, H2.2, H2.3, H2.4*	12
TOTAL for H1 from page 14	7
Total Score for Habitat Functions – add the points for H 1, H 2 and record the result on p. 1	19

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Please determine if the wetland meets the attributes described below and circle the appropriate Category.

Wetland Type *Check off any criteria that apply to the wetland. Circle the Category when the appropriate criteria are met.*	**Category**
SC 1.0 Estuarine wetlands (*see p. 86)* Does the wetland unit meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt. YES = Go to SC 1.1 NO ☒	
SC 1.1 Is the wetland unit within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-151? ☐YES = Category I ☐NO = go to SC 1.2	**Cat. I**
SC 1.2 Is the wetland unit at least 1 acre in size and meets at least two of the following three conditions? ☐YES = Category I ☐NO = Category II ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. If the non-native Spartina spp. are the only species that cover more than 10% of the wetland, then the wetland should be given a dual rating (I/II) The are aof Spartina would be rated a Category II while the relatively undisturbed upper marsh with native species would be a Category I. Do not, however, exclude the area of Spartina in determining the size threshold of 1 acre. ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed wetland. ☐ The wetland has at least 2 or the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands.	**Cat. I** **Cat. II** **Dual rating I/II**

SC 2.0 Natural Heritage Wetlands ***(see p. 87)*** Natural Heritage wetlands have been identified by the Washington Natural Heritage Program/DNR as either high quality undisturbed wetlands or wetlands that support state Threatened, Endangered, or Sensitive plant species. SC 2.1 Is the wetland being rated in a Section/Township/Range that contains a Natural Heritage wetland? *(this question is used to screen out most sites before you need to contact WNHP/DNR)* S/T/R information from Appendix D ☐ or accessed from WNHP/DNR web site ☐ YES☐ – contact WNHP/DNR (see p. 79) and go to SC 2.2 NO ☒ SC 2.2 Has DNR identified the wetland as a high quality undisturbed wetland or as or as a site with state threatened or endangered plant species? YES = Category I NO ☐ Not a Heritage Wetland	**Cat. I**
SC 3.0 Bogs ***(see p. 87)*** Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below to identify if the wetland is a bog. If you answer yes, you will still need to rate the wetland based on its functions.* 1. Does the wetland have organic soils horizons (i.e. layers of organic soil), either peats or mucks, that compose 16" or more of the first 32 inches of the soil profile? (See Appendix B for a field key to identify organic soils.) Yes - go to Q.3 NO - go to Q.2 2. Does the wetland have organic soils, either peats or mucks, that are less than 16 inches deep over bedrock or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? Yes - go to Q.3 NO ☒ is not a bog for purpose of rating 3. Does the wetland have more than 70% cover of mosses at ground level, AND other plants, if present, consist of the "bog" species listed in Table 3 as a significant component of the vegetation (more than 30% of the total shrub and herbaceous cover consists species in Table 3)? Yes – Is a bog for purpose of rating NO - go to Q.4 *NOTE: If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16" deep. If the pH is less than 5.0 and the "bog" plant species in Table 3 are present, the wetland is a bog.* 4. Is the wetland forested (>30% cover) with sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Englemann's spruce, or western white pine, WITH any of the species (or combination of species) on the bog species plant list in Table 3 as a significant component of the ground cover (*>30% coverage of the total shrub/herbaceous* cover)? YES = Category I NO ☐ is not a bog for purpose of rating	**Cat. I**

SC 4.0 Forested Wetlands *(see p. 90)*	
Does the wetland have at least 1 acre of forest that meet one of these criteria for the Department of Fish and Wildlife's forests as priority habitats? *If you answer yes you will still need to rate the wetland based on its functions.*	
☐ Old growth forests: (west of Cascade crest) Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/acre (20 trees/hectare) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 inches (81 cm) or more. *Note: The criterion for dbh is based on measurements for upland forests. Two hundred year old trees in wetlands will often have a smaller dbh because their growth rates are often slower. The DFW criterion is and "OR" so old-growth forests do not necessarily have to have trees of this diameter.*	
☐ Mature forests: (west of the Cascade crest) Stands where the largest trees are 80-200 years old OR have average diameters (dbh) exceeding 21 in (53 cm); crown cover may be less than 100%; decay, decadence, numbers of snags, and quanitity of large downed material is generally less than that found in old-growth	
YES = Category 1 NO ☒ not a forested wetland with special characteristics	**Cat. I**
SC 5.0 Wetlands in Coastal Lagoons (see p. 91)	
Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?	
☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks.	
☐ The lagoon in which the wetland is located contains surgace water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon (*needs to be measured near the bottom*)	
YES – Go to SC 5.1 NO ☒ not a wetland in a coastal lagoon	**Cat. I**
SC 5.1 Does the wetland meet all of the following three conditions?	
☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of invasive plant species (see list of invasive species on p. 74).	
☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland.	
☐The wetalnd is larger than 1/10 acre (4350 square feet)	
YES = Category I NO = Category II	**Cat. II**

SC 6.0 Interdunal Wetlands (see p. 93) Is the wetalnd unit west of the 1889 line (also called the Westarn Boundary of Upland Ownership or WBUO)? YES – go to SC 6.1 NO ☒ not an interdunal wetland for rating *If you answer yes you will still need to rate the wetland based on its functions.* In practical terms that means the following geographic areas: – Long Beach Peninsula – lands west of SR 103 – Grayland-Westport – lands west of SR 105 – Ocean Shores-Copalis – lands west of SR 115 and SR 109 SC 6.1 Is the wetland 1 acre or larger, or is it in a mosaic of wetlands that is 1 acre or larger? YES = Category II NO – go to SC 6.2 SC 6.2 Is the unit between 0.1 and 1 acre, or is it in a mosaic of wetlands that is between 0.1 and 1 acre? YES = Category III	**Cat. II** **Cat. III**
Category of wetland based on Special Characteristics *Choose the "highest" rating if wetland falls into several categorie, and record on p. 1 .* If you answered NO for all types enter "Not Applicable" on p.1.	NA

APPENDIX D. ELECTROFISHING DATA

Photo D.1. Pool A – Mainstem Boeing Creek immediately upstream of Hidden Lake

Photo D.2. Fish caught in Pool A

Photo D.3. Pool B – Mainstem Boeing Creek downstream of former fish hatchery structure

Photo D.4. Fish caught in Pool B

Photo D.5. Pool C – Mainstem Boeing Creek

Photo D.6. Pool D – Mainstem Boeing Creek

Photo D.7. Pool E – Confluence of north and south forks of Boeing Creek

Photo D.8. Pool F – South fork of Boeing Creek upstream of wet crossing

Photo D.9. Pool G – South fork of Boeing Creek

Photo D.10. Pool I – North fork of Boeing Creek upstream of confluence

Photo D.11. Pool J – North fork of Boeing Creek

Photo D.12. Pacific giant salamanders caught in Pool J

Photo D.13. Pool K – North fork of Boeing Creek

Photo D.14. Pool L – North fork of Boeing Creek

Photo D.15. Fish caught in Pool L

Boeing Creek fishing results by fish length 6-20-12

Cutthroat	Pool		
100	J	N	15
111	J	Min	100
121	J	Max	247
122	I	Mean	160.1
139	C	Median	164
144	B	St. Dev	38.88
158	C		
164	A		
166	H		
173	C		
175	F		
191	B		
194	E		
197	G		
247	L		

Coho	Pool		
69	A	N	16
71	C	Min	69
72	C	Max	92
72	E	Mean	76.8
74	C	Median	77
74	E	St. Dev	5.47
74	J		
77	E		
77	I		
78	A		
78	C		
78	E		
79	C		
81	A		
82	A		
92	E		

Boeing Creek fishing results by pool 6-20-12

Cutthroat	Pool		
164	A	N	15
144	B	Min	100
191	B	Max	247
158	C	Mean	160.1
173	C	Median	164
139	C	St. Dev	38.88
194	E		
175	F		
197	G		
166	H		
122	I		
111	J		
100	J		
121	J		
247	L		

Coho	Pool		
82	A	N	16
69	A	Min	69
81	A	Max	92
78	A	Mean	76.8
71	C	Median	77
74	C	St. Dev	5.47
78	C		
72	C		
79	C		
78	E		
77	E		
72	E		
74	E		
92	E		
77	I		
74	J		

Denise Dahn, Dahn Design, LLC
February 21, 2011

Welcome to Boeing Creek & Shoreview Parks

TRAILS MAP

Enjoy this special natural park — one of the finest in Shoreline! Explore the trails and enjoy a quiet moment. For your safety and the protection of park resources, please stay on designated trails, keep dogs on a leash outside the designated off-leash area, and clean up after your pet.

You can download this map from our webpage at:
www.shorelinewa.gov/parks

To volunteer in our parks, contact the City of Shoreline at (206) 801-2700.

APPENDIX E. RAW WATER QUALITY MONITORING DATA

Water Quality Monitoring Data
City of Shoreline
Station: BC-2 (Boeing Creek)

Date	Time	FC (col/100mL)	DO (mg/L)	pH (Std Units)	TP (mg/L)	TSS (mg/L)	Temp (deg. C)	TN (mg/L)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
9/11/2001	12:05 PM		9.20	8.04			10.5		0.0	188.1	260.4	0.1
9/25/2001	2:00 PM		10.36	7.74			10.5		0.3	188.7	261.2	0.1
10/9/2001	11:50 AM		10.38	7.91			10.1		0.0	186.3	260.2	0.1
10/22/2001	12:50 PM		10.76	7.99			10.1		0.0	185.1	258.4	0.1
11/16/2001	2:10 PM		10.00	7.72			10.1		0.0	182.4	254.9	0.1
12/3/2001	10:40 PM		9.65	7.61			8.7		1.2	144.1	209.1	0.1
12/28/2001	9:00 AM		9.92	7.67			9.3		0.7	181.1	259.1	0.1
1/9/2002	2:00 PM		10.30	7.69			9.7		0.0	180.7	255.2	0.1
1/18/2002	4:05 PM		11.93	7.24			7.3		12.8	86.2	130.0	0.1
1/31/2002	11:20 AM		10.69	7.50			7.3		16.8	109.5	165.4	0.1
2/14/2002	9:20 AM		11.08	7.79			8.4		5.2	173.3	253.7	0.1
3/1/2002	3:15 PM		10.19	7.78			9.1			179.1	257.0	0.1
3/15/2002	11:05 AM		10.50	7.46			7.9		3.5	97.2	144.4	0.1
3/29/2002	10:40 AM		10.94	7.87			9.8			181.9	256.3	0.1
4/5/2002	2:20 PM		11.17				10.4			184.0	255.9	0.1
4/18/2002	4:00 PM		9.20	7.68			10.2		0.0	182.9	254.7	0.1
4/29/2002	11:20 AM		9.94	7.66			10.1		0.0	183.6	257.4	0.1
5/13/2002	1:00 PM		9.98	7.68			10.2		0.0	182.6	254.7	0.1
5/28/2002	2:30 PM		10.12	7.66			10.5		0.0	141.5	195.4	0.1
6/25/2002	3:25 PM		10.07	6.46			11.3		0.0	189.6	257.2	0.1
7/23/2002	3:40 PM		9.42	7.68			11.3		2.3	189.9	257.2	0.1
8/12/2002	11:10 AM		9.97	7.92			10.8		1.8	186.5	256.0	0.1
9/25/2002	11:35 AM		9.34	7.70			10.4		4.4	182.3	250.9	0.1
10/8/2002	10:10 AM		10.01	7.75			10.3		1.3	185.2	257.3	0.1
10/28/2002	5:00 PM		9.76	7.66			10.0		1.4	184.2	258.3	0.1
11/15/2002	10:10 AM		9.85	7.72			9.7		1.3	183.1	258.5	0.1
11/27/2002	11:20 AM		9.07	7.70			9.2		0.4	180.9	259.3	0.1
12/20/2002	10:40 AM		9.45	7.75			9.2		0.3	180.7	258.8	0.1
1/3/2003	11:30 AM		9.80	7.67			9.6		1.9	171.5	243.0	0.1
2/6/2003	10:00 AM		9.94	7.73			9.0		1.2	182.0	262.2	0.1
3/17/2003	10:10 AM		9.77	7.61			9.7		2.1	18.1	256.1	0.1
4/25/2003	2:20 PM		9.90				10.2		1.9	188.4	263.1	0.1
5/25/2003	3:10 PM		9.45				10.4		2.1	189.9	263.4	0.1
6/17/2003	11:55 AM		11.41	8.10			12.1		4.6	208.5	276.4	0.1
7/10/2003	8:55 AM		9.66	7.82			10.4		1.6	189.1	262.5	0.1
8/15/2003	11:20 AM		9.92				10.9		1.0	190.9	261.6	0.1
9/22/2003	1:45 PM		9.61	7.76			10.5		1.5	188.0	259.9	0.1
10/13/2003	2:55 PM		9.99	7.58			10.4		0.4	188.3	261.3	0.1
10/31/2003	3:23 PM		9.82	7.58			9.3		0.4	182.4	260.8	0.1
11/19/2003	1:45 PM		9.59	7.47			9.7		0.2	184.7	260.6	0.1
12/4/2003	3:05 PM		9.99	7.38			9.6		0.0	183.3	259.9	0.1
12/23/2003	11:20 AM		9.71	7.23			9.5		0.3	183.9	261.3	0.1
1/8/2004	3:00 PM		9.69	7.13			6.4		11.6	106.2	164.8	0.1
1/28/2004	2:50 PM		9.26	7.41			9.8		0.7	183.4	258.3	0.1
2/12/2004	3:50 PM		10.43	7.59			9.4		1.3	182.5	259.9	0.1
3/10/2004	2:10 PM		10.27	7.98			10.2		1.4	187.7	261.5	0.1
3/26/2004	3:00 PM		9.28	7.69			9.9		1.9	154.0	216.5	0.1
4/14/2004	10:00 AM		10.08	7.75			10.2		0.6	127.6	178.1	0.1
4/28/2004	10:45 AM		9.61	7.67			10.0		0.7	184.2	258.2	0.1
6/24/2004	2:45 PM		10.32	7.73			10.9		4.5	191.4	262.2	0.1
7/22/2004	9:17 AM		9.15				10.8		3.5	174.9	240.1	0.1
8/19/2004	1:45 PM		10.05				11.5		5.3	167.8	238.4	0.1
9/27/2004	3:00 PM		9.40	7.87			10.6		2.6	174.6	240.8	0.1
10/12/2004	11:30 AM		10.11	7.75			10.4		3.1	173.9	240.7	0.1
11/18/2004	10:45 AM		9.31	7.73			9.6		0.9	170.0	240.7	0.1
12/13/2004	12:52 PM		10.58	7.25			8.6		18.8	59.3	86.8	0.0
1/10/2005	2:30 PM		9.67	7.91			8.9		0.3	167.0	241.2	0.1

Water Quality Monitoring Data
City of Shoreline
Station: BC-2 (Boeing Creek)

Date	Time	FC (col/100mL)	DO (mg/L)	pH (Std Units)	TP (mg/L)	TSS (mg/L)	Temp (deg. C)	TN (mg/L)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
1/31/2005	11:00 AM		10.08	7.76			10.0		0.7	172.0	241.1	0.1
2/9/2005	1:15 PM		10.28	7.84			9.2		11.1	167.8	240.2	0.1
2/22/2005	2:45 PM		10.32	7.80			9.3		0.9	169.1	241.4	0.1
3/9/2005	12:45 PM		10.37	5.61			10.3		2.9	166.2	231.1	0.1
3/31/2005	3:05 PM		11.46	7.66			10.1		0.2	171.5	239.5	0.1
4/28/2005	2:00 PM		9.58	6.89			11.0		5.8	176.5	241.1	0.1
5/26/2005	1:40 PM		10.80	7.61			11.7		1.1	178.9	240.0	0.1
6/28/2005	12:15 PM		9.80	7.17			10.7		8.1	174.9	240.6	0.1
7/19/2005	1:05 PM		9.74	7.81			11.2		4.5	177.4	240.1	0.1
8/17/2005	3:00 PM		9.02	7.73			11.1		8.0	176.5	240.4	0.1
10/18/2005	11:00 AM		9.46	7.67			10.4		2.9	173.9	241.4	0.1
11/10/2005	2:30 PM		8.66	7.46			10.2		2.3	172.3	240.5	0.1
12/22/2005	9:45 AM		10.09	7.17			8.7		45.9	37.7	54.7	0.0
1/19/2006	8:30 AM		9.99	7.12			9.6		1.6	163.4	231.2	0.1
2/27/2006	9:10 AM		9.26	7.76			9.8		3.6	166.8	235.0	0.1
3/24/2006	10:50 AM		8.28	7.60			9.8			130.0	183.4	0.1
4/25/2006	3:10 PM		9.71	7.90			10.6			170.5	235.0	0.1
5/31/2006	2:10 PM		9.51	7.77			11.0			173.0	236.4	0.1
7/3/2006	9:25 AM		3.02	7.72			10.7			170.3	234.8	0.1
8/4/2006	10:50 AM		0.98	7.90			10.8			172.7	238.6	0.1
9/8/2006	11:00 AM		8.24	7.63			10.5		0.0	174.2	241.3	0.1
10/13/2006	2:05 PM		10.75	7.63			10.2		0.6	171.5	239.3	0.1
11/14/2006	2:30 PM		11.11	7.71			9.8		0.1	170.0	239.3	0.1
12/22/2006	2:55 PM		9.56	7.70			9.1		1.4	155.2	223.2	0.1
1/29/2007	11:00 AM		9.42	7.62			8.8		0.7	167.0	242.0	0.1
2/26/2007	10:05 AM		9.20	7.79			9.2		0.5	165.3	236.9	0.1
3/27/2007	10:35 AM		9.29	7.70			9.7		0.4	170.2	240.8	0.1
4/24/2007	10:20 AM		9.11	7.89			10.0		0.5	172.6	241.6	0.1
5/29/2007	9:10 AM		9.17	7.70			10.1		0.3	174.0	242.8	0.1
6/24/2007	9:40 AM		9.97	7.99			10.3		1.1	171.1	237.7	0.1
6/26/2007	10:35 AM		9.05	7.66			10.4		1.1	173.9	241.4	0.1
7/31/2007	11:15 AM		8.49	7.65			10.7		1.7	175.4	241.4	0.1
8/28/2007	10:25 AM		9.16	7.73			10.4		2.8	173.8	241.4	0.1
9/24/2007	8:45 AM		7.95	7.70			10.1		1.6	172.3	241.0	0.1
10/30/2007	10:50 AM	1	7.36	7.66	0.0446	0.5	9.5	1.35	0.3	168.2	239.1	0.1
11/27/2007	10:30 AM	4	8.89	7.82	0.0369	0.3	9.0	1.03	0.3	165.6	238.5	0.1
12/18/2007	10:10 AM	1000	11.13	7.15	0.0626	16.2	6.3	0.98	21.6	43.6	67.9	0.0
1/22/2008	11:10 AM	2	9.81	7.61	0.0401	0.3	8.5	1.03	0.4	165.5	241.8	0.1
2/26/2008	11:25 AM		9.37	7.67	0.0387	0.5	9.8	0.92	0.7	169.1	238.8	0.1
3/24/2008	11:15 AM	3	9.80	7.54	0.0347	0.3	9.4	0.94	0.9	164.8	235.0	0.1
4/22/2008	10:20 AM	7	9.90	7.51	0.0389	0.3	9.6	0.93	0.3	158.6	224.8	0.1
5/27/2008	9:45 AM	9	10.08	7.55	0.0379	0.7	10.6	0.90	2.6	172.5	238.2	0.1
6/24/2008	9:40 AM	3	9.97	7.99	0.0382	0.3	10.3	0.89	1.1			
7/22/2008	9:45 AM	1	9.53	7.73	0.0345	0.3	10.5	0.91	0.6	171.8	237.3	0.1
8/26/2008	10:00 AM	13	9.10	7.71	0.0393	0.6	10.6	0.93	1.3	170.9	235.4	0.1
9/23/2008	9:50 AM	9	8.56	7.76	0.0350	0.5	10.2	0.91	0.6	168.4	234.7	0.1
10/28/2008	10:20 AM		8.51	7.75	0.0382	0.3	9.9	0.95	0.4	171.0	240.5	0.1
11/25/2008	10:30 AM	1	8.34	7.68	0.0379	0.3	9.9	0.99	0.5	170.9	240.3	0.1
12/30/2008	10:25 AM	8	8.36	7.42	0.0372	0.8	8.9	0.97	1.0	163.9	236.5	0.1
1/27/2009	11:00 AM	16	8.11	7.40	0.0379	0.5	9.0	0.92	0.8	168.9	242.9	0.1
2/17/2009	10:30 AM		7.91	8.18	0.0399	0.5	9.6	0.92	0.8	172.2	243.7	0.1
3/31/2009	10:45 AM	1	9.65	7.76	0.0350	0.3	9.7	0.96		171.7	242.9	0.1
4/28/2009	11:00 AM	1	8.97	7.38	0.0369	0.5	10.2	0.98	1.0	167.4	233.3	0.1
5/26/2009	9:45 AM	2			0.0394	1.1		1.01				
5/26/2009	11:30 AM		9.30	7.30			11.0		0.1	178.2	243.6	0.1
6/23/2009	10:50 AM	30	9.35	7.77	0.0388	0.1	10.5	0.94	0.6	175.7	242.9	0.1
7/28/2009	10:05 AM	7	9.17	7.63	0.0369	0.3	11.1	0.92	0.4	180.1	245.0	0.1

Water Quality Monitoring Data
City of Shoreline
Station: BC-2 (Boeing Creek)

Date	Time	FC (col/100mL)	DO (mg/L)	pH (Std Units)	TP (mg/L)	TSS (mg/L)	Temp (deg. C)	TN (mg/L)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
8/25/2009	9:50 AM	6	9.62	7.36	0.0372	0.5	10.5	0.93	0.8	177.0	244.6	0.1
9/23/2009	2:25 PM	23	9.58	6.71	0.0366	0.3	10.6	0.97	0.4	177.1	244.4	0.1
10/27/2009	9:55 AM	8	8.93		0.0335	0.9	8.7	1.03	1.6			
11/2/2009	11:30 AM		8.64				9.9		0.8	172.9	242.7	0.1
11/17/2009	10:45 AM	59	6.32		0.0327	1.8	9.4	0.90	6.1			
11/17/2009	11:15 AM		7.15				9.5		1.0	130.5	185.5	0.1
12/29/2009	10:20 AM		9.48	8.05			8.9		0.5	165.2	238.8	0.1
12/29/2009	10:20 AM	1	10.15	8.08	0.0352	1.1	5.9	0.95	1.5			
1/26/2010	8:10 AM	9	10.33	7.98	0.0331	0.6	9.0	1.04	1.3			
1/26/2010	11:05 AM		9.96	7.90			9.5		0.4	166.8	256.9	0.1
2/22/2010	10:30 AM		9.60	7.92			9.6		1.1	168.1	238.0	0.1
2/22/2010	10:30 AM	1	10.67	8.11	0.0324	1.0	7.4	0.94	1.2			
3/23/2010	10:17 AM	11	10.68	8.25	0.0318	0.5	9.6	0.97	2.3			
3/23/2010			9.13	8.00			10.1		0.4	169.3	236.6	0.1
4/27/2010	10:10 AM		9.35	8.18			10.4		1.0	158.6	220.3	0.1
4/27/2010	10:10 AM	150	8.83	7.92	0.0352	2.2	12.1	0.91	4.9			
5/25/2010	4:20 PM		9.05	8.22			10.7		0.6	171.9	237.0	0.1
5/25/2010	9:30 PM	7	8.63	7.95	0.0343	0.8	12.5	0.98	3.3			
6/22/2010	9:50 AM		9.52	8.31			10.4		0.3	170.1	235.7	0.1
6/22/2010	9:50 AM	18	6.75	8.37	0.0348	0.8	14.0	0.91	1.7			
7/27/2010	10:40 AM		9.57	8.32			11.3		0.7	172.4	237.1	0.1
7/27/2010	10:40 AM	2	7.15	8.70	0.0389	0.6	20.5	0.96	2.9			
8/24/2010	10:15 AM		9.51	8.27			10.9		0.6	172.7	239.1	0.1
8/24/2010	10:15 AM	61	7.43	8.30	0.0358	1.4	16.3	0.87	2.1			
9/28/2010	10:15 AM		8.94	8.15			10.9		0.5	173.2	237.6	0.1
9/28/2010	10:15 AM	20	8.88	8.12	0.0246	0.3	14.9	0.93	1.6			
10/27/2010	9:35 AM	15	9.17	8.04	0.0345	0.9	10.2	0.99	2.1	152.8	213.0	0.1
11/30/2010	10:50 AM	600	11.25	7.10	0.1210	44.5	6.8	0.60	52.4	48.8	75.2	0.0
12/28/2010	11:00 AM	170	10.78	7.89	0.0242	4.3	8.8	0.75	3.5	121.1	174.5	0.1
1/25/2011	10:50 AM	14	9.60	7.99	0.0314	0.6	10.0	0.94	2.0	163.7	229.5	0.1
2/22/2011	10:00 AM	1	10.42	7.76	0.0322	0.8	8.7	0.90	1.3	166.0	237.5	0.1
3/22/2011	9:35 AM	2	10.54	7.82	0.0364	0.5	10.2	1.03	1.4			
4/12/2011	3:10 PM		10.54	7.82			10.2		1.4	171.1	239.3	0.1
4/26/2011	9:55 AM	15	12.36	7.82	0.0331	0.3	10.0	0.92	0.8	172.9	242.4	0.1
5/24/2011	10:55 AM	1			0.0346	1.4		0.92				
6/3/2011	9:55 AM		11.28	7.81			10.5		1.0	172.4	239.2	0.1
6/28/2011	10:50 AM	12	12.20	8.00	0.0341	0.9	10.9	0.92	2.7	175.8	242.4	0.1
7/26/2011	10:25 AM	750			0.0376	1.6		0.96				
7/28/2011	4:25 PM		10.25	8.03			11.3		0.7	174.6	238.3	
8/23/2011	9:50 AM	2	10.46	8.11	0.0355	0.3	10.7	0.91	1.6	94.3	129.5	
10/4/2011	11:25 AM	24			0.0438	1.8		0.88				
10/4/2011	2:35 PM		9.65	7.98			10.5		0.6	174.0	240.9	
10/25/2011	10:50 AM	25	9.80	8.11	0.0298	0.3	9.9	0.94	0.4	170.6	239.8	
11/29/2011	11:03 AM	6	9.20	7.63	0.0319	0.3	9.5	1.03	0.6	168.4	239.0	
12/20/2011	10:35 AM	2	9.20	7.74	0.0343	0.5	9.6	1.01	1.4	171.0	242.5	

Water Quality Monitoring Data
City of Shoreline
Station: BC-3 (Boeing Creek)

Date	Time	FC (col/100mL)	DO (mg/L)	pH (Std Units)	TP (mg/L)	TSS (mg/L)	Temp (deg. C)	TN (mg/L)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
9/11/2001	12:15 PM		10.23	8.17			11.6		0.0	208.6	280.6	0.1
9/25/2001	2:10 PM		10.68	8.06			11.6		0.0	209.9	282.0	0.1
10/9/2001	12:05 PM		11.24	8.07			10.8		0.0	205.3	281.3	0.1
10/22/2001	1:00 PM		11.24	7.98			10.8		0.0	201.3	276.1	0.1
11/16/2001	2:00 PM		10.54	7.70			10.9		0.0	183.1	250.8	0.1
12/3/2001	10:50 AM		10.73	7.58			8.7		0.2	126.4	183.5	0.1
12/28/2001	9:15 AM		10.70	7.91			9.3		0.0	183.7	262.6	0.1
1/9/2002	2:05 PM		11.35	7.70			9.7		0.0	155.7	219.8	0.1
1/18/2002	3:05 PM		12.49	7.42			8.1		47.3	115.7	170.8	0.1
1/31/2002	11:30 AM		11.72	7.45			7.0		2.7	99.3	151.2	0.1
2/14/2002	9:10 AM		10.40	7.70			8.8		10.1	176.8	255.8	0.1
3/1/2002	3:25 PM		10.76	7.91			9.2			177.7	254.4	0.1
3/15/2002	11:20 AM		10.92	7.65			8.2		0.0	121.1	178.1	0.1
3/29/2002	10:45 AM		11.68	8.10			10.1			184.3	257.9	0.1
4/5/2002	2:30 PM		11.30				11.0			192.2	262.8	0.1
4/18/2002	4:15 PM		9.58	7.96			11.7		0.0	195.3	261.8	0.1
4/29/2002	11:30 AM		10.55	7.89			10.7		0.0	191.0	263.3	0.1
5/13/2002	1:10 PM		10.98	7.79			10.9		0.0	193.8	264.9	0.1
5/28/2002	2:38 PM		10.84	7.88			11.6		0.0	199.0	267.3	0.1
6/25/2002	3:30 PM		10.35	6.92			13.5		0.0	213.5	274.1	0.1
7/23/2002	3:50 PM		9.93	7.96			13.2		3.7	215.0	277.5	0.1
8/12/2002	11:00 AM		10.95	8.09			12.0		1.8	208.0	276.9	0.1
9/25/2002	11:40 PM		10.02	7.92			11.3		1.9	206.6	279.7	0.1
10/8/2002	10:20 AM		10.44	8.00			10.9		0.7	204.7	279.9	0.1
10/28/2002	5:10 PM		10.63	7.92			10.4		1.1	204.1	282.9	0.1
11/15/2002	10:15 AM		10.73	7.77			10.1		0.9	201.2	281.3	0.1
11/27/2002	11:30 AM		10.01	7.89			9.2		0.5	196.4	281.3	0.1
12/20/2002	10:50 AM		9.53	7.94			9.3		0.4	194.0	277.0	0.1
1/3/2003	11:10 AM		11.17	7.66			9.4		25.3	156.3	222.6	0.1
2/6/2003	10:05 AM		10.55	8.00			8.9		1.0	183.2	264.3	0.1
3/17/2003	10:00 AM		10.96	7.76			9.9		2.0	120.8	170.1	0.1
4/25/2003	2:25 PM		10.15				11.8		1.6	192.7	257.3	0.1
5/22/2003	3:15 PM		10.30				11.4		1.4	204.1	275.8	0.1
6/17/2003	11:40 AM		10.85	7.94			10.7		3.5	190.5	261.8	0.1
7/10/2003	9:00 AM		10.21	7.95			11.4		1.0	205.4	277.5	0.1
8/15/2003	11:30 AM		10.43				12.2		0.8	178.9	236.3	0.1
9/22/2003	2:00 PM		9.91	8.03			11.8		1.5	210.3	281.6	0.1
10/13/2003	3:00 PM		10.24	7.78			11.3		0.5	208.4	282.1	0.1
10/31/2003	3:26 PM		9.85	7.74			9.3		0.3	196.5	280.4	0.1
11/19/2003	1:55 PM		9.16	7.65			10.1		0.1	200.0	279.5	0.1
12/4/2003	3:15 PM		11.20	7.51			9.6		0.0	187.5	265.8	0.1
12/23/2003	11:27 AM		10.86	7.31			9.6		0.2	188.0	266.2	0.1
1/8/2004	3:10 PM		10.70	7.24			6.5		5.3	117.4	181.4	0.1
1/28/2004	3:00 PM		10.08	7.51			9.6		1.6	167.0	236.4	0.1
2/12/2004	3:45 PM		10.35	7.40			9.4		0.7	181.5	258.2	0.1
3/10/2004	2:00 PM		9.55	7.92			9.7		1.3	183.5	259.1	0.1
3/26/2004	3:10 PM		10.48	7.86			10.3		2.8	129.0	202.8	0.1
4/14/2004	10:15 AM		10.54	8.03			10.6		1.5	182.2	251.4	0.1
4/28/2004	10:50 AM		10.34	7.77			10.6		0.4	198.3	273.7	0.1
6/24/2004	2:50 PM		10.73	8.03			12.3		4.6	212.6	280.6	0.1
7/22/2004	9:30 AM		9.40				11.9		0.6	193.0	257.3	0.1
8/19/2004	1:53 PM		9.56				12.9		4.5	200.6	260.8	0.1
9/27/2004	3:05 PM		9.92	8.10			11.8		2.5	193.4	258.5	0.1
10/12/2004	11:40 AM		10.81	8.08			11.4		2.6	193.1	260.8	0.1
11/18/2004	10:55 AM		10.08	8.03			9.8		0.9	180.1	253.6	0.1
12/13/2004	1:03 PM		10.91	6.92			9.1		11.3	72.3	105.1	0.0
1/10/2005	2:40 PM		10.51	8.00			8.3		1.7	162.2	238.3	0.1
1/31/2005	11:05 AM		10.78	7.91			10.2		1.4	178.2	248.6	0.1

Water Quality Monitoring Data
City of Shoreline
Station: BC-3 (Boeing Creek)

Date	Time	FC (col/100mL)	DO (mg/L)	pH (Std Units)	TP (mg/L)	TSS (mg/L)	Temp (deg. C)	TN (mg/L)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
2/9/2005	1:30 PM		10.78	8.00			9.3		13.5	188.9	269.9	0.1
2/22/2005	2:55 PM		11.22	8.10			9.8		0.5	184.1	259.7	0.1
3/9/2005	1:00 PM		10.36	6.88			11.3		0.8	193.3	262.1	0.1
3/31/2005	3:15 PM		10.92	7.97			10.7		0.6	193.6	266.8	0.1
4/28/2005	2:20 PM		10.17	8.07			12.7		2.5	202.3	264.4	0.1
5/26/2005	1:50 PM		11.35	7.96			13.7		2.2	212.2	270.7	0.1
6/28/2005	12:25 PM		10.40	7.97			12.0		7.0	193.5	257.2	0.1
7/19/2005	1:10 PM		10.38	8.04			12.5		4.1	201.4	264.7	0.1
8/17/2005	3:10 PM		8.47	7.91			13.6		7.0	200.1	255.8	0.1
10/18/2005	11:10 AM		9.70	7.99			11.2		2.3	194.5	264.8	0.1
11/10/2005	2:35 PM		9.41	7.65			10.6		3.5	194.0	267.5	0.1
12/22/2005	9:55 AM		10.30	4.90			8.4		11.4	35.6	52.4	0.0
1/19/2006	8:45 AM		10.50	7.61			9.8		3.7	168.4	238.5	0.1
2/27/2006	9:20 AM		10.92	7.59			9.9		1.4	162.7	228.5	0.1
3/24/2006	10:55 AM		8.02	7.58			9.8			113.8	160.3	0.1
4/24/2006	10:05 AM		9.60	8.23			11.0		0.5	188.5	256.9	0.1
4/25/2006	3:00 PM		10.52	8.13			12.9			191.0	249.0	0.1
5/31/2006	2:20 PM		10.58	8.13			12.4			193.4	255.0	0.1
7/3/2006	9:32 AM		3.18	8.12			11.7			149.8	253.4	0.1
8/4/2006	10:45 AM		0.12	8.05			12.0			184.7	245.9	0.1
9/8/2006	11:10 AM		9.49	7.97			11.6		0.0	184.4	249.3	0.1
10/13/2006	1:55 PM		10.50	7.81			11.4		0.7	112.1	222.5	0.1
11/14/2006	2:20 PM		11.61	7.80			11.1		0.4	193.9	263.0	0.1
12/22/2006	2:45 PM		10.27	7.89			10.0		1.7	171.5	240.2	0.1
1/29/2007	10:45 AM		10.38	7.96			10.0		0.5	180.7	253.1	0.1
2/26/2007	9:40 AM		10.24	8.06			10.0		0.5	171.1	239.9	0.1
3/27/2007	10:15 AM		10.23	8.07			10.7		0.4	183.3	252.7	0.1
5/29/2007	9:00 AM		10.06	7.96			10.9		0.4	197.5	269.8	0.1
6/26/2007	10:20 AM		9.18	7.94			11.6		0.9	198.6	266.7	0.1
7/31/2007	11:30 AM		8.67	7.97			12.2		0.9	180.1	231.8	0.1
8/28/2007	10:15 AM		9.23	7.85			11.4		1.8	206.7	279.3	0.1
9/24/2007	8:40 AM		7.79	7.90			10.8		0.6	201.3	276.3	0.1
10/30/2007	10:30 AM	5	7.80	7.99	0.0378	0.3	9.6	1.01	0.2	194.8	276.2	0.1
11/27/2007	10:10 AM	13	10.64	8.02	0.0406	0.5	8.6	1.34	0.7	177.2	257.6	0.1
12/18/2007	10:00 AM	560	11.53	7.09	0.0755	29.0	6.4	0.65	18.0	43.3	67.0	0.0
1/22/2008	10:55 AM	3	11.00	7.69	0.0373	0.6	8.0	1.92	0.9	168.6	248.3	0.1
2/26/2008	11:00 AM	4	10.90	7.89	0.0434	0.9	9.8	1.63	0.4	180.0	254.7	0.1
3/24/2008	11:00 AM	12	10.91	7.57	0.0411	2.0	9.1	1.59	0.8	169.2	242.7	0.1
4/22/2008	10:15 AM	29	9.71	7.64	0.0388	0.8	9.6	1.61	0.9	176.1	249.3	0.1
5/27/2008	9:40 AM	64	10.34	7.78	0.0430	0.5	11.4	1.54	2.0	195.7	264.6	0.1
6/24/2008	9:30 AM	15	10.02	8.06	0.0453	0.3	10.8	1.52	0.9	197.7	270.8	0.1
7/22/2008	9:30 AM	1	9.80	8.07	0.0418	0.3	11.3	1.42	0.2	203.2	274.9	0.1
8/26/2008	9:50 AM	230	9.54	7.73	0.0461	0.5	12.1	1.42	2.3	190.3	252.3	0.1
9/23/2008	9:40 AM	3	9.33	7.57	0.0481	0.9	10.5	1.48	0.6	193.5	267.7	0.1
10/28/2008	10:05 AM		9.23	7.98	0.0464	0.3	10.2	1.46	0.3	193.4	268.1	0.1
11/25/2008	10:20 AM	3	9.08	7.63	0.0466	0.6	10.2	1.51	0.3	197.7	275.6	0.1
12/30/2008	10:15 AM	5	8.89	7.16	0.0456	0.3	9.2	1.66	0.3	188.0	269.5	0.1
1/27/2009	10:50 AM	1	9.09	7.37	0.0482	0.5	8.8	1.48	0.3	187.0	271.3	0.1
2/17/2009	10:15 AM		8.82	7.70	0.0492	0.3	9.8	1.53	0.4	191.7	270.5	0.1
3/31/2009	10:35 AM	4	10.24	7.66	0.0536	0.3	9.8	1.58		191.1	269.0	0.1
4/28/2009	10:50 AM	2	8.90	7.64	0.0417	0.3	10.7	1.50	0.4	192.3	266.0	0.1
5/26/2009	11:20 AM	5	9.88	7.68	0.0497	0.5	11.7	1.66	0.1	199.6	267.2	0.1
6/23/2009	10:40 AM	46	9.97	7.88	0.0510	0.3	11.2	1.55	0.6	198.3	269.3	0.1
7/28/2009	9:55 AM	15	9.51	7.77	0.0420	0.3	12.2	1.40	0.4	204.8	271.4	0.1
8/25/2009	9:45 AM	4	10.53	8.02	0.0476	0.3	11.5	1.47	0.3	201.1	270.6	0.1
9/23/2009	2:20 PM	21	10.23	7.63	0.0461	0.3	12.0	1.56	0.2	201.5	268.5	0.1
11/4/2009	11:20 AM	10	8.56		0.0439	0.3	10.5	1.67	0.3	198.4	274.6	0.1
11/17/2009	11:05 AM	46	7.15		0.0437	1.2	9.6	1.89	2.3	98.8	140.0	0.1

Water Quality Monitoring Data
City of Shoreline
Station: BC-3 (Boeing Creek)

Date	Time	FC (col/100mL)	DO (mg/L)	pH (Std Units)	TP (mg/L)	TSS (mg/L)	Temp (deg. C)	TN (mg/L)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
12/29/2009	10:10 AM	2	10.35	8.23	0.0457	0.3	8.9	1.44	0.6	179.2	259.1	0.1
1/26/2010	10:55 AM	4	10.70	8.03	0.0411	0.3	9.7	1.46	1.1	178.1	251.8	0.1
2/22/2010	10:20 AM	2	10.31	8.10	0.0425	0.6	9.9	1.40	0.9	181.8	255.8	0.1
3/23/2010	10:35 AM	86	9.50	8.22	0.0373	0.5	11.0	1.41	0.5	189.0	258.1	0.1
4/27/2010	10:00 AM	84	9.70	8.24	0.0439	0.6	10.9	1.39	0.8	162.5	222.7	0.1
5/25/2010	4:10 PM	9	9.66	8.40	0.0410	0.5	11.4	1.47	0.4	195.9	264.4	0.1
6/22/2010	9:40 AM	5	8.25	8.44	0.0414	0.3	11.1	1.38	0.2	195.2	265.5	0.1
7/27/2010	10:50 AM	3	10.31	8.50	0.0446	0.7	12.0	1.47	0.6	198.7	266.5	0.1
8/24/2010	10:10 AM	5	9.96	8.40	0.0500	1.0	11.3	1.45	0.9	198.3	268.6	0.1
9/28/2010	10:00 AM	7	9.94	8.20	0.0452	0.3	11.8	1.50	0.2	201.4	269.7	0.1
10/27/2010	9:45 AM	35	10.52	8.18	0.0558	1.7	10.7	1.61	0.2	193.6	266.9	0.1
11/30/2010	10:40 AM		11.32	7.38			6.6		52.3	43.7	67.2	0.0
11/30/2010	10:40 AM	540	11.25	7.10	0.0794	21.3	6.8	0.67	52.4			
12/28/2010	10:45 AM	86	10.31	7.84	0.0285	0.5	8.9	1.69	1.6	143.2	204.6	0.1
1/25/2011	10:40 AM	4	10.02	8.30	0.0391	0.7	10.4	1.53	1.1	190.1	263.9	0.1
2/22/2011	10:10 AM	7	10.88	7.90	0.0381	0.6	8.8	1.44	0.7	182.4	260.8	0.1
3/22/2011	9:30 AM	1	11.30	8.02	0.0351	0.6	11.3	1.64	0.9			
4/12/2011	3:00 PM		11.30	8.02			11.3		0.9	190.0	257.8	0.1
4/26/2011	10:05 AM	18	12.64	7.87	0.0368	0.3	10.2	1.44	0.5	186.0	259.0	0.1
5/24/2011	11:00 AM	3	11.24	7.95	0.0452	0.3	11.2	1.47	0.7			
6/3/2011	9:45 AM		11.24	7.95			11.2		0.7	191.0	261.6	0.1
6/28/2011	10:40 AM	7	11.82	8.13	0.0432	0.5	11.6	1.47	0.6	196.8	266.2	0.1
7/26/2011	10:20 AM	160			0.0442	1.0		1.43				
7/28/2011	4:15 PM		10.55	8.21			13.0		0.4	175.6	232.8	
8/23/2011	9:40 AM	5	10.97	8.19	0.0464	0.5	11.6	1.48	0.5	198.3	266.7	
10/4/2011	11:20 AM	12	10.05	7.89	0.0462	2.0	11.3	1.37	0.4			
10/4/2011	2:30 PM		10.05	7.89			11.3		0.4	197.4	267.7	
10/25/2011	10:40 AM	8	10.19	8.19	0.0405	1.9	10.4	1.53	0.4	191.6	265.9	
11/29/2011	10:55 AM	2	9.60	7.58	0.0404	0.3	9.8	1.63	0.4	186.7	262.8	
12/20/2011	10:25 AM	2	9.30	7.64	0.0402	0.6	9.8	1.50	0.0	189.3	267.1	

Water Quality Monitoring Data
City of Shoreline
Station: HLO-1 (Boeing Creek/Hidden Lake)

Date	Time	DO (mg/L)	pH (Std Units)	Temp (deg. C)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
9/5/2001	12:01 PM	10.40	8.07	12.1	0.0	195.3		0.1
9/11/2001	12:45 PM	10.17	8.12	12.0	0.0	195.0	259.3	0.1
9/25/2001	2:35 PM	11.96	8.10	12.4	0.1	198.5	261.8	0.1
10/9/2001	12:30 PM	11.29	7.87	10.4	0.0	185.8	257.8	0.1
10/11/2001	1:37 PM	11.78	7.26	7.7	17.9	98.5	147.7	0.1
10/16/2001	1:20 PM			10.0	13.9			
10/22/2001	12:05 PM	10.21	7.50	10.1	5.5	133.4	185.8	0.1
11/16/2001	2:00 PM	8.47	7.41	10.7	1.0	123.1	170.2	0.1
12/3/2001	11:45 AM	9.50	7.57	7.6	0.0	129.9	194.5	0.1
12/28/2001	10:00 AM	10.14	7.76	7.5	0.0	169.3	254.2	0.1
1/9/2002	2:55 PM	9.70	7.48	9.3	0.0	116.1	168.8	0.1
1/31/2002	11:00 AM	11.06	7.54	6.3	3.8	116.8	182.8	0.1
2/14/2002	9:55 AM	10.24	7.63	7.1	0.0	161.9	246.2	0.1
3/1/2002	3:00 PM	10.75	7.66	7.2		165.2	250.3	0.1
3/15/2002	1:50 PM	10.21	7.73	8.2	19.4	149.6	220.4	0.1
3/28/2002	4:30 PM	11.56	7.91	9.5		176.6	251.0	0.1
4/18/2002	3:42 PM	11.02	7.93	10.7	0.0	173.0	238.4	0.1
4/29/2002	11:10 AM	11.01	7.77	10.4	0.0	166.5	231.1	0.1
5/13/2002	12:50 PM	11.60	8.01	12.5	0.0	192.3	252.9	0.1
5/28/2002	2:20 PM	13.46	8.33	13.9	0.0	198.5	251.8	0.1
6/26/2002	2:45 PM	15.99	8.46	18.5		270.2	252.4	0.1
7/23/2002	4:35 PM	12.17	8.43	17.8	6.5	217.0	255.6	0.1
8/12/2002	11:40 AM	13.79	8.45	14.4	4.0	204.1	255.6	0.1
9/25/2002	11:20 AM	9.59	7.74	11.5	5.3	190.0	256.0	0.1
10/8/2002	11:00 AM	9.16	7.66	11.2	1.5	187.8	255.5	0.1
10/31/2002	11:00 AM	10.06	7.75	6.8	1.5	169.1	259.2	0.1
11/15/2002	10:30 AM	9.16	7.37	9.5	3.6	173.9	247.2	0.1
12/20/2002	10:10 AM	9.00	7.68	7.3	2.5	160.6	241.3	0.1
1/3/2003	12:45 PM	8.04	7.39	8.8	17.7	52.3	75.0	0.0
2/5/2003	9:30 AM	9.72	7.63	7.5	3.4	156.7	235.1	0.1
3/17/2003	11:00 AM	9.83	7.58	9.5	3.9	161.8	230.3	0.1
4/25/2003	1:45 PM	10.16		11.1	5.7	137.6	187.6	0.1
5/22/2003	3:10 PM	11.07		13.7	3.5	203.0	259.1	0.1
6/17/2003	11:20 AM	12.21	8.31	13.9	3.6	2.5	260.6	0.1
7/10/2003	9:25 AM	14.00	8.70	13.5	4.1	202.3	259.1	0.1
8/15/2003	3:00 PM	12.12		16.8	1.0	219.7	261.3	0.1
9/30/2003	10:10 AM	10.90	7.70	12.3	1.5	198.2	261.3	0.1
10/13/2003	1:45 PM	8.25	6.81	11.9	5.6	151.9	202.8	0.1
10/31/2003	2:38 PM	9.43	7.60	7.5	1.0	173.3	259.1	0.1
11/13/2003	11:35 AM	9.21	7.47	7.7	1.6	176.7	264.3	0.1
12/4/2003	1:40 PM	10.50	7.18	7.6	3.5	153.8	230.7	0.1
12/26/2003	10:50 AM	10.52	6.96	6.2	7.0	92.5	144.3	0.1
1/14/2004	2:43 PM	9.47	7.24	9.2		97.2	139.4	0.1
1/28/2004	2:30 PM	9.79	7.41	8.6	2.3	160.4	233.5	0.1
2/12/2004	4:15 PM	10.50	7.85	7.8	2.1	172.7	256.8	0.1
3/9/2004	2:35 PM	9.06	7.91	10.1	4.0	168.1	235.4	0.1

Water Quality Monitoring Data
City of Shoreline
Station: HLO-1 (Boeing Creek/Hidden Lake)

Date	Time	DO (mg/L)	pH (Std Units)	Temp (deg. C)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
3/26/2004	2:42 PM	9.86	7.50	9.9	9.8	85.7	120.3	0.1
4/14/2004	10:30 AM	10.83	8.15	11.9	1.5	192.0	256.6	0.1
4/28/2004	10:05 AM	10.83	7.71	10.3	1.0	184.9	256.9	0.1
7/22/2004	9:55 AM	11.45		15.0	4.2	194.2	239.9	0.1
8/19/2004	2:06 PM	9.89		15.8	6.3	199.1	243.6	0.1
9/27/2004	3:15 PM	11.78	8.33	12.2	3.9	181.9	239.8	0.1
10/12/2004	12:10 PM	10.40	7.92	11.7	5.6	171.3	230.7	0.1
11/18/2004	11:20 AM	9.41	7.27	8.9	10.3	125.7	181.3	0.1
12/14/2004	11:10 AM	8.79	7.17	8.9	15.8	84.4	122.6	0.1
1/10/2005	3:00 PM	10.02	7.65	5.8	9.6	134.7	213.0	0.1
1/31/2005	11:20 AM	10.01	7.32	9.2	2.8	168.6	241.8	0.1
2/9/2005	12:45 PM	11.06	7.56	6.7	13.1	142.2	218.8	0.1
2/24/2005	3:05 PM	11.89	7.87	7.5	1.6	161.0	241.6	0.1
3/18/2005	11:00 AM	11.07	7.71	9.3	7.8	150.5	214.9	0.1
3/31/2005	3:45 PM	9.86	7.56	9.9	7.3	135.3	190.1	0.1
4/28/2005	2:50 PM	11.85	8.59	14.0	5.3	189.7	240.5	0.1
5/25/2005	4:20 PM	12.72	8.19	15.2	3.0	195.4	240.2	0.1
6/29/2005	3:02 PM	13.03	8.04	13.9	9.8	187.6	237.6	0.1
7/20/2005	11:00 AM	11.89	8.42	14.6	4.2	193.2	241.2	0.1
8/17/2005	3:30 PM	10.27	7.97	14.2	4.6	189.6	239.0	0.1
10/18/2005	10:30 AM	8.21	7.15	11.7	6.2	173.0	232.3	0.1
11/10/2005	9:15 AM	8.57	7.34	9.2		161.9	232.3	0.1
12/30/2005	9:20 AM	9.57	6.90	8.2	11.8	93.3	137.4	0.1
1/19/2006	9:00 AM	9.71	6.32	8.5	8.2	140.7	205.6	0.1
2/10/2006	2:52 PM	9.80	7.40	7.5	3.2	159.1	238.9	0.1
3/24/2006	10:40 AM	8.83	7.66	9.7		102.4	144.7	0.1
4/25/2006	3:30 PM	12.61	8.34	13.7		182.1	232.0	0.1
5/31/2006	2:00 PM	12.24	8.28	14.5		169.1	211.5	0.1
7/3/2006	9:20 AM	3.42	8.86	15.2		187.4	230.7	0.1
8/4/2006	10:25 AM	0.95	8.33	13.4		186.5	239.7	0.1
9/8/2006	11:30 AM	9.10	7.73	12.6	0.6	186.0	243.7	0.1
10/13/2006	2:20 PM	11.32	7.81	11.1	0.9	182.3	248.3	0.1
11/14/2006	2:55 PM	13.36	7.40	9.0	2.3	139.4	200.8	0.1
12/22/2006	2:30 PM	9.92	7.28	8.1	7.4	117.9	174.4	0.1
1/30/2007	2:15 PM	10.48	7.66	6.5	2.1	157.2	242.9	0.1
2/26/2007	2:15 PM	10.38	7.53	8.5	5.6	124.9	182.3	0.1
3/28/2007	2:15 PM	10.42	8.04	10.2	1.5	166.6	237.7	0.1
4/25/2007	9:25 AM	10.05	8.43	11.7	1.2	182.6	244.7	0.1
5/30/2007	2:10 PM	9.36	7.89	14.7	1.6	201.0	249.6	0.1
6/26/2007	2:40 PM	10.62	8.71	16.3	2.0	201.3	241.5	0.1
8/2/2007	11:25 AM	10.60	8.41	14.2	2.0	192.3	242.6	0.1
8/28/2007	5:20 PM	8.27	7.94	15.6	0.8	201.0	244.9	0.1
9/24/2007	2:10 PM	6.99	7.95	12.0	0.6	179.9	239.7	0.1
10/30/2007	4:30 PM	7.99	7.46	8.6	1.0	163.8	238.6	0.1
11/27/2007	10:50 AM	9.40	7.48	6.0	7.8	113.6	178.2	0.1
12/19/2007	10:00 AM	10.09	6.48	7.1	23.6	69.6	106.4	0.0

Water Quality Monitoring Data
City of Shoreline
Station: HLO-1 (Boeing Creek/Hidden Lake)

Date	Time	DO (mg/L)	pH (Std Units)	Temp (deg. C)	Turbidity (NTU)	Cond (µs)	Sp Cond (µs @ 25°C)	Salinity (ppt)
1/23/2008	3:00 PM	10.97	7.49	5.6	3.5	151.1	240.2	0.1
2/28/2008	11:45 AM	11.18	7.68	9.7	1.8	171.0	241.3	0.1
3/24/2008		10.85	7.09	9.1	4.7	119.8	171.5	0.1
4/22/2008	1:45 PM	11.20	7.39	9.7	2.5	148.7	209.8	0.1
5/27/2008	10:15 AM	11.18	7.80	12.6	1.4	184.2	241.6	0.1
6/24/2008	9:55 AM	10.70	8.07	11.6	1.2	140.1	241.5	0.1
7/23/2008	11:40 AM	9.58	7.56	12.9	0.8	187.1	243.3	0.1
8/28/2008	2:40 PM	7.90	6.95	14.3	11.5	159.9	200.6	0.1
9/23/2008	10:10 AM	9.16	7.79	11.2	1.3	146.2	198.8	0.1
10/28/2008	9:45 AM	9.08	7.83	8.8	0.6	168.0	243.4	0.1
11/25/2008	10:40 AM	8.59	7.37	7.5	3.1	156.4	234.9	0.1
12/30/2008	10:40 AM	9.11	6.95	5.1	32.5	92.9	150.8	0.1
1/30/2009	1:09 PM	9.05		7.2	1.8	159.0	240.5	0.1
2/20/2009	11:00 AM	8.99	6.95	7.0	3.3	161.2	245.5	0.1
4/1/2009	4:00 PM	9.99	6.84	7.1		105.5	159.0	0.1
4/30/2009	4:15 PM	8.33	6.92	12.8	0.5	187.4	244.2	0.1
5/29/2009	12:45 PM	10.21	7.43	14.4	1.6	193.2	242.9	0.1
6/23/2009	2:50 PM	8.15	7.75	14.4	1.6	193.9	243.6	0.1
7/28/2009	10:25 AM	11.64	8.04	15.6	0.6	203.1	247.5	0.1
9/23/2009	2:00 PM	8.72	6.67	12.2	0.8	93.7	124.2	0.1
11/4/2009	11:10 AM	8.93		8.7	1.6	167.1	242.3	0.1
11/17/2009	2:05 PM	6.32		9.4	6.1	47.6	68.2	0.0
12/29/2009	10:40 AM	10.15	8.08	5.9	1.5	152.7	240.2	0.1
1/29/2010	2:15 PM	10.33	7.98	9.0	1.3	163.9	236.0	0.1
2/22/2010	10:00 AM	10.67	8.11	7.4	1.2	158.5	239.0	0.1
4/1/2010	11:50 AM	10.68	8.25	9.6	2.3	154.8	218.8	0.1
4/27/2010	4:00 PM	8.83	7.92	12.1	4.9	102.9	136.3	0.1
5/25/2010	11:30 AM	8.63	7.95	12.5	3.3	138.3	182.5	0.1
6/22/2010	2:10 PM	6.75	8.37	14.0	1.7	186.4	239.1	0.1
7/27/2010	4:15 PM	7.15	8.70	20.5	2.9	211.0	245.0	0.1
8/24/2010	2:20 PM	7.43	8.30	16.3	2.1	194.8	241.4	0.1
9/28/2010	2:05 PM	8.88	8.12	14.9	1.6	180.4	231.4	0.1
10/27/2010	9:20 AM	9.28	8.23	10.0	0.9	153.4	216.8	0.1
12/6/2010	12:00 PM	8.97	7.91	7.2	1.3	160.5	243.6	0.1
12/30/2010	11:15 AM	6.59	8.24	8.5	8.9	156.3	231.3	0.1
1/26/2011	11:15 AM	8.96	7.86	9.5	5.8	161.4	231.4	0.1
3/22/2011	2:45 PM	11.79	8.13	11.9	2.7	164.2	224.1	0.1
5/2/2011	3:00 PM	8.16	7.63	11.4	11.0	99.2	133.4	0.1
6/3/2011	10:05 AM	11.85	7.93	12.0	2.5	157.6	210.4	0.1
6/29/2011	8:25 AM	10.47	8.33	14.1	0.9	163.8	212.9	0.1
7/28/2011	4:45 PM	10.23	8.02	18.6	2.9	184.0	214.6	
8/23/2011	3:45 PM	12.60	8.92	13.0	1.1	176.6	229.7	
10/10/2011	3:45 PM	9.06	7.95	11.5	1.0	174.5	235.0	
10/25/2011	2:10 PM	8.96	7.47	9.7	2.8	139.8	197.3	
11/30/2011	2:10 PM	9.08	7.49	8.0	1.4	153.7	226.3	
12/20/2011	10:00 AM	9.18	7.57	8.2	1.5	164.4	242.3	

APPENDIX F. WATER QUALITY INDEX SPREADSHEETS

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-2
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2007-2008**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-07	1	7.36	7.66	0.0446	0.5	9.5	1.35	0.27	61
November-07	4	8.89	7.82	0.0369	0.25	9	1.03	0.3	85
December-07	1000	11.13	7.15	0.0626	16.2	6.3	0.975	21.6	29
January-08	2	9.81	7.61	0.0401	0.25	8.5	1.03	0.4	91
February-08		9.37	7.67	0.0387	0.5	9.8	0.924	0.7	88
March-08	3	9.8	7.54	0.0347	0.25	9.4	0.943	0.9	94
April-08	7	9.9	7.51	0.0389	0.25	9.6	0.931	0.3	93
May-08	9	10.08	7.55	0.0379	0.7	10.6	0.898	2.6	93
June-08	3	9.97	7.99	0.0382	0.25	10.3	0.888	1.1	84
July-08	1	9.53	7.73	0.0345	0.25	10.5	0.906	0.6	86
August-08	13	9.1	7.71	0.0393	0.6	10.6	0.929	1.3	77
September-08	9	8.56	7.76	0.035	0.5	10.2	0.914	0.6	75
Constituent Scores:	74	52	93	70	96	94	14	91	
							Overall Score:		**55**

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-3
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2007-2008**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-07	5	7.80	7.99	0.0378	0.3	9.6	1.01	0.2	67
November-07	13	10.64	8.02	0.0406	0.5	8.6	1.34	0.7	89
December-07	560	11.53	7.09	0.0755	29.0	6.4	0.65	18.0	56
January-08	3	11.00	7.69	0.0373	0.6	8.0	1.92	0.9	95
February-08	4	10.90	7.89	0.0434	0.9	9.8	1.63	0.4	90
March-08	12	10.91	7.57	0.0411	2.0	9.1	1.59	0.8	91
April-08	29	9.71	7.64	0.0388	0.8	9.6	1.61	0.9	91
May-08	64	10.34	7.78	0.0430	0.5	11.4	1.54	2.0	82
June-08	15	10.02	8.06	0.0453	0.3	10.8	1.52	0.9	79
July-08	1	9.80	8.07	0.0418	0.3	11.3	1.42	0.2	82
August-08	230	9.54	7.73	0.0461	0.5	12.1	1.42	2.3	60
September-08	3	9.33	7.57	0.0481	0.9	10.5	1.48	0.6	77
Constituent Scores:	61	59	91	66	94	91	1	91	
							Overall Score:		**61**

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-2
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2008-2009**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-08		8.51	7.75	0.0382	0.3	9.9	0.95	0.4	72
November-08	1	8.34	7.68	0.0379	0.3	9.9	0.99	0.5	81
December-08	8	8.36	7.42	0.0372	0.8	8.9	0.97	1.0	81
January-09	16	8.11	7.40	0.0379	0.5	9.0	0.92	0.8	77
February-09		7.91	8.18	0.0399	0.5	9.6	0.92	0.8	70
March-09	1	9.65	7.76	0.0350	0.3	9.7	0.96		93
April-09	1	8.97	7.38	0.0369	0.5	10.2	0.98	1.0	86
May-09	2	9.30	7.30	0.0394	1.1	11.0	1.01	0.1	88
June-09	30	9.35	7.77	0.0388	0.1	10.5	0.94	0.6	78
July-09	7	9.17	7.63	0.0369	0.3	11.1	0.92	0.4	80
August-09	6	9.62	7.36	0.0372	0.5	10.5	0.93	0.8	85
September-09	23	9.58	6.71	0.0366	0.3	10.6	0.97	0.4	81
Constituent Scores:	88	60	86	72	100	93	16	100	
							Overall Score:		**73**

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-3
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2008-2009**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-08		9.23	7.98	0.0464	0.3	10.2	1.46	0.3	73
November-08	3	9.08	7.63	0.0466	0.6	10.2	1.51	0.3	82
December-08	5	8.89	7.16	0.0456	0.3	9.2	1.66	0.3	80
January-09	1	9.09	7.37	0.0482	0.5	8.8	1.48	0.3	82
February-09		8.82	7.70	0.0492	0.3	9.8	1.53	0.4	77
March-09	4	10.24	7.66	0.0536	0.3	9.8	1.58		87
April-09	2	8.90	7.64	0.0417	0.3	10.7	1.50	0.4	82
May-09	5	9.88	7.68	0.0497	0.5	11.7	1.66	0.1	86
June-09	46	9.97	7.88	0.0510	0.3	11.2	1.55	0.6	76
July-09	15	9.51	7.77	0.0420	0.3	12.2	1.40	0.4	80
August-09	4	10.53	8.02	0.0476	0.3	11.5	1.47	0.3	80
September-09	21	10.23	7.63	0.0461	0.3	12.0	1.56	0.2	80
Constituent Scores:	87	72	92	65	100	91	1	100	
							Overall Score:		**75**

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-2
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2009-2010**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-09	8	8.79		0.0335	0.9	9.3	1.03	1.2	77
November-09	59	6.74		0.0327	1.8	9.5	0.90	3.6	54
December-09	1	9.82	8.07	0.0352	1.1	7.4	0.95	1.0	93
January-10	9	10.15	7.94	0.0331	0.6	9.3	1.04	0.9	93
February-10	1	10.14	8.02	0.0324	1.0	8.5	0.94	1.2	93
March-10	11	9.91	8.13	0.0318	0.5	9.9	0.97	1.4	91
April-10	150	9.09	8.05	0.0352	2.2	11.3	0.91	3.0	70
May-10	7	8.84	8.09	0.0343	0.8	11.6	0.98	2.0	83
June-10	18	8.14	8.34	0.0348	0.8	12.2	0.91	1.0	68
July-10	2	8.36	8.51	0.0389	0.6	15.9	0.96	1.8	64
August-10	61	8.47	8.29	0.0358	1.4	13.6	0.87	1.4	64
September-10	20	8.91	8.14	0.0246	0.3	12.9	0.93	1.1	82
Constituent Scores:	74	41	80	73	100	80	13	97	
							Overall Score:		**61**

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-3
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2009-2010**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-09	10	8.56		0.0439	0.3	10.5	1.67	0.3	69
November-09	46	7.15		0.0437	1.2	9.6	1.89	2.3	59
December-09	2	10.35	8.23	0.0457	0.3	8.9	1.44	0.6	88
January-10	4	10.70	8.03	0.0411	0.3	9.7	1.46	1.1	90
February-10	2	10.31	8.10	0.0425	0.6	9.9	1.40	0.9	89
March-10	86	9.50	8.22	0.0373	0.5	11.0	1.41	0.5	80
April-10	84	9.70	8.24	0.0439	0.6	10.9	1.39	0.8	77
May-10	9	9.66	8.40	0.0410	0.5	11.4	1.47	0.4	86
June-10	5	8.25	8.44	0.0414	0.3	11.1	1.38	0.2	67
July-10	3	10.31	8.50	0.0446	0.7	12.0	1.47	0.6	79
August-10	5	9.96	8.40	0.0500	1.0	11.3	1.45	0.9	77
September-10	7	9.94	8.20	0.0452	0.3	11.8	1.50	0.2	79
Constituent Scores:	76	48	80	66	100	91	1	100	
							Overall Score:		**65**

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-2
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2010-2011**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-10	15	9.17	8.04	0.0345	0.9	10.2	0.99	2.1	79
November-10	600	11.25	7.10	0.1210	44.5	6.8	0.60	52.4	46
December-10	170	10.78	7.89	0.0242	4.3	8.8	0.75	3.5	79
January-11	14	9.60	7.99	0.0314	0.6	10.0	0.94	2.0	91
February-11	1	10.42	7.76	0.0322	0.8	8.7	0.90	1.3	95
March-11	2	10.54	7.82	0.0364	0.5	10.2	1.03	1.4	94
April-11	15	11.45	7.82	0.0331	0.3	10.1	0.92	1.1	94
May-11	1	11.28	7.81	0.0346	1.4	10.5	0.92	1.0	95
June-11	12	12.20	8.00	0.0341	0.9	10.9	0.92	2.7	87
July-11	750	10.25	8.03	0.0376	1.6	11.3	0.96	0.7	52
August-11	2	10.46	8.11	0.0355	0.3	10.7	0.91	1.6	86
September-11	24	9.65	7.98	0.0438	1.8	10.5	0.88	0.6	79
Constituent Scores:	49	76	90	64	91	93	16	82	
							Overall Score:		**59**

A Water Quality Index for Washington State streams (Version 5: 2009.09.09)

Station:	BC-3
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

Water Year: **2010-2011**

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
October-10	35	10.52	8.18	0.0558	1.7	10.7	1.61	0.2	74
November-10	540	11.29	7.24	0.0794	21.3	6.7	0.67	52.4	47
December-10	86	10.31	7.84	0.0285	0.5	8.9	1.69	1.6	84
January-11	4	10.02	8.30	0.0391	0.7	10.4	1.53	1.1	91
February-11	7	10.88	7.90	0.0381	0.6	8.8	1.44	0.7	94
March-11	1	11.30	8.02	0.0351	0.6	11.3	1.64	0.9	94
April-11	18	12.64	7.87	0.0368	0.3	10.2	1.44	0.5	94
May-11	3	11.24	7.95	0.0452	0.3	11.2	1.47	0.7	89
June-11	7	11.82	8.13	0.0432	0.5	11.6	1.47	0.6	83
July-11	160	10.55	8.21	0.0442	1.0	13.0	1.43	0.4	65
August-11	5	10.97	8.19	0.0464	0.5	11.6	1.48	0.5	81
September-11	12	10.05	7.89	0.0462	2.0	11.3	1.37	0.4	80
Constituent Scores:	61	85	86	64	95	89	1	87	
							Overall Score:		**62**

APPENDIX G. PROJECT DESCRIPTIONS AND COST ESTIMATES

Table of Contents

1 Water Quality Monitoring

Project: **BC-Mon-1**

Project Name: Improve current water quality monitoring program

Description: The City has a substantial water quality monitoring program in place for all Shoreline-area water bodies, and has been collecting water quality data in Boeing Creek since 2001. However, several potential improvements to the current monitoring program are recommended, including:

Minimize data gaps – If field meters become inoperable during sampling events, or if results appear abnormal, confirmatory sampling should be rescheduled, or grab samples should be collected and submitted to a laboratory for analysis of the parameters of interest.

Additional monitoring – Add a monitoring station downstream of Hidden Lake to evaluate the effect of Hidden Lake on downstream water quality conditions, and to monitor any improvements that may occur with the implementation of other projects, such as BC-Hab-1.

Evaluate and expand (if necessary) City programs – Assess and (possibly) enhance programs designed to control contaminant sources and the amount of stormwater runoff being produced. This includes the Illicit Discharge Detection and Elimination (IDDE) Program, the Car Wash Kit Program, and the Commercial Storm Drain Inspection Program.

Use more recent 2009 Water Quality Index

Benefits: More reliable interpretation of water quality trends and potential sources of pollutants.

Assumptions: Project would be taken on by City staff.

Estimated Cost/

Level of Effort: 0 – 4 hours per month and associated laboratory costs

Potential Partners: None. It is difficult to ensure monitoring consistency with citizen volunteers.

Priority: Medium

Project: **BC-Ed-1**

Project Name: Implement targeted pet waste control education and outreach

Description: Review and expand ongoing education, outreach, and incentive programs to inform public on improved pet waste control. This project could also involve installation of signs and pet waste bags at primary access points to the Boeing Reserve trail running alongside the creek, and Boeing Creek and Shoreview Parks. Additionally, trash receptacles should be installed where not already present.

Example pet waste bag dispenser

Benefits: One well-known source of fecal coliform bacteria is dog poop. Encouraging residents to pick up after their pets and making it easy for them to do so would help reduce fecal coliform bacteria from pet sources. This is especially true along stream corridors, such as those in Boeing Creek and Shoreview Parks.

Assumptions: Project would be taken on by City staff, enhancing the existing pet waste reduction program. Information is already available on the City's website about the importance of picking up after your pets, and there are signs requesting visitors pick up after their dogs at Boeing Creek Park. The addition of pet waste bag dispensers and trash receptables would make it easier for responsible dog owners to pick up after their pets.

Estimated Cost/ Level of Effort: 20 hours per year to maintain website, distribute materials, or coordinate partnerships. Approximately $500 for pet waste bag dispensers.

Potential Partners: Innis Arden group for placement of pet waste bag dispensers in Boeing Reserve.

Priority: Medium

2 Erosion

Project: **BC-Ed-2**

Project Name: Education and outreach to Highland's residents about stormwater discharges

Description: Several stormwater pipes were observed to discharge on the hillslopes above Boeing Creek near Beach Drive in the Highlands. These pipes have initiated erosion at several locations, resulting in gullying and slope failures. This project would education of Highland's residents and the homeowners assocation as the alternatives for stormwater discharges to minimize erosion and sedimentation in Boeing Creek.

Benefits: The purpose of this project would be to reduce erosion being caused by stormwater flows that discharge from multiple pipes. Hillslope erosion contributes to sedimentation in Boeing Creek, as well as a subsequent reduction in the quality of aquatic habitat for salmonids and other aquatic species.

Assumptions: City staff would work with the Highlands' homeowners association to suggest tightlined stormwater discharges from Highlands properties to reduce erosion.

Estimated Cost/

Level of Effort: 40 hours of staff time to work with homeowners.

Potential Partners: Highlands Community Group. This project would need the support of the Highlands community, as it would be located on privately owned Highlands property.

Priority: Medium

3 Repair and Replacement of Conveyance Pipes

Project: **BC-CIP-1**

Project Name: Open-cut pipe replacement and modification of drainage structures

Description: There are 15 pipe segments (totaling 330 ft) recommended for complete replacement using an open-cut technique. Most of these pipe segments were rated very poorly on the Structural Pipe Ratings Index (SPRI) (greater than 4) and require immediate attention within the next few years, either because of their location or the type of failure.

Benefits: The benefit of replacing these pipe segments soon is avoidance of catastrophic future failure in the, which might require an emergency action.

Assumptions: The attached tables lists specific problems and solutions for each pipe segment, and recommended new storm drain connections. Locations of the pipes are shown on Figure G-1.

Estimated Cost/ Level of Effort: $508,000

Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Open-cut storm drain replacement, 12 in. (PVC)	linear ft	$35.00	330	$11,550
Storm drain CB or manhole	ea	$4,000	56	$224,000
Roadway improvement/pavement patching	sq yd	$60.00	770	$46,200
Traffic control	lump sum	$10,000	1	$10,000
Total				$291,800
Contingency (20%)				$58,400
Subtotal				$350,200
Survey, permitting, design, and engineering (45%)				$157,600
Total Project Cost				**$508,000**

CB – catch basin

Potential Partners: None

Priority: High

Table G-1. Recommended open cut pipe replacement

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
28184	15	CMP	188.06	5	0	5	Deformed 122.62 feet from upstream end	Repair/replace pipe at deformation (5 LF). (Based on site visit, determined to be high priority because of location at busy intersection.)	Along Dayton Ave. N, from intersection with N 166th St. to intersection with Carlyle Hall Rd. N, near Herzel Memorial Park
5734	12	CONC	158.91	4.5	2	3.67	Crack/hole 12.29 and 30.42 feet from downstream end, alignment separation (2 inch) 36.26 feet from downstream end, pipe failing from top 29.41 feet from upstream end, and roots blocking pipe need to be removed	Jet pipe and replace 30 linear feet at upstream end. (Site visit verified.)	16065 Dayton Ave. N, at intersection of Dayton Ave. N and N Greenwood Dr.
6712	12	CONC	200.21	5	3.5	4	Defective repair patch 8.35 feet from upstream end (1st segment), improper sd connection 33.95 feet from upstream end (1st segment), crack with roots 68.30 feet from upstream end (1st segment), and joint offset (2 inch) 24.30 feet from downstream end (2nd segment)	Add catch basin/structure at storm connection and repair pipe, and repair/replace 10 linear feet at upstream end (1st seg). (Site visit verified.)	At intersection of N Greenwood Dr. and Fremont Pl. N
3627	12	CONC	203.36	5	2	3.5	Pipe failing on side 62.65 feet from downstream end, and blocked by brick obstacles 64.30 feet from downstream end	Remove obstacles, provide outlet at downstream end, and replace 10 linear feet of pipe 60 feet from downstream end. (Site visit verified.)	548 N 170th Pl., between Dayton Ave. N and Fremont Ave. N, near Shorewood Senior High School
4738	12	CONC	65.74	5	2	3.5	Broken, hole with soil visible 42.30 feet from upstream end	Repair/replace pipe at hole (5 LF).	On Whitman Ave. N, behind Econo Lodge, south of N 149th St.
4695	12	CONC	37.65	5	3	4	Pipe failing from top with soil visible 16.01 feet from downstream end	Replace pipe. (Based on site visit, determined best to replace entire pipe rather than only 20 linear feet.)	Pipe crosses under Linden Ave. N, at the intersection of Linden Ave. N and N 153rd Pl.
6651	12	CMP	137.50	4.5	0	4.5	Deformed pipe 26.62 feet from upstream end and 77.94 feet from downstream end, collapsed pipe 34.09 feet from upstream end	Replace 30 linear feet at 25 feet from upstream end.	518 N 195th St., between Dayton Ave. N and Evanston Ave. N, north and east of Crista Ministries
6688	18	CMP	138.59	4	3	3.67	Collapsed/broken pipe 57.03 feet from downstream end	Replace 60 linear feet at downstream end. (Site visit verified.)	17531 Fremont Ave. N, between N 175th St. and N 178th St.
786	18	CONC	41.74	5	0	5	Pipe failure 10.41 feet from upstream end	Repair/replace pipe at failure (5 LF).	Pipe crosses under 1st Ave. NW, near intersection with NW 180th St.
3462	18	CONC	128.07	4.5	0	4.5	Defective repair patch with soil visible 60.43 feet from downstream end and possible sag	Repair pipe at hole (5 LF). (Site visit verified.)	104 NW 181st St., at intersection of NW 181st St. and 1st Ave. NW

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
2448	12	CONC	129.04	5	2.13	3.57	Broken and unknown conduit 31.60 feet from downstream end, pipe failing at top 39.25 feet from downstream end, and sediment and rocks remaining in pipe need to be removed	Jet pipe, verify conduit utility owner and have them relocate conduit, and replace 40 feet at downstream end. (Site visit verified.)	20016 Greenwood Ave. N, north of intersection with N 200th St.
5027	12	CMP	123.11	4	0	4	Holes with soil visible 79.57 and 83.80 feet from upstream end	Repair/replace pipe at break (5 LF). (Site visit verified.)	On 10th Ave. NW, at intersection with NW 175th Pl.
2847	12	CONC	50.91	2	5	3	Joint offset (2 inch) 14.81 feet from downstream end, unknown obstacle intrusion 18.63 feet from downstream end, and crack 20.65 feet from downstream end	Based on site visit, replace pipe and reset catch basins to grade.	Pipe crosses under North Park Ave. N, along N 165th St.
8784	12	CPP	101.19	4	3	3.5	Hole at bottom with soil visible 36.30 feet from downstream end, debris intrusion 57.05 feet from upstream end, rocks and sediment remaining in pipe need to be removed	Replace 25 linear feet at 35 feet from upstream end.	17128 3rd Ave. NW, at intersection with Carlyle Hall Rd. NW
6759	12	CONC	239.32	5	0	5	Sag and hole with soil visible 9.86 feet from downstream end (2nd segment)	Repair pipe at hole (5 LF). (Based on site visit, hole to be repaired and sag to be monitored.)	On N 175th St., across from St. Luke Catholic School near St. Luke Pl. N

Table G-2. Improper storm drain connections

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
8729	12	CONC	73.77	4	3	3.67	Fractured 22.36 feet from downstream end, and improper sd connection 32.63 feet from downstream end	Add catch basin/structure at storm connection and repair pipe with patch at structure.	Driveway culvert beginning at 19912 Dayton Ave. N, near N 199th St.
7669	12	CONC	181.42	4	1	2.5	Alignment separation 7.55 (2 inch) and 18.20 (4 inch) feet from downstream end, joint offset (3 inch) 40.90 feet from upstream end, improper sd connections 102.08 and 148.14 feet from upstream end, alignment separation (3 inch) 167.76 feet from upstream end, and sediment and rocks remaining in pipe need to be removed	Jet pipe, add catch basins/structures at storm connections, trenchless repair of entire pipe.	On N 200th St., at intersection with Palatine Ave. N
8445	48	CONC	711.42	5	2.95	3.14	Improper sd connection 7.55 feet from upstream end (1st segment), and 207.89, 239.62, 323.01 feet from upstream end (2nd segment); and sediment and rocks remaining in pipe need to be removed	Jet pipe, add catch basins/structures at storm connections, and repair pipe with patch at structure.	On east side of 15711 Aurora Ave. N (Sears)
5388	48	CONC	338.58	5	2.05	2.2	Improper sd connection 129.33 feet from upstream end (2nd segment), and sediment and rocks remaining in pipe need to be removed	Jet pipe, add catch basin/structure at storm connection, and repair pipe with patch at structure.	On east side of 15823 Westminster Way N (Marshall's)
2831	12	CONC	200.10	5	3.2	3.5	Hole 45.53 feet from downstream end, improper sd connection 69.60 feet from downstream end, end blocked by brick wall, and sediment and roots in pipe need to be removed	Jet pipe, add catch basin/structure at storm connection and repair pipe, remove brick wall and provide outlet at downstream end, and repair pipe with patch at structure.	On Evanston Ave. N, north of N 183rd St.
752	12	CONC	192.48	5	2.5	3.33	Rocks that need to be removed 29.11 feet from downstream end, 97.75 feet from upstream end; fractured 51.04 feet from downstream end; broken 21.56 feet from upstream end, 92.49 feet from upstream end; improper sd connection 59.05 feet from downstream end; and joint offsets 95.17 (2 inch) and 95.63 (3 inch) feet from upstream end	Jet pipe, add catch basin/structure at storm connection, trenchless repair upstream 100 linear feet of pipe.	On N 172nd St., east of Midvale Ave. N
6712	12	CONC	200.21	5	3.5	4	Defective repair patch 8.35 feet from upstream end (1st segment), improper sd connection 33.95 feet from upstream end (1st segment), crack with roots 68.30 feet from upstream end (1st segment), and joint offset (2 inch) 24.30 feet from downstream end (2nd segment)	Add catch basin/structure at storm connection and repair pipe, and repair/replace 10 linear feet at upstream end (1st seg). (Site visit verified.)	At intersection of N Greenwood Dr. and Fremont Pl. N

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
3714	24	CONC	177.84	4	2.25	3	Sag (1 inch) 41.80 feet from upstream end, improper sd connection 84.71 feet from upstream end, alignment separation (1-2 inch) 101.73 feet from upstream end, and rocks remaining in pipe need to be removed	Jet pipe, add catch basin/structure at storm connection, trenchless repair of entire pipe.	West side of 340 N 190th St. (Crista Campus)
4235	15	CMP	177.54	5	2.8	3.17	Improper sd connections 43.01, 43.11, 85.51 (2), and 88.03 feet from downstream end; and pipe failing from bottom 115.33 feet from downstream end	Add catch basins/structures at storm connections, replace/repair pipe at break.	Lateral between NW Innis Arden Way and NW 163rd St., in Shorewood Hills #1
816	12	PLAST	74.61	4	3	3.5	Improper sd connection 24.45 feet from upstream end, 36.50 feet from downstream end	Add catch basins/structures at storm connections, and repair pipe with patch at structure.	20214 Greenwood Ave. N, near intersection with N 203rd St.
5555	12	CONC	111.88	5	2.5	3.75	Improper sd connection 11.99 feet from upstream end, fractured 23.37 feet from upstream end, and possible sag in two locations	Add catch basin/structure at storm connection.	Behind 14817 Whitman Ave. N (Golf Club Acres Apartments)
7674	12	CONC	110.10	0	4.5	4.5	Improper sd connection 63.55 feet from upstream end, and sediment, rocks, and basketball remaining in pipe need to be removed	Jet pipe, add catch basin/structure at storm connection and repair pipe, remove basketball.	On 1st Ave. NW, at intersection with N 193rd St.
8558	24	CONC	174.671823	4.86	2	4.5	Broken at improper sd connections 25.80, 84.20, and 114.51 feet from downstream end	Add catch basin/structure at storm connection and repair pipe at structure.	Northwest corner of Crista Ministries campus in front of the gym, near intersection of Palatine Ave. N and N 193rd St.
4678	12	CONC	59.50	5	3	4	Broken at improper sd connection 40.80 feet from upstream end	Add catch basin/structure at storm connection and repair pipe at structure.	940 N 163rd St., Highland Acres, near intersection of N 163rd St. and Aurora Ave. N
29011	24	CONC	381.392167	4	2.25	2.6	Broken at improper sd connection 44.34 feet from downstream end	Add catch basin/structure at storm connection and repair pipe at structure.	16032 Aurora Ave. N, Brown Bear Car Wash to southeast corner of 16300 Aurora Ave. N retail shop
5748	12	CONC	45.4677935	5	3	4	Broken at improper sd connection 21.45 feet from upstream end	Add catch basin/structure at storm connection and repair pipe at structure.	Driveway culvert at 17021 10th Ave. NW

Shoreline

816
2448
7669
8729
6651
Einstein Middle School
Hillwood Park
7674
8558
3714
Crista Senior Ministries
NW RCHMND BCH RD
2831
3462
786
6TH AVE NW
St Luke Catholic School
5027
NW 175TH ST
6759
6688
N 175TH ST
Boeing Creek Park
8784
CARKEEK PARK RD
5748
3627
752
Boeing Creek Reserve
Shoreview Park
Shoreline Community College
Shorewood Senior High School
AURORA AVEN
Interurban Trail
2818
2847
N 165TH ST
Boeing Creek
4235
NW INNIS ARDEN W
5734
6712
4678
2901
PUGET SOUND
GREENWOOD AVE N
Sears Shopping Center
5388
8445
WESTMINSTER WYN
4695
5555
4738
Shoreline
Seattle
N 145TH ST

- Recommended open cut pipe replacement
- Improper storm drain connection
- Channel
- Ditch
- Pipe
- Wetlands
- Tax parcel
- Boeing Creek basin

N

0 250 500 Yards

0 200 400 Meters

Wind Ward environmental LLC

Figure G-1. Recommended open cut pipe replacement and improper storm drain connections

Prepared by craigh, 12/27/2012, W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig G-1 5176 Open cut pipe repl and improper SD connections.mxd

Project: **BC-CIP-2**

Project Name: Trenchless pipe repair

Description: There are 26 pipe segments (totaling 1,750 ft) recommended for trenchless repair. This category includes pipes that received a poor structural rating, were relatively high risk and, upon further investigation, were identified to be candidates for a trenchless solution. Trenchless solutions include slip-lining, cured in place pipe (CIPP), pipe bursting, pipe reaming, and others.

Benefits: It is less expensive to repair pipes than to replace them. The benefit of implementing trenchless repair techniques to fix pipes such as those identified in the condition assessment is that it avoids the need for immediate replacement.

Assumptions: The attached table lists specific problems and solutions for each pipe segment. Pipe locations are shown on Figure G-2.

Estimated Cost/ Level of Effort: $447,000

Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Trenchless pipe replacement	linear ft	$50.00	1750	$87,500
Storm drain CB or manhole	each	$4,000	52	$208,000
Roadway improvement/pavement patching	sq yd	$60.00	580	$34,800
Traffic control	lump sum	$8,000	1	$8,000
Total				$338,300
Contingency (10%)				$33,900
Subtotal				$372,200
Permitting, design, and engineering (20%)				$74,500
Total Project Cost				**$447,000**

CB – catch basin

Potential Partners: None
Priority: High

Table G-3. Recommended trenchless repair

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
7670	12	CONC	167.19	5	5	5	Broken with unknown 3 inch conduit 26.30 feet from downstream end, alignment separation (2 inch) 10.30 feet from upstream end, sag (1-2 inch) 120 feet from upstream end, and sediment and roots remaining in pipe need to be removed	Jet pipe, verify conduit utility owner and have them relocate conduit, and trenchless repair of entire pipe.	On NW 200th St., at the intersection with 3rd Ave. NW
3352	12	CONC/ PLAST	82.40	5	2.5	3.75	Deformed 19.16 feet from upstream end at material change, and debris blocking pipe needs to be removed	Jet pipe, trenchless repair of upstream 40 linear feet of pipe.	On 6th Ave. NW, between NW 181st Ct. and NW 182nd St.
4763	24	CONC	70.25	5	0	5	Fracture/collapsing pipe 15.01-67.99 feet from upstream end	Trenchless repair of entire pipe.	Pipe crosses under 6th Ave. NW, at intersection with NW 178th Pl.
7730	18	CMP	177.84	4.5	2	4.27	Fractures 40.72, 43.76, 53.80-65.13, and 65.13-83.74 feet from upstream end; and hole 74.07 feet from upstream end	Trenchless repair of upstream 80 linear feet of pipe.	Pipe crosses under N 167th St., at intersection with Fremont Ave. N near Richmond Beach Rec Center
3619	12	CMP	121.70	4.33	2.67	3.5	Construction debris obstacles 38.69 feet from downstream end, deformed 77.48 feet from downstream end, hole 84.57 feet from downstream end, and defective repair patch 84.57 feet from downstream end	Remove debris, trenchless repair of upstream 45 linear feet of pipe.	On Fremont Ave. N, near intersection with N 175th St. and Shorewood Senior High School
31293	12	CONC	78.75	5	2	3.5	Pipe failing from top 52.25 feet from downstream end, and alignment separation (2 inch) 76.05 feet from downstream end	Trenchless repair of upstream 30 linear feet of pipe.	On NW 200th St., at intersection with 3rd Ave. NW
3618	18	CMP	118.48	5	0	5	Defective repair patch 7.74 feet from downstream end, and holes 9.30 and 74.90 feet from downstream end	Trenchless repair of downstream 10 linear feet of pipe.	On Fremont Ave. N, near intersection with N 175th St. and Shorewood Senior High School
6717	18	CMP	117.73	5	2	3.5	Broken 32.24 feet from upstream end (1st segment), and fractured 9.57-20.85 feet from downstream end (3rd segment)	Trenchless pipe repair entire pipe (1st segment), trenchless pipe repair entire pipe (3rd segment).	On Fremont Ave. N, at intersection with N 166th St. near Richmond Beach Rec Center

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
7669	12	CONC	181.42	4	1	2.5	Alignment separation 7.55 (2 inch) and 18.20 (4 inch) feet from downstream end, joint offset (3 inch) 40.90 feet from upstream end, improper sd connections 102.08 and 148.14 feet from upstream end, alignment separation (3 inch) 167.76 feet from upstream end, and sediment and rocks remaining in pipe need to be removed	Jet pipe, add catch basins/structures at storm connections, trenchless repair of entire pipe.	On N 200th St., at intersection with Palatine Ave. N
1630	12	CMP	188.87	4.5	1.67	2.8	Alignment separation (1-2 inch) 27.60 feet from upstream end, sag (2-3 inch) 57.92 and 161.76 feet from upstream end, and deformed 64.86 and 78.66 feet from upstream end	Trenchless repair of entire pipe.	On N Richmond Beach Rd., near intersection with Fremont Ave. N
5742	12	CMP	58.32	4	4	4	Sag (3-4 inch) from downstream end to 31.62 feet from downstream end, sediment in pipe needs to be removed	Trenchless repair of entire pipe.	635 N 185th St., at intersection of N 185th St. and Fremont Ave. N
2048	18	ADS-1	82.39	4	2	3.2	Deformed 12.07 feet from upstream end, joint/alignment separation (3 inch) 22.39 feet from upstream end, crack open above ground 22.39 feet from upstream end, and rocks that need to be removed 22.39 feet from upstream end	Jet pipe, trenchless repair of upstream 25 linear feet of pipe.	Lateral to stream, from Carlyle Hall Rd. NW at intersection with 2nd Ave. NW
4679	12	CMP	154.89	4	3	3.75	Small hole 109.11 feet from upstream end, broken 136.84 feet from upstream end, sag (2 inch) 150.20 feet from upstream end, and roots in pipe need to be removed	Jet pipe, trenchless repair of downstream 50 linear feet of pipe.	On North Park Ave. N, at intersection with Fremont Ave. N across from Shorewood Senior High School
6750	18	CMP	57.95	5	2	3.5	Sag (2 inch), deformed 37.17 feet from upstream end	Trenchless repair of upstream 40 linear feet.	Pipe crosses under N 188th St., near intersection with N Richmond Beach Rd.
752	12	CONC	192.48	5	2.5	3.33	Rocks that need to be removed 29.11 feet from downstream end, 97.75 feet from upstream end; fractured 51.04 feet from downstream end; broken 21.56 feet from upstream end, 92.49 feet from upstream end; improper sd connection 59.05 feet from downstream end; and joint offsets 95.17 (2 inch) and 95.63 (3 inch) feet from upstream end	Jet pipe, add catch basin/structure at storm connection, trenchless repair upstream 100 linear feet of pipe.	On N 172nd St., east of Midvale Ave. N

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
8654	12	CONC	77.51	5	2	4	Pipe failing from bottom 7.00 and 9.15 feet from upstream end, and joint angular/alignment separation (2 inch) 51.90 feet from downstream end	Trenchless repair of upstream 25 linear feet of pipe.	217 N 201st St., between Palatine Ave. N and Greenwood Ave. N
6715	12	CMP	104.16	4.5	2.2	3.62	Small holes 59.25 and 69.45 feet from upstream end, pipe failing from top 73.75 feet from upstream end, and deformed 67.45-71.95 and 88.80 feet from upstream end	Trenchless repair downstream 40 linear feet of pipe.	On N 163rd St., at intersection with Fremont Ave. N near intersection with Fremont Pl. N and Forest Villa Condominiums
1466	12	CONC/ CMP	133.18	5	0	5	Deformed 103.37 feet from downstream end	Trenchless repair of upstream 30 linear feet of pipe.	Driveway culvert on NW 203rd St., east of 3rd Ave. NW
3679	12	CMP	239.68	5	2.5	3.33	Broken and defective repair patch 45.83 feet from upstream end, and sediment and roots remaining in pipe need to be removed	Jet pipe, trenchless repair of upstream 50 linear feet of pipe.	On Whitman Ave. N, north of N 145th St., near Pepper Hill Center
3625	12	CONC	86.93	4	3.17	3.44	Sag (2-3 inch) 26.39 feet from upstream end, fractured 29.91 and 31.02 feet from upstream end, and debris obstacles need to be removed	Jet pipe, trenchless repair upstream 35 linear feet of pipe.	544 N 167th St., east of Dayton Ave. N
2590	12	CMP/ CONC	107.92	4	2.2	2.71	Deformed 57.01 feet from upstream end, hole 57.01 feet from upstream end, and joint offset (2 inch) at material change 106.26 feet from upstream end	Trenchless repair of downstream 55 linear feet of pipe.	On 2nd Ave. NW, north of intersection with NW 156th St.
8731	12	CONC	129.28	5	2.67	3.25	Broken from top 8.20 feet from upstream end, sag (2-3 inch) 15.94 feet from upstream end, and unknown conduit 59.14 feet from upstream end	Trenchless repair of upstream 30 linear feet of pipe.	From 19820 Dayton Pl. N to 19811 Dayton Pl. N
3714	24	CONC	177.84	4	2.25	3	Sag (1 inch) 41.80 feet from upstream end, improper sd connection 84.71 feet from upstream end, alignment separation (1-2 inch) 101.73 feet from upstream end, and rocks remaining in pipe need to be removed	Jet pipe, add catch basin/structure at storm connection, trenchless repair of entire pipe.	West side of 340 N 190th St. (Crista Campus)
14084	12	CMP	90.78	4	0	4	Broken 4.10 feet from downstream end, failure at bottom 10.75 feet from downstream end, deformed first 8.28 feet from downstream end, corrosion	Trenchless repair of entire pipe.	Forest Villa at Fremont Pl. - One, on Fremont Pl. N near intersection with N 160th St.

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Location
4706	12	CONC	88.08	4.25	2.5	3.73	Broken 49.86, 54.09, and 68.59 feet from upstream end	Trenchless repair of downstream 40 linear feet of pipe.	On Whitman Ave. N, north of N 145th St., near Pepper Hill Center
32292	15	CONC	26.58	0	4.5	4.5	Alignment separation (3-4 inch) 3.90 feet from upstream end, sediment and roots blocking pipe need to be removed	Jet pipe, trenchless repair of entire pipe.	Pipe crosses NW 195th St., near intersection with 1st Ave. NW

Shoreline

1466
8654
7670
31293
7669
8731
32292
3714
6750
1630
5742
3352
4763
3618
3619
752
4679
3625
7730
6717
6715
1408
4
2590
4706
3679

Einstein Middle School

Hillwood Park

Crista Senior Ministries

St Luke Catholic School

Shorewood Senior High School

Boeing Creek Park

Boeing Creek Reserve

Shoreview Park

Shoreline Community College

Sears Shopping Center

Interurban Trail

NW RCHMND BCH RD

6TH AVE NW

NW 175TH ST

N 175TH ST

20TH AVE NW

ARBUTUS RD

AURORA AVEN

N 165TH ST

NW INNIS ARDEN W

GREENWOOD AVE N

WESTMINSTER WY N

N 145TH ST

Boeing Creek

PUGET SOUND

Shoreline
Seattle

Recommended trenchless repair
Channel
Ditch
Pipe
Wetlands
Tax parcel
Boeing Creek basin

Wind Ward environmental LLC

N

0 250 500 Yards

0 200 400 Meters

Figure G-2. Recommended trenchless repair

Prepared by craigh, 12/27/2012, W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig G-2 5177 Recommended trenchless repair.mxd

Project:	**BC-CIP-3 (By OTHERS)**
Project Name:	Remove Utility Crossings
Description:	Utility crossings that run through the storm drain pipe have resulted directly in structural deficiencies. Unidentified conduit, likely containing cable, fiber optic, or electrical services, are the primary crossing issues, but some waterlines have also been identified. It is recommended that the City identify the likely utility owners and coordinate relocation of the utility crossings and repair of the stormwater pipe.
Benefits:	This project provides a benefit to the City by removing obstacles in stormwater infrastructure, and a benefit to homeowners by preventing utility service interruptions in the event that utility lines that cross stormwater pipes are broken or damaged.
Assumptions:	The table below lists specific problems and solutions for each pipe segment. Locations of the pipes are shown on Figure G-3.
Estimated Cost/ Level of Effort:	80 hours of City staff time to send letters, coordinate with Utility companies for required repairs and relocations, and confirm that the work was completed
Potential Partners:	Utility companies that own lines that cross the City's stormwater pipes.
Priority:	High

Table G-4. Utility crossings

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Utility	Location
7670	12	CONC	167.19	5	5	5	Broken with unknown 3 inch conduit 26.30 feet from downstream end, alignment separation (2 inch) 10.30 feet from upstream end, sag (1-2 inch) 120 feet from upstream end, and sediment and roots remaining in pipe need to be removed	Jet pipe, verify conduit utility owner and have them relocate conduit, and trenchless repair of entire pipe.	Unknown, 3 inch Conduit	On NW 200th St., at the intersection with 3rd Ave. NW
4632	12	CMP	148.48	4	5	4.5	Hole at top 7.74 feet from downstream end, and unknown 3 inch conduit 74.99 feet from downstream end	Verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	On Linden Ave. N, near Richmond Highlands Add.
3632	12	CMP	18.39	0	5	5	Unknown 3 inch conduit 33.04 feet from downstream end	Verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	704 N 165th St., at intersection of N 165th St. and Fremont Ave. N
2448	12	CONC	129.04	5	2.13	3.57	Broken and unknown conduit 31.60 feet from downstream end, pipe failing at top 39.25 feet from downstream end, and sediment and rocks remaining in pipe need to be removed	Jet pipe, verify conduit utility owner and have them relocate conduit, and replace 40 linear feet at downstream end. (Site visit verified.)	Unknown, Conduit	20016 Greenwood Ave. N, north of intersection with N 200th St.
8580	12	CONC	115.48	4	2	2.67	Unknown 3 inch conduit with hole 58.32 feet from upstream end	Verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	On NW 182nd St., between 6th Ave. NW and 3rd Ave. NW
1627	12	CONC	93.02	0	4	4	Unknown 3 inch conduit 25.18 feet from downstream end	Verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	On N 171st St., at intersection with Stone Ave. N, near Ahavat Shalom Society Cemetery
6757	12	CONC	131.04	0	5	5	Unknown pipe intrusion 64.03 feet from upstream end, and debris in pipe	Verify conduit utility owner and have them relocate conduit, and remove debris.	Unknown	On Stone Ave. N, at intersection with N 167th St., near Ahavat Shalom Society Cemetery
772	12	CONC	156.88	2	5	5	Unknown 3 inch conduit 82.09 feet from downstream end, and fracture 3.93 feet from upstream end	Verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	On NW 163rd St., in Shorewood Hills #1 near NW Innis Arden Way and 6th Ave. NW

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Proposed Solution	Utility	Location
8198	12	CONC	254.57	0	5	5	Unknown 3 inch conduit 106.77 feet from upstream end	Verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	On NW 163rd St., in Shorewood Hills #1 near NW Innis Arden Way and 6th Ave. NW
8731	12	CONC	129.28	5	2.67	3.25	Broken from top 8.20 feet from upstream end, sag (2-3 inch) 15.94 feet from upstream end, and unknown conduit 59.14 feet from upstream end	Verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	From 19820 Dayton Pl. N to 19811 Dayton Pl. N to Crista Ministries (King's Elementary school)
4311	18	CONC	28.49	4	2.67	3	Unknown conduit crossing pipe at 7.28 feet from upstream end, pipe blocked with debris 32.71 feet from upstream end	Jet pipe, verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, Conduit	Pipe crosses 3rd Ave. NW at 17202 3rd Ave. NW
787	12	CMP	26.73	0	4	4	Unknown 3 inch conduit 16.67 feet from downstream end with roots that need to be removed	Jet pipe, verify conduit utility owner and have them relocate the conduit, and repair pipe.	Unknown, 3 inch Conduit	Lateral to 1st Ave. NW, north of N 175th St.

