Springbrook Creek Watershed Assessment

FINAL REPORT December 26, 2018 SRFB Project #14-1517

Funded by:

Washington Recreation and Conservation Office Salmon Recovery Funding Board
Project #14-1517, Springbrook Creek Evaluation and Feasibility

Significant in-kind support provided by:
Bainbridge Island Land Trust, Bainbridge Island Watershed Council, City of Bainbridge Island, Washington Department of Ecology, Wild Fish Conservancy, and Volunteers

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Acknowledgements:

In addition to the work of the project team, the Springbrook Creek Watershed Evaluation and Feasibility Project benefited greatly from participation, input and feedback from a large number of technical experts, local landowners, and volunteers:

- Bainbridge Island Land Trust: Projects Committee and Board of Directors
- City of Bainbridge Island: Chris Hammer, Barry Loveless, Rob Grant, Peter Corelis, Marilyn Guthrie, Pam Cienega , Melva Hill (former employee)
- Kitsap Health District: Stuart Whitford, Susan Walter
- Kitsap County Conservation District: Brian Stahl
- Kitsap County: Kathy Peter
- Mid Fisheries Enhancement Group: Troy Fields (former staff)
- Washington Department of Fish and Wildlife: Nam Siu, Christy Rains, Justin Zweifel, Michael Blanton Suquamish Tribe: Alison O’Sullivan, Steve Todd
- Washington Recreation and Conservation Office Salmon Recovery Funding Board: Amee Bahr (RCO Project Manager)
- West Sound Watersheds Council Citizens and Technical Advisory Committee

- United States Environmental Protection Agency: Provided NEP funding of Puget Sound Watershed Characterization

- Water Monitoring Volunteers: Sandra O'Connor, Sarah Pearl, Gary Peterson, Barry Sacks, Randal Samstag, Omana Taylor, Roger Williams, Sally Wilmeth, Dallas Young

- Salmon Monitoring Volunteers: Tim Bird, Elizabeth Carr, Brian Copp, Wayne Daley, Katrina Godshalk, John Grinter, Dan Groff, Ellen Gunderson, Curtis Hughes, Lisa Lindsay, Sandra O'Connor, Christine Perk, Janelle Perreira, Bob Ross, Deb Rudnick

- Landowners and Interested Parties: Over 50 property owners within the Springbrook Creek Watershed provided historical context, access to their property, and input on proposed actions. With their participation, the level of knowledge gained about the watershed and landscape was greatly enhanced. Special appreciation to the following property owners who invested a number of hours with the project team on this project include: Ross and Sharon Boundy, Jerilyn Brusseau, Janice Cohen, Claire Cramer, Elizabeth Dequine, Barbara Eddy, Friends of the Farms, Fletcher Bay Estates Homeowners Association, Jeff Glanzrock, Emily Grice, Dan and Linda Groff, Dax Hansen, Joe Hendrickson, Wayne Loverich, Michael Loverich, Lisa Martin, James and Hisako Matsudaira, Rob Ferguson and Kia Micaud, William and Catherine Nickum, Olemara Peters, Ken Rekow and Rosalie Frazier, Brad and Helen Waggoner

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Glossary of Terms

Aquifer: A body of permeable, porous rock, sand, or gravel that holds water underground.

AU (or PAU): Assessment Unit (or Project Assessment Unit)

Benthic macroinvertebrates: Animals without backbones, large enough to be seen with the naked eye, living among the stones and sediments of the stream bed.

Channelization: Alteration of the course of a stream to form straight channels.

Confluence: Where two streams meet.

Culvert: A pipe carrying a stream under a road.

Downstream: In the direction of water flow.

Impervious: Hard surfaces such as pavement that do not allow water to infiltrate.

In situ physiochemistry: Physical and chemical properties of water within the stream, such as pH, dissolved oxygen, and temperature.

Left bank: Left side of the stream when facing downstream.

LIDAR: Light Detection and Ranging. A survey method creating high-definition mapping of elevations using pulsed laser light to measure distances to the ground.

Right bank: Right side of the stream when facing downstream.

Riparian: The interface between land and a stream; the zone along a natural watercourse.

Sediment: Particles of naturally occurring substances that are transported by, and settle out of, streams.

Septic system: A self-contained underground treatment system for household wastewater and sewage.

Stormwater: Surface water generated by precipitation and runoff from impervious surfaces.

Watershed: An area of land draining downslope to the lowest point. May also be referred to as a drainage basin.

Water types (as per Washington Department of Natural Resources guidelines https://www.dnr.wa.gov/forest-practices-water-typing, WAC 222-16-031):

> Type “F” - Fish habitat; Streams and waterbodies that are known to be used by fish, or meet the physical criteria to be potentially used by fish. Fish streams may or may not have flowing water all year; they may be perennial or seasonal.
>
> Type"Np"- Non-fish-habitat perennial; Streams that have flow year round and may have spatially intermittent dry reaches downstream of perennial flow. Type Np streams do not contain fish or meet the physical criteria of a Type F stream.
>
> Type"Ns"- Non-fish-habitat seasonal; Streams that do not have surface flow during at least some portion of the year, and do not contain fish or meet the physical criteria of a Type F stream.
>
> Type"S"- Shoreline; Streams and waterbodies that are designated “shorelines of the state” as defined in chapter 90.58.030 RCW.

1. Executive Summary

The Springbrook Creek Evaluation and Feasibility (Assessment) Project (SRFB/RCO Project #14-1517) assessed the condition of Springbrook Creek, its tributaries, and the 999 acre Springbrook Creek watershed. The Project identified limiting factors affecting ecosystem functions; reported on those conditions for planning activities within the watershed; conducted a watershed restoration and protection project feasibility analysis using existing and new data/information, including a significant amount of on the ground field work; and identified and prioritized potential protection and restoration projects addressing ecological health and fish passage limitations in the Springbrook Creek Watershed.

Springbrook Creek is situated on the west side of Bainbridge Island and drains into Fletcher Bay. Within the watershed, there are just over seven miles of stream of which approximately 4.7 miles are typed as fish habitat. Springbrook Creek is one of the largest and most productive salmon-bearing streams on Bainbridge Island and contains one of only two stream reaches on Bainbridge Island designated as Critical Habitat for Puget Sound steelhead. The stream currently hosts populations of a number of fish species including cutthroat trout, coho and chum salmon, sculpin, and Western brook lamprey.

The Springbrook Creek Watