

# AGENDA

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## BOTHELL SHORELINES BOARD

Bothell City Hall, 18415 101st Avenue NE

Monday, January 14, 2019, 6:00 PM

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1. CALL TO ORDER
2. NON-AGENDA PUBLIC COMMENTS  
A chance for members of the audience to address the Commission on a topic NOT on this evening's agenda. Please limit comments to 3 minutes per speaker.
3. APPROVAL OF MINUTES  
December 10, 2018
4. NEW BUSINESS
5. PUBLIC HEARING  
None
6. STUDY SESSION  
Review of shoreline jurisdiction / environment designation changes and potential "clarification"  
Code amendments
7. OLD BUSINESS  
Discussion of items to recommend for addition to the 2019 Planning Docket and plans for a February public open house and potential joint meetings with Planning Commission and the Parks & Recreation Board
8. REPORTS FROM STAFF
9. REPORTS FROM MEMBERS
10. ADJOURNMENT

Official tapes of meetings are available through the Community Planning Division.

SPECIAL ACCOMMODATIONS: The City of Bothell strives to provide accessible meetings for people with disabilities. If special accommodations are required, please contact the ADA Coordinator at 425-806-6150 at least three days prior to the meeting.

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# Minutes

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**BOTHELL SHORELINE BOARD**

**REGULAR MEETING** - December 10, 2018

**COMMISSIONERS PRESENT:** Patrick Ewing, Ann Aagaard, Ryan Page, Sarah Gustafson, David Bain, Jim Orr

**COMMISSIONER ABSENT:** David Cox

**STAFF PRESENT:** Senior Planner Dave Boyd, Amy Summe of Shannon & Wilson, and Lisa Grueter of Berk.

**CALL TO ORDER:** The Regular Meeting of the Bothell Shoreline Board was called to order by Chair Patrick Ewing on December 10, 2018, at 6:00 p.m. in the Council Chambers at Bothell Town Hall, 18415 101<sup>st</sup> Avenue NE.

**APPROVAL OF MINUTES AND BYLAWS:** Review of November 5, 2018 Minutes and accompanying Bylaws amendments.

**BAIN MOVED TO APPROVE THE MINUTES AND BYLAW AMENDMENTS AS REVISED, ORR SECONDED AND IT PASSED WITH ALL PRESENT IN FAVOR.**

**NEW BUSINESS:** None

**PUBLIC HEARING:** None

**STUDY SESSION:** Review of Washington Department of Ecology Checklist Responses, Potential Code Amendments and Revised Draft Public Participation Plan.

Amy Summe presented the DOE Checklist responses and responded to Board questions. Lisa Grueter presented a revised Public Participation Plan, including possible scheduling of a public outreach open house in February.

**REPORTS FROM STAFF:** None

**REPORTS FROM MEMBERS:** None

**ADJOURNMENT:**

**ORR MOVED TO ADJOURN, EWING SECONDED AND IT PASSED WITH ALL PRESENT IN FAVOR.**

The meeting was adjourned at 8:20 p.m.

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**Study Session:  
Shoreline Jurisdiction /  
Environment Designation Changes  
and Potential “Clarification” Code  
Amendments**

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# MEMORANDUM

## Community Development Department



**DATE:** January 14, 2019

**TO:** Shorelines Board

**FROM:** Senior Planner Dave Boyd, Amy Summe of Shannon & Wilson

**SUBJECT:** Shorelines Board Study Session on the 2019 SMP Update

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### Purpose

Tonight's meeting of the City of Bothell Shorelines Board (SB) will cover the following topics:

1. Recommendation for Shoreline Jurisdiction / Environment Designation Changes:
  - a. Shoreline jurisdiction boundary and environment designation at the new Horse Creek channel in the Park at Bothell Landing.
  - b. Shoreline jurisdiction boundary at the new Sammamish River side channel across from the Park at Bothell Landing
  - c. Shoreline jurisdiction boundary and environment designation on the former Wayne Golf Course back nine. Parks Planning and Grants Program Manager Tracey Perkosky will attend to discuss this area as it relates to the SB scope of work.
2. Review of potential "clarification" amendments to Title 13.
3. Review of items the Board wants to recommend for inclusion in the 2019 Planning Docket.
4. Discuss February open house and joint meeting with Planning Commission and (possibly) Parks & Recreation Board.

This is a full agenda, so it will be important to stay on point.

### Shoreline Jurisdiction / Environment Designation Changes

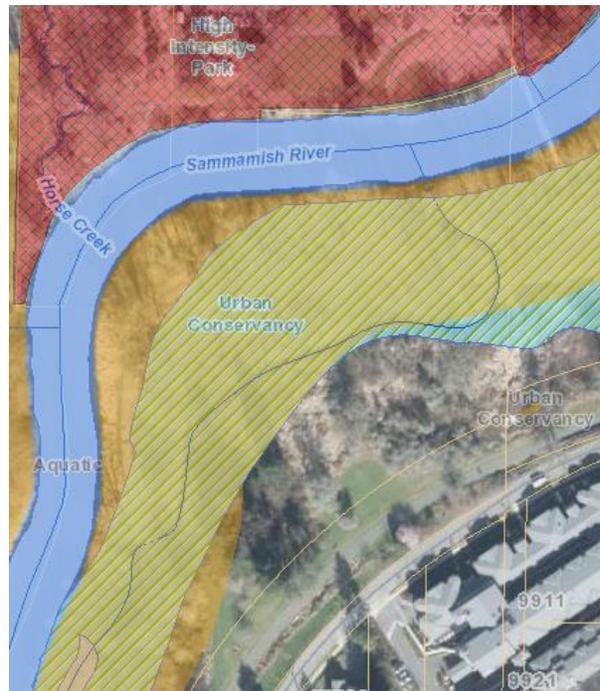
Part of the scope of the 2019 Shorelines Master Program (SMP) is to do "additional analysis deemed necessary to address changing local circumstances, new information or improved data that has occurred since 2013." Our consultants have done this analysis and summarized it in a memorandum, included as **Attachment 1**. Three areas are covered.

Horse Creek: The daylighting of Horse Creek in 2015 extended the Ordinary High Water Mark of the Sammamish River a short distance up the new stream channel, which extends the shoreline jurisdiction from the existing condition, as shown on the map to the right (with current parcels, wetlands, boundaries and designations) to the proposed as shown in the memorandum.



**Sammamish River Side Channel:** In 2017, the City constructed a new side channel in Sammamish River Park, across from the Park at Bothell Landing, which extends the Urban Conservancy designation further into the park, from the existing condition, as shown on the map to the right (with current parcels, wetlands, boundaries and designations) to the proposed as shown in the memorandum.

**Former Wayne Golf Course Back Nine:** The City has recently purchased the former Wayne Golf Course. The back nine currently has a split designation: Urban Conservancy within the 100' buffer and Shoreline Residential within the outer 100' of the shoreline jurisdiction, which is no longer appropriate. As part of the purchase, a new wetland delineation was done, as reflected in the map below (with current parcels, wetlands, boundaries and designations) and in the memorandum.



## **Code Amendments for clarity and readability**

At the December meeting, the Shorelines Board reviewed proposed amendments related to the Ecology Checklist. At the January 14 meeting, the Board will review amendments proposed for greater clarity and readability, included in **Attachment 2**.

## **Items to forward to Council for consideration in the 2019 Planning Docket**

Because of the limited scope of this SMP Update, issues that are outside the scope may be suggested for consideration in the 2019 Planning Docket, with support from a majority of Board members. Some issues have already been discussed and circulated. **Attachment 3** includes issues proposed for consideration by Ann Aagaard.

These issues were addressed by our consultants in an email to the Board the morning of November 5, just prior to the meeting that evening. That response is repeated below:

In order to have the 2013 SMP Update approved, the City:

- submitted an inventory and analysis report;
- developed SMP policies and regulations designed to address Shoreline Management Act requirements for ecological protection, preferred uses, and public access; and
- developed a cumulative impacts analysis demonstrating no-net-loss of ecological functions.

All of this effort was done with public review and input from other agencies. Ecology reviewed the documents carefully and made their comments known, went on field reviews with the City, and approved the SMP with no changes. That is rare for Ecology to approve an SMP with no changes.

At the permit level, projects must demonstrate consistency with the SMP policies and regulations which were designed to achieve no-net-loss of ecological function.

- The City requires a critical areas report in Section 13.13.010(O) prepared by a qualified professional. "The critical areas report shall use scientifically valid methods and studies in the analysis of critical areas data and field reconnaissance and reference the source of science used. The critical areas report shall evaluate the proposal and all probable impacts to critical areas in accordance with the provisions of this chapter."
- Where mitigation is required in Subsection Q, it has to also consider "A review of the most current, available scientific and technical information supporting the proposed mitigation and a description of the report author's experience to date in restoring or creating the type of critical area proposed" plus performance standards and a monitoring program.
- In order to use Table 13.13.060-3, "The critical areas report must include a site-specific assessment of the conditions that demonstrate an evaluation of the buffer as 'degraded.'" If a buffer reduction is proposed with Table 13.13.060-3 there must be full consistency with requirements for enhancement and removal of hard structures or other efforts listed. The shoreline is fairly degraded in the HI

and SR environments due to past development, and the measures identified in the table are designed to both recognize that and improve conditions.

At the January 14 meeting, the Board should discuss this request, and any others that may be made, and decide whether to support forwarding to Council for consideration in the 2019 Planning Docket. Planning Commission will hear a preview of the Docket on January 23, and it is scheduled for Council consideration on February 19.

### **Public Open House and Potential Joint meetings with Planning Commission and the Parks & Recreation Board**

Staff is working to schedule a February public open house and potential joint meeting with Planning Commission and the Parks & Recreation Board. SB members are asked to come to the meeting with their calendars, prepared to discuss alternate dates in February. Staff may poll members prior to the meeting in the hope of setting the date at the meeting.

### **Background information**

At the December meeting, the Board requested additional background information on the Shoreline Analysis done for the 2013 SMP Update. An excerpt of the 2011 Shoreline Analysis Report for the Cities of Bothell and Brier is included as **Attachment 4**.

### **Attachments:**

1. Memorandum on Shoreline Jurisdiction / Environmental Designation Changes
2. Draft Proposed Title 13 "Clarification" Amendments
3. Letter from Ann Aagaard regarding suggestions for Shorelines issues to include in the 2019 Planning Docket
4. Excerpt of the 2011 Shoreline Analysis Report for the Cities of Bothell and Brier

## MEMORANDUM

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TO: David Boyd, City of Bothell

FROM: Amy Summe (Shannon & Wilson) and Lisa Grueter (BERK)

DATE: January 7, 2019

RE: **CONSULTANT RECOMMENDATION FOR SMP JURISDICTION / ENVIRONMENT DESIGNATION CHANGES – FOR DISCUSSION WITH SHORELINES BOARD**

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Since adoption of the 2012 Shoreline Master Program (SMP), including maps of shoreline jurisdiction and environment designations, the City of Bothell (City) has continued to collect wetland data and refine its own geographic information system layers. In addition to the minor adjustments of jurisdiction throughout the City to reflect that new information, there have also been two significant projects within shoreline jurisdiction and one significant property acquisition by the City that have led to more in-depth assessment of jurisdiction and designations: Horse Creek daylighting, new Sammamish River side channel, and acquisition of the old Wayne Golf Course “back 9.” After a review of state rules addressing amended SMP environment designations, each of these areas are discussed in greater detail below, including a potential revised jurisdiction boundary and suggestions for environment designations.

### **AMENDED ENVIRONMENT DESIGNATION REQUIREMENTS**

As part of the periodic review, the City is considering some amendments to its environment designations. When submitting the designations to Washington State Department of Ecology with the SMP Periodic Review amendments, the City will need to provide the following information:

*WAC 173-26-110 (3): Amended environment designation map(s), showing both existing and proposed designations, together with corresponding boundaries described in text for each change of environment. All proposals for changes in environment designation and redesignation shall provide written justification for such based on existing development patterns, the biophysical capabilities and limitations of the shoreline being considered, and the goals and aspirations of the local citizenry as reflected in the locally adopted comprehensive land use plan;*

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## HORSE CREEK

The City received permits for the Horse Creek daylighting project in 2013 and completed construction in 2015. Jurisdiction is measured from the ordinary high water mark (OHWM) of shoreline waterbodies. Horse Creek is not a shoreline of the state because it does not have a mean annual flow of 20 cubic feet per second or more. The Sammamish River is a shoreline, however, so the OHWM of the river must be projected upstream on the Horse Creek channel to determine that point from which the minimum 200-foot shoreline jurisdiction boundary should extend. The OHWM of the Sammamish River was not flagged and surveyed at the time of the project, nor was the elevation of the new stream channel. Accordingly, the upstream limit of the Sammamish River OHWM on Horse Creek is difficult to assess.

In the absence of better information, an estimate of the upstream limit was generated using the following steps and assumptions.

1. The construction plans for Horse Creek daylighting use a vertical datum of North American Vertical Datum of 1988 (NAVD 88).
2. The OHWM of Lakes Sammamish and Lake Washington are known: 21.8 Corps of Engineers (COE) datum and 27.0 National Geodetic Vertical Datum of 1929 (NGVD), respectively.
3. Converting the COE datum to NAVD 88 requires subtraction of 3.25. Thus, Lake Washington has an OHWM of 18.55 NAVD 88.
4. Converting the NGVD 29 datum to NAVD 88 requires addition of 3.57. Thus, Lake Sammamish has an OHWM of 30.6 NAVD 88.
5. Assuming that the 14-mile distance between Lake Washington and the Sammamish River has a steady slope, and that the project site is approximately 3 miles upstream of Lake Washington, the Sammamish River OHWM at the site is approximately 21.13 NAVD 88 ( $18.55 + 2.57$ ).
6. The upstream limit of the 21-foot elevation is approximately at the downstream pedestrian bridge crossing.

The extension of the Sammamish River OHWM upstream adds shoreline jurisdiction area within the Park at Bothell Landing and encroaches slightly into a City-owned property that is zoned State Route (SR) 522 Corridor just west of the Park property.

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**Designation Recommendation:** Continue the application of High Intensity-Park at the developed portions of the Park at Bothell Landing, including the daylighted stream section. Although this area now has an open stream channel, it also has a considerable length of paved trail and pedestrian bridge crossings. The stream channel also has a buffer of 100 feet (based on Type F typing), which would limit the potential for new modifications within this area. Where the shoreline jurisdiction now extends onto the SR 522 Corridor-zoned parcel, the shoreline portion of that parcel is recommended to be High Intensity.

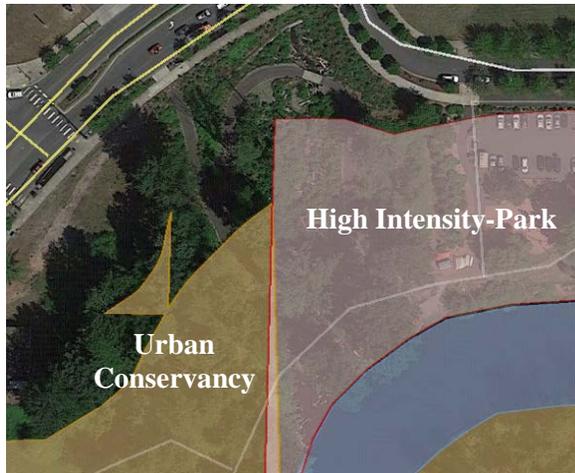
Now may also be an appropriate time to update the language in the existing code under the High Intensity designation criteria which reads:

- B. Designation Criteria. Assign a high intensity environment designation to shoreline areas within city limits and urban growth areas if they currently support high-intensity uses related to commerce, industry, transportation or navigation, or are suitable and planned for high-intensity water-oriented uses. A high intensity – park subclassification has been created and is applied to the portion of the park at Bothell Landing east of the extension of 98<sup>th</sup> Avenue NE. The high intensity – park designation more accurately reflects the nature, purpose and existing use of this urban park that contains buildings, an amphitheater, tot lots, canoe/kayak launch and parking as well as trails, plazas, and other recreation facilities along the Sammamish River.

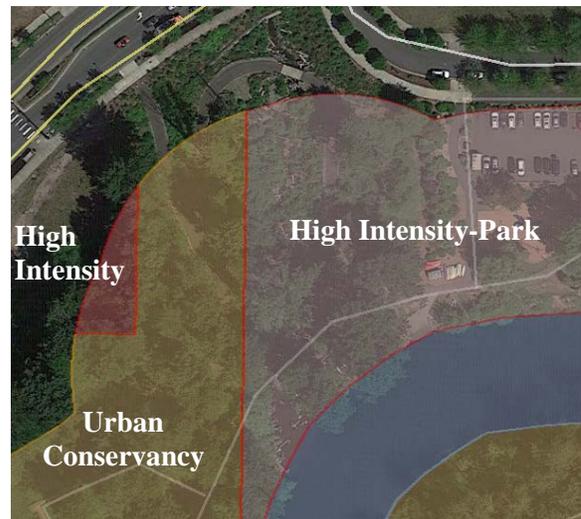
At the time of the 2012 update, the “extension of 98<sup>th</sup> Avenue NE” was an imaginary line to provide a little more narrative description of where the boundary between High Intensity – Park and Urban Conservancy falls. That was more appropriate before 98<sup>th</sup> Avenue NE had been extended into the Park. Considering the quality of the maps and the use of parcel lines, it may not be necessary to add what may be confusing language to indicate the location of the boundary between those two designations.

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**Existing Shoreline Designation Map**



**Proposed Shoreline Designation Map**

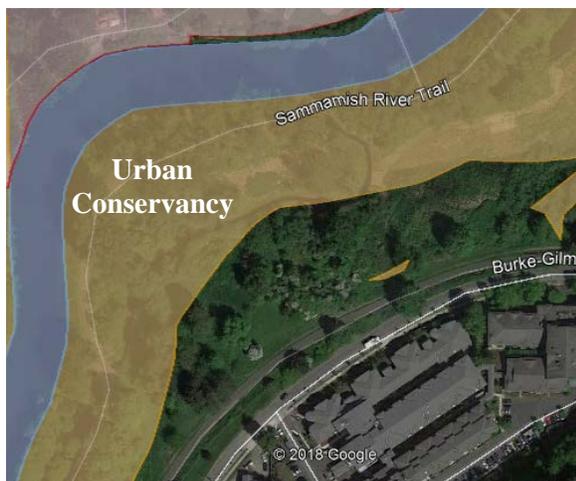
### **SAMMAMISH RIVER SIDE CHANNEL**

In 2017, the City completed construction of a restored 1,100-foot-long remnant channel in a floodplain area between the Sammamish River Trail and the Burke-Gilman Trail. Because the channel is at and below the OHWM of the Sammamish River mainstem, it is also considered part of the shoreline waterbody. The 200-foot minimum shoreline jurisdiction is thus measured from the OHWM of the new side channel.

**Designation Recommendation:** Continue the application of Urban Conservancy throughout the expanded jurisdictional area which is fully contained within City park containing only trails and natural areas.

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**Existing Shoreline Designation Map**



**Proposed Shoreline Designation Map**

### **OLD WAYNE GOLF COURSE**

The City has acquired through a series of grant-funded efforts the “back 9” of the old Wayne Golf Course, which is currently designated as Shoreline Residential based on future use anticipated during development of the 2012 SMP. Although there are many years of public process and design ahead before final decisions are made regarding future uses and modifications, all the property is intended to be managed and operated as a public park.

**Designation Recommendation:** Convert the existing Shoreline Residential designation to Urban Conservancy. The purpose and criteria of the Urban Conservancy designation are excerpted below for reference.

- A. Purpose. The purpose of the “urban conservancy” environment is to protect and restore ecological functions of open space, parks, floodplains and floodways and lands containing critical areas, where they exist in urban and developed settings, while allowing a variety of compatible uses.
- B. Designation Criteria. This designation is appropriate for lands:
  1. Containing or suitable for parks and recreation facilities or other water-enjoyment uses;
  2. Designated for low density single-family uses;
  3. Suitable for water-related uses;
  4. Designated open space, floodplain or other sensitive areas that should not be more intensively developed;

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5. Having potential for ecological restoration;
6. Retaining important ecological functions, even though partially developed; or
7. Having potential for development that is compatible with ecological restoration.



**Existing Shoreline Designation Map**



**Proposed Shoreline Designation Map**

AJS/ajs

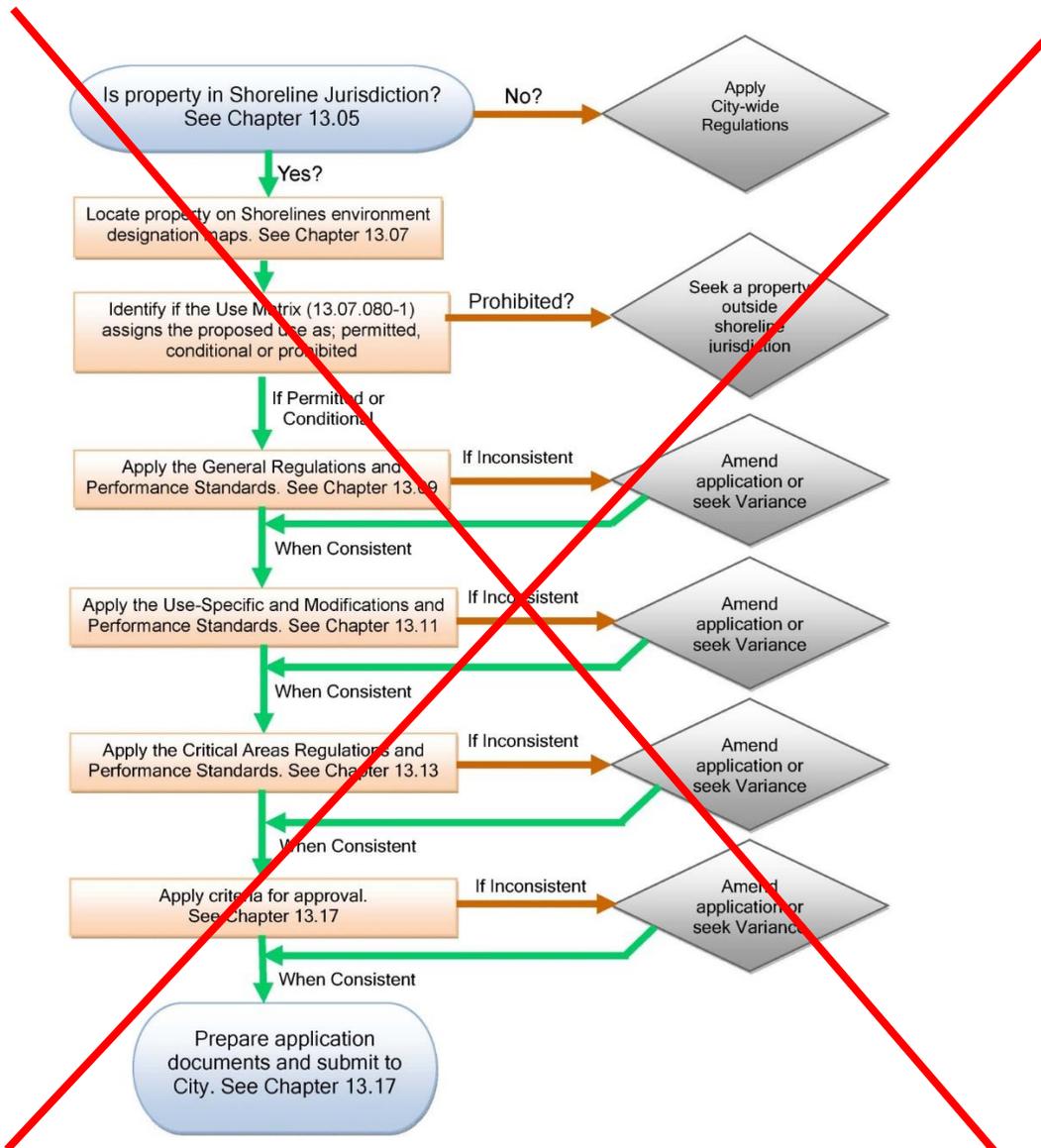
# DRAFT 2018 Shoreline Master Program Amendments

Proposed amendments are shown in underline/~~strikethrough~~ format below, unless otherwise noted. All proposed amendments originate from staff suggestions to improve clarity and usability. Notes that are not part of the proposed code language are shown in text boxes following the amendments. Skipped sections are indicated by three asterisks: \* \* \*

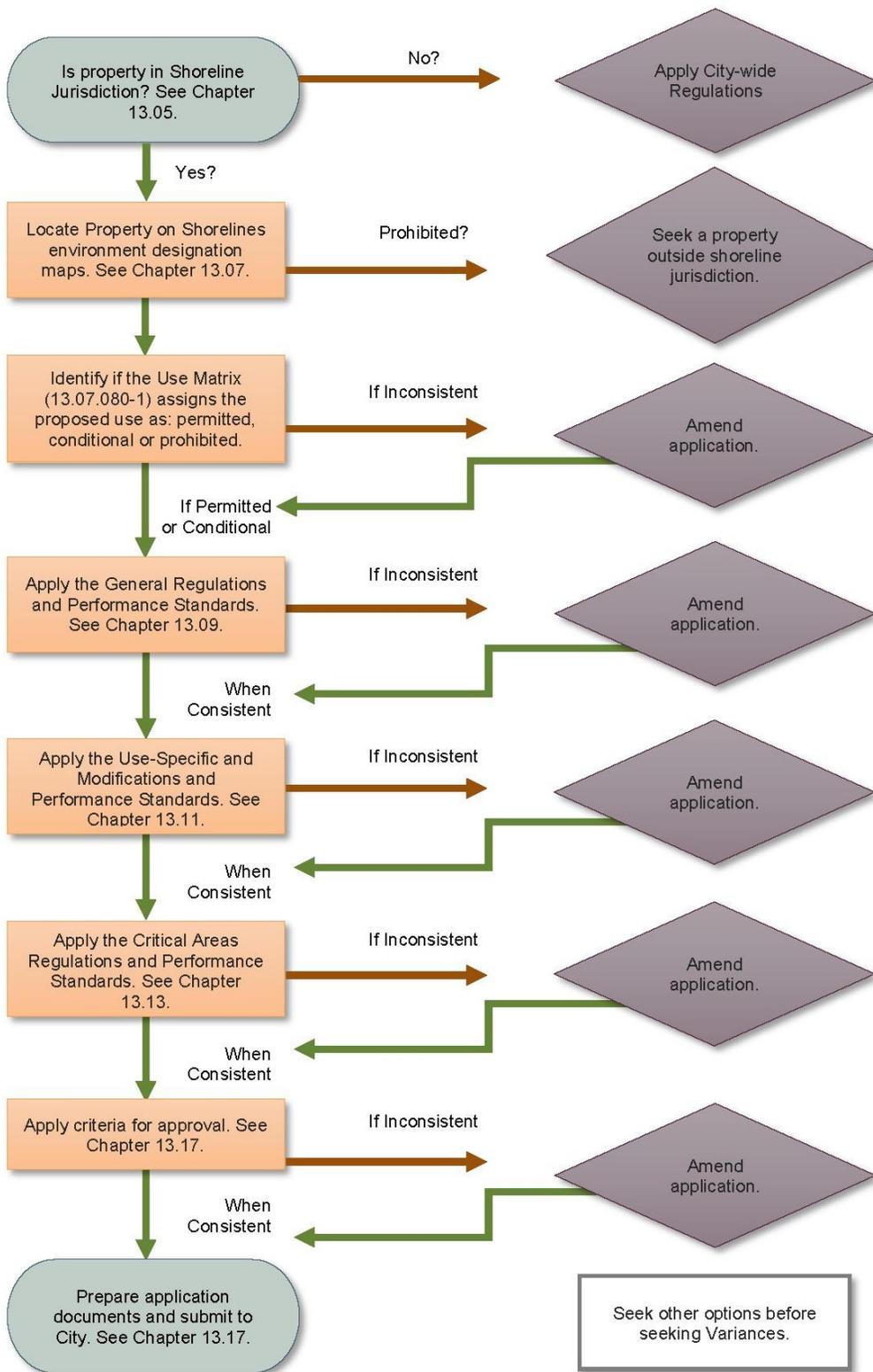
## Title 13 SHORELINE MANAGEMENT\*

### Chapter 13.00 READER'S GUIDE

\* \* \* **\*13.00.020 Flow chart.**



New Chart



**Figure 13-1. Flow Chart**

NOTE: Change to flow chart is intended to clarify desire to first amend proposal (seek other options) before seeking variances.

\* \* \*

**Chapter 13.03  
DEFINITIONS**

**13.03.010 Definitions.**

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\* \* \*

“Boat launch” means an inclined slab, set of pads, rails, planks, or graded slope which extends waterward of the OHWM, and is used for transferring watercraft between uplands and the water by means of a trailer, hand, or mechanical device.

NOTE: New definition added to distinguish boat launches from other in-water facilities.

\* \* \*

**Chapter 13.07  
SHORELINE ENVIRONMENT DESIGNATIONS, USE MATRIX, AND DEVELOPMENT STANDARDS**

NOTE: Title of chapter amended for wayfinding to indicate that use tables and development standards are here as well.

\* \* \*

**Chapter 13.09  
GENERAL REGULATIONS AND PERFORMANCE STANDARDS**

\* \* \*

**13.09.030 Shoreline vegetation conservation.**

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\* \* \*

E. Significant trees located in shoreline jurisdiction outside of wetlands and wetland, stream or shoreline buffers shall be retained using the preferences specified in subsection D of this section as a guide and consistent with the percent of the total in diameter inches of the significant trees located within the net buildable area of the subject property by ~~number~~ provided in Table 13.09.030-1; significant trees shall mean existing trees over eight inches in caliper as measured four feet above grade.

**Table 13.09.030-1. Significant Tree Retention Requirements outside of Wetlands and Wetland, Stream or Shoreline Buffers (Percent by Diameter Inches~~Number~~)**

Shoreline Water Body	Natural	Urban Conservancy	Shoreline Residential	High Intensity/High Intensity-Park or Marina
Sammamish River	NA	65	<u>20</u> <del>40</del>	<u>20</u> <del>40</del>
North Creek	90	65	35	35
Swamp Creek	NA	65	35	35

NOTE: Updated tree retention measurement unit (by number to by diameter inches) and increased the 10% minimum retention in SR and HI along Sammamish River to match the new citywide tree retention requirements (20% by diameter).

\* \* \*

I. The shoreline administrator shall require a maintenance bond or other surety be submitted to the city of Bothell to ensure retention of existing trees and plant material during construction. In the event any trees designated by the city to be retained are removed, the city shall have the option of enforcing any bond posted. Each tree identified for retention shall be bonded pursuant to Table 13.09.030-2:

**Table 13.09.030-2. Tree Diameter and Bonding Required**

Tree Diameter	Amount
8 – <u>12</u> <del>16</del> inches	\$ <u>12,000</u>
<u>Larger than 12 – 16 inches</u>	<u>\$4,000</u>
<u>Larger than 16 – 20 inches</u>	<u>\$1,58,000</u>
20 – <u>24</u> <del>30</del> inches	\$ <u>12,000</u>
<u>Larger than 24 – 28 inches</u>	<u>\$16,000</u>
Larger than <u>28</u> <del>30</del> inches	<u>\$3,520,000</u>

NOTE: Changes made to reflect higher bond requirements found in BMC 12.18.030.F.

\* \* \*

**13.09.050 Public access.**

\* \* \*

C. Except for detached single-family residential dwellings and detached residential subdivisions, shoreline development proposals that have the potential to impact public views of the shoreline from public land or substantial

numbers of residences, shall demonstrate protection of shoreline views through implementation of the following standards:

Note: Minor grammatical clarification.

\* \* \*

E. In order to maintain public access, ~~The city shall not vacate such public rights-of-way or easements as a means of retaining public access.~~ Public access provided by public street ends, public utilities and rights-of-way shall not be diminished by a proposed use, activity or development.

NOTE: Suggested rearrangement of text adds clarity to the statement.

\* \* \*

**13.09.060 Flood hazard reduction.**

\* \* \*

B. The channel migration zone (CMZ) is considered to be that area of a stream channel which may erode as a result of normal and naturally occurring hydrological and related processes<sup>2</sup> ~~or areas mapped by the Department of Ecology [pending] prepared consistent with WAC [173-26-221](#)(3)(b).~~ Applicants for shoreline development or modification may submit a site-specific channel migration zone special study if they believe these conditions do not exist on the subject property ~~or Ecology's mapping is in error.~~ The CMZ special study must be prepared consistent with WAC [173-26-221](#)(3)(b), and may include, but is not limited to, historic aerial photographs, topographic mapping, flooding records, and field verification.

\* \* \*

<sup>2</sup> There are only four ~~Four~~ potential areas of channel migration ~~have been identified on North Creek~~ in the city. These are identified in the city's shoreline analysis report: 1) in North Creek – Centennial Park (Reach 2), 2) the open space/wetland area just north of 228th in North Creek – Canyon Park assessment unit (lower Reach 3), 3) south of 228th Street SE and north of 240th Street SE along the North Creek – Fitzgerald assessment unit (Reach 4), and 4) west of Interstate-405 and north of the North Creek confluence with the Sammamish River within the North Creek – Campus assessment unit (Reach 6).

NOTE: Endnote worded to more clearly indicate that these are the only CMZs in the City. The mapping effort that Ecology had once been planning was never undertaken, and Ecology has stated that it has no active CMZ mapping projects (per Lynn Schmidt, Ecology Flood Engineer, 28 December 2018). "Hydrological and related" was added to the definition consistent with the definition in WAC 173-26-020(7).

\* \* \*

## Shoreline Board 2019 Planning Docket Issue

### **Request to amend BMC 13.13.060 E.6.a.**

*Alternative Buffer Widths for Streams with Residential/ High Intensity, and High Intensity Park Shoreline Master Program Designations: This section applies to new development and Legal pre-existing development.*

**Requested Amendment:** The Bothell Shoreline Master Program be amended to eliminate the Decreased Standard Stream Buffer Widths BMC 13.13.060 E.6.a. and all applicable sections, footnotes, tables, and figures **and that the standard buffer width of 100' be made the requirement on Residential/ High Intensity, High Intensity Park Shorelines \***

*\*Currently, application of high intensity park shorelines only applies to a small area along the shoreline of Park at Bothell Landing east of 96<sup>th</sup> Ave. N.E. The reference to Park Shorelines should be omitted from the requested amendment.*

This request to amend BMC 13.13.060 E.6.a. includes: applicable sections, footnotes, tables and figures including [ but not limited to] *Table 13.13.060-1 (page 210); Figure 13.13.060-1 (page 211); ; Decreased Standard Stream Buffer Widths section 6 ( pg. 212-213); Table 13.13.060-3 Buffer Width Reduction Options (page 214-215); 13.13.060-2a Buffer Reduction Option Figure 13.13.060-2a (pg. 222); & Figure 13.13.060-2c.); and 13.13.060 2d Buffer Width Reduction Option pg.222-223.*

The standard buffer width for the Sammamish River has been 100' since the inception of the first Bothell Shoreline Master Program adopted in 1975.

The buffer width North Creek located between 240<sup>th</sup> St. SE and 228<sup>th</sup> SE and all of Swamp Creek is 150' all environment designations.

#### **Current BSMP:**

The 2011 review and adoption of the BSMP allowed a reduction of the standard (100') buffer widths up to 40% and up to an additional 10% (50%) with buffer averaging as a means of increasing the ecological functions of shoreline and stream buffers that are determined to be adversely altered by past development or activities. New or substantial redevelopment in residential/ high intensity/ and high intensity park may request the reduced buffer dimension in exchange for increasing the ecological functions of the degraded shoreline and stream buffers.

#### **Background and Scientific Studies:**

This past year is on pace to be the earth's fourth warmest on record, and the five warmest years have all occurred since 2010. Locally, 2018's heat set records; 4 of

Seattle's 5 hottest years have come this decade. The average high temperature in 2018 of 62.3 degrees. The only warmer years were 2015 (63.4), 2014 (62.6) 2016 (62.5) and 1992 62.5. The average high this decade is so far surpassing 61 degrees, a steady climb since 58 degrees in 1950's.

Federal and State law requires protections of anadromous fish species. The Governor will be proposing new legislation and increased funding for protection of southern resident JKL pods orca whales and increase in Chinook populations the necessary for food our Orca listed populations. Chinook populations returning to all rivers in Puget Sound are declining, including the Skagit River the largest river in Puget Sound, producing approximately half of all Puget Sound Chinook, and providing habitat for all five wild salmon species as well as Steelhead and Cutthroat trout.

Salmon require cool, well-oxygenated water to survive. (Washington State Department of Ecology- "Effects of Elevated Water Temperatures on Salmonids" July 2000). Warm water causes multiple harmful effects on salmonids, including decreased oxygen supply, disrupted metabolism, increased susceptibility to toxins, increased vulnerability to disease, reduced ability to avoid predators, and reduced food supply. Temperature is a form of "pollution" under state water quality laws. There is a legal duty under 90.48 to both prevent nonpoint source pollution, and ensure that impaired water bodies improve on a path to recovery according to the State Supreme Court Lemire case (2003). The Water Quality Standard is 18°C and for salmon spawning and rearing creek it was revised to 16°C reflecting best available science (BAS)

The science is well established that the protection and restoration of functional riparian habitat is necessary to achieve water quality standards of salmon viability. The Washington Department of Fish and Wildlife (WDFW) recommendations based on BAS, included 200' buffers for fish streams 5-20' wide, and 150' buffers for streams less than 5' wide, equivalent to roughly 1 Sight Potential Tree Height (SPTH). SPTH is defined as average (200 years or more) for a given site class.

WDFW 2018 Riparian Ecosystems, Volume I: Science and Synthesis Management Implications, "states that, "protecting functions within at least one SPTH is a scientifically supported approach if the goal is to protect and maintain high function of the riparian ecosystem." Pg. 252

Additionally WDFW's Volume 1 concluded that "all else being equal, protecting areas less than a SPTH results in lower levels of function, and generally increase risk to aquatic fish and wildlife.

The City of Bothell's Alternative Buffer widths allowing 40% with additional 10% average, a 50% reduction is only 25% of the SPTH and does not comply with

BAS. Further, the requirements for tree planting do not meet the criteria for Sight Potential Tree Height (SPTH) average maximum height of the tallest dominant trees (200 years or more) for a given class”.

The native vegetation enhancement plan required for buffer reduction option(s) consists of trees and shrubs planted along water body frontage -- at least five conifer or deciduous per 100 linear feet do not meet BAS.

Climate Change is expected to cause August stream temperatures “ to increase an average of 2.83 degrees Celsius by the 2080’s (Isaak et al 2015) and stream temperatures are expected to increase in all seasons of the year. It is clear that truly bold action is needed.

WRIA 8 (Lake Washington/Cedar/ Sammamish Watershed) Chinook Salmon Conservation Plan 10 year update 2017 uses recent habitat monitoring efforts that establish baseline conditions to development near term ( 2025) and long term (2055) quantifiable habitat recovery goals .

WRIA 8 Salmon Conservation Plan 10 year update in 2017 contains adaptive management goals for 2020, and 2025. Regulatory authority to require setbacks along salmon bearing streams where land uses are currently exempted or setback or buffer requirements are inadequate and securing commitment to prioritize riparian habitat restoration along salmon streams and to use BAS to guide such restoration is necessary.

Current Average return Chinook Status for Sammamish River population ( 2006-2015) was 1,269 adults ( including HOS- Hatchery origin) with 2025 goal of 1,083 NOS( naturally spawning) Pg. 16-17 WRIA

Sammamish River is a Tier 1 river the highest priority habitat for protection, as a migratory and rearing corridor. North Creek is Tier 2 . The lethal temperatures in Sammamish River during adult migration are considered a key constraint on recovery of Chinook salmon pg.8 WRIA. Goal for 2025 is to increase riparian cover by at least 10% and add two thermal refugia by 2025. Pg. 14 WRIA

Stream spawning and rearing occurs in North Creek, a key constraint is insufficient instream rearing and refuge habitat, loss of floodplains and side channels/off-channel rearing, and lack of large woody debris. Goal 2025 is to increase riparian cover by at least 10% and average wood volume to double over current basin conditions by 2025. Chinook salmon red survey 1999- 2015 shows 4 redds 2015, the latest survey results. There were 14 redds in 2012. pg. 21WRIA

Protecting and restoring riparian trees is important throughout the WRIA 8 watershed, and offers direct and indirect benefits to Chinook salmon via food web

inputs, water quality protection, and a source of large wood for recruitment. Pg. 35  
WRIA 8.

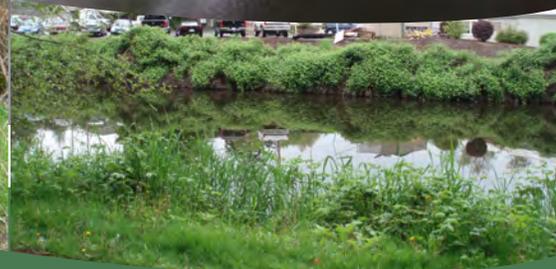
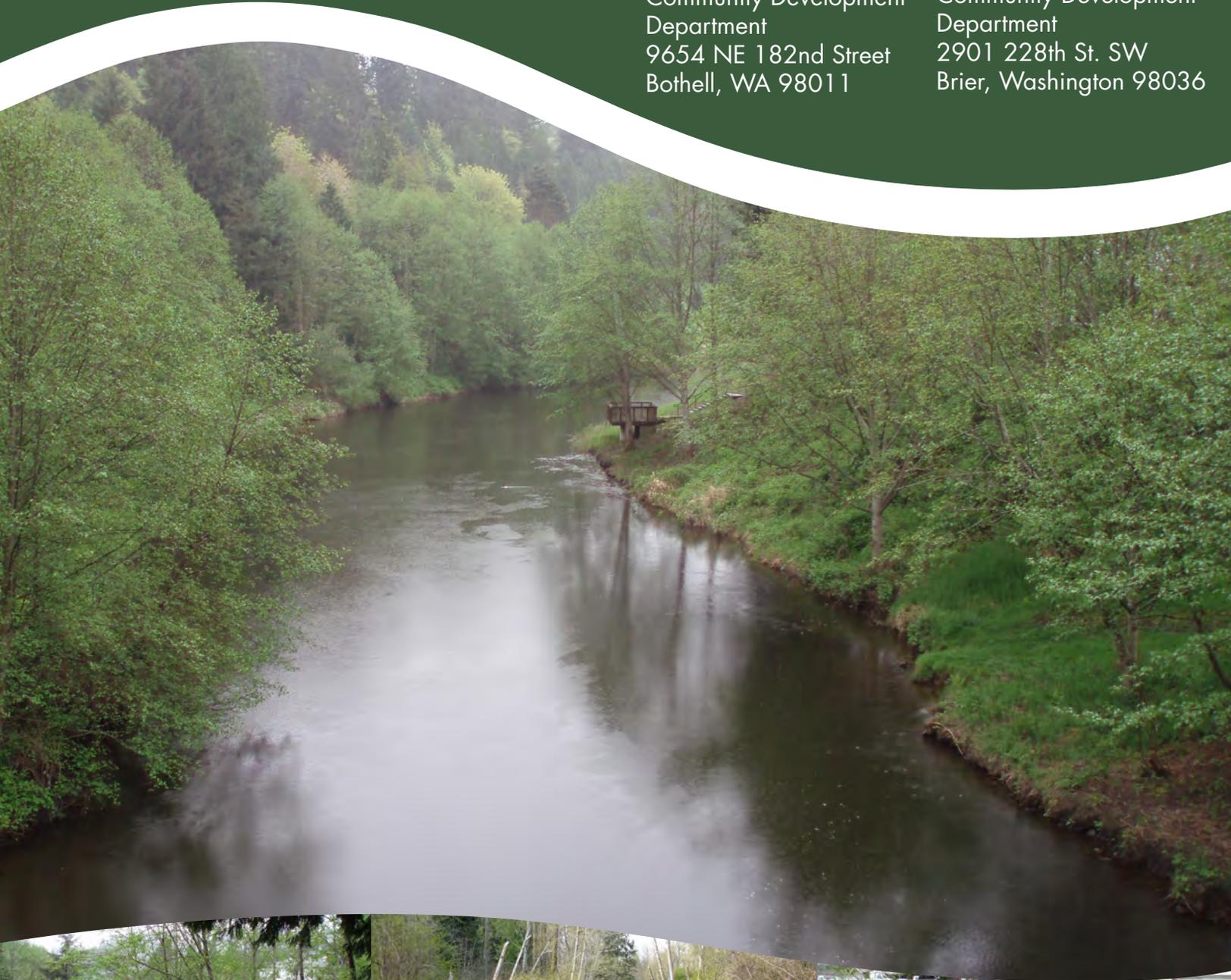
Based upon critical climate warming, BAS, status of our Bothell shorelines and the currently inadequate BSMP alternative buffer regulations , I request Bothell Shoreline Board support to forward this proposal to the Bothell City Council for consideration in the 2019 planning docket.

Ann Aagaard

# Shoreline Analysis Report for the Cities of Bothell and Brier Shorelines: Sammamish River, North Creek, and Swamp Creek

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## 4 Analysis of Ecological Functions and Ecosystem Wide Processes

### 4.1 Geographic and Ecosystem Context (WRIA 8)

The City of Bothell is located in King and Snohomish County, and the City of Brier is located entirely in Snohomish County. The Cities contain freshwater shorelines associated with Washington State's Water Resource Inventory Area (WRIA) 8 – Cedar/Sammamish (Exhibit 3). WRIA 8 encompasses 692 square miles and collects water from two major rivers (Cedar and Sammamish Rivers) before flowing through Lake Union and ultimately into Puget Sound via the Lake Washington Ship Canal and Hiram M. Chittenden locks.

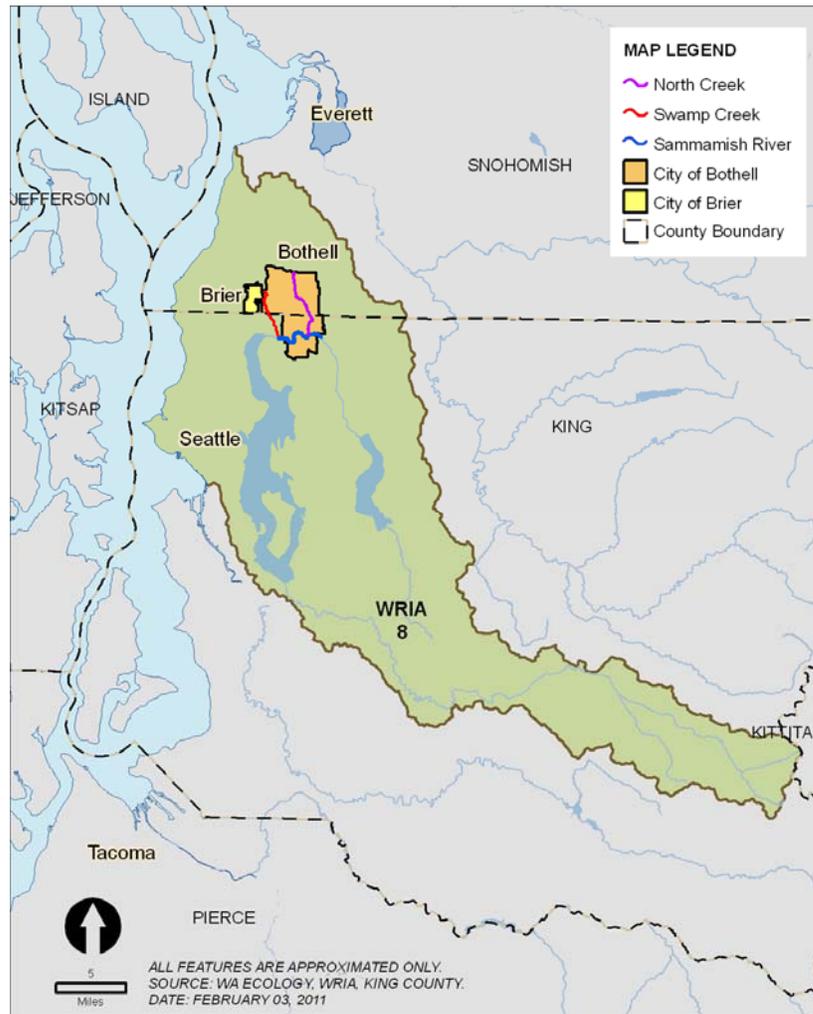


Exhibit 3. Overview of the Cedar Sammamish Water Resource Inventory Area (WRIA) 8.

### 4.1.1 North Creek

North Creek (WRIA 08.0070) has its headwaters in highly-urbanized south Everett, near Everett Mall, and flows southward, through unincorporated Snohomish County, Mill Creek, and Bothell, where it discharges into the Sammamish River just downstream of River Mile (RM) 4.5. The basin drains a watershed area of approximately 28.5 square miles, roughly two-thirds of which lies in unincorporated Snohomish County (Snohomish County 2002a).

The creek is approximately 13 miles long and begins on a plateau area at approximately 500 feet elevation to descend through a valley that gradually broadens into a recently restored floodplain on the Sammamish River valley floor in the vicinity of the Cascadia Community College/University of Washington Bothell (CCC/UW-B) campus. Basin topography was shaped during the most recent period of glaciation, which left behind an undulating landscape of till, advance and recessional outwash, and lacustrine sediments. Most soils in the watershed are generally a gravelly sandy type loam (Alderwood, Everett, and Norma soils) (Figures 11A & B, pages C-24 & C-25).

#### Fish Use

North Creek supports runs of federally threatened Chinook salmon (*O. tshawytscha*) and steelhead trout (*O. mykiss*), as well as coho salmon (*O. kisutch*), a federal species of concern, and sockeye (*O. nerka*), kokanee (*O. nerka*); and coastal cutthroat trout (*O. clarki*) (Kerwin 2001), all of which are Washington State Priority Species (Figures 15A & B, pages C-32 & C-33).

#### Channel/Floodplain/Riparian Condition

Throughout the basin, including through Bothell, channel complexity and connectivity with the floodplain and adjacent stream reaches have been reduced due to road crossings/culverts, streambank hydromodification, channel incision and instability, and historical and on-going clearing and development in riparian areas. Changes in land-use practices have limited in-stream large woody debris (LWD) recruitment that would have contributed to stream channel complexity. Degraded riparian conditions in these reaches, and the lack of LWD recruitment potential have contributed to an overall reduction in habitat function. Current land use practices will generally preclude any long-term LWD recruitment (Kerwin 2001).

Clearing and development in the riparian corridors has reduced the extent of riparian forests and changed land cover from predominantly mature coniferous and mixed forests to a young deciduous forest, and, in turn, from forest to impervious surface land cover. These changes in riparian conditions have led to a reduced amount of available wood that could function as LWD. Basin hydrology has also been significantly altered as a consequence of land use

changes associated with urbanization. The present 2-year flood discharge exceeds the historical 100-year discharge, and 100-year flows have increased by 50 percent (Kerwin 2001). This resulted in a suite of flooding problems along the lower creek in Bothell. Levees constructed by private business park developments in the early 1980s have been raised in height and otherwise modified in recent years to contain the increasing flood flows. The first record of levee installation on North Creek, however, was noted as occurring in 1964 and was completed by the Corps as part of a large-scale flood control project on the Sammamish River (Tetra Tech, Inc. 2002).

Furthermore, the potential for the recruitment of LWD to the stream channel from those areas which are now occupied by levees is virtually eliminated, since Corps and FEMA requirements call for maintaining the levees and associated stream banks in an open and essentially vegetation-free condition. Only grasses and emergents are allowed. This mandated tree-free condition in turn affects the evaluation and analysis of ecological functions (as reported in Table 12, Section 4.3.5).

### **Water Quality**

High measured temperatures in North Creek not only exceed State designated standards, but also are in excess of required temperatures for successful salmonid rearing. These high stream temperatures in the basin result from riparian clearing, direct runoff from impervious surfaces, decreased groundwater recharge/discharge, and low flows. Dissolved oxygen, fecal coliform, temperature and concentrations of metals, including copper, lead, zinc, and chromium, have also been problematic (Ecology, electronic reference, Thornburgh and Williams 2000).

Three reaches of North Creek were added to the state's 303(d) list of polluted waters for low dissolved oxygen levels in 2008. These listings were based on a portion of samples exceeding the minimum standard of the 9.5 mg/L dissolved oxygen between 2003 and 2006 (Ecology, electronic reference). The lower reach of North Creek has been on the 303(d) list for temperature since 2004 because the temperature criterion for salmon spawning, rearing, and migrating (17.5°C or 63.5°F) was exceeded in every year from 1998-2002 (Ecology, electronic reference).

Several reaches of North Creek (Reaches 1, 2, 4, 5 and 6) are impaired by fecal coliform bacteria levels, and the southern reaches (Reaches 4-6) also have low dissolved oxygen concentrations. The North Creek Fecal Coliform Total Maximum Daily Load (TMDL) (Ecology 2001) was developed and adopted to identify concerns and develop a plan for reducing fecal coliform levels in those reaches and throughout the basin.

Still other reaches of North Creek are listed as Category 2 waters (waters of concern) for high levels of mercury, temperature, and pH (Ecology, electronic source). Minimum water quality standards and water quality impairments for the Cities' shoreline units are listed in Table 5. Further information on specific water quality impairments can be found on Ecology's website at <http://www.ecy.wa.gov/programs/wq/303d/index.html>.

Table 5. Minimum water quality standards and impairments by shoreline unit based on Ecology's (electronic source) Washington State Water Quality Assessment.

Water Quality Standard		Temperature	Dissolved Oxygen	Fecal Coliform	Mercury
Core salmon migration and rearing habitat and primary contact recreation		7-day average of the daily max. temp. less than 17.5°C	1 day minimum DO of 9.5 mg/L	Geometric mean of 100 colonies /100 ml, not more than 10 percent of all samples exceeding 200 colonies /100 mL	1 hr average of 2.1 mg/L or 4 d average of 0.012 mg/L
Supplemental salmon spawning and incubation habitat in Swamp and North Creeks		7-day average of the daily max. temp. less than 13°C from 11/15 to 5/15			
Reach	Reach Name	Water Quality Listing			
		Temperature	Dissolved Oxygen	Fecal Coliform	Mercury
1	North Creek – Thrasher's Corner (north of SR-524)			TMDL	
2	North Creek – Centennial Park			TMDL	
3	North Creek – Canyon Park				
4	North Creek – Fitzgerald (228 <sup>th</sup> Street SE to 240 <sup>th</sup> Street SE)	Water of Concern	303d	TMDL	
5	North Creek – North Creek Business Parks (240 <sup>th</sup> Street SE to I-405)	Water of Concern	303d	TMDL	
6	North Creek – Campus (I-405 to Sammamish River)	303d	TMDL	TMDL	Water of Concern
7	Swamp Creek – City of Bothell	Water of Concern	303d	TMDL	
8	Swamp Creek – City of Brier				
9-12	Sammamish River – Woodinville Drive, Brackett's Landing, Sammamish River Park, Downtown, and Bothell Way Corridor		303d	303d	
13-15	Sammamish River – Bothell Way Corridor, Wayne Golf Course to Bothell Business Park Floodway				

## Channel Migration Zone

Reach 1, North Creek – Thrasher’s Corner. Potential for significant channel migration in Reach 1 is considered to be low due to established streambank vegetation, topographical constraints, and the built-out nature of areas adjoining the stream. Existing infrastructure would be protected.

Reach 2, North Creek - Centennial Park. The well-vegetated streambanks through this reach result in relatively stable banks and limit the *rate* of potential channel migration and associated erosion. However, since the reach lies in a low-gradient, depositional area which presently exhibits some channel braiding, channel locations, forms, and braiding patterns can be expected to evolve over time. Channel migration may occur due to deposition in existing channel sections associated with the low gradients, causing channel locations to shift, though this is not necessarily detrimental. The broad floodplains are largely depositional areas.

Reach 3, North Creek – Canyon Park. Upper Reach 3 is constrained by existing development and some areas of armoring which remain from past agricultural and commercial land uses. Dense bank vegetation is also present at many locations. Channel migration will likely be prevented in that area to protect existing development and associated infrastructure, though ongoing commitments for monitoring and maintenance amongst and between the City and private parties are needed.

The well-vegetated streambanks through the lower parts of Reach 3 also result in relatively stable banks and limit the rate of channel migration and associated erosion. Channel migration may occur due to low gradients and resulting deposition in the existing channel, and may also occur due to changes in meander patterns associated with bank erosion on the outsides of meander bends with deposition and bar formation on the insides. The broad floodplain areas provide for the deposition of fine sediments.

Reach 4, North Creek – Fitzgerald. Though the vegetation that exists along the streambanks through this area also contributes to bank stability and limits the rate of channel migration and associated erosion, some channel shifting can still be expected to occur. Furthermore, the North Creek channel through Reach 4 is fairly constrained by the surrounding topography, limiting the extent of adjoining floodplain areas as well as the channel migration zone. Thus any channel migration would be expected to be limited in both rate and degree. Adjoining development along Reach 4, particularly on the west side, would also be protected and so would limit the channel migration zone similarly to upper Reach 3.

Reach 5, North Creek – North Creek Business Parks. Reach 5 is constrained by existing development, constructed levees, and some areas of armoring which remain from past agricultural and commercial land uses. Like upper Reach 3, any significant channel migration will likely be prevented to protect existing development and associated infrastructure, though ongoing commitments for monitoring and maintenance amongst and between the City and private parties are needed. Dense bank vegetation to help slow and prevent migration is also present at many locations.

Reach 6, North Creek – Campus. According to the University of Washington Water Center Website, “The new channel was designed to allow the river to re-meander across the floodplain (within project constraints)...” (University of Washington, electronic source).

“Re-meander” can be interpreted to be synonymous with “migrate.” The well-vegetated streambanks and placed log structures through this area, coupled with lower gradients, result in relatively stable banks and limit the *rate* of channel migration and associated erosion. However, channel migration may occur over time due to the low gradients and resulting deposition in the existing channel. Migration may also occur due to changes in meander patterns associated with bank erosion on the outsides of meander bends with deposition and bar formation on the insides. As indicated above, such channel movement over time was intended by design and is not considered to be detrimental within limits. The broad floodplain areas are largely depositional.

#### **4.1.2 Swamp Creek**

Swamp Creek (WRIA 08.0059) has its origins in Snohomish County and flows southward into King County, before it empties into the Sammamish River at RM 0.6. Its drainage basin covers approximately 25 square miles, most of which is in unincorporated Snohomish County, but also included are the Cities of Everett, Lynnwood, Brier, Bothell, Mountlake Terrace, and Kenmore. Swamp Creek is approximately 11 miles in length (SCSWM 2002b).

Similar to North Creek, the Swamp Creek basin topography was shaped during the most recent period of glaciation, which left behind an undulating landscape of till, advance and recessional outwash, and lacustrine sediments. Most soils in the basin are a gravelly sandy type loam (Alderwood, Everett, and Norma soils) (Figure 11A, page C-24).

Swamp Creek historically supported runs of chinook, sockeye, kokanee, and coho salmon; steelhead and coastal cutthroat trout (Williams et al. 1975). More recently, spawning coho, sockeye, and kokanee have been noted just south of the King/Snohomish County line (Kerwin 2001). WDFW (2010) maps fall Chinook, sockeye, kokanee, coho, and winter steelhead in Swamp Creek through shoreline

jurisdiction and farther upstream. Of these species, Chinook salmon (*O. tshawytscha*) and steelhead trout (*O. mykiss*) are federally threatened and state candidate species. Coho salmon (*O. kisutch*) are a federal species of concern. And all of the salmonid species are Washington State Priority Species (Figure 15A, page C-32).

Similar to North Creek, within the Swamp Creek basin, channel complexity and connectivity with the floodplain and adjacent stream reaches are reduced due to road crossings/culverts, streambank hydromodification, channel incision and instability, and historical and on-going clearing and development in riparian areas. Clearing and development in the riparian corridors has reduced the extent of riparian forests and changed land cover from predominantly mature coniferous and mixed forests to young deciduous forest, and, in turn, from forest to impervious surface land cover. These changes in riparian conditions have led to a reduced amount of available wood that could function as LWD and limited in-stream large wood recruitment that contributes to channel complexity (Kerwin 2001).

Also similar to North Creek, it is estimated that the current 2-year flood discharge exceeds the historical 100-year discharge in Swamp Creek (SCSWM 1994a). The loss of floodplain area and wetlands in the basin, combined with water withdrawals and an increase in impervious surfaces has reduced water storage capacity. This has resulted in reduced summer low flow conditions, and many tributaries as well as mainstem sections run dry in the summer months (Kerwin 2002). Basin land cover alterations have resulted in changes to the basin's hydrology, resulting in peak flows of greater intensity and duration, lower summer flows, increased flashiness, over-widening of the stream channel, bank erosion, and scour of the streambed. This has led to the washout of LWD, reduction in the frequency and quality of pools, scour of salmon redds, and degradation of the aquatic macroinvertebrate communities (May et al. 1997 in Kerwin 2002).

High stream temperatures in Swamp Creek result from riparian clearing, direct runoff from impervious surfaces, decreased groundwater recharge/discharge, and low flows. These values exceed State designated standards and required temperatures for successful salmonid rearing (Thornburgh and Williams 2000). The lowest reach of Swamp Creek is on the 303(d) list for temperature based on readings collected from 1998-2002, and the reaches within and downstream of the Cities are listed as waters of concern (Category 2) (Ecology, electronic reference).

Several reaches within Swamp Creek, including the Swamp Creek- City of Bothell unit (shoreline unit 7), have not consistently met standards for dissolved oxygen and fecal coliform bacteria (Ecology, electronic reference). Based on

sampling results from 2000 to 2006, Swamp Creek south of 228<sup>th</sup> Street SW in the City of Bothell is 303(d)-listed for dissolved oxygen (Ecology, electronic reference; Figure 17A, page C-36). A TMDL for fecal coliform in Swamp Creek was adopted in 2006 to address concerns throughout the creek (Ecology 2006). Concentrations of metals in Swamp Creek, including copper, lead, zinc, and chromium, are some of the highest in Snohomish County (Thornburgh and Williams 2000).

### 4.1.3 Sammamish River

The Sammamish River (WRIA 08.0057) flows between the north ends of Lakes Sammamish and Washington and drains a watershed area of approximately 240 square miles. Historically, it overflowed its banks regularly and had a complex, highly sinuous, meandering channel that was somewhat longer than it is today. In 1891, the U.S. Army Corps of Engineers reported that the river was 17 miles long; today it has been shortened to about 13.5 miles long.

Throughout the 1900s, the river went through dramatic changes that reduced the complexity of the floodplain, including the lowering of Lake Washington, the channelization of the river, and the construction of drainage ditches in the river valley. Floodplain wetlands, side-channels, and spring-fed streams were affected. The elevation of Lake Washington was lowered by about 9 feet with the opening of the Chittenden Locks in 1916, also draining much of the Sammamish River corridor which had included extensive forested wetlands, especially near the mouth of North Creek (U.S. Department of Interior 1859). Prior to this, backwater effects from Lake Washington appear to have extended beyond the confluence with Little Bear Creek, including all of present-day Bothell (King County 1892).

Around the same time period, farmers in the Sammamish River Valley formed a drainage district that began to straighten the upper reach (east of the Bothell area) of the river dramatically. In 1962, the Corps began to systematically dredge the river, primarily as a flood control project, thus deepening the river 5 to 10 feet throughout most its length (Tetra Tech, Inc. 2002), hardening the river's banks, and dramatically decreasing its remaining connection to and interaction with the floodplain. Although a formal levee system was not constructed, the excavated material from dredging was "typically sidecast to fill in low spots (probable wetlands) and form short berms along the banks" on both sides of the channel through Bothell (Tetra Tech, Inc. 2002). These actions have greatly simplified the river and cut it off from its natural connections with the vast wetland complexes and off-channel habitats that historically characterized much of the river corridor. Many of the sidewall tributaries were left to enter the lowered river channel from hanging culverts that are impossible for fish to access, particularly during low flows (Kerwin 2001).

Discernible channel migration of the Sammamish River through the City of Bothell is not expected due primarily to the channelization (dredging) and armoring of the river accomplished by the Corps during the 1960s as described above. An exceptionally low channel gradient and associated low energy level available to drive bank erosion also greatly limit the risks of channel migration within the City. Lake Sammamish, located approximately 10 miles (16 kilometers) upstream, also provides a high level of natural and enhanced detention (via the King County weir at the Lake Sammamish outlet), which meters flood flows through the river channel within the City across a much extended time period to further reduce the potential for bank erosion and associated channel migration, however slow or limited.

Woody debris was also removed from the channel along with essentially all of the natural vegetation from the riverbanks. The Sammamish River is still classified as a navigable waterbody by the EPA, Corps, and U.S. Coast Guard, and FEMA is concerned with the roughness of the river and its ability to accommodate large flood flows. As such, recruitment of new woody debris has been largely precluded by these agencies which have continued to promote clearing of natural vegetation in riparian areas to maintain channel conveyance as required by the Corps. This maintained virtually LWD-free condition in turn affects the evaluation and analysis of ecological functions (as reported in Table 15, Section 4.3.8).

The lack of normal riparian characteristics further contributes to a loss of channel complexity, increased temperatures, and poor cover and forage for both aquatic and terrestrial wildlife (Kerwin 2001). This project did, however, meet its flood control objective and practically eliminated flooding throughout the Sammamish River Valley (King County Water and Land Resources, electronic source).

The lower reach of the river, extending downstream from Woodinville, has a much narrower direct drainage area than the upper. It includes the downtown core of Bothell and open space areas including the Wayne Golf Course and Bothell parkland along the Sammamish River Trail. The trail and a major King County sewer line which runs beneath it create potential constraints for restoration projects along their side of the river, mostly the north bank. From the standpoint of planning, the trail is also important for the public access, non-motorized transportation, and recreational uses it provides.

Chinook, coho, sockeye, kokanee, steelhead, and cutthroat are the salmonid fish species known to currently inhabit the Sammamish River system. Of these species, Chinook salmon (*O. tshawytscha*) and steelhead trout (*O. mykiss*) are federally threatened and state candidate species. Coho salmon (*O. kisutch*) are a federal species of concern, and all of the salmonid species are Washington State Priority Species (Figure 15B, page C-33). Kokanee are non-anadromous sockeye

and steelhead and cutthroat exhibit both sea-going and resident life histories. The lower reach includes two large salmon-bearing tributaries which are also Bothell shoreline streams: Swamp Creek and North Creek (Kerwin 2001).

Reaches of the Sammamish River are on the state's 303(d) list for temperature, fecal coliform, and dissolved oxygen (Ecology, electronic source; Figure 17B, page C-37). The mainstem Sammamish reaches extremely high water temperatures (by salmonid fish habitat standards) exceeding 17.5°C (63.5°F) during the summer and early fall, when Chinook and sockeye adults are migrating through it (Kerwin 2001). Historically, the river was probably always warmer in the summer and early fall than most Northwest rivers, since it is fed by the warm upper layers (the epilimnion) of Lake Sammamish and it flows slowly through a low-gradient valley (Kerwin 2001). However, the complex and heavily forested historic channel of the river would have provided far more shade than the river receives today (Kerwin 2001). Furthermore, the weir at Lake Sammamish reduces summer low flows in the Sammamish River (Kerwin 2001). Lower flows in the river during the late summer and early fall may exacerbate water temperature problems (Martz, et al 1999 cited in Kerwin 2001).

During the course of WRIA 8 salmon planning efforts, it was observed that Sammamish River water temperatures within the vicinity of Bothell's Blyth Park were less than that predicted by modeling studies and expected based on the location of this reach near the bottom of the watershed (TetraTech 2002). Factors that may be responsible for lower temperatures in this reach include: 1) cool groundwater inputs from the adjacent Norway and Finn Hills which contain large amounts of ground water and aquifer storage; 2) the presence of significant mature vegetation and trees that shade the River from solar gain; and 3) a combination of groundwater input and shading of the River (TetraTech 2002). As part of the SMP update, the City is conducting water temperature monitoring along a stretch of the Sammamish River near Blyth Park in hopes of verifying the water temperature pattern and identifying any cause. Depending on the results of the study, special SMP regulations may be crafted to maintain processes or conditions that create the cooler waters.

## **4.2 Major Land Use Changes and Current Shoreline Condition**

The City of Bothell was incorporated in 1909, while Brier was incorporated in 1965. By 2008, Bothell had grown to a population of approximately 32,000 while Brier had a population of approximately 6,300 people. Bothell and Brier contain sizable residential communities, while Bothell in addition is a regional employment center. Due to its significant transformation from a small town to a regional center of business, the City of Bothell land use pattern is a focus below.

At the time of incorporation, Bothell relied heavily upon the Sammamish River for transportation of goods and passengers, primarily as part of the logging industry. However, most boat traffic came to an end shortly thereafter, when Lake Washington was lowered in 1917. Logging then quickly declined and the economy mostly shifted to farming.

In the early 20<sup>th</sup> century, development occurred along major routes such as the road connecting Bothell to Seattle which followed along the Sammamish River and Lake Washington, as well as the Bothell-Everett Highway, generally following Horse Creek and North Creek, and Waynita Way. Houses and businesses concentrated along these routes and in downtown Bothell (City of Bothell 2009).

The downtown and corridor type development continued until the 1960s, when Interstate 405 was constructed, and there was much flat land adjacent to the interchanges. In the late 1970s and early 1980s, Bothell and Snohomish County updated their comprehensive plans to provide for the development of business parks in the North Creek Valley. The last two decades have seen residential, commercial and industrial development activity at a pace and magnitude not before seen in Bothell. In particular, the North Creek Valley has extensively developed, consisting of business parks, retail and services centers, and single- and multi-family residential development in a variety of configurations (City of Bothell 2009).

Since approximately 1980, Bothell has evolved from a bedroom community, sending its workers to Seattle, Everett and Bellevue, to a regional employment center that still provides a residential character (City of Bothell 2009).

As a result of intensive development over the last 20 and more years, most of the shorelines in both Brier and Bothell are in use for residential, commercial, and/or industrial/manufacturing purposes. These uses are interspersed with public and private open space and recreation. Land use in shoreline jurisdiction includes a mixture of single-family, multi-family, commercial, manufacturing, and open space uses. The majority of commercial uses are located along both banks of North Creek between State Route 524 and I-405. Residential uses dominate the majority of Swamp Creek through both Bothell and Brier. The Sammamish River is characterized by park/open space uses as well as residential and commercial uses. Both Cities' Comprehensive Plans call for shoreline land uses to remain virtually unchanged.

### **4.3 Analysis of Ecological Functions and Processes**

Current ecological processes and functions of the Cities' shorelines are summarized in Tables 7 through 15, and establish a baseline for measurement of the SMPs' performance against the no net loss of ecological functions standard.

These tables are organized around Ecology’s list of processes and functions for freshwater streams. The list includes the evaluation of four major processes: 1) hydrologic; 2) vegetation; 3) hyporheic; and 4) habitat.

Hydrologic processes pertain to the supply and movement of both ground and surface water within the environment, including sources, timing, amount, and direction. Hyporheic processes are related to and may be considered to be a special subset of hydrologic processes. Specifically, the hyporheic zone is the region beneath and lateral to stream beds where there is a mixing of shallow groundwater and surface water and where water percolates through the spaces between substrate and soil particles. Within the hyporheic zone, exchanges of water, nutrients, and organic matter occur between the surface stream and groundwater in response to variations in stream discharge, groundwater supply, channel form, and soil/substrate porosity. Upwelling subsurface water supplies stream organisms with nutrients while downwelling stream water provides dissolved oxygen and organic matter to microbes and invertebrates within the hyporheic zone, as well as water to plants growing along streambanks and within buffers.

These four primary processes are further broken down into the following functions which are in turn used to evaluate current reach performance (Table 6).

Table 6. Identification of Functions Evaluated for Each Major Process Based on Ecology’s Shoreline Master Program Guidelines (WAC 173-26).

<b>Stream Functions</b>
<p><b>1. Hydrologic Functions</b></p> <ul style="list-style-type: none"> <li>• Storing water and sediment</li> <li>• Transport of water and sediment</li> <li>• Attenuating flow energy</li> <li>• Developing pools, riffles, and gravel bars</li> <li>• Removing excess nutrients and toxic compounds</li> <li>• Recruitment of LWD and other organic material</li> </ul>
<p><b>2. Vegetative Functions</b></p> <ul style="list-style-type: none"> <li>• Temperature regulation</li> <li>• Water quality improvement</li> <li>• Slowing riverbank erosion; bank stabilization</li> <li>• Attenuating flow energy</li> <li>• Sediment removal</li> <li>• Provision of LWD and other organic matter</li> </ul>
<p><b>3. Hyporheic Functions</b></p> <ul style="list-style-type: none"> <li>• Removing excess nutrients and toxic compounds</li> <li>• Water storage and maintenance of base flows</li> <li>• Support of vegetation</li> <li>• Sediment storage</li> </ul>
<p><b>4. Habitat Functions</b></p> <ul style="list-style-type: none"> <li>• Physical space and conditions for life history</li> <li>• Food production and delivery</li> </ul>

Assessment of each function by The Watershed Company is based upon both quantitative data results derived from the GIS inventory information described in Chapter 3; a qualitative assessment based on aerial photography, field inventory (where possible); and existing assessment information prepared by such entities as King County, WRIA 8 entities, and others. As described in Section 3.2, the shoreline has been divided into assessment units based on land use and ecological condition (see Exhibit 2 above and Figures 19A and B in Appendix C, pages C-43 & C-44). In the ensuing tables, each unit has been given an overall “rating” for ecological functions based on the available and relevant GIS information and the corresponding quantitative and qualitative evaluation.

Rating was completed using a “low” to “high” function scale, judged on a scale relative to other urban environments as opposed to an absolute scale including pristine habitats. It is not practical to identify quantitative ranges for the rating of each parameter because a comprehensive, quantitative field study of functions in each reach has not been conducted and existing quantitative information comes from mixed sources that are not always directly comparable. Further, the judgment calls are generally made based on the reach’s existing ability to perform a certain function, not whether the reach has the opportunity to perform that function. It is reasonable to assume that within the urbanized setting of the Cities of Bothell and Brier, development in the area provides sufficient opportunity to improve ecological conditions (e.g., water quality, habitat complexity, flood retention).

The level categories are:

- Low
- Low/Moderate
- Moderate
- Moderate/High
- High

No reach in its entirety received a High score. Many of the reaches scored High or Low for one or more individual functions, but these were generally offset by other functions which were performing at lower or higher levels. For purposes of ranking each reach’s relative function within the Cities of Bothell and Brier and assisting with later development of the Restoration Plan, each of the possible ratings was assigned a value of 1 through 5, with 5 representing high function and 1 representing low function. Each process group was averaged, and the averaged process scores were averaged to obtain a total reach score. The total reach scores are presented below, in order of highest to lowest function (Table 7) and are mapped in Figures 20A through 20L.

Table 7. Reach ranking order from highest to lowest function based on mean reach scores assigned in Tables 8 through 16.

Unit Number	Unit Name	Mean Score
6	North Creek – Campus (I-405 to Sammamish River)	4.04
2	North Creek – Centennial Park	3.65
3	North Creek – Canyon Park	3.38
5	North Creek – North Creek Business Parks (240 <sup>th</sup> Street SE to I-405)	3.35
4	North Creek – Fitzgerald (228 <sup>th</sup> Street SE to 240 <sup>th</sup> Street SE)	3.33
7 & 8	Swamp Creek – Cities of Bothell and Brier	2.85
1	North Creek – Thrasher's Corner (north of SR-524)	2.83
11	Sammamish River – Sammamish River Park	1.92
14 & 15	Sammamish River – Wayne Golf Course to Bothell Business Park Floodway	1.63
9, 10, 12, 13	Sammamish River – Woodinville Drive, Brackett's Landing, Downtown, and Bothell Way Corridor	1.50

#### 4.3.1 North Creek – Thrasher's Corner (north of SR-524)

The North Creek – Thrasher's Corner assessment unit (Reach 1) consists of those areas of shoreline jurisdiction located north of the current Bothell City limits within the City's future annexation area (Exhibit 4, Figure 2A on page C-3). The assessment unit includes lands along both banks of North Creek and all associated wetlands. Reach 1 includes a total of approximately 0.22 mile of shoreline and 12.8 acres of total jurisdiction. An additional 17.88 acres of potentially associated wetlands extends upstream. Final determinations of association and wetland boundary will need to be made at the project level.

In 2003, 75% of samples in this unit had fecal coliform levels exceeding water quality standards, so this reach is included in the North Creek TMDL for fecal coliform bacteria (Ecology, electronic source). Other exceedances of tested water quality parameters (e.g., temperature, pH, dissolved oxygen) have not been documented (Ecology, electronic source), but this could be due to a lack of sampling of other parameters in this reach.

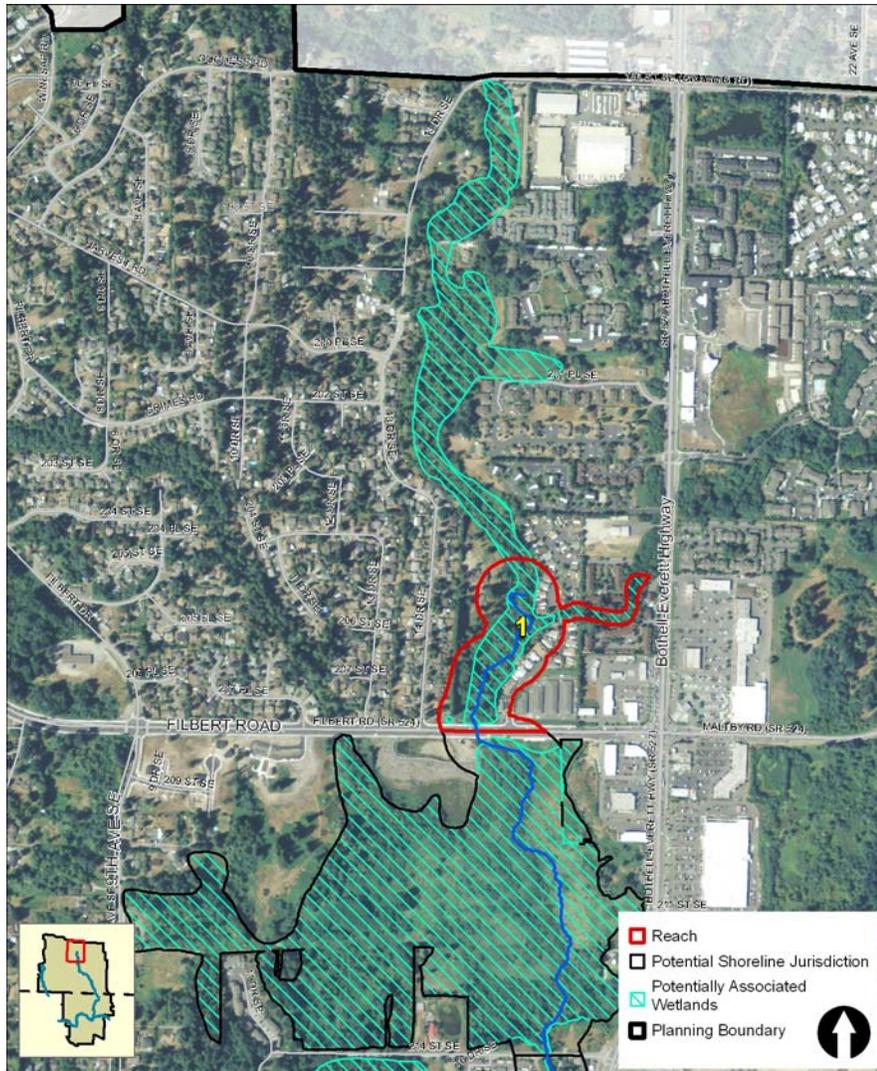


Exhibit 4. Aerial photo of North Creek – Thrasher’s Corner assessment unit (Reach 1)

Table 8. Function Summary of North Creek – Thrasher’s Corner (Reach 1).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p><b>Hydrologic</b></p> <p>Storing water and sediment</p>	<p>LOW/MODERATE: Within Reach 1, North Creek flows through a residential area with a moderately-wide and fairly well-vegetated buffer in most places. However, while streambanks are not high, the actual floodplain is fairly narrow (Figure 13A, page C-28). Out-of-channel flows do not tend to flood adjacent residential properties, being confined to the fairly narrow floodplain/buffer areas. As such, the floodplain storage function for water during flood events and for sediment following flood events is relatively low.</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Transport of water and sediment	MODERATE/HIGH: The single-thread stream corridor has a moderate gradient and, though it has well-vegetated banks and moderate channel roughness, it appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment.
Attenuating flow energy	MODERATE/HIGH: With exceptions, this section of North Creek is lined with young forest and shrubby vegetation dominated by young alder. As such, channel roughness is moderately high and well-distributed, providing energy attenuation during high flows.
Developing pools, riffles, and gravel bars	MODERATE: This section of North Creek includes moderate-sized, but short-lived pieces of wood derived from the predominantly young alder forest it flows through. Sinuosity is moderate. These conditions are conducive to the formation of pools of moderate depth and complexity, with intervening riffles, and the formation of some gravelly bars on the inside of channel bends.
Removing excess nutrients and toxic compounds	MODERATE: The lack of a broad floodplain in this area results in incomplete biofiltration functions, and due to the urbanized nature of the basin, including upstream of Bothell, loading of nutrients and other pollutants is expected to be relatively high. The presence of densely-vegetated uplands and relatively stable vegetated banks help to filter out some nutrients and toxic compounds; however, many stormwater conveyance systems discharge directly to the stream reducing effective biofiltration in the stream buffers or on the floodplain in all reaches. Quality of discharge from such systems is more dependent on the efficacy of the treatment provided within the system itself.
Recruitment of LWD and other organic matter	MODERATE: Well-vegetated uplands through this reach and extending farther upstream in the potentially associated wetlands contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. In this case, <i>detritus</i> refers to the debris consisting of this decomposing leaf litter and other organic materials. However, trees along the banks and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
<b>Vegetation</b>	
Temperature regulation	MODERATE: The existing banks and buffers are fairly well vegetated and therefore provide a moderate amount of shading to the creek. These good shading conditions tend to decrease temperature and allow for increased dissolved oxygen.
Water quality improvement	MODERATE: Elevated fecal coliform levels in this reach provide an opportunity to improve water quality. Areas that are vegetated with trees, shrubs, grasses, emergent vegetation, and other riparian vegetation offer a fairly effective level of biofiltration for water moving to the creek through the uplands. However, as mentioned above, many stormwater conveyance systems discharge directly to the stream and so bypass the buffers. While buffer vegetation is fairly dense, relatively narrow floodplain areas limit the biofiltration of flood flows.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area result in relatively stable banks and limit the rate of channel migration and associated erosion.
Attenuating flow	MODERATE: The presence of significant adjacent streambank and

<b>Shoreline Processes and Functions within Assessment Unit</b>	<b>Alterations and Assessment of Functions</b>
energy	riparian vegetation results in energy attenuation during high flows. In-stream wood is of only moderate size and is short-lived.
Sediment removal	MODERATE: As stated above, the lack of a wide floodplain limits the ability of buffer vegetation to filter fine sediments from flood flows already in the channel. But this buffer vegetation is able to remove sediment from locally generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the primarily alder trees along the banks and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. Fevold et al. (2001) found that the frequency of large woody debris in this reach was the highest among the reaches within the City of Bothell's jurisdiction at 96 pieces.
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	MODERATE: Elevated fecal coliform levels in this reach provide an opportunity for hyporheic processes to improve water quality. The somewhat meandering nature of the channel and moderate bank height indicate the presence of a functional hyporheic zone with alluvial, somewhat pervious soils. However, the width of the zone is limited. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be moderate based on this limited width.
Water storage and maintenance of base flows	MODERATE: As above, the width of the zone of hyporheic flow is not high, limiting the potential for water storage and associated base-flow maintenance.
Support of vegetation	MODERATE/HIGH: Streambanks through the area appear to be low enough to allow vegetation to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: The narrow width of the hyporheic zone and the flashiness of North Creek flows tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
<b>Habitat</b>	
Physical space and conditions for life history	<p>LOW/MODERATE: Though a fairly well vegetated functional area of moderate width is present, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The vegetative community has been reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. This reduction in dense, but also in diverse, riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.</p> <p>Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.</p>
Food production and delivery	LOW/MODERATE: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are well-vegetated in places, overall diversity and complexity is diminished, thereby diminishing its value as wildlife habitat.
<b>Summary</b>	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Thrasher’s Corner assessment unit, the overall shoreline ecological function is considered MODERATE.

### 4.3.2 North Creek – Centennial Park

The North Creek – Centennial Park assessment unit (Reach 2) consists of those areas of shoreline jurisdiction located south of 208<sup>th</sup> Street SE (SR-524) and north of 214<sup>th</sup> Street SE along both banks of North Creek and all associated wetlands (Exhibit 5). The assessment unit includes a total of approximately 0.49 mile of shoreline and 77.11 acres of total jurisdiction. An additional 19.79 acres of potentially associated wetlands extends south of the primary Centennial Park wetland complex. Final determinations of association and wetland boundary will need to be made at the project level.

The upper portion of this reach and Filbert Creek, a tributary to this unit, are both included in the TMDL for fecal coliform bacteria (Ecology 2001). In 2003, 75% of samples in this upper portion of this unit had fecal coliform levels exceeding water quality standards, but other exceedances have not been measured and reported to date (Ecology, electronic source). Filbert Creek is also listed on the State’s 303(d) list for dissolved oxygen because 25% of the samples in 2003 did not meet water quality standards (Ecology, electronic source).



Exhibit 5. Aerial photo of North Creek – Centennial Park assessment unit (Reach 2)

Table 9. Function Summary of North Creek – Centennial Park (Reach 2)

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p><b>Hydrologic</b></p> <p>Storing water and sediment</p>	<p>HIGH: The mapped floodway (which is also considered to be floodplain) is fairly wide across this unit (Figure 13A, page C-28), and frequent out-of-channel flows and the vegetation present allow the over-bank storage function for both water and sediment to be relatively high. The streambanks are low and the extensive associated wetland areas across the floodway, and also extending well beyond it, are vegetated with shrubby vegetation which is effective at slowing the velocity of overbank flow and filtering out or allowing fine sediments to deposit. Wetland areas beyond the floodplain are also effective at storing water and filtering out locally-</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	generated sediments before the reach the active stream channel. Effective buffer widths are wide through the park and associated open space areas.
Transport of water and sediment	LOW/MODERATE: The broad floodplain areas in Centennial Park are less water and sediment transport sections and more storage areas. The importance of water and sediment transport through this unit is also low, however, since little infrastructure is present to be threatened by flooding or sedimentation. Storage rather than transport here benefits water quality and reduces flooding potential downstream.
Attenuating flow energy	HIGH: A combination of low, vegetated banks, a low stream gradient, and a broad, vegetated floodplain across this unit provides a high level of flow energy attenuation, especially at high flows.
Developing pools, riffles, and gravel bars	LOW/MODERATE: This low-gradient, wide floodplain section of North Creek is fairly low energy and so is more of a glide/run and less of a pool/riffle/bar area. Fevold et al. (2001) found that glides composed over 60% of this reach. Pool, riffle, and gravel bar formation is not extensive due to low energy and low levels of wood. This unit has relatively low potential for large wood recruitment, since the trees lining the banks or growing on the floodplain tend to be shrubby and/or young.
Removing excess nutrients and toxic compounds	HIGH: The broad floodplain across this unit allows for the effective biofiltration of overbank flood flows. The presence of wide and densely-vegetated buffers and relatively stable, vegetated banks also helps to filter nutrients and toxic compounds entering the creek locally. Because of water quality concerns and exceedance of state standards for fecal coliform and dissolved oxygen in this reach and its tributary, and because of the urbanized nature of the drainage basin, this ability to biofilter is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>Trees along the banks and throughout the buffer of the unit are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings. Wood may be removed from the stream in an attempt to protect infrastructure and reduce flooding and localized erosion.</p>
<b>Vegetation</b>	
Temperature regulation	LOW/MODERATE: Though the banks are generally well enough vegetated to be stable, forest cover is not consistently dense enough or tall enough to provide adequate shade. Portions of the stream flowing across the he broad floodplain are partly exposed to direct sunlight, which tends to allow for temperature increases.
Water quality improvement	HIGH: The wide floodway and adjoining wetland and buffer areas across this unit, all vegetated with shrubs, grasses, emergent vegetation, and some trees, offer a fairly effective level of biofiltration

<b>Shoreline Processes and Functions within Assessment Unit</b>	<b>Alterations and Assessment of Functions</b>
	for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area result in relatively stable banks and limit the rate of channel migration and associated erosion. The broad floodplains are largely depositional areas.
Attenuating flow energy	MODERATE/HIGH: Lower-gradient, broad floodplain areas as well as significant adjacent streambank and riparian vegetation results in energy attenuation during high flows. However, in-stream wood is of only moderate in size and tends to be short-lived, limiting the number, size, and persistence of log jams and other LWD formations.
Sediment removal	HIGH: As stated above, the presence of a wide, vegetated, flat floodplain allows buffer vegetation to filter fine sediments from flood flows already in the channel. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	LOW/MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, some sections are not tree-lined, and the primarily small, shrubby willow and other trees along the sections that are lined and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	MODERATE: The low streambanks and broad floodplain areas throughout this unit contribute to a potentially broad hyporheic zone, however fine-grained soils may hinder hyporheic flows and function. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be reduced somewhat based on reduced soil permeability. (As stated above, biofiltration function associated with vegetation at the surface is expected to be high, however.)
Water storage and maintenance of base flows	MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for water storage and associated base-flow maintenance. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	HIGH: Low streambanks and wide floodplains through the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for subsurface sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-grained hyporheic soils tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
<b>Habitat</b>	
Physical space and conditions for life	MODERATE/HIGH: The broad, largely wetland floodplain areas in Centennial Park provide a diverse assemblage of habitat types for a

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
history	<p>variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Even so, as for nearly all other areas in the basin, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The density and diversity of riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted. Vegetation will contribute more to habitat function over time with maturity.</p> <p>Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.</p>
Food production and delivery	<p>MODERATE/HIGH: Food production from upland, wetland, and riparian areas originates largely from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically well-vegetated and such vegetated areas are wide in places, overall diversity and complexity is diminished, thereby diminishing its value as wildlife habitat.</p>
<b>Summary</b>	<p>Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Centennial Park assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.</p>

### 4.3.3 North Creek – Canyon Park

The North Creek – Canyon Park assessment unit (Reach 3) consists of those areas of City lands located within shoreline jurisdiction south of 214<sup>th</sup> Street SE and north of 228<sup>th</sup> Street SE along both banks of North Creek (Exhibit 6). The assessment unit includes a total of approximately 1.42 miles of shoreline and 87.45 acres of total jurisdiction.

No water quality impairments have been measured and reported within this reach itself; however, tributaries to this reach are 303(d) listed for dissolved oxygen and included in the TMDL for fecal coliform (Ecology 2001) based on exceedances observed in 2003 and 2004.

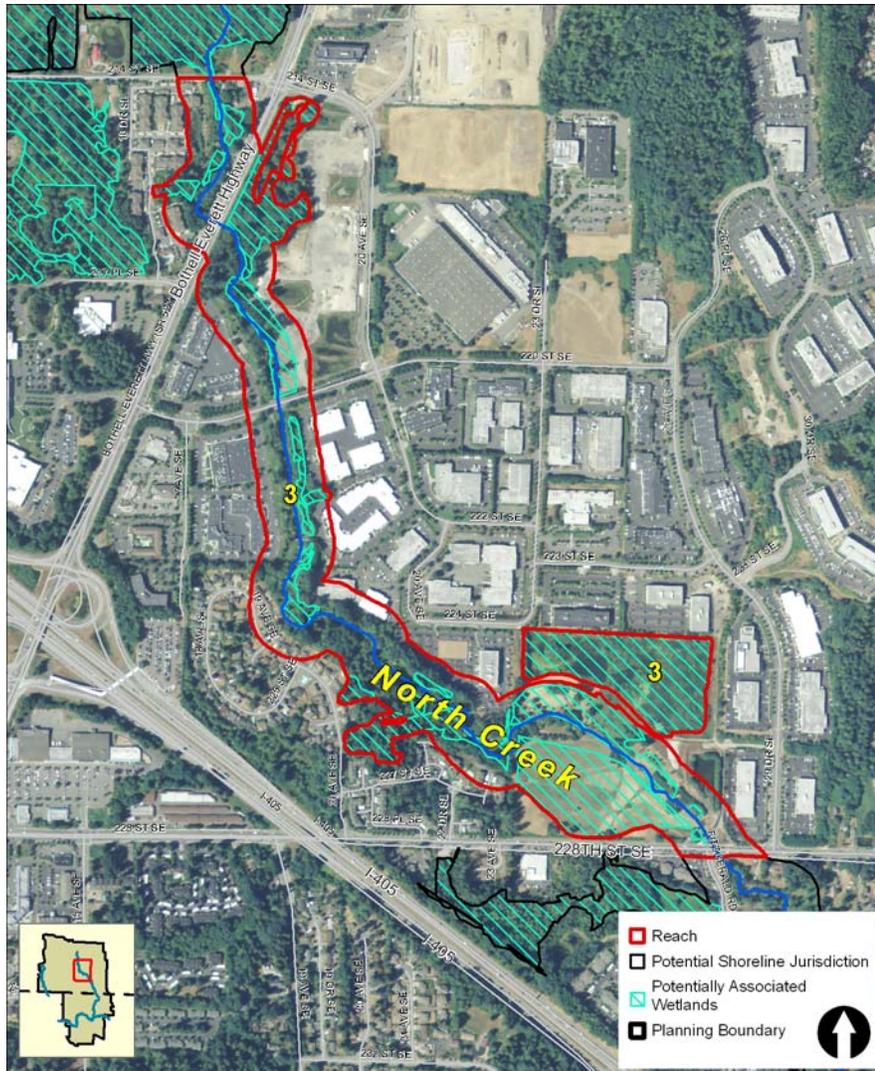


Exhibit 6. Aerial photo of North Creek – Canyon Park assessment unit (Reach 3)

Table 10. Function Summary of North Creek – Canyon Park (Reach 3).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p><b>Hydrologic</b></p> <p>Storing water and sediment</p>	<p><b>MODERATE/HIGH:</b> Within the Canyon Park Assessment Unit, North Creek flows primarily through business park areas extending downstream of the Bothell-Everett Highway (SR 524), and some broad, open space areas downstream of the business park approaching 228<sup>th</sup> Street SE. Some limited residential areas are also included just upstream and downstream of the Canyon Park Business Center, including at the upstream end of the unit between 214<sup>th</sup> Street SE and SR 524. Effective buffer widths vary widely across this unit, being very wide through the open space areas at the lower end and</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	quite narrow through the central portion in the business park downstream from 220 <sup>th</sup> Street SE (Figure 16A, page C-34). The floodplain is quite broad and well-functioning at the downstream end of this unit (Figure 13A, page C-28), and frequent, out-of-channel flows in that area allow the floodplain storage function for both water and sediment to be moderately high for the unit as a whole.
Transport of water and sediment	MODERATE: The North Creek channel through the central, business park portion of this unit has a moderate gradient with armored banks in places. It appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment. In contrast, the broad floodplain areas approaching 228 <sup>th</sup> Street SE are less water and sediment transport areas and more storage areas.
Attenuating flow energy	MODERATE/HIGH: A combination of vegetated banks throughout and broad floodplain areas in some sections contribute to a fairly high level of flow energy attenuation at high flows.
Developing pools, riffles, and gravel bars	LOW/MODERATE: This section of North Creek has relatively low potential for large wood recruitment. Through the business park, the channel is constrained, sinuosity is not high, and gravel bar formation is not extensive. Low-gradient sections through the wide floodplain areas at the downstream end are more glide/run and less pool/riffle areas.
Removing excess nutrients and toxic compounds	MODERATE: The broad floodplain areas at the downstream end of this unit allow for the biofiltration of overbank flood flows. The presence of relatively stable, vegetated banks along many sections also helps to filter nutrients and toxic compounds entering the creek locally, keeping in mind, though, that many stormwater conveyance systems discharge directly to the stream. Because of water quality concerns with fecal coliform and low dissolved oxygen upstream and because of the urbanized nature of the basin, this ability to biofilter is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>However, trees along the banks and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings. Wood may be removed from the stream in an attempt to protect infrastructure and reduce flooding and localized erosion.</p>
<b>Vegetation</b>	
Temperature regulation	LOW/MODERATE: Though the banks are generally well enough vegetated to be stable, forest cover is not consistently dense enough or tall enough to provide adequate shade. In particular, the broad floodplain areas at the downstream end of this unit are partly exposed to direct sunlight. These exposed conditions tend to allow for temperature increases.
Water quality	MODERATE/HIGH: Broad floodplain buffer areas at the downstream

<b>Shoreline Processes and Functions within Assessment Unit</b>	<b>Alterations and Assessment of Functions</b>
improvement	end of this unit, vegetated with shrubs, grasses, emergent vegetation, and some trees, offer a fairly effective level of biofiltration for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: Upper Reach 3 is constrained by existing development and some areas of armoring which remain from past agricultural and existing commercial land uses. Dense bank vegetation is also present at most locations. The well-vegetated streambanks through the lower parts of Reach 3 result in relatively stable banks and limit the rate of channel migration and associated erosion. The broad floodplain areas are largely depositional.
Attenuating flow energy	MODERATE/HIGH: The presence of lower-gradient, broad floodplain areas as well as significant adjacent streambank and riparian vegetation results in energy attenuation during high flows. However, in-stream wood is of only moderate size and tends to be short-lived, limiting the number, size, and persistence of log jams and other LWD formations.
Sediment removal	MODERATE/HIGH: As stated above, the presence of wide floodplain areas allows buffer vegetation to filter fine sediments from flood flows already in the channel. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek. (Again, not all stormwater moves through the buffers since most stormwater conveyance systems discharge more or less directly to the stream and so bypass them.)
Provision of LWD and other organic matter	LOW/MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, some sections are not tree-lined, and the primarily alder and willow trees along other bank sections and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	MODERATE: The low streambanks and broad floodplain areas at the downstream end of this unit contributes to a potentially broad hyporheic zone, however fine-grained soils may hinder hyporheic flows and function. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be reduced somewhat based reduced soil permeability. (As stated above, biofiltration function at the surface is expected to be high, however.)
Water storage and maintenance of base flows	MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for water storage and associated base-flow maintenance. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	MODERATE/HIGH: Low streambanks and wide floodplains through portions of the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	grained hyporheic soils tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
<b>Habitat</b>	
Physical space and conditions for life history	<p>MODERATE/HIGH: The broad, partially wetland floodplain areas in the open space areas approaching 228<sup>th</sup> Street SE at the lower end provide a diverse assemblage of habitat types for a variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Even so, as for nearly all other areas in the basin, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The density and diversity of riparian vegetation is a limiting factor for terrestrial species (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.</p> <p>Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.</p>
Food production and delivery	MODERATE/HIGH: Food production from upland, wetland, and riparian areas originates primarily from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provides food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically well-vegetated and such vegetated areas are wide in places, overall diversity and complexity is diminished, thereby diminishing its value as wildlife habitat.
<b>Summary</b>	
Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Canyon Park assessment unit, the overall shoreline ecological function is considered MODERATE.	

#### 4.3.4 North Creek – Fitzgerald (228<sup>th</sup> Street SE to 240<sup>th</sup> Street SE)

The North Creek – Fitzgerald assessment unit (Reach 4) consists of those areas of City lands located within shoreline jurisdiction south of 228<sup>th</sup> Street SE and north of 240<sup>th</sup> Street SE along both banks of North Creek (Exhibit 7). The assessment unit includes a total of approximately 1.12 mile of shoreline and 72.05 acres of total jurisdiction. This is a section of North Creek and a regulatory planning area identified as the North Creek Fish and Wildlife Critical Habitat Protection Area (NCFWCHPA) which have been identified by various studies as containing superior habitat as well as a high potential for further habitat improvements and recovery. However, these increased protections do not translate to immediate improvements on the ground and will take some time to take more or less full effect.

This reach is on the state’s 303(d) list for low levels of dissolved oxygen, although sampling has shown a gradually decreasing trend in the proportion of samples exceeding standards from initial sampling between 1992-1995 (Thornburg 1996 cited by Ecology, electronic reference) and sampling from 2003-2006 (Ecology, electronic reference). This reach is also included in the TMDL for fecal coliform bacteria in North Creek (Ecology 2001). It is also listed as a water of concern for temperature because of excursions above water quality standards in 5% of samples between 1992 and 1998 (Thornburg 1996 and Snohomish County 1998 cited in Ecology, electronic reference).

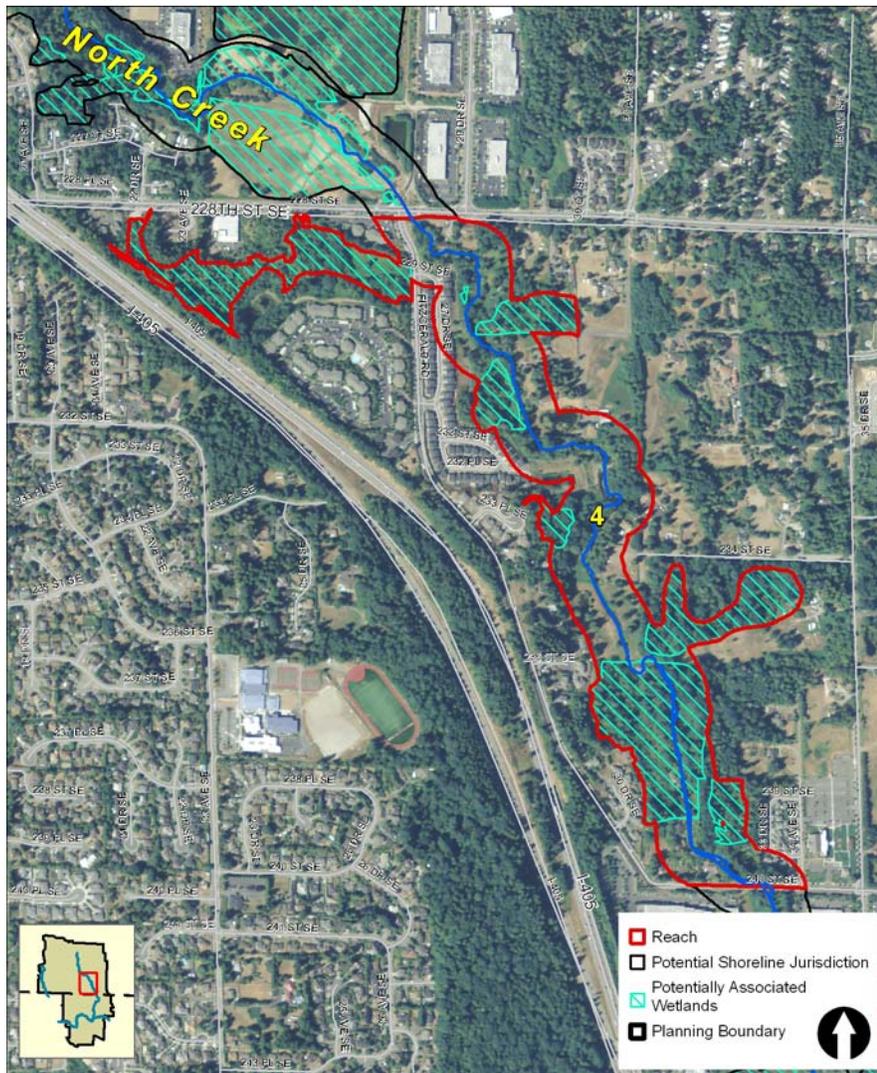


Exhibit 7. Aerial photo of North Creek – Fitzgerald assessment unit (Reach 4)

Table 11. Function Summary of North Creek – Fitzgerald (Reach 4).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<b>Hydrologic</b>	
Storing water and sediment	MODERATE: Within Reach 4, North Creek flows through a scattered, established residential area with some areas of newer, much higher density housing along the west side, between Fitzgerald Road and the creek (Figure 5A, page C-12). The creek has a vegetated buffer of varying effective width, with some areas of mowed grass still near the creek in places. While the immediate streambanks are not high, ground rises moving away from the creek and the actual floodplain is fairly narrow. Out-of-channel flows do not tend to flood adjacent residential properties, being confined to the fairly narrow floodplain/buffer areas (Figure 13A, page C-28). As such, the floodplain storage function for both water during and sediment following flood events is fairly average.
Transport of water and sediment	MODERATE/HIGH: The single-thread stream corridor has a moderate gradient and, though it has well-vegetated banks in places and moderate channel roughness, it appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment.
Attenuating flow energy	MODERATE/HIGH: This section of North Creek is lined with trees and shrubby vegetation along much of its length, though there are still some yard and other open grassy areas in others. As such, channel roughness is moderately high, providing energy attenuation during high flows.
Developing pools, riffles, and gravel bars	MODERATE/HIGH: This section of North Creek includes some moderate-sized, pieces of wood derived from the young, mixed forest it flows through. Sinuosity is moderate. These conditions are conducive to the formation of pools of moderate depth and complexity, with intervening riffles, and the formation of some gravelly bars on the inside of channel bends.
Removing excess nutrients and toxic compounds	MODERATE: The lack of a broad floodplain in this area puts an upper cap on the level of biofiltration function and loading of nutrients and other pollutants is expected to be relatively high given the high levels of fecal coliform and low levels of dissolved oxygen in the reach (Ecology, electronic reference). The presence of moderately well-vegetated buffers and relatively stable banks help to filter out some of the nutrients and toxic compounds of local origin.
Recruitment of LWD and other organic matter	MODERATE: Moderately well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. Additional such materials arrive from upstream. However, trees along the banks and throughout the buffer are still fairly small and of varying density, though this is expected to improve with time. Those which are deciduous have a fairly short functional lifespan when and if they do fall into the stream.
<b>Vegetation</b>	
Temperature regulation	MODERATE: The forest cover is not yet consistently dense enough or tall enough to provide optimal shade. These partially exposed conditions tend to allow for temperature increases, which are a concern given the known history of temperature exceedances in this

<b>Shoreline Processes and Functions within Assessment Unit</b>	<b>Alterations and Assessment of Functions</b>
	reach (Ecology, electronic reference). Regulatory requirements targeting this area will likely improve this condition over time.
Water quality improvement	MODERATE: Buffer areas are generally vegetated with trees, shrubs, though there are also some actively or passively landscaped mowed grass and yard areas. This vegetation offers a moderate level of biofiltration for water moving to the creek through the buffers. Also, relatively narrow floodplain areas limit the biofiltration of flood flows.
Slowing riverbank erosion; bank stabilization	MODERATE: Though the vegetation that exists along the streambanks through this area contributes to bank stability and limits the rate of channel migration and associated erosion, there is some potential for channel shifting.
Attenuating flow energy	MODERATE: The presence of moderate-density streambank and riparian vegetation results in energy attenuation during high flows. In-stream wood is of only of moderate size and much of what is present is short-lived.
Sediment removal	LOW/MODERATE: As stated above, the lack of a wide floodplain limits the ability of buffer vegetation to filter fine sediments from flood flows already in the channel. Buffer vegetation is able to remove some of the sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the trees along the banks and throughout the buffer are presently of only moderate density and size. Many are fairly small deciduous trees such as alder with a fairly short functional lifespan when and if they do fall into the stream.
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	MODERATE: The somewhat meandering nature of the channel and moderate bank height indicate the presence of a functional hyporheic zone with alluvial, somewhat pervious soils. However, the width of the zone is limited. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be moderate based on this limited width.
Water storage and maintenance of base flows	MODERATE: As above, the width of the zone of hyporheic flow is not high, capping the potential for water storage and associated base-flow maintenance.
Support of vegetation	MODERATE/HIGH: Streambanks through the area appear to be low enough to allow buffer vegetation to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: The narrow width of the hyporheic zone and the flashiness of North Creek flows tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
<b>Habitat</b>	
Physical space and conditions for life history	MODERATE/HIGH: Though a somewhat well-vegetated and functional buffer area of moderate width is present, habitat in and along North Creek through this unit has still been reduced in quality, quantity, and complexity compared to its original condition. As mentioned, regulatory changes specific to this area are expected to

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	<p>result in improvements, but these will take time. However, though the vegetative community has been reduced somewhat in scale, the area is less urbanized compared to other areas of the City and includes forested slopes with varying levels of accumulated downed wood and snags, providing places for various wildlife species to find cover or suitable nesting and rearing sites. The prevalence of dense, but also diverse, riparian vegetation affects terrestrial species' (birds, mammals, amphibians) use of the shoreline, since such dense vegetation provides cover, food, nesting sites, travel corridors,.</p> <p>Within the channel itself, additional and more persistent wood would help provide cover and complexity to the existing pools and riffles; substrate quality is favorable for use by salmonid fish.</p>
Food production and delivery	<p>MODERATE/HIGH: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though the density of streamside vegetation could be improved, well-vegetated areas remain in places to provide overall diversity and complexity for wildlife habitat.</p>
<b>Summary</b>	<p>Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Fitzgerald assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.</p>

### 4.3.5 North Creek – North Creek Business Parks (240<sup>th</sup> Street SE to I-405)

The North Creek – Business Park assessment unit (Reach 5) consists of those areas of City lands located within shoreline jurisdiction south of 240<sup>th</sup> Street SE and northeast of I-405 along both banks of North Creek (Exhibit 8). The assessment unit includes a total of approximately 1.25 miles of shoreline and 77.25 acres of total jurisdiction. An additional 4.34 acres of wetlands may be associated via ditched or piped hydrologic connections to a complex east of the reach. Final determinations of association and wetland boundary will need to be made at the project level.

According to GeoEngineers, Inc. (2008), the levees in the Schnitzer North Creek and Bothell Business Park were constructed and certified in 1994 for a 100-year event of 1,400 cfs. However, recalculations of the new 100-year flow resulted in an increase to 1,700 cfs. Accordingly, portions of the levees required 1 ½ to 2 feet of new fill to contain the new 100-year event with an additional foot or more of height added beyond the required 3 feet of freeboard to provide additional

protection against increasing 100-year floods and factor in levee settling (GeoEngineers, Inc. 2008).



Exhibit 8. Aerial photo of North Creek – North Creek Business Parks assessment unit (Reach 5)

While levees are meant to protect uses and developments on the upland side, they can also result in increased flood damages if they fail. The constrained flood is higher and has increased energy, such that the impact of the water passing through a levee breach can have greater destructive impacts than a non-constrained flood of equal volume might have had (Snohomish County 2001).

The upper portion of this unit is on the state's 303(d) list for low levels of dissolved oxygen, although sampling has shown a gradually decreasing trend in the proportion of samples exceeding standards from initial sampling between 1992-1995 (Thornburg 1996 cited by Ecology, electronic reference) and sampling

from 2003-2006 (Ecology, electronic reference). The upper portion of this unit is also included in the TMDL for fecal coliform bacteria in North Creek (Ecology 2001). It is also listed as a water of concern for temperature because of excursions above water quality standards in 5% of samples between 1992 and 1998 (Thornburg 1996 and Snohomish County 1998 cited in Ecology, electronic reference). Although no exceedances for water quality parameters (e.g., temperature, dissolved oxygen, fecal coliform, pH) have been documented in the lower portion of this reach, that could be a result of limited sampling stations along the creek, and upstream impairments likely transfer through the entire unit.

Table 12. Function Summary of the North Creek – North Creek Business Parks (Reach 5)

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<b>Hydrologic</b>	
Storing water and sediment	MODERATE: Within Reach 5, North Creek flows successively through several business park areas developed on a broadening North Creek and Sammamish River floodplain as the creek enters the Sammamish River Valley (Figures 5A & B, pages C-12 & C-13). This unit extends between Interstate 405 at the downstream end to 240 <sup>th</sup> Street SE at the upstream end. Effective buffer widths are fairly uniform across this unit, as planned in conjunction with business park development, with two wider areas incorporating fairly extensive riparian wetlands. One is on the right bank on the Snohomish County side of the county line (Monte Villa park) and the second also mostly on the right bank extending downstream of North Creek Parkway N. (Koll North Creek park). There has been a large overall historic loss in active floodplain along this section due to construction of levees and the developments they protect (Figures 13A & B, pages C-28 & C-29). The reduced extent of the active floodplain has in turn reduced its capacity to provide hydrologic benefits. However, where retained, the floodplain is generally well-functioning across this unit, and frequent, out-of-channel flows allow the floodplain storage function for both water and sediment to be relatively high for the unit as a whole.
Transport of water and sediment	LOW/MODERATE: The North Creek channel through the Business Park unit has a well defined channel through wetland and floodplain areas and a flattening gradient. Banks are armored banks in places, especially at the upstream end, associated with previous agricultural uses. The reduced gradient along this unit allows flood flows to slow and spread across portions of the floodplain where finer sediments are stored. The reduced gradient allows some of the coarser sediments to be deposited within the channel.
Attenuating flow energy	MODERATE/HIGH: A combination of diminishing channel gradient, vegetated banks throughout, and broad floodplain areas in some sections contribute to a fairly high level of energy attenuation of high flows.

<b>Shoreline Processes and Functions within Assessment Unit</b>	<b>Alterations and Assessment of Functions</b>
Developing pools, riffles, and gravel bars	LOW/MODERATE: A low-gradient section in the central part of this unit also has a wide floodplain and the channel consists more of glide/run and less pool/riffle areas. Little gravel bar formation occurs along this central portion. More pool/riffle sequencing with associated gravel bar formation occurs near each end of this unit. This section of North Creek has relatively low potential for large wood recruitment (see below), and such wood tends to facilitate and accentuate pool/riffle sequencing.
Removing excess nutrients and toxic compounds	MODERATE/HIGH: The broad floodplain areas, especially near the central part of this unit, allow for the biofiltration of overbank flood flows. The presence of wide and densely-vegetated buffers and relatively stable, vegetated banks along many sections also helps to filter nutrients and toxic compounds entering the creek locally. Again, due to the urbanized nature of the basin, and documented water quality concerns with fecal coliform and dissolved oxygen, loading of nutrients and other pollutants is expected to be relatively high, and so this ability to biofilter is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>Trees along the banks and throughout the buffer are largely fairly small, shrubby deciduous trees, including willow, alder, and cottonwood, with a fairly short functional lifespan when and if they do fall into the stream. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings. Wood may be removed from the stream in contributing areas upstream an attempt to protect infrastructure and reduce flooding and localized erosion.</p>
<b>Vegetation</b>	
Temperature regulation	LOW/MODERATE: Though the banks are generally well enough vegetated to be stable, forest cover is not consistently dense enough or tall enough to provide adequate shade. In particular, only relatively shrubby vegetation tends to grow along the broad floodplain area in the central portion of this unit, where the channel is partly exposed to direct sunlight. These exposed conditions tend to allow for temperature increases.
Water quality improvement	MODERATE/HIGH: Broad floodplain buffer areas in the central part of this unit vegetated with shrubs, grasses, emergent vegetation, and some trees, offer a fairly effective level of biofiltration for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area, coupled with lower gradients, result in relatively stable banks and limit the rate of channel migration and associated erosion. Where present, the broad floodplains are largely depositional areas.
Attenuating flow energy	MODERATE: The presence of lower-gradient, broad floodplain areas as well as significant adjacent streambank and riparian vegetation

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	results in energy attenuation during high flows. However, in-stream wood is of only moderate size and tends to be short-lived, limiting the number, size, and persistence of log jams and other LWD formations.
Sediment removal	MODERATE/HIGH: As stated above, the presence of a wide floodplain and lower channel gradient allows buffer vegetation to filter fine sediments from flood flows already in the channel. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	LOW/MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, some sections are not tree-lined, and the primarily alder and willow trees along other bank sections and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. In 2001, LWD loading in this reach was low, 19 pieces/km (Fevold et al. 2001).
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	MODERATE: The low streambanks and broad floodplain areas in the central portion of this unit contribute to a potentially broad hyporheic zone there, however fine-grained soils including areas of peat may hinder hyporheic flows and function. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be reduced somewhat based reduced soil permeability. (As stated above, biofiltration function at the surface is expected to be high, however.)
Water storage and maintenance of base flows	MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for water storage and associated base-flow maintenance. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	HIGH: Low streambanks and wide floodplains through portions of the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: As above, the permeability of fine-grained hyporheic soils, which include areas of peat, is not expected to be high, limiting the potential for sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-grained hyporheic soils tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
<b>Habitat</b>	
Physical space and conditions for life history	MODERATE/HIGH: The broad, partially wetland floodplain areas in the central part of this unit provide a diverse assemblage of habitat types for a variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Even so, as for nearly all other areas in the basin, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The density and diversity of riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.
Food production and delivery	MODERATE/HIGH: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically well-vegetated and such vegetated areas are wide in places, overall diversity and complexity is diminished from its original condition, thereby diminishing its value as wildlife habitat.
<b>Summary</b>	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – North Creek Business Parks assessment unit, the overall shoreline ecological function is considered toward the higher end of the MODERATE range.

#### 4.3.6 North Creek - Campus (I-405 to Sammamish River)

The North Creek – Campus assessment unit (Reach 6) consists of those areas of City lands located along both banks of North Creek west of Interstate-405 and north of its confluence with the Sammamish River (Exhibit 9). The assessment unit includes a total of approximately 0.86 mile of shoreline and 83.33 acres of total jurisdiction, largely on the campus of Cascadia Community College / University of Washington – Bothell (CCC/UW-B).

This reach is the site of a large-scale restoration mitigating impacts to wetlands resulting from development of the campus. Approximately 58 acres of riverine and floodplain ecosystem was restored by reconnecting the Creek to portions of its historical floodplain through creation of a new primary and secondary channel. As former grazed pasture land prior to implementation of the large-scale restoration project in 1998, the young, largely planted forest is still in the process of growing and developing into mature riverine or riparian forest.

The lower portion of this unit is 303(d) listed for temperature based on unpublished data from King County showing that temperature standards were exceeded every year from 1998-2002 (Ecology, electronic reference). This unit is included in the North Creek TMDL for fecal coliform, and correspondingly, for dissolved oxygen (Ecology 2001). The state also listed this unit as a water of concern (Category 2) for mercury concentrations (Ecology, electronic reference).

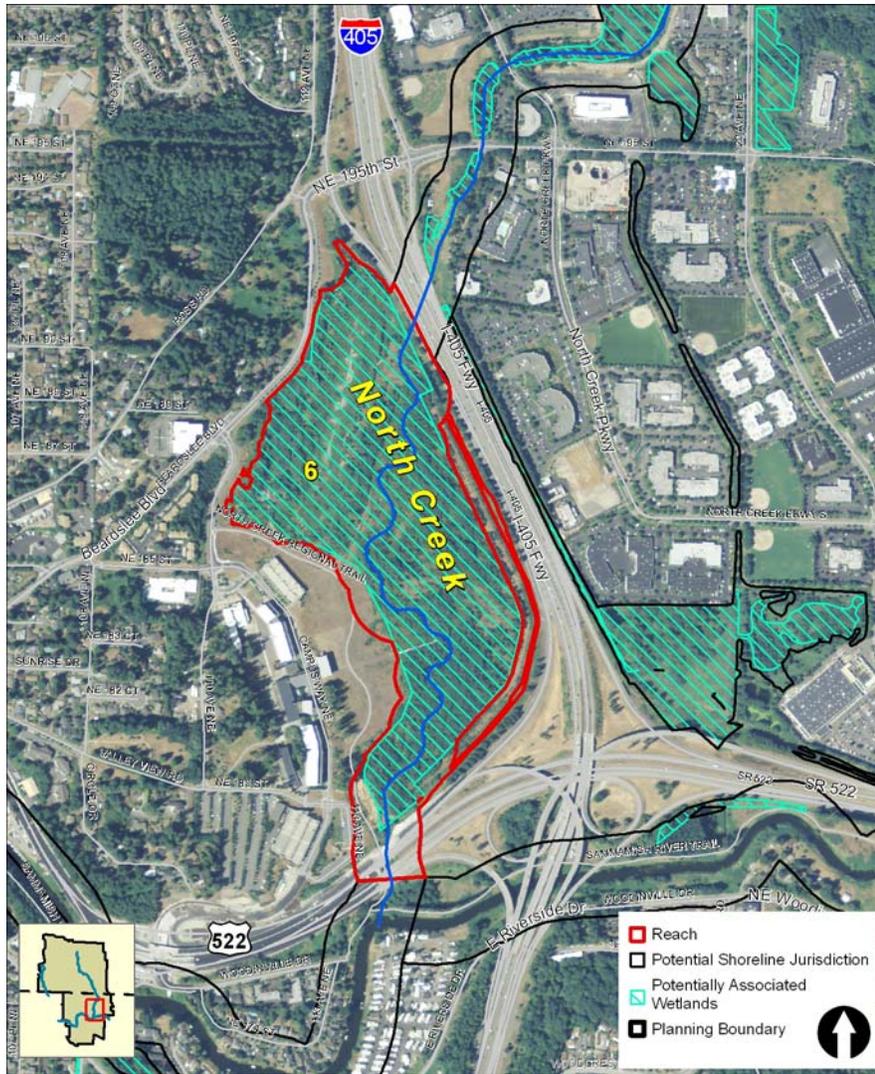


Exhibit 9. Aerial photo of North Creek - Campus assessment unit (Reach 6)

Table 13. Function Summary of North Creek – Campus (Reach 6).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p><b>Hydrologic</b></p> <p>Storing water and sediment</p>	<p>HIGH: Within Reach 6, North Creek flows through a broad floodplain area with extensive riparian wetlands within the Sammamish River Valley (Figure 13B, page C-29). This area was formerly diked and used as agricultural land but is now being restored as habitat. University campus areas lie on the sloped upland areas west of the floodplain. This unit extends along North Creek downstream from Interstate 405 to the mouth at the Sammamish River. The restored floodplain is generally well-functioning across this unit, and frequent, out-of-channel flows allow the floodplain storage function for both</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	water and sediment to be quite high for the unit as a whole, likely the highest of anywhere along North Creek.
Transport of water and sediment	LOW/MODERATE: The North Creek channel through the UW unit has a low-gradient channel through broad floodplain and wetland areas. The reduced gradient and low banks along this unit allow flood flows to slow and spread across the floodplain where both water and fine sediments are stored. Some of the coarser sediments are also presumably deposited within the channel since they cannot ultimately be carried by the low-gradient Sammamish River. However, the importance of the transport of water and sediment through this unit is diminished, as it is intended to function as a habitat area and these functions are not needed to protect infrastructure.
Attenuating flow energy	MODERATE/HIGH: A combination of low channel gradient, vegetated banks throughout, and overall broad floodplain areas contribute to a fairly high level of energy attenuation of high flows.
Developing pools, riffles, and gravel bars	MODERATE/HIGH: Though this section of North Creek still has a relatively low potential for large wood recruitment due to the young age of the trees growing along the banks, large numbers of logs have been placed in conjunction with restoration efforts. Such wood tends to facilitate and accentuate pool/riffle sequencing. Furthermore, the low gradient is conducive to gravel deposition to form bars and riffles where logs are not present to provide sufficient turbulence to prevent such deposition.
Removing excess nutrients and toxic compounds	HIGH: The broad floodplain areas throughout this unit allow for the effective biofiltration of overbank flood flows. The presence of wide and densely-vegetated buffers and relatively stable, vegetated banks also helps to filter nutrients, bacteria, and toxic compounds entering the creek locally. Again, given the TMDL for high levels of fecal coliform in this reach and the urbanized nature of the basin, biofiltration capacity is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>Trees along the banks and throughout the buffer are fairly small, shrubby deciduous trees, including willow, alder, and cottonwood, with a fairly short functional lifespan when and if they do fall into the stream. The frequency of LWD was very low, only 3 pieces/km in 2001 (Fevold et al. 2001), but as a restored and revegetated reach, LWD recruitment potential is expected to increase over time. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings and the presence of FEMA-certified levees in other portions of the watershed which are required to be LWD-free. Wood may be removed from the stream in contributing areas upstream an attempt to protect infrastructure and reduce flooding and localized erosion.</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<b>Vegetation</b>	
Temperature regulation	MODERATE/HIGH: This reach is presently impaired by high water temperatures (Ecology, electronic reference). Though the banks are generally stabilized by vegetation, forest cover is still immature and not consistently dense enough or tall enough to provide optimal shade. Though this condition may not be apparent from ground level, as from a drive-by along I-405, it becomes apparent with the viewing of aerials with much of the stream channel still appearing to be relatively exposed. Most of the vegetation present along the creek through this broad floodplain area is relatively shrubby vegetation such as and including willows. As such, the channel is partly exposed to direct sunlight, which tends to allow for temperature increases. The remedy for this condition is in place with the existing, immature vegetation, and shade cover should increase substantially over the next decade.
Water quality improvement	HIGH: Broad floodplain buffer areas across most of this unit are vegetated with shrubs, grasses, emergent vegetation, and some trees. These combine to provide a fairly effective level of biofiltration for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area, coupled with lower gradients, result in relatively stable banks and limit the rate of channel migration and associated erosion. However, channel migration may occur due to the low gradients and resulting deposition in the existing channel, though this is not necessarily detrimental.
Attenuating flow energy	HIGH: The dense, shrubby vegetation across broad, active floodplain areas as well as along the streambanks results in high levels of energy attenuation during high flows. Placed in-stream wood is of fairly large size and some has been placed in the form of jams. These LWD features tend to further attenuate energy, forming pool and riffle features in the process.
Sediment removal	HIGH: As stated above, the presence of a wide floodplain throughout this unit coupled with a lower channel gradient allows buffer vegetation to filter fine sediments from flood flows as they spread out of the channel and across the floodplain. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the primarily willow trees along other bank sections and throughout the buffer are shrubby, fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	MODERATE/HIGH: The low streambanks and broad floodplain areas throughout this unit contribute to an extensive hyporheic zone. Soils may be finer than ideal for most hyporheic functions; however, the broad area available tends to make up for this. (As stated above, biofiltration function at the surface is also expected to be high.)
Water storage and	MODERATE/HIGH: As above, though the permeability of hyporheic

<b>Shoreline Processes and Functions within Assessment Unit</b>	<b>Alterations and Assessment of Functions</b>
maintenance of base flows	soils may not be particularly high, the area of hyporheic flow is extensive. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	HIGH: Low streambanks and wide floodplains through portions of the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	MODERATE: As above, the permeability of the relatively fine-grained hyporheic soils across this unit is not expected to be high, limiting the potential for sediment storage even though the area available is fairly large. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Non-hyporheic sediment storage can also occur due deposition at the surface, however.
<b>Habitat</b>	
Physical space and conditions for life history	<p>MODERATE/HIGH: The broad, partially wetland floodplain areas across this unit provide a diverse assemblage of habitat types for a variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Though habitat in and along North Creek through this unit has still been reduced somewhat in quality, quantity, and complexity compared to its original condition, it has changed markedly from the times of its agricultural use, and restoration activities have put it on track for a nearly full recovery over time. Maturing trees will provide an increasing number of nesting sites, including hollows, and will eventually recruit LWD to the channel, though much of this wood will be short-lived deciduous. Impaired water quality and quantity inputs from upstream may slow recovery progress and limit potential, however.</p> <p>Within the channel, placed and constructed log jams and other structures have similarly resulted in a good start to recovery, helping to form pool and riffle sequencing and providing cover. LWD recruitment going forward will be important to replace this placed wood as it reaches its useful lifespan.</p>
Food production and delivery	MODERATE/HIGH: Food production from riparian and upland areas originates largely from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically broad and well-vegetated across this unit, the vegetative community still lacks in maturity and diversity compared to its original condition, though this will improve over time.
<b>Summary</b>	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Campus assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.