Shoreline

7670

2448

8731

Einstein Middle School

Hillwood Park

Crista Senior Ministries

NW RCHMND BCH RD

4632

8580

6TH AVE NW

St Luke Catholic School

787

NW 175TH ST

N 175TH ST

4311

Shorewood Senior High School

Boeing Creek Park

CARKEEK PARK RD

1627

AURORA AVEN

Boeing Creek Reserve

Shoreview Park

Shoreline Community College

6757

3632

N 165TH ST

Boeing Creek

772

8198

NW INNIS ARDEN W

Interurban Trail

GREENWOOD AVE N

Sears Shopping Center

WESTMINSTER WY N

PUGET SOUND

Shoreline Seattle

N 145TH ST

Utility crossings
Channel
Ditch
Pipe
Wetlands
Tax parcel
Boeing Creek basin

Wind Ward LLC environmental

N

0 250 500 Yards

0 200 400 Meters

Figure G-3. Utility crossings

Prepared by craigh, 12/27/2012: W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig G-3 5178 Utility crossings.mxd

Project:	**BC-Mon-2**
Project Name:	Monitor pipes not recommended for immediate repair
Description:	Pipes that did not fall into replacement categories yet received a poor structural rating are included in this category. Structural deficiencies in this category include fractures, holes, minor deformity, and other problems. It is recommended that the City actively monitor these pipes to ensure the structural deficiency does not worsen.
Benefits:	Proactive monitoring will prevent reactive repair or replacement necessitated by an emergency. Also, monitoring will help the City plan for future repairs and replacements and budget accordingly.
Assumptions:	The attached table and Figure G-4 show the locations of the approximate 3,150 linear ft of pipe that should be monitored. It is assumed that these pipes will be inspected via a video inspection program once every 2 years to determine if conditions have worsened.
Estimated Cost/	
Level of Effort:	The estimated cost for monitoring approximately 3,150 linear ft of pipe is $15,750 every other year. This assumes a cost of $5/linear foot for the video inspection, incidental traffic control, pipe jetting, and disposal.
Potential Partners:	None
Priority:	High

Table G-5. Pipes recommended for monitoring

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Reason	Location
2831	12	CONC	200.10	5	3.2	3.5	Hole 45.53 feet from downstream end, improper sd connection 69.60 feet from downstream end, end blocked by brick wall, and sediment and roots in pipe need to be removed	Based on site visit, homeowner reported no home or driveway flooding. (Note: Yard drain backs up, but not catch basin.) Home elevation lower than catch basin, and cannot find end of pipe.	On Evanston Ave. N, north of N 183rd St.
4235	15	CMP	177.54	5	2.8	3.17	Improper sd connections 43.01, 43.11, 85.51 (2), and 88.03 feet from downstream end; and pipe failing from bottom 115.33 feet from downstream end	Based on site visit and pipe inspection, water determined still able to flow unimpeded through pipe.	Lateral between NW Innis Arden Way and NW 163rd St., in Shorewood Hills #1
738	12	CMP	130.41	5	2.5	3.33	Deformed 28.54 feet from downstream end	Based on pipe inspection, water still able to flow through pipe.	On N 170th St., at intersection with North Park Ave. N near Shorewood Senior High School
1616	12	CMP	165.58	5	0	5	Deformed 38.35 feet from upstream end	Based on pipe inspection, water still able to flow through pipe.	Pipe crosses under N 161st Pl., along Linden Ave. N near Lindengrove Apartments
3645	12	CPP	56.83	5	0	5	Collapsed/broken pipe 3.96 feet from downstream end	Based on site visit, determined to only affect two houses and can be bypassed.	107 N 172nd St., near Palatine Ave. N
7263	12	CMP	130.59	4.5	0	4.5	Deformed 80.33 feet from upstream end, and hole with soil visible 99.68 feet from upstream end	Based on pipe inspection, water still able to flow through pipe.	505 N 188th St., at intersection of Dayton Pl. N and N 188th St.
4726	12	CONC	93.63	5	2.5	3.75	Fractures 29.48 feet from upstream end, joint offset (2inch) 34.55 feet from upstream end, and sediment and rocks remaining in pipe need to be removed	Based on pipe inspection, water still able to flow through pipe.	Driveway culvert at 17052 10th Ave. NW, north of NW Innis Arden Way
5555	12	CONC	111.88	5	2.5	3.75	Improper sd connection 11.99 feet from upstream end, fractured 23.37 feet from upstream end, and possible sag in two locations	Based on pipe inspection, water still able to flow through pipe.	Behind 14817 Whitman Ave. N (Golf Club Acres Apartments)
6574	12	CONC	28.55	5	2.67	3.25	Holes with soil visible 23.75 and 24.80 feet from downstream end, and sediment and rocks remaining in pipe need to be removed	Based on pipe inspection, water still able to flow through pipe.	Driveway culvert at 103 N 201st St.

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Reason	Location
8725	12	CPP	192.59	5	0	5	Collapsed pipe 153.40 feet from upstream end	Based on site visit, flow determined able to drain along curb to next catch basin. Low priority area.	19306 3rd Ave. NW, at intersection of NW 193rd St. and 3rd Ave. NW
3693	12	CMP	273.99	4.66	3.5	4.58	Small holes 7.05, 11.08, and 133.115 feet from downstream end; corrosion 86.82, 96.79, and 103.24 feet from downstream end; and alignment separation/joint angular (2 inch) 235.49 feet from downstream end	Based on pipe inspection, water still able to flow through pipe.	On N 185th St., at intersection with Linden Ave. N across from Windermere Real Estate
5735	12	CONC	161.216959	5	2	3.5	Failing from top 29.51 feet from upstream end, hole 160.95 feet from upstream end	Majority of pipe in good condition	16336 Dayton Ave. N, south of intersection with Carlyle Hall Rd. N
8653	12	CONC	55.104374	5	2	3.5	Failing from top 52.25 feet from upstream end	Majority of pipe in good condition	20011 Greenwood Ave. N, north of N 200th St.
8573	12	CONC	73.87	5	1	2.5	Broken 22.54, 48.47, and 74.11 feet from upstream end, roots remaining in pipe need to be removed	Majority of pipe in good condition	Pipe crosses under N 181st St., at intersection with 6th Ave. NW
3721	12	CONC	109.33	4	0	4	Hole 95.08 feet from downstream end	Based on pipe inspection, water still able to flow through pipe.	On NW 163rd St., In Shorewood Hills #1 near NW Innis Arden Way and 6th Ave. NW
6759	12	CONC	239.32	5	0	5	Sag and hole with soil visible 9.86 feet from downstream end (2nd segment)	Based on site visit, monitor sag.	On N 175th St., across from St. Luke Catholic School near St. Luke Pl. N
5726	12	CMP	150.88	5	0	5	Deformed and broken 110.39 feet from downstream end	Deformation not blocking pipe (based on pipe inspection), under sidewalk (site visit verified).	15001 Westminster Way N (Highlands Townhomes), at intersection of Westminster Way N and N 150th St.
8181	15	CMP	72.2896955	5	2	3.5	Broken with repair patch 47.94 feet from upstream end	Based on pipe inspection, water still able to flow through pipe.	Pipe crosses NW 163rd St. at 504 NW 163rd St.
7746	12	CONC	97.3141943	5	3	3.67	Broken on side 50.06 feet from upstream end	Majority of pipe in good condition	15738 Palatine Ave. N, south of N 160th St.
35691	12	CONC	163.42505	4	2.25	2.38	Pipe failing from top 138.28 feet from upstream end	Based on pipe inspection, water still able to flow through pipe.	19811 Dayton Pl. N to Crista Ministries (King's Elementary school)
3702	12	CMP	156.82	4.33	2.57	3.1	Corrosion 63.70 feet from downstream end, holes 76.25 and 80.90 feet from downstream end, and sediment blocking pipe needs to be removed	Based on pipe inspection, corrosion and holes not affecting flow.	On Linden Ave. N, at intersection with N 160th St. near Forest Villa Condominiums

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Reason	Location
31268	12	CMP	196.24	4.33	0	4.33	Corrosion 2.92 feet from upstream end, and small holes 32.13 and 160.45 feet from upstream end	Based on pipe inspection, water still able to flow through pipe.	Lateral from NW 177th St. to 6th Ave. NW, through 349 NW 177th St.
7516	12	CMP	111.981042	4	0	4	Possible sag (1 inch) from upstream end of pipe to 76.83 feet from upstream end	Based on pipe inspection, water still able to flow through pipe.	Hillwood Park on 3rd Ave. NW, south of driveway, between NW 191st St. and NW 189th St.

Shoreline

6574
8653
35691
Einstein Middle School
Crista Senior Ministries
8725
Hillwood Park
7516
NW RCHMND BCH RD
7263
3693
6TH AVE NW
2831
8573
St Luke Catholic School
31268
NW 175TH ST
6759
N 175TH ST
Shorewood Senior High School
4726
Boeing Creek Park
3645
CARKEEK PARK RD
738
AURORA AVEN
Boeing Creek Reserve
Shoreview Park
Shoreline Community College
Boeing Creek
3721
5735
N 165TH ST
Interurban Trail
4235
NW INNIS ARDEN W
8181
1616
3702
7746
GREENWOOD AVE N
Sears Shopping Center
WESTMINSTER WY N
PUGET SOUND
5726
5555
Shoreline
Seattle
N 145TH ST

Pipes recommended for monitoring
Channel
Ditch
Pipe
Wetlands
Tax parcel
Boeing Creek basin

Wind Ward LLC environmental

N

0 250 500 Yards

0 200 400 Meters

Figure G-4. Pipes recommended for monitoring

Prepared by craigh, 12/27/2012; W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps and Analysis\Boeing Crk Basin Plan\Fig G-4 5179 Pipes recommended for monitoring.mxd

Project:	**BC-Main-1**
Project Name:	Pipe maintenance
Description:	During the closed-circuit television (CCTV) inspection, several pipes required heavy cleaning and root cutting in order to proceed with the inspection. Those pipes identified by the City as being very high priority were cleaned. However, several identified segments were not cleaned, and were placed on a list as needing future maintenance. Potentially, these pipes may also need to be replaced in the future, if the frequent sedimentation is due to an inadequate design.
Benefits:	Improved functionality of pipe segments, leading to better overall functionality of the stormwater system.
Assumptions:	The attached table and Figure G-5 provide more detail on the types of problems and locations.
Estimated Cost/ Level of Effort:	The estimated cost to clean out those pipes not cleaned during the condition assessment but identified as needing excessive cleaning is $118,000. This assumes approximately 6,600 linear ft of pipe requiring heavy cleaning.
Potential Partners:	None
Priority:	High

Table G-6. Pipes recommended for jetting or frequent maintenance

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Location
1664	12	CONC	57.70	0	5	5	Sediment and bricks blocking pipe need to be removed.	Pipe crosses under 3rd Ave. NW, at intersection with NW 180th St.
3960	15	CONC	192.25	0	5	5	Sediment blocking pipe needs to be removed.	On NW 195th St., spans intersections with 1st Ave. NW
3634	12	CONC	55.83	0	5	5	Sediment blocking pipe needs to be removed.	Pipe crosses under N 170th Pl., at intersection with Dayton Ave. N near Herzel Memorial Park
6646	12	CMP/ CONC	214.58	0	5	5	Sediment blocking pipe at material change needs to be removed.	On 3rd Ave. NW, at intersection with NW 191st St. near Albert Einstein Junior High School playing fields
7670	12	CONC	167.19	5	5	5	Broken with unknown 3 inch conduit 26.30 feet from downstream end, alignment separation (2 inch) 10.30 feet from upstream end, and sediment and roots remaining in pipe need to be removed	On NW 200th St., at the intersection with 3rd Ave. NW
32292	15	CONC	26.58	0	4.5	4.5	Alignment separation (3-4 inch) 3.90 feet from upstream end, sediment and roots blocking pipe need to be removed	Pipe crosses NW 195th St., near intersection with 1st Ave. NW
4311	18	CONC	28.49	4	2.67	3	Unknown conduit crossing pipe at 7.28 feet from upstream end, pipe blocked with debris 32.71 feet from upstream end	Pipe crosses 3rd Ave. NW at 17202 3rd Ave. NW
6649	12	CONC	72.58	0	4	4	Sediment and gravel blocking pipe need to be removed.	On 3rd Ave. NW, across from Albert Einstein Junior High School
5725	12	CONC	46.37	0	4	4	Sediment blocking pipe needs to be removed.	Pipe crosses N 150th St., at intersection with Westminster Way N, near Highlands Townhomes
7763	12	CONC	103.14	0	4	4	Sediment blocking pipe needs to be removed.	On N 185th St., near Richmond TRS fire station and office buildings, west of the intersection with Linden Ave. N
8733	12	CONC	106.01	0	4	4	Roots blocking pipe need to be removed.	On Dayton Ave. N, at 507 N 197th Ct., across from Crista King's Elementary School
7731	12	CMP	104.22	4.5	4	4.25	Deformed 58.82 feet from upstream end, and hole with roots that need to be removed 70.71 feet from upstream end	Driveway culvert at 18520 Fremont Ave. N, north of intersection with N 185th St.

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Location
8058	12	CONC	84.97	5	3	4	Hole with soil visible 7.70 feet from upstream end; sediment blocking pipe needs to be removed.	312 NW 195th St., across from Albert Einstein Junior High School
8532	12	CMP	104.73	4	3	3.13	Deformed 10.37 feet from upstream end; sediment and gravel blocking pipe need to be removed.	On N 185th St., near intersection with Fremont Ave. N and N Richmond Beach Rd. and the Richmond TRS fire station
4679	12	CMP	154.89	4	3	3.75	Small hole 109.11 feet from upstream end, broken 136.84 feet from upstream end, sag (2 inch) 150.20 feet from upstream end, and roots in pipe need to be removed	On North Park Ave. N, at intersection with Fremont Ave. N across from Shorewood Senior High School
3702	12	CMP	156.82	4.33	2.57	3.1	Corrosion 63.70 feet from downstream end, holes 76.25 and 80.90 feet from downstream end, and sediment blocking pipe needs to be removed	On Linden Ave. N, at intersection with N 160th St. near Forest Villa Condominiums
8445	48	CONC	711.42	5	2.95	3.14	Improper sd connection 7.55 feet from upstream end (1st segment), and 207.89, 239.62, 323.01 feet from upstream end (2nd segment); and sediment and rocks remaining in pipe need to be removed	On east side of 15711 Aurora Ave. N (Sears)
3352	12	CONC/P LAST	82.40	5	2.5	3.75	Deformed 19.16 feet from upstream end at material change, and debris blocking pipe needs to be removed	On 6th Ave. NW, between NW 181st Ct. and NW 182nd St.
5388	48	CONC	338.58	5	2.05	2.2	Improper sd connection 129.33 feet from upstream end (2nd segment), and sediment and rocks remaining in pipe need to be removed	On east side of 15823 Westminster Way N (Marshall's)
2048	18	ADS-1	82.39	4	2	3.2	Deformed 12.07 feet from upstream end, joint/alignment separation (3 inch) 22.39 feet from upstream end, crack open above ground 22.39 feet from upstream end, and rocks that need to be removed 22.39 feet from upstream end	Lateral to stream, from Carlyle Hall Rd. NW at intersection with 2nd Ave. NW

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Location
7669	12	CONC	181.42	4	1	2.5	Alignment separation 7.55 (2 inch) and 18.20 (4 inch) feet from downstream end, joint offset (3 inch) 40.90 feet from upstream end, improper sd connections 102.08 and 148.14 feet from upstream end, alignment separation (3 inch) 167.76 feet from upstream end, and sediment and rocks remaining in pipe need to be removed	On N 200th St., at intersection with Palatine Ave. N
1625	12	CONC	123.83	0	5	5	Unknown object blocking pipe needs to be removed.	On Midvale Ave. N, at intersection with N 172nd St.
6746	12	CONC	90.51	0	5	5	Rocks and debris blocking pipe need to be removed.	On N 171st St., near Stone Ave. N and Ahavat Shalom Society Cemetery
1608	12	CONC	52.11	0	5	5	Sediment blocking pipe needs to be removed.	Driveway culvert at 568 N 167th St., near Fremont Ave. N
2445	12	CONC	34.41	0	5	5	Sediment blocking pipe needs to be removed.	Pipe crosses under NW 203rd St., at 124 NW 203rd St.
7674	12	CONC	110.10	0	4.5	4.5	Improper sd connection 63.55 feet from upstream end, and sediment, rocks, and basketball remaining in pipe need to be removed	On 1st Ave. NW, at intersection with N 193rd St.
8602	12	CONC	66.97	0	4	4	Sediment and bricks blocking pipe need to be removed.	Driveway culvert at 312 NW 183rd St., near 3rd Ave. NW
5717	12	CMP	99.18	0	4	4	Sediment and roots blocking pipe need to be removed.	On N 155th St., at intersection with Dayton Ave. N
3688	12	CONC	186.44	0	4	4	Sediment blocking pipe needs to be removed.	On N 172nd St., at intersection with Midvale Ave. N
3641	12	CONC	86.78	0	4	4	Sediment blocking pipe needs to be removed.	On Palatine Ave. N, at intersection with N 177th St.
5537	12	CONC	38.35	0	4	4	Sediment blocking pipe needs to be removed.	Driveway culvert at 115 NW 183rd St., between 3rd Ave. N and 1st Ave. NW
6728	12	CMP	55.97	0	4	4	Rocks and debris blocking pipe need to be removed.	On 2nd Ave. NW, between NW 156th St. and NW 159th St., near the Highlands
5701	12	CONC	62.58	2	5	3.5	Sediment blocking pipe needs to be removed.	15559 Greenwood Ave. N, between N 155th St. and N 160th St.

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Location
3706	18	CONC	58.50	0	5	5	Sediment blocking pipe needs to be removed.	1133 N 166th St., near intersection of Aurora Ave. N and N 165th St.
3658	12	CONC	52.55	1	5	3	Sediment blocking pipe needs to be removed.	15525 Greenwood Ave. N, between N 155th St. and N 160th St.
3697	12	CMP	122.86	1.67	5	5	Roots blocking pipe need to be removed.	On N Richmond Beach Rd., near 1st Ave. NW
5635	12	CONC	76.65	4	4	4	Crack 25.60 feet from upstream end, fractured 27.65 feet from upstream end; roots and rocks in pipe need to be removed.	19333 1st Ave. NW, north of intersection with N 193rd St.
787	12	CMP	26.73	0	4	4	Unknown 3 inch conduit 16.67 feet from downstream end with roots that need to be removed	Lateral to 1st Ave. NW, north of N 175th St.
2831	12	CONC	200.10	5	3.2	3.5	Hole 45.53 feet from downstream end, improper sd connection 69.60 feet from downstream end, end blocked by brick wall, and sediment and roots in pipe need to be removed	On Evanston Ave. N, north of N 183rd St.
3625	12	CONC	86.93	4	3.17	3.44	Sag (2-3 inch) 26.39 feet from upstream end, fractured 29.91 and 31.02 feet from upstream end, and debris obstacles need to be removed	544 N 167th St., east of Dayton Ave. N
6574	12	CONC	28.55	5	2.67	3.25	Holes with soil visible 23.75 and 24.80 feet from downstream end, and sediment and rocks remaining in pipe need to be removed	Driveway culvert at 103 N 201st St.
7020	12	CONC	192.75	5	2.5	3	Hole with roots 87.83 feet from downstream end, and CPP pipe section within pipe 123.18 feet from downstream end; roots and sediment blocking pipe need to be removed.	Driveway culvert on 10th Ave. NW, near confluence of subbasins 122, 130, and 300
4726	12	CONC	93.63	5	2.5	3.75	Fractures 29.48 feet from upstream end, joint offset (2 inch) 34.55 feet from upstream end, and sediment and rocks remaining in pipe need to be removed	Driveway culvert at 17052 10th Ave. NW, north of NW Innis Arden Way
3679	12	CMP	239.68	5	2.5	3.33	Broken and defective repair patch 45.83 feet from upstream end, and sediment and roots remaining in pipe need to be removed	On Whitman Ave. N, north of N 145th St., near Pepper Hill Center

Object ID	Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Location
752	12	CONC	192.48	5	2.5	3.33	Rocks that need to be removed 29.11 feet from downstream end, 97.75 feet from upstream end; fractured 51.04 feet from downstream end; broken 21.56 feet from upstream end, 92.49 feet from upstream end; improper sd connection 59.05 feet from downstream end; and joint offsets 95.17 (2 inch) and 95.63 (3 inch) feet from upstream end	On N 172nd St., east of Midvale Ave. N
7133	12	CONC	143.24	4	2.33	2.57	Cracks 11.99 feet from downstream end; sediment blocking pipe needs to be removed.	16218 6th Ave. NW, north of intersection with NW 162nd St.
3714	24	CONC	177.84	4	2.25	3	Sag (1 inch) 41.80 feet from upstream end, improper sd connection 84.71 feet from upstream end, alignment separation (1-2 inch) 101.73 feet from upstream end, and rocks remaining in pipe need to be removed	West side of 340 N 190th St. (Crista Campus)
753	12	CONC	135.93	4	2.2	2.5	Sediment blocking pipe needs to be removed.	On N 171st St., at intersection with Midvale Ave. N, near Ahavat Shalom Society Cemetery
2448	12	CONC	129.04	5	2.13	3.57	Broken and unknown conduit 31.60 feet from downstream end, pipe failing at top 39.25 feet from downstream end, and sediment and rocks remaining in pipe need to be removed	20016 Greenwood Ave. N, north of intersection with N 200th St.
5734	12	CONC	158.91	4.5	2	3.67	Crack/hole 12.29 and 30.42 feet from downstream end, alignment separation (2 inch) 36.26 feet from downstream end, pipe failing from top 29.41 feet from upstream end, and roots blocking pipe need to be removed	16065 Dayton Ave. N, at intersection of Dayton Ave. N and N Greenwood Dr.
5742	12	CMP	58.32	4	4	4	Sag (3-4 inch) from downstream end to 31.62 feet from downstream end, sediment in pipe needs to be removed	635 N 185th St., at intersection of N 185th St. and Fremont Ave. N
8747	12	CONC	182.63	5	0	5	Hole with outside visible 42.81 feet from downstream end, and CPP pipe section within pipe 85.21 feet from downstream end	Driveway culvert beginning at 728 N 188th St., between Fremont Ave. N and Firlands Way N
35691	12	CONC	163.43	4	2.25	2.38	Pipe failing from top 138.28 feet from upstream end, roots in pipe need to be removed	19811 Dayton Pl. N to Crista Ministries (King's Elementary school)

Shoreline

2445
6574
7670
2448
7669
35691
8733
8058
3960
3292
6649
7674/5635
Einstein Middle School
Crista Senior Ministries
Hillwood Park
6646
3714
3697
8747
NW RCHMND BCH RD
7731
7763
5742
8532
6TH AVE NW
8602
5537
2831
3352
1664
St Luke Catholic School
3641
787
NW 175TH ST
N 175TH ST
Shorewood Senior High School
7020
4726
4311
Boeing Creek Park
2048
CARLYL HALL RD
3634
4679
1625
3688/752
753/6746
AURORA AVEN
Boeing Creek Reserve
Shoreview Park
3625
1608
Shoreline Community College
Boeing Creek
3706
N 165TH ST
Interurban Trail
NW INNIS ARDEN W
7133
5734
3702
6728
5701
GREENWOOD AVE N
Sears Shopping Center
5388
3658
8445
5717
WESTMINSTER WY N
5725
3679
PUGET SOUND
Shoreline
Seattle
N 145TH ST

Pipes recommended for jetting or frequent maintenance
Channel
Ditch
Pipe
Wetlands
Tax parcel
Boeing Creek basin

Wind Ward LLC environmental

N

0 250 500 Yards

0 200 400 Meters

Figure G-5. Pipes recommended for jetting or frequent maintenance

Prepared by craigh, 12/27/2012; W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig G-5 5180 Pipes recommended for jetting-freq maintenance.mxd

Project:	**BC-Main-2**
Project Name:	Pipe maintenance to be accomplished by City staff
Description:	Four pipes with poor SPRI ratings have been determined to be issues that can be readily fixed by City maintenance staff, as the problems are generally acute and localized.
Benefits:	Utilizing City staff to accomplish relatively minor fixes of conveyance pipes is an efficient use of resources.
Assumptions:	The attached table and Figure G-6 provide more detail of the types of problems and locations.
Estimated Cost/	
Level of Effort:	Assume $40,000 ($10,000 per location) for budgeting purposes
Potential Partners:	None.
Priority:	High

Table G-7. Pipes recommended for Operations and Maintenance (O&M)

Pipe Diam	Pipe Type	Length	SPRI	MPRI	OPRI	Problem	Solution	Location
12	CONC	182.63	5	0	5	Hole with outside visible 42.81 feet from downstream end, and CPP pipe section within pipe 85.21 feet from downstream end	Based on site visit, jet and O&M repair pipe at hole.	Driveway culvert beginning at 728 N 188th St., between Fremont Ave. N and Firlands Way N
12	CMP	104.22	4.5	4	4.25	Deformed 58.82 feet from upstream end, and hole with roots that need to be removed 70.71 feet from upstream end	Based on site visit, jet and possible slipline.	Driveway culvert at 18520 Fremont Ave. N, north of intersection with N 185th St.
12	CONC	71.39	4	3	3.5	Mailbox post through pipe 10.87 feet from upstream end	Coordinate with homeowner to relocate mailbox, and O&M to patch pipe.	17002 Dayton Ave. N, between N 169th St. and N 170th St., near Herzel Memorial Park
12	CMP	150.88	5	0	5	Deformed and broken 110.39 feet from downstream end	Based on pipe inspection, repair pipe at deformation.	15001 Westminster Way N (Highlands Townhomes), at intersection of Westminster Way N and N 150th St.

Shoreline

Einstein Middle School

Hillwood Park

Crista Senior Ministries

8747

NW RCHMND BCH RD

7731

6TH AVE NW

St Luke Catholic School

NW 175TH ST

N 175TH ST

Shorewood Senior High School

Boeing Creek Park

CARLYL HALL RD

727

AURORA AVEN

Boeing Creek Reserve

Shoreview Park

Shoreline Community College

Boeing Creek

N 165TH ST

NW INNIS ARDEN W

Interurban Trail

GREENWOOD AVE N

Sears Shopping Center

WESTMINSTER WY N

5726

PUGET SOUND

Shoreline Seattle

N 145TH ST

Pipes recommended for repairs by City staff
Channel
Ditch
Pipe
Wetlands
Tax parcel
Boeing Creek basin

Wind Ward environmental LLC

N

0 250 500 Yards

0 200 400 Meters

Figure G-6. Pipes recommended for repairs by City staff

Prepared by craigh, 12/27/2012: W:\Projects\City of Shoreline Basin Plan\Data\GIS\Maps_and_Analysis\Boeing Crk Basin Plan\Fig G-6 5355 Pipes recommended for repairs by City.mxd

4 Habitat and Fish Passage

Project: **BC-Hab-1**

Project Name: Hidden Lake and Boeing Creek channel restoration, fish passage, and trail improvement feasibility study

Description: This project involves developing a feasibility study for multi-functional restoration in Shoreview and Boeing Creek Parks that encompasses Hidden Lake, Boeing Creek, and the recreational trail adjacent to the creek. The issues through this reach include bank erosion that has affected the adjacent recreational trail, log weirs that may not be passable to fish at different stages of flow, and sedimentation in Hidden Lake, a large annual maintenance expense for the City. One option to be considered is the discontinuation of maintenance dredging in Hidden Lake. If this were to occur, Hidden Lake would, over time, fill in with sediment and become more vegetated with additional wetland characteristics. Another option is the construction of a single-thread channel through what is now Hidden Lake. Opportunities to improve fish passage and habitat through this reach of Boeing Creek would also be considered in the feasibility study.

Benefits: The potential benefits that would come out of a restoration project in this area are reduced annual or biannual maintenance efforts by the City, improved fish passage for resident cutthroat trout, and improved recreational trail benefits. In the City's *Surface Water Master Plan Update* (SAIC 2011), instream stabilization, such as the installation of large wood, is mentioned as a possible solution in addition to upstream flow control (low impact development, infiltration, and/or detention) to address channel degradation in the upper reaches of Boeing Creek and sedimentation in the lower reaches. The potential for instream restoration would be evaluated in this feasibility study, along with incorporation of trail improvements, fish passage, and opportunities to reduce dredging in Hidden Lake.

Assumptions: The feasibility study would include elements described below in the attached feasibility scope outline.

Estimated Cost/

Level of Effort: $100 K

Potential Partners: City of Shoreline Parks Department, Shoreline Community College, private entities within the City that require natural resource

mitigation credits for other project impacts, local residents and neighbors

Priority: Medium

Feasibility Study Outline of Scope of Work

Purpose:

The purpose of this feasibility study is to evaluate existing geomorphic, biological and surface water flow conditions in the vicinity of Hidden Lake and Boeing Creek within Boeing and Shoreview Parks, and identify potential restoration projects.

Goals:

Identify a preferred habitat and trail restoration alternative or suite of alternatives to address multiple issues within this reach of Boeing Creek, including Hidden Lake. Specific goals include:

- Improved fish passage and aquatic habitat conditions
- Reduced maintenance dredging
- Improved trail conditions

Scope of Work:

It is anticipated that the tasks listed below would be included in the feasibility study.

Hidden Lake Evaluation

- Review as-built and operation and maintenance plans for documentation regarding outlet control structure, lake bathymetry, and flow by-pass structures used for maintenance.
- Review maintenance records for estimates of sediment volumes dredged from Hidden Lake to estimate annual sedimentation rates.
- Review 2008 Shoreview and Boeing Creek parks vegetation management plan for areas identified as requiring invasive plant management or removal, and opportunities for vegetation enhancement.

Geomorphic Assessment of Boeing Creek

- Construct a longitudinal profile of Boeing Creek from the confluence of the North and South forks to Hidden Lake for the purpose of identifying overall grade, and grade drops (particularly downstream of channel spanning weirs).
- Conduct pebble counts at representative reaches to evaluate particle size distribution of channel bed materials.
- Evaluate critical shear stress and mobilization of different particle sizes relative to different flow conditions, using existing hydrologic model and pebble count data.
- Construct channel cross sections at a minimum of three different locations at representative reaches to obtain geometric information about channel bed and bank configuration.

- Evaluate bed, bank and hillslope erosion processes that contribute to downstream sedimentation, including incision, channel widening, slope failure associated with seepage and other factors.
- Evaluate potential for sediment inputs from upstream urban sources (i.e., road runoff, ditch erosion, etc.)

Existing Conditions Conceptual Model

Develop a conceptual model of existing hydrologic, geomorphic, and biologic conditions using data obtained in the tasks above, and including information on fish passage and fish presence collected during this Boeing Creek Basin Plan. The conceptual model can be used as a framework for evaluating potential effects of restoration improvements and/or upstream stormwater retrofit actions. For instance, understanding the sources of sediment and deposition rates in Hidden Lake would help evaluate the effects of discontinued dredging, and/or the channel configurations and flows necessary to facilitate sediment transport through this reach.

Identification of Restoration Project Alternatives

Evaluate restoration alternatives for Hidden Lake and Boeing Creek within Shoreview and Boeing Creek parks, including combinations of the following potential options for different project elements:

- Hidden Lake
  - Conversion of Hidden Lake to a wetland
  - Construction of a single thread channel through what is now Hidden Lake, connecting Boeing Creek channel on the upstream side to an outlet structure upstream of Innis Arden Way
- Boeing Creek/fish passage
  - Installation of grade control or hydraulic structures to rebuild channel between existing weirs to facilitate fish passage and hydraulic variability
  - Removal of existing weirs
  - Large woody debris
- Revegetation
  - Uplands
  - Riparian/bank stabilizing vegetation
  - Wetlands (Hidden Lake area)

- Trail
  - Reconstruction
  - Relocation
  - Replacement with a boardwalk
  - Removal

Project: **BC-Hab-2**

Project Name: Develop overall restoration plan for Boeing Creek

Description: There are at least eight fish passage barriers in Boeing Creek, in addition to reaches that have been thoroughly modified by the large rocks, debris, and other materials placed in the channel to minimize erosion and stabilize otherwise eroding bed and banks. Nonetheless, the Boeing Creek riparian corridor has many elements that could sustain stream restoration improvements, if actions were taken upstream to further reduce high peak flows and durations that contribute to in-channel erosion. The task of restoring Boeing Creek to more natural conditions capable of sustaining anadromous and resident fish populations would be significant, both in cost and time.

The degradation of Boeing Creek has occurred over many decades, although the initial degradation was probably quite rapid, coinciding with the input of high flows after the development of the Sears shopping center. Similarly, the overall restoration of Boeing Creek can be expected to take many decades; stormwater retrofit must first occur in the upper watershed, and in-stream restoration projects will be tackled as money becomes available and the desire to reach a long-term restoration goal is articulated by the City, residents, and interested stakeholders. This project would require working with stakeholders to devise a long-term plan for the restoration of Boeing Creek, including a timeframe of what projects should be accomplished first.

Benefits: Several recommended projects in this plan would benefit the overall stream health of Boeing Creek, but a restoration plan with a vision of what Boeing Creek could be and how to get there would be especially beneficial. Additionally, identification of projects as part of an overall plan for Boeing Creek would help developers and other entities to take on projects that not only benefit the system, but allow the opportunity to provide mitigation for other impacts to natural resources.

Assumptions: This plan would include options for removal of fish passage barriers, removal of channel debris (concrete, fences, barrels, rip rap and other placed or dumped materials) and enhancing aquatic habitat conditions. Specific stand-alone projects would be identified and prioritized. For instance, fish passage barrier removal would be sequenced to allow time for channel adjustment and stabilization between barrier removal events.

Estimated Cost/ Level of Effort: $ 100 K

Potential Partners: Residents, Shoreline Community College, business interests, public transportation agencies in need of mitigation opportunities, Seattle Golf and Country Club, and others

Priority: Medium

Project:	**BC-Hab-3**
Project Name:	Hillwood Park wetland improvement
Description:	Hillwood Park in the northwest corner of the Boeing Creek basin includes a short open-channel section of Boeing Creek just downstream of Einstein Middle School. This project involves enhancing the existing wetland in the vicinity of the open channel to enhance water quality, produce wildlife habitat, and provide some storage for stormwater runoff during higher flows.
Benefits:	Enhancing and expanding the existing wetland along the open channel will improve water quality, increase wildlife habitat, provide interpretive and educational opportunities, and provid limited additional storage for stormwater runoff during higher flows.
Assumptions:	This project would involve coordination with the City Parks Department in order to ensure that it fits with the overall plan and vision for Hillwood Park. Additional coordination would be necessary with neighbors, including Einstein Middle School.
Estimated Cost/ Level of Effort:	$334,000

Description	QTY	Unit	Unit Price	Total Cost
Mobilization/Demobilization	1	LS	10%	$16,180.00
Demolition and haul of exist gravel access roadway and culvert	1	LS	$1,000	$1,000
Clearing and Grubbing	1	LS	$1,000	$1,000
Grading of extended wetland area and off-site disposal	2,100	YD3	$18	$37,800
Habitat log structure placement	6	EA	$400	$2,400
Soil supplementation - imported compost	700	YD3	$35	$24,500
Revegetation including mulch/soil stabilization	38,000	FT2	$2.25	$85,500
Bird and bat boxes	6	EA	$100	$600
Interpretive Signage	2	EA	$3,000	$6,000
Temporary Erosion and Sediment Control	1	LS	$3,000	$3,000
Survey	1	LS	$3,000	$3,000
	Construction Cost		**Subtotal**	**$180,980**
	Sales Tax		**9.5%**	**$17,193**
	Design Allowance		**30%**	**$54,294**
	Mitigation		**--**	**$0**
	Engineering Design		**0%**	**$0**
	Permitting		**15%**	**$27,147**
	Permitting Studies		**10%**	**$18,098**
	Construction Management		**20%**	**$36,196**
	TOTAL PROJECT COST			**$333,908**

Potential Partners: City Parks Department, local neighborhood or environmental groups (i.e., Birds, Bees, Fish and Trees), Einstein Middle School

Priority: Medium

Project: **BC-Mon-3**

Project Name: Cross section monitoring

Description: This project involves the annual evaluation of physical channel conditions in Shoreview and Boeing Creek Parks to monitor geomorphic changes for the purpose of understanding the stability of the existing channel. This information would help City staff evaluate channel stability within the context of future basin changes, particularly upland stormwater retrofits that may occur with redevelopment.

Benefits: Quantitative measurement of channel conditions to evaluate overall stability and monitor the success of upland stormwater retrofit projects that are implemented for the purpose of minimizing erosive effects on small streams such as Boeing Creek.