### 4.3.7 Swamp Creek – City of Bothell and City of Brier

The Swamp Creek – City of Bothell and City of Brier assessment units (Reaches 7a/b and 8) consist of the entire Swamp Creek shoreline jurisdiction in both cities (Exhibits 10a & b and 11). These assessment units are grouped in this function analysis because there are no significant differences in ecological function. The assessment units include a total of approximately 2.37 and 0.12 miles of shoreline, respectively, and 109.22 and 5.01 acres, respectively, of total jurisdiction. An additional 39.01 acres of potentially associated wetlands extend into Brier city limits and expansion areas and the City of Bothell upstream of the 20 cfs limit of Swamp Creek and along Locust Creek.

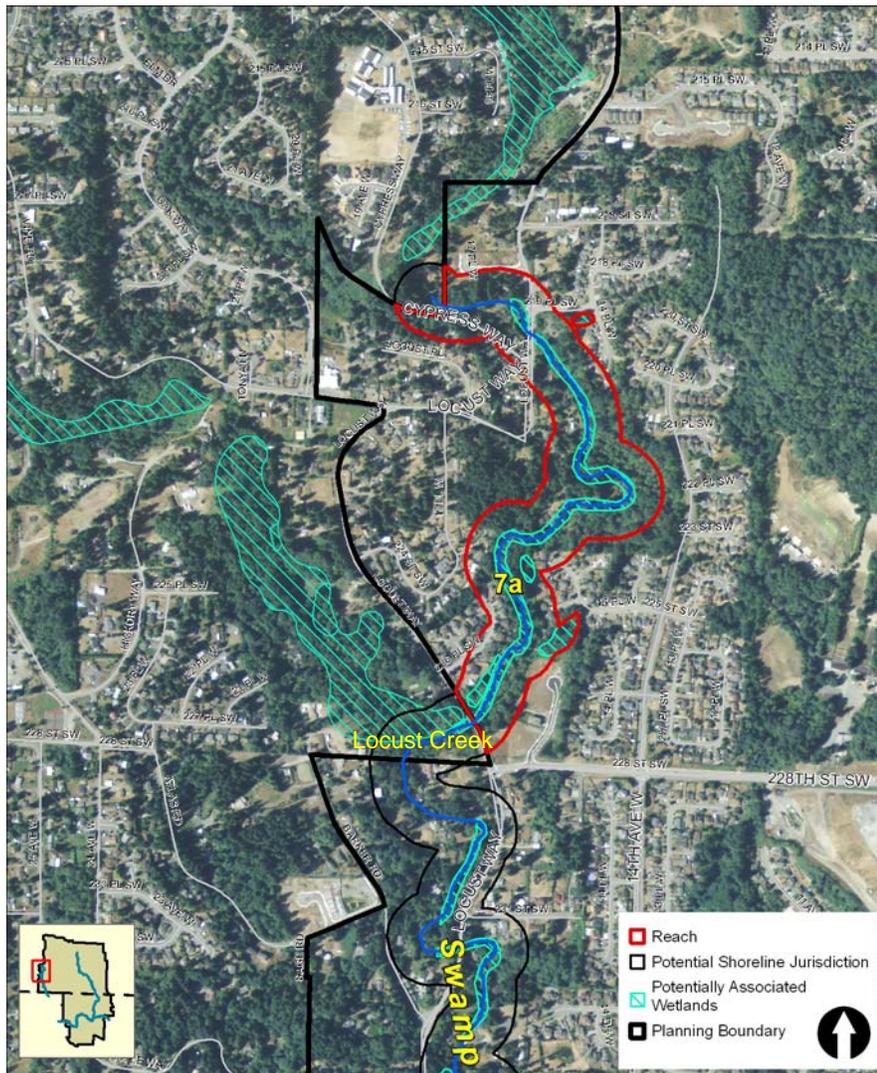


Exhibit 10a. Aerial photo of North Creek - City of Bothell assessment unit north of 228<sup>th</sup> Street SW (Reach 7a)

Swamp Creek in the City of Bothell (Unit 7) is listed as impaired for dissolved oxygen based on sampling from 2004-2006 (Ecology, electronic reference). Fecal coliform impairment has also been documented in this unit, and it is included by the Swamp Creek fecal coliform TMDL (Ecology 2006). Unit 7 is also listed as a water of concern for temperature based on temperature measurements in 2001 (Ecology, electronic reference). Although Swamp Creek water quality impairments have not been explicitly identified in the City of Brier, water quality conditions are likely similar to the adjacent downstream unit, so concerns about dissolved oxygen, fecal coliform, and temperature should be addressed in this reach as well.

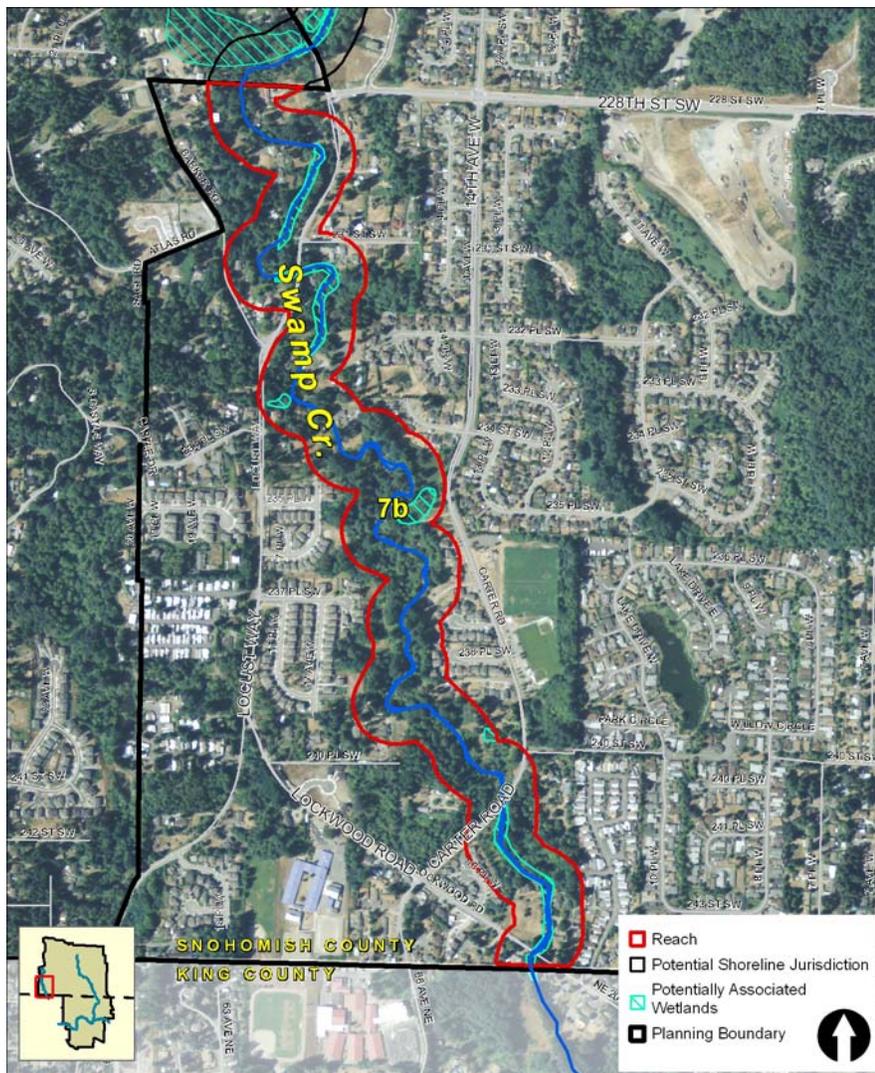


Exhibit 10b. Aerial photo of North Creek - City of Bothell assessment unit south of 228<sup>th</sup> Street SW (Reach 7b)

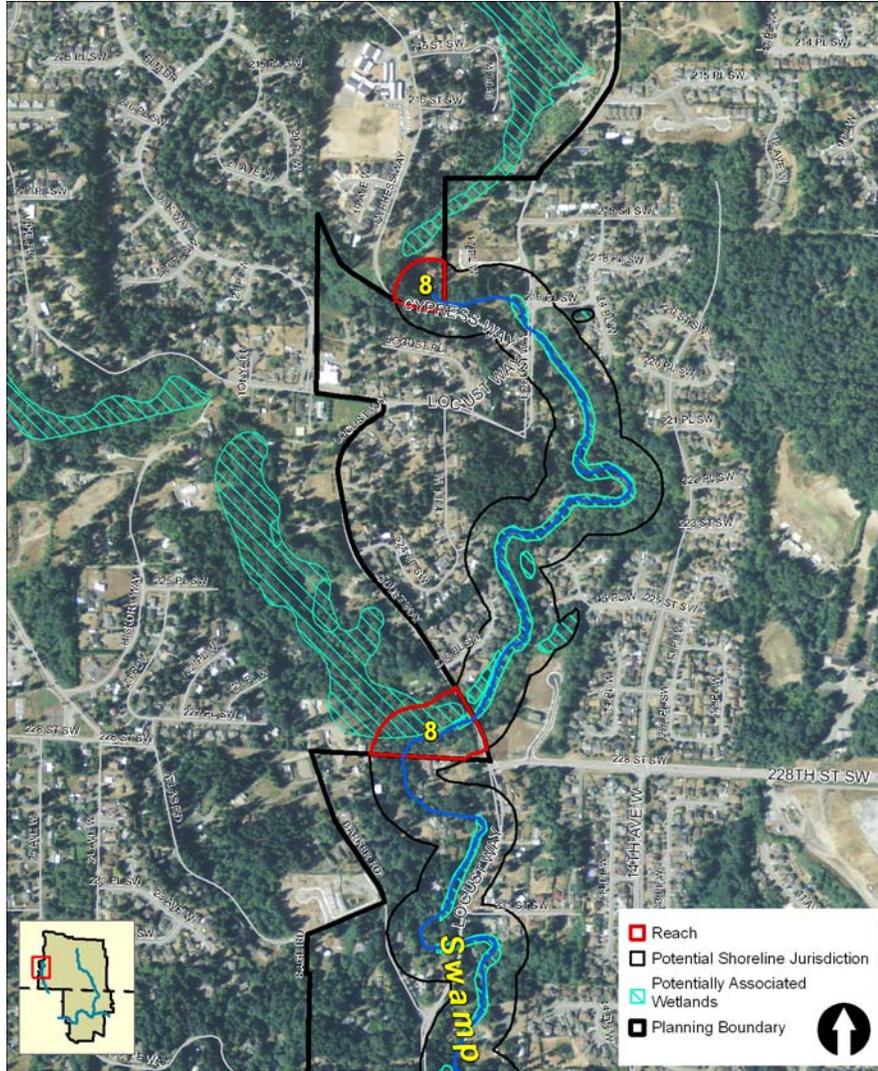


Exhibit 11. Aerial photo of Swamp Creek - City of Brier assessment unit (Reach 8)

Table 14. Function Summary of Swamp Creek – City of Bothell and City of Brier (Reaches 7 and 8).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p><b>Hydrologic</b></p> <p>Storing water and sediment</p>	<p>LOW/MODERATE: Within Reaches 7 and 8, Swamp Creek flows through a residential area with quite variable effective buffer widths and degree of vegetation. While streambanks are not particularly high, the actual floodplain is fairly narrow (Figure 13A, page C-28 and Figure 10, page D-10). Out-of-channel flows do not tend to flood adjacent residential properties, being confined to the fairly narrow floodplain/buffer areas. Basin-wide, Swamp Creek is true to its name in that its basin includes several extensive riparian wetland floodplain</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	areas which are effective at storing both water and sediment. One of these areas occurs just north of the I-5/I-405 interchange. However, these do not occur within the Bothell and Brier shoreline jurisdiction assessment units, and the floodplain storage function for both water and sediment in these units is relatively low.
Transport of water and sediment	MODERATE/HIGH: The single-thread stream corridor has a moderate gradient and, though it has moderate bank vegetation and moderate channel roughness, it appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment.
Attenuating flow energy	MODERATE: Portions of this section of Swamp Creek are lined with young forest and shrubby vegetation dominated by young alder (Figure 16A, page C-34 and Figure 13, page D-13). As such, channel roughness is moderately high and well-distributed where such vegetation and in-channel wood derived from it is present, providing energy attenuation during high flows.
Developing pools, riffles, and gravel bars	MODERATE: This section of Swamp Creek includes predominantly moderate-sized, but short-lived pieces of wood derived from the predominantly young forest it flows through. Much of the wood recruited is short-lived deciduous, such as and including alder. Sinuosity is moderate. These conditions are conducive to the formation of pools of moderate depth and complexity, with intervening riffles, and the formation of some gravelly bars on the inside of channel bends. The reach is relatively evenly balanced between riffles and pools, with riffles composing approximately 40% of the total reach length (Fevold et al. 2001)
Removing excess nutrients and toxic compounds	MODERATE: The lack of a broad floodplain along this unit results in incomplete biofiltration functions and, high levels of fecal coliform bacteria and low levels of dissolved oxygen indicate that the loading of nutrients and other pollutants is high in this unit. The presence of some densely-vegetated buffer areas and relatively stable vegetated banks helps to filter nutrients and toxic compounds.
Recruitment of LWD and other organic matter	MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Unevenly-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, trees along the banks and throughout the buffer are generally immature deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. Fevold et al. (2001) found that the frequency of large wood in this unit was low, at 39 pieces per km.
<b>Vegetation</b>	
Temperature regulation	MODERATE: The existing banks and buffers are vegetated with dense, shrubby vegetation along much of the channel length through this unit and therefore provide a good amount of shading to the creek where present; a moderate level overall. Good shading conditions tend to decrease temperature and allow for increased dissolved oxygen.
Water quality improvement	MODERATE: While buffer vegetation is fairly dense in places, it is not dense in others. Relatively narrow floodplain areas also tend to limit the biofiltration of flood flows. Buffer areas that are vegetated with trees, shrubs, grasses, emergent vegetation, and other riparian

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	vegetation offer a fairly effective level of biofiltration for water moving to the creek through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: With exceptions, the generally well-vegetated streambanks through this area result in relatively stable banks and limit the rate of channel migration and associated erosion.
Attenuating flow energy	MODERATE: The presence of fairly dense adjacent streambank and riparian vegetation contributes to energy attenuation during high flows. However, in-stream wood is of only moderate size and is short-lived.
Sediment removal	MODERATE: As stated above, the lack of a wide floodplain limits the ability of the buffer vegetation that is present to filter fine sediments from flood flows already in the channel. However, this buffer vegetation is able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, unevenly vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the immature trees along the banks and throughout the buffer are typically fairly small deciduous trees, including alder, with a fairly short functional lifespan when and if they do fall into the stream.
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	LOW/MODERATE: Although the somewhat meandering nature of the channel and moderate bank height indicate the presence of a functional hyporheic zone with alluvial, somewhat pervious soils, the width of the zone is fairly limited. The natural potential for hyporheic removal of excess nutrients and toxic compounds is not expected to be high based on this limited width.
Water storage and maintenance of base flows	LOW/MODERATE: As above, the width of the zone of hyporheic flow is fairly narrow, limiting the potential for water storage and associated base-flow maintenance.
Support of vegetation	MODERATE: Streambanks through the area appear to be low enough along much of the length to allow vegetation to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: The narrow width of the hyporheic zone and the fluctuating, urban nature of Swamp Creek flows tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
<b>Habitat</b>	
Physical space and conditions for life history	MODERATE: Though the buffer area is of moderate width and is fairly well-vegetated and functional in places, habitat in and along Swamp Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The vegetative community has been reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. This reduction in dense, but also in diverse, riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	Within the channel, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.
Food production and delivery	MODERATE: Food production from riparian and upland areas originates largely from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are well-vegetated in places, overall diversity, complexity, and maturity are diminished, thereby detracting from this unit's value as wildlife habitat.
<b>Summary</b>	The ecological conditions in the Swamp Creek- City of Bothell and City of Brier assessment units are essentially identical. Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Swamp Creek – City of Bothell and City of Brier assessment units, the overall shoreline ecological function is considered MODERATE.

#### 4.3.8 Sammamish River – Reaches 9 through 14

The following reaches are merged in the function summary table below:

9. Sammamish River – Woodinville Drive (from east city limits to mobile home park) (Exhibit 12)
10. Sammamish River – Brackett's Landing (from Valley View mobile home park to Sammamish River Trail bridge crossing) (Exhibit 12)
11. Sammamish River – Sammamish River Park (Exhibit 13)
12. Sammamish River – Downtown (from SRT bridge to Park at Bothell Landing bridge - north bank only) (Exhibit 13)
13. Sammamish River – Bothell Way Corridor (from Bothell Landing Bridge to 96<sup>th</sup> Avenue NE - north bank only) (Exhibit 13)
14. Sammamish River – Wayne Golf Course (both banks west of 96<sup>th</sup> Avenue NE) (Exhibit 13)



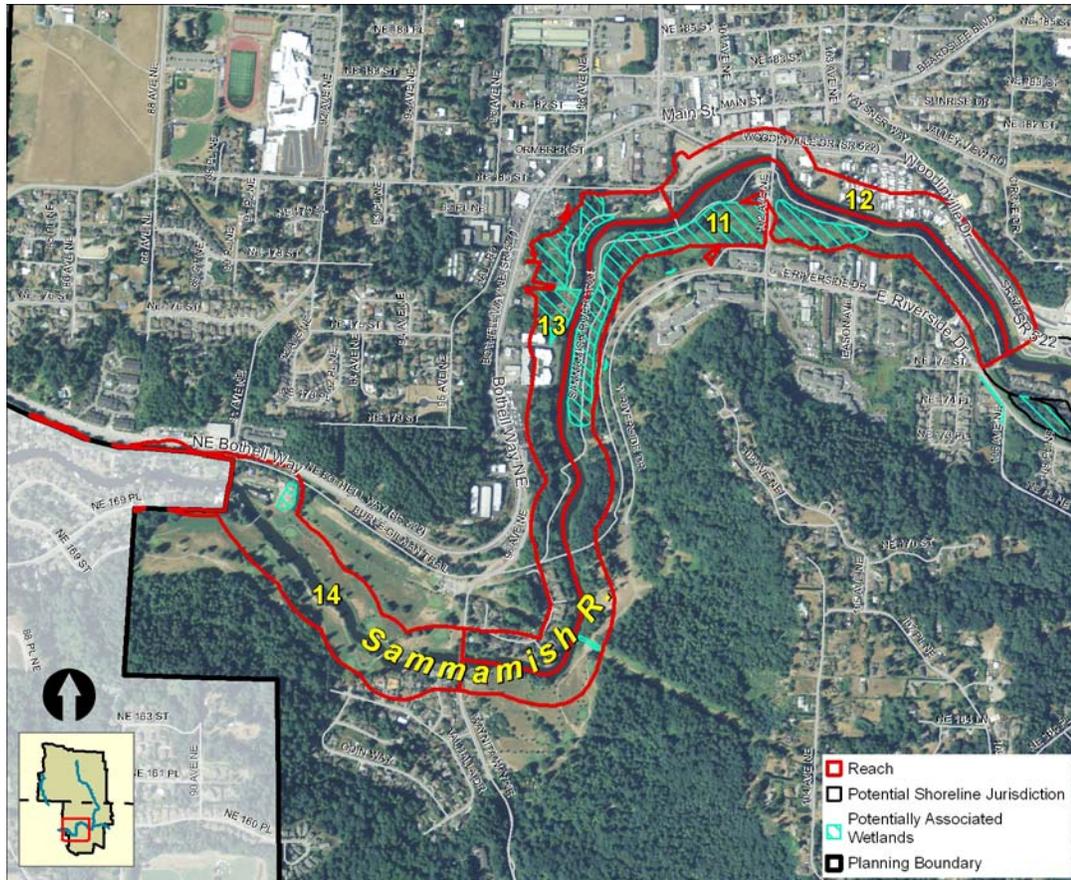


Exhibit 13. Aerial photo of Sammamish River – Reach 11 (Sammamish River Park), Reach 12 (Downtown), Reach 13 (Bothell Way Corridor), and Reach 14 (Wayne Golf Course)

Because of past alteration and management of the Sammamish River as it passes through the City of Bothell, instream conditions and ecological functions are essentially identical. In any reach where the condition and function is unique from the other reaches, that is described within the appropriate subject row of the table. The total shoreline jurisdiction area of Reaches 9 through 14 is 174.55 acres, along 5.18 miles of the Sammamish River (Exhibits 12 & 13).

The flow rate and, particularly, the river elevation or level of the Sammamish River through Bothell, is controlled significantly by artificial means – the weir at Lake Sammamish and the Locks, respectively. The locks do not affect flow, but control the level by backwatering from Lake Washington and tend to create high water in the summer and maintain low water in the winter, which is the opposite of a natural system.

Reaches 9-12 are on the state's 303(d) list of impaired waters for dissolved oxygen and fecal coliform because sampling from 2004 through 2006 found that water consistently did not meet standards (Ecology, electronic reference).

Hallock (2001 cited by Ecology, electronic reference) found similar results in water quality sampling in 1993 and 1994.

Table 15. Function Summary of the Sammamish River – Reaches 9 through 14.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<b>Hydrologic</b>	
Storing water and sediment	<p>LOW: Within the study area, the river flows through and is constrained by a constructed (dredged) channel cross section. The river is prevented from migrating or meandering, and is cut off from and/or excavated below its historic floodplain and/or former channel where either or both of these still exist (Figure 9B, page C-21). Though a formal system of flood control levees does not appear to have been constructed, berms formed as a result of dredge spoil placement tend to disconnect and otherwise reduce interaction between the river and its floodplain, including remnants of the old channel (Figure 13B, page C-29). There is virtually no space available within the constructed cross section to allow for any meaningful storage of water or sediment while still allowing sufficient conveyance capacity for the flood protection of infrastructure and other property. The narrow, deepened channel prevents fine sediments from reaching all portions of floodplain topsoil to nourish vegetative growth, in turn supporting wildlife habitat.</p>
Transport of water and sediment	<p>LOW/MODERATE: Though the channel form was created by dredging specifically for the purpose of improving flow conveyance, the very low channel gradient and associated low-energy nature of the system limit its ability to move both water and sediment. However the needs for water and sediment transport are moderated, because Lake Sammamish provides a high level of natural detention storage to attenuate river flow fluctuations as well as providing an essentially sediment-free source of flow. Sediment supply to the river comes primarily from its various tributaries including Bear Creek, Little Bear Creek, North Creek, and Swamp Creek. Deposition tends to occur near the mouths of these creeks.</p>
Attenuating flow energy	<p>LOW/MODERATE: The Sammamish River channel is generally simple and smooth with few features such as LWD or dense vegetation along its banks to provide roughness and dissipate energy. However, within portions of the Sammamish River Park (Reach 11), there is quite a large growth of black cottonwood and Oregon ash trees which have, on occasion, fallen into the river. Also, the northern portion of Reach 13 has received large amounts of re-vegetation with deciduous trees and shrubs. However, the channel is very low gradient and so there is very little energy to diffuse. Attenuating what little flow energy there is could interfere with the channel's ability to pass flow.</p>
Developing pools, riffles, and gravel bars	<p>LOW: By design, the Sammamish River tends to consist predominantly of runs (which are lengths of relatively deep but still-moving water) along its entire length from Lake Sammamish to Lake Washington. In order to provide adequate conditions for salmon migration, pool habitats, with greater than 1.5 ft residual depth, should cover 40-60% of the total length of the river (Raleigh et al. 1986 cited in Tetra Tech 2002).</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	<p>The river is generally lacking in large woody debris within the channel and is maintained as such to provide adequate conveyance capacity. Though volunteers have planted numerous trees as part of the Bothell – Woodinville – Redmond Re-Leaf projects in both Reach 11 and the northern portion of Reach 13, these plantings have not yet translated to in-channel wood, nor is it clear if they will be allowed to do so given maintenance activities described previously which are intended to keep the channel largely clear of such wood. As mentioned above, source flow from Lake Sammamish is virtually sediment-free and so gravel to form bars is only available from the tributaries. Limited bars have formed at the mouths of these tributaries, such as at the mouths of North and Swamp Creeks. Another gravel bar, similarly supplied by a tributary located on the golf course, somewhat restricts the river in front of the ‘back’ nine of Wayne Gold Course, east of 96<sup>th</sup> Avenue. Energy and obstructions such as log jams are generally not sufficient to scour pools or form intervening riffles, hence the predominance of runs. Combined with the fine-grained texture of the bank soils and substrate, the development of pools, riffles, and gravel bars is very limited.</p>
<p>Removing excess nutrients and toxic compounds</p>	<p>LOW: The much reduced extent and function of a once-extensive floodplain, especially along Reach 9, results in very limited biofiltration function. The remaining limited function now occurs only within the channel itself. Developed upland shoreline areas are a source of nutrients, bacteria (fecal coliform), and toxic compounds from landscaping runoff (pesticides, fertilizers, herbicides) and road runoff (hydrocarbons, metals).</p>
<p>Recruitment of LWD and other organic matter</p>	<p>LOW (Reaches 9, 10, and 12-14): Little or no channel migration tends to occur, which would recruit any trees in the channel’s path as LWD. Furthermore, riverbank vegetation other than grasses and low, sometimes non-native shrubs is generally sparse, precluding significant recruitment of large logs and reducing inputs of small woody debris as well.</p> <p>LOW/MODERATE (Reach 11): Some leaf litter and other small vegetative materials are recruited where trees overhang the banks, such as along Reach 11, Sammamish River Park. A few trees have also fallen into the river in the past few years. Some of these trees have remained where they fell, but others have been removed.</p>
<p><b>Vegetation</b></p>	
<p>Temperature regulation</p>	<p>LOW (Reaches 9, 10, and 12-14): The Sammamish River is largely lacking in riparian vegetation. Since riverbank vegetation other than grasses and low shrubs is sparse except for some select areas within these reaches, the river channel goes largely unshaded. A more continuous riparian buffer is a critical step to addressing high water temperatures in the Sammamish River. Also contributing to high temperatures in the river are reduced summer low flow conditions (Tetra tech 2002) and the fact that flows in the river are derived predominantly from the surface waters of Lake Sammamish, which stratifies during the summer with surface waters much warmer than at depth.</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	LOW/MODERATE (Reaches 11 and 13): Better shade is provided by trees on the south side of the river in Sammamish River Park and along Bothell Landing Park. In fact, these reaches may have the most riparian vegetation of all the reaches along the entire Sammamish River.
Water quality improvement	<p>LOW (Reaches 9, 10, and 12-14): Wide floodplain areas that are densely vegetated with trees, shrubs, grasses, emergent vegetation, and other riparian vegetation offer an effective level of biofiltration. Historically, the Sammamish River had such a floodplain, but it has been largely eliminated due to the lowering of Lake Washington and Corps dredging and armoring along the length of the river. Not only does the water within the river channel go largely unfiltered, but water quality contaminants such as fertilizers, herbicides, pesticides, hydrocarbons, metals, and eroded soils (from developed upland areas and roadways) can now more easily reach the river via distinct drainage pathways which cut across the former floodplain. Vegetation along these reaches presently offers little potential to improve fecal coliform and dissolved oxygen impairments in these reaches of the Sammamish River.</p> <p>LOW/MODERATE (Reach 11): Improved biofiltration is provided by mixed vegetation lining the river in Sammamish River Park.</p>
Slowing riverbank erosion; bank stabilization	MODERATE: River flow energy is quite low so, while existing riverbank vegetation consists primarily of grasses and low shrubs, this existing vegetation appears relatively effective at stabilizing soils and slowing the rate of bank erosion.
Attenuating flow energy	LOW/MODERATE: As stated above, the Sammamish River channel generally lacks dense vegetation along its banks to provide roughness and dissipate energy. However, the channel is very low gradient and so there is very little energy to diffuse. Attenuating what little flow energy there is could interfere with the channel's ability to pass flow.
Sediment removal	LOW/MODERATE: The lack of an effective floodplain results in the inability to effectively filter fine sediments. However only the tributaries are potential sources of significant levels of sediment given the predominance of source flow from Lake Sammamish.
Provision of LWD and other organic matter	<p>LOW (Reaches 9, 10, and 12-14): As stated previously, riverbank vegetation other than grasses and low shrubs is sparse, precluding significant recruitment of large logs and other vegetative materials.</p> <p>LOW/MODERATE (Reach 11): Some leaf litter and other small vegetative materials are recruited where trees overhang the banks, most notably along Reach 11, Sammamish River Park.</p>
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	LOW: The river has been isolated from its floodplain, and similarly its hyporheic zone, primarily due to channel lowering by dredging. Furthermore, soils along the river are largely fine-grained and not as conducive to hyporheic flow as a coarser substrate would be, limiting the natural potential for hyporheic removal of excess nutrients and

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	toxic compounds.
Water storage and maintenance of base flows	LOW: As described above, the hyporheic zone has been partially drained through channel lowering by dredging and existing soils are not likely conducive to significant hyporheic flow, both limiting the potential for water storage and base-flow maintenance.
Support of vegetation	<p>LOW (Reaches 9-13): Especially during the summer, the river is well below its banks. The vegetation supported by hyporheic flow would likely extend only a short distance up the steep banks.</p> <p>MODERATE (Reach 14): Banks are lower along the Wayne Golf Course (Reach 14), however, including the lower reaches and mouth of Tributary 0066, with its broad, grassy floodplain-like area. With these low banks, less impervious surface, and lack of a storm drainage and roadway grid that would be associated with urban or suburban development, this area likely has increased hyporheic activity compared with adjacent reaches.</p>
Sediment storage	LOW: As described above, the river has been isolated from its floodplain, and similarly its hyporheic zone, primarily due to channel lowering by dredging. In addition, soils along the river are largely fine-grained and not as conducive to hyporheic flow as a coarser substrate would be, limiting the natural potential for hyporheic fine-grained sediment removal and storage.
<b>Habitat</b>	
Physical space and conditions for life history	<p>LOW/MODERATE (Reaches 9, 10, and 12-14): Habitat in and along the Sammamish River has been reduced in quality, quantity, and complexity compared to its original condition (prior to channelization in 1964 and its use as a navigable waterbody). The vegetative community has been much reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. The reduction of dense riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.</p> <p>Within the channel itself, far fewer log jams, much less wood overall, and a simple, single-thread channel form similarly result in less available habitat with less protective cover as well.</p> <p>The river also has 1.06 acres of overwater structures, distributed in each reach. The most overwater cover (0.5 acre) is present in Reach 9 (I-405/SR 522 overpass), which has sufficient height above the water to preclude major impacts. The largest overwater cover close to the water's surface is provided by the Blue Heron Marina, totaling approximately 0.1 acre in a small embayment in Reach 14. Most of the other overwater structures are small bridges and a few piers. There is a pretty wide scattering of individual docks along the residential areas.</p> <p>MODERATE (Reach 11): Somewhat more abundant vegetation along this reach provides additional upland habitat function compared to the other reaches.</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Food production and delivery	<p>LOW/MODERATE (Reaches 9, 10, and 12-14): Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life.</p> <p>MODERATE (Reach 11): Again, somewhat more abundant vegetation along this reach provides additional upland habitat function with respect to food production compared to the other reaches.</p>
<b>Summary</b>	<p>Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River, the overall shoreline ecological function for each reach is listed below:</p> <p>Woodinville Drive - Reach 9: LOW/MODERATE            Brackett's Landing – Reach 10: LOW/MODERATE            Sammamish River Park – Reach 11: MODERATE            Downtown – Reach 12: LOW/MODERATE            Bothell Way Corridor – Reach 13: LOW/MODERATE            Wayne Golf Course – Reach 14: MODERATE</p>

### 4.3.9 Sammamish River – Bothell Business Park Floodway

The Sammamish River – Business Park Floodway assessment unit (Reach 15) consists of those areas of Sammamish River floodplain/floodway located north of State Route 522 and east of Interstate-405 (Exhibit 14). The assessment unit includes approximately 22.88 acres of total jurisdiction.

No water quality impairments have been measured and reported in this unit (Ecology, electronic reference), however, that may be attributable to a lack of sampling stations in this unit, and some impairment is likely given sampling results in units upstream.

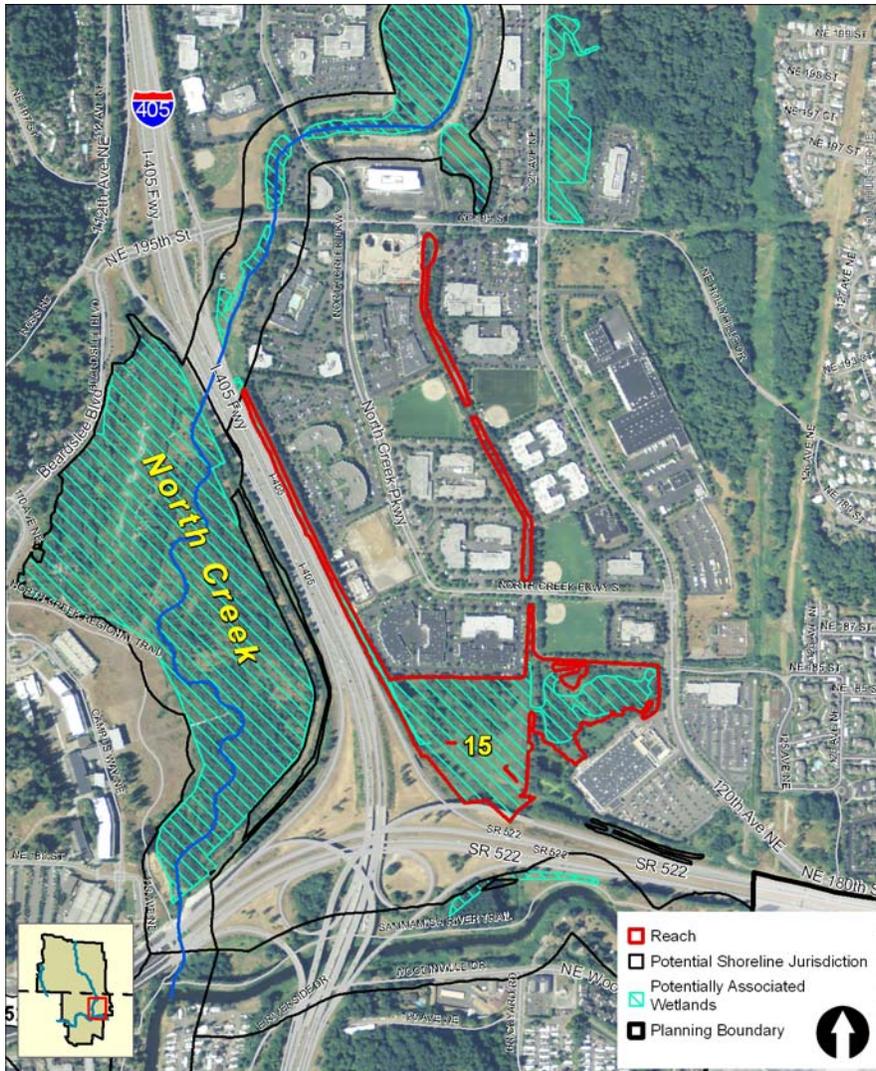


Exhibit 14. Aerial photo of Sammamish River – Reach 15 (Bothell Business Park Floodway)

Table 16. Function Summary of Sammamish River – Bothell Business Park Floodway (Reach 15)

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p><b>Hydrologic</b></p> <p>Storing water and sediment</p>	<p>LOW: These floodplain areas would be moderately effective at storing water and sediment, but only when activated during extreme flood events. These floodplain areas are separated from the Sammamish River by SR 522. Exchange of water between the river and floodplain is restricted/constricted by various culvert crossings, both upstream and downstream, which would inhibit the free exchange of water and sediment. These constrictions may prevent fine sediments from</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	reaching all portions of floodplain topsoil to nourish vegetative growth, in turn supporting wildlife habitat.
Transport of water and sediment	LOW: These are floodplain areas that function primarily to store water and sediment rather than transport them except as they drain out as flood levels drop.
Attenuating flow energy	LOW: These are low-energy, floodplain storage areas that would have little energy-attenuating function.
Developing pools, riffles, and gravel bars	LOW/NA: These floodplain areas do not include a shoreline channel, so these processes are not applicable.
Removing excess nutrients and toxic compounds	LOW/MODERATE: These floodplain areas would be effective at biofiltering out nutrients and toxic compounds, but only when activated during extreme flood events.
Recruitment of LWD and other organic matter	LOW: Tree size and abundance is limited on these floodplain areas and it is doubtful that any LWD from these areas would pass through culverts to be recruited to the river. Some smaller organic materials such as and including leaf litter could be supplied to the river.
<b>Vegetation</b>	
Temperature regulation	LOW: There is little water present in these floodplain areas to shade most of the time. Some vegetative shading could be provided to the drainage (Parr Creek) which passes through the area, but these floodplain areas are not well-forested overall and flooding typically occurs during the late fall and winter when temperature is not of concern.
Water quality improvement	LOW/MODERATE: As stated above, these floodplain areas would be effective at biofiltering out nutrients and toxic compounds, but only when activated during extreme flood events. They are primarily vegetated with fine-textured grasses, emergents, and low shrubs which are particularly effective at biofiltration.
Slowing riverbank erosion; bank stabilization	LOW/NA: These floodplain areas do not include a shoreline channel, so these processes and functions are not applicable.
Attenuating flow energy	LOW: Again, these are low-energy, floodplain storage areas that would have little energy-attenuating function.
Sediment removal	LOW/MODERATE: These floodplain areas would be effective at biofiltering out fine sediments, but only when activated during extreme flood events.
Provision of LWD and other organic matter	LOW: Some leaf litter and other small organics could be supplied to the river as a result of storm events. Few trees are present in these areas to supply LWD, and it is also doubtful that LWD would be supplied to the river by intervening culverts.
<b>Hyporheic</b>	
Removing excess nutrients and toxic compounds	LOW: The river has been isolated from its floodplain, and similarly its hyporheic zone, primarily due to channel lowering by dredging. These floodplain areas are also located at some distance laterally from the river channel. Furthermore, soils along the river are largely fine-grained and not as conducive to hyporheic flow as a coarser substrate would be, limiting the natural potential for hyporheic removal of excess nutrients and toxic compounds.
Water storage and	LOW: As described above, the hyporheic zone has been partially

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
maintenance of base flows	drained through channel lowering by dredging and existing soils are not likely conducive to significant hyporheic flow, both limiting the potential for water storage and base-flow maintenance.
Support of vegetation	MODERATE: Though hyporheic flow from the river is limited, drainages (including Parr Creek) pass through these floodplain areas and would tend to keep soil moisture fairly high across the floodplain during the growing season for use by plants. However, a network of drainages tends to reduce this plant-watering effect.
Sediment storage	LOW: Hyporheic flows associated with the river are expected to be low due to the dredged nature of the river channel and the distance of these floodplain areas from the river. Also, as above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-grained hyporheic soils tend to limit the amount of sediment that can be captured and stored.
<b>Habitat</b>	
Physical space and conditions for life history	LOW/MODERATE: Habitat in and along the Sammamish River, including these remnant floodplain areas, has been reduced in quality, quantity, and complexity compared to its original condition (prior to lowering of the river channel through channelization). The vegetative community has been much reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. The reduction of dense riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.
Food production and delivery	MODERATE: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Though immature, the vegetative community in these floodplain areas provides considerable diversity and complexity, including convoluted edges between meadow and tree/shrub areas.
<b>Summary</b>	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River – Bothell Business Park Floodway assessment unit, the overall shoreline ecological function is considered LOW.

#### 4.4 Restoration Opportunities

The assessment of processes and functions for each assessment unit is followed in the table by identification of opportunities and recommendations for protecting existing functions and processes or restoring impaired functions and processes. Ecology's *Shoreline Master Program Guidelines* (173-26 WAC) includes the following definition:

“Restore,” “Restoration” or “ecological restoration” means the reestablishment or upgrading of impaired ecological shoreline processes