Assumptions: This project could be implemented by instructors at Shoreline Community College in geography and geology courses that already have units on stream channel cross section development. With help from City staff or others, geology and geography instructors could standardize the methods of cross section measurement, so that the data would be repeatable and robust enough to evaluate potential cause and effect relationships and trends. Monitoring points would be established from permanent or semi-permanent structures, or very large trees that are outside of the active channel zone. Techniques outlined in *Stream channel reference sites: an illustrated guide to field technique* (Harrelson, et. al 1994) should be used for the installation and annual measurements of cross sections.

Estimated Cost/

Level of Effort: The estimated cost to establish four cross sections, including survey gear rental, is approximately $1,200. The level of effort for annual measurements is approximately 10 hours per year.

Potential Partners: Shoreline Community College

Priority: Medium

5 Flooding

Project: **BC-CIP-4**

Project Name: Flood reduction in Linden Avenue neighborhood

Description: This project involves upgrading the pipe network along Linden Avenue North, Fremont Avenue North, Evanston Avenue North, and Dayton Avenue North, north of North 175th Street.

Benefits: Upgrades to the pipe networks in this area would alleviate flooding that occurs due to undersized pipes and excess flows. Flooding in this area would also be reduced by flow control retrofit projects that would occur upstream with redevelopment, such as in the Town Center.

Assumptions: Figure G-7 shows the pipes to be upgraded and the locations of proposed bio-retention swales.

Estimated Cost/ Level of Effort: $386,380

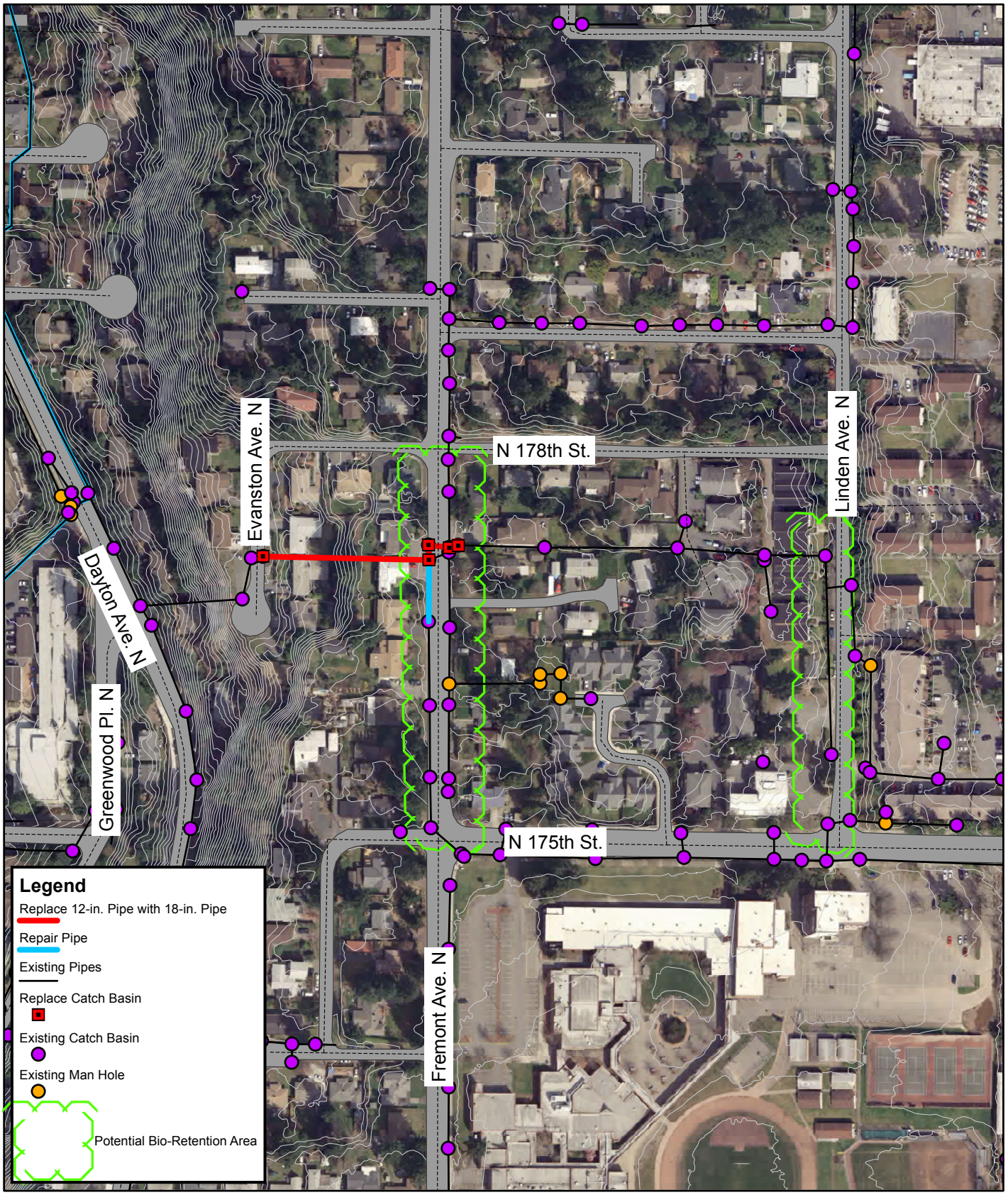
Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Open-cut storm drain replacement, 18 in.	linear ft	$45.00	410	$18,450
Storm drain CB or manhole	ea	$4,000	5	$20,000
Roadway improvement/pavement patching	sq yd	$60.00	235	$14,100
Drainage easements	lump sum	$10,000	4	$40,000
Bio-retention/rain gardens	linear ft	$143.00	800	$114,000
Traffic Control	lump sum	$15,000	1	$15,000
Total				$222,000
Contingency (20%)				$44,400
Subtotal				$266,400
Survey, permitting, design, and engineering (45%)				$119,880
Total project cost				**$386,280**

CB – catch basin

Potential Partners: None

Priority: High



OSBORN CONSULTING INCORPORATED

N

75 0 75 Yards

75 0 75 Meters

Figure G-7: Stormwater Upgrades from Linden Ave. N to Dayton Ave. N

Boeing Creek Basin - Shoreline, WA

Prepared by MLP, 9/12/12

6 Transportation Master Plan Opportunities

Project: **BC-CIP-5**

Project Name: Water quality improvements in association with North 160th Street re-channelization project

Description: A boulevard-style three-lane road is planned for North 160th Street between Greenwood Avenue North and Aurora Avenue North (City of Shoreline 2011). This project, which will involve re-channelizing the existing four-lane street to include median landscaping and bicycle lanes. Opportunities for low impact development and potential water quality improvements associated with this project include use of pervious pavement for reconstruction of sidewalks, potential stormwater treatment in the amenity zone between sidewalks and travel lanes, and a potential rain garden in a round-about at the intersection of Greenwood Avenue N. and N 160th St (re-design of this intersection is being explored by the City's transportation department)

Benefits: Incorporation of water quality treatment, such as a rain garden in a roundabout (if included in the intersection design) or bioinfiltration swales in the amenity zones, would provide water of improved quality to receiving waters. Additionally, use of pervious paving materials for sidewalks would help minimize stormwater flow volumes.

Assumptions: This project element would be coordinated with transportation projects.

Estimated Cost/

Level of Effort: To be determined.

Potential Partners: City transportation staff.

Priority: Medium

Project: **BC-CIP-6**

Project Name: Utilize low-impact development (LID) techniques for sidewalk improvements

Description: High-priority pedestrian improvement projects are identified for seven street segments within the Boeing Creek basin in the City's transportation master plan (City of Shoreline 2011). There are several potential LID opportunities that could be performed in conjunction with new sidewalks, including the installation of roadside bio-infiltration swales for water quality treatment, and construction of sidewalks utilizing permeable materials.

Benefits: Incorporating LID techniques into new pedestrian improvement projects would include the following stormwater management benefits:

- Reduced flow to downstream stormwater infrastructure and Boeing Creek
- Improved water quality

Assumptions: Some of the pedestrian improvement projects are located on streets where pipe repair and replacement or other stormwater capital projects have been identified. It would be in the City's best interest to schedule transportation-related construction activities, including stormwater utility projects, pedestrian improvements, and other roadway projects, together, such that road closures and residential impacts would be kept to a minimum.

Estimated Cost/

Level of Effort: To be determined.

Potential Partners: City transportation staff.

Priority: Medium

Table G-8. Recommended pedestrian improvement projects and potential associated stormwater improvements

Recommended Pedestrian Improvement Project[a]	Existing Conveyance	Other Relevant Capital Projects Recommended	Infiltration Potential Based on Surface Geology	Potential LID Projects	Stormwater Benefits
Northwest 175th Street between 6th Avenue Northwest and St. Luke's Place North	pipes	BC-CIP-2 open-cut pipe replacement on Northwest 175th Street	good	bio-infiltration swales within ROW, pervious sidewalks	reduced flow to conveyance system, improved water quality
North Innis Arden Way between 10th Avenue Northwest and Greenwood Avenue North	primarily roadside ditches	none	mixed: very good in some areas (advance outwash), not so good in others (till)	conversion of ditches to bio-infiltration swales with and without under-drains	reduced flow to conveyance system, improved water quality
3rd Avenue Northwest/ Carlyle Hall Road between North 175th Street and Dayton Avenue North	primarily roadside ditches	none	good	conversion of ditches to bio-infiltration swales	improved water quality
Fremont Avenue North between North 165th Street and North 205th Street	pipes	BC-CIP-2 and BC-CIP-6 many pipe repair and replacement projects, as well as flood reduction project in this vicinity	poor infiltration potential	bio-infiltration swales with under-drains or connection to deep infiltration wells, pervious sidewalks	improved water quality
Linden Avenue North between North 175th Street and North 185th Street	pipes	BC-CIP-6 flood-reduction project	poor infiltration potential	bio-infiltration swales with under-drains or connection to deep infiltration wells, pervious sidewalks	improved water quality, possible flow reduction depending on swale configuration and/or connection to deep infiltration
North 170th Street between Fremont Avenue North and Aurora Avenue North	pipes	BC-Mon-2 pipe to be monitored in this vicinity because of poor condition	poor infiltration potential	bio-infiltration swales with under-drains or connection to deep infiltration wells, pervious sidewalks	improved water quality, possible flow reduction depending on swale configuration and/or connection to deep infiltration
North 165th Street between Dayton Avenue North and Aurora Avenue North	pipes	none	poor infiltration potential	pervious sidewalks, bio-infiltration swales with under-drains	improved water quality

[a] Source: City (2011)

City – City of Shoreline

LID – low-impact development

ROW – right-of-way

7 General Stormwater Runoff Improvements

Project: **BC-CIP-7**

Project Name: Stormwater improvements associated with major roadway preservation projects

Description: Two roadway preservation projects in the Boeing Creek basin are recommended for funding in the City's transportation master plan (City of Shoreline 2011): Fremont Avenue North between North 175th Street and North 185th Street, and Westminster Way between North 145th Street and North 155th Street. These projects would involve setting aside money, if possible, to improve storm drainage systems simultaneously with transportation-related construction projects that involve tearing up roads. The Westminster Way project will likely be constructed in 2013 using grant money, so there may not be an opportunity to incorporate storm drainage improvements in that project, however, future opportunities should be identified as they arise.

Benefits: Incorporation of stormwater treatment improvements into roadway preservation projects could:

- Reduce flow to downstream stormwater infrastructure and Boeing Creek
- Improve water quality

Assumptions: The two segments recommended for roadway preservation (i.e., pavement overlay) are also the subject of other recommended projects, including pedestrian improvements and pipe repairs and replacements. Overlay should be coordinated with these other projects, and stormwater improvements should be considered if there is an opportunity to improve water quality treatment in association with these transportation projects.

Estimated Cost/

Level of Effort: To be determined.

Potential Partners: City transportation staff.

Priority: Medium

Project: **BC-CIP-8**

Project Name: Construct bio-infiltration swales adjacent to Interurban Trail.

Description: This project would involve conversion of approximately 1,300 linear feet of existing stormwater conveyance system located in the Seattle City Light right-of-way (ROW) along the Interurban trail to bio-infiltration swales.

Benefits: Conversion of the existing conveyance system could easily be accomplished within the ROW and would result in improved water quality treatment of stormwater runoff from NW 145th Street and parking lots located on the east side of the trail.

Assumptions: This project would involve replacement of existing conveyance pipes and rock-lined ditches with cascading bio-infiltration facilities with under-drains, if necessary.

Estimated Cost/

Level of Effort: $745,416

Potential Partners: City transportation staff, City Parks Department, Seattle City Light

Priority: Medium

Cost estimate – Interurban Trail bio-infiltration swales

Item	Unit	Unit Cost	Quantity	Cost
Demolition and haul of existin pipe segments and rip rap in open channel sections	LS	$5,000	1	$5,000
Under-drain pipe (6 in.)	linear ft	$15.00	1,300	$19,500
Grading	cubic yd	$20.00	10,400	$208,000
Biorention/rain garden plants and soil mix	Linear ft	$143.00	1,300	$185,900
Temporary Erosion and Sediment Control including dewatering/bypass	lump sum	$10,000	1	$10,000
Total				$428,400
Contingency (20%)				$85,680
Subtotal				$514,080
Survey, permitting, design, and engineering (45%)				$231,336
Total project cost				**$745,416**

Project: **BC-CIP-9**

Project Name: Construct bio-infiltration swale in ROW adjacent to Westminster Triangle Park.

Description: This project would involve replacing an existing ditch along North 150th Street with a formal bio-retention swale or rain garden.

Benefits: A bio-retention swale or rain garden would result in improved roadway runoff water quality.

Assumptions: Work would be conducted entirely within the ROW of North 150th Street, and could be accomplished by City staff.

Estimated Cost/ Level of Effort: $57,456

Cost estimate – Westminster Bioinfiltration swale

Item	Unit	Unit Cost	Quantity	Cost
Under-drain pipe (6 in.)	linear ft	$15.00	150	$2,250
Gravel bed material	cubic yd	$100.00	25	$2,500
Filter soils	cubic yd	$20.00	35	$700
Filter fabric	sq yd	$2.50	1,200	$3,000
Bio-retention/rain garden plants	Linear ft	$143.00	150	$21,450
Traffic control	lump sum	$10,000	1	$10,000
Total				$39,900
Contingency (20%)				$7,980
Subtotal				$47,880
Survey, permitting, design, and engineering (20%)				$9.576
Total project cost				**$57,456**

Potential Partners: City parks department staff

Priority: Medium

Project:	**BC-Mon-4**
Project Name:	Monitor and evaluate the functionality of deep infiltration wells installed at Shorewood High School.
Description:	This project would involve coordination with the consultant that will be conducting groundwater monitoring following installation of deep infiltration (underground injection control [UIC]) wells at Shorewood High School. Quarterly groundwater monitoring is scheduled for a period of 5 years following installation, with analytical testing being conducted for total lead, nitrate, zinc, total dissolved solids, pH, fecal coliform bacteria, and total organic carbon.
Benefits:	Monitoring data could be used to provide the City and private developers with a greater comfort level when using deep infiltration as a stormwater management technique within the City.
Assumptions:	City staff would request monitoring results from the Shoreline School District to keep up-to-date on the functionality of the deep infiltration wells. Additionally, downgradient conditions would be evaluated, including potential daylighting of subsurface flows where none had previously existed.
Estimated Cost/ Level of Effort:	20 hours annually (5 hours per quarterly monitoring event)
Potential Partners:	Shoreline School District
Priority:	Medium

Project: **BC-Ed-4**

Project Name: Develop educational materials targeting developers and property owners in areas that will likely be redeveloped.

Description: This project would involve developing low-impact development (LID) and sustainable stormwater management educational materials specifically for developers and owners of large properties that will be involved in major redevelopment projects within the next decade.

Benefits: City stormwater management and sustainability goals will have a better chance of being realized if guidance and outreach takes place among developers and owners of large properties that will likely undergo redevelopment. Identifying specific LID techniques that could be successfully employed at sites in the Boeing Creek basin would help developers navigate the plethora of stormwater management options available.

Assumptions: City staff would lead this education effort. Reference materials would consist of those already developed by others (such as the *Puget Sound Partnership Low Impact Development Manual*), but with an emphasis on why such techniques may be applicable to sites within Shoreline's Boeing Creek Basin. This project could be combined with BC-Ed-3, which would facilitate focus groups with the same developers and property owners targeted in this project.

Estimated Cost/ Level of Effort: Assume $15,000

80 hours to compile information and develop brochures, as well as additional time to target and distribute to developers and property owners

Potential Partners: City planning staff

Priority: High

Project:	**BC-Ed-5**
Project Name:	Facilitate focus group of owners of large properties who have redevelopment plans
Description:	This project would involve the facilitation of focus groups of property owners and developers to solicit input on redevelopment plans, as well as the incorporation of stormwater facilities into the design and function of those plans.
Benefits:	This project would proactively address redevelopment and ensure mutually beneficial stormwater management approaches that are consistent with the City's vision, meet regulatory requirements, and ease the permitting process.
Assumptions:	City education and outreach staff would lead this effort, with potential assistance from a public involvement firm.
Estimated Cost/ Level of Effort:	Assume $20,000 100 hours of staff time to solicit focus group members, conduct focus groups, and evaluate results
Potential Partners:	City Planning Department and Public Outreach staff
Priority:	Medium

Project:	**BC-Study-1**
Project Name:	Evaluate potential for City-owned stormwater facilities that provide regional benefits.
Description:	This project will involve conducting an evaluation of potential opportunities for the City to construct a regional stormwater facility funded by facility charges, connection fees for redeveloped properties, or sub-basin-specific capital facilities charges.
Benefits:	A regional stormwater facility would give the City control over where and how the facility operates, while providing developers with reliable stormwater management on their redeveloped properties.
Assumptions:	This project would involve using the existing Boeing hydrologic model to develop potential locations, and alternative strategies for regional stormwater management.
Estimated Cost/	
Level of Effort:	$ 50,000
Potential Partners:	None
Priority:	High

Project:	**BC-Study-2**
Project Name:	Develop infrastructure plan for Shoreline Town Center, including financing options.
Description:	This project would involve the development of an infrastructure plan for the Shoreline Town Center that would emphasize the City's Town Center vision for "green infrastructure" and environmental quality, economic vitality, and social equity.
Benefits:	Developing a stormwater infrastructure plan could help facilitate private development in the Town Center.
Assumptions:	This project would include evaluation of different financing options.
Estimated Cost/ Level of Effort:	$ 40,000
Potential Partners:	None
Priority:	Medium

Project:	**BC-Study-3**
Project Name:	Prepare FEMA Lettter of Map Amendment for Boeing Creek
Description:	This project would involve applying for a LOMA to modify the current Zone A boundary using approximate methods described by FEMA in the following documents: • *Guideline and Specifications for Flood Hazard Mapping Partners- Appendix C: Guidance for Reiverine Flooding Analysis and Mapping. FEMA, April 2003* • *Managing Floodplain Development in approximate Zone A Areas: A guide for obtaining and developing base (100-year) flood elevations. FEMA, July 1995.*
Benefits:	A revised Zone A boundary will conform better to local topography and will make it easier for City staff to permit residential projects in the vicinity of Boeing Creek.
Assumptions:	Hydrologic modeling conducted for this basin plan is sufficient to proceed with a LOMA application.
Estimated Cost/ Level of Effort:	$ 16,800
Potential Partners:	None
Priority:	Medium

8 References

City of Shoreline. 2011. 2011 transportation master plan. Draft. City of Shoreline, WA.

SAIC. 2011. Surface water master plan update, City of Shoreline. Draft report. Science Applications International Corporation, Bothell, WA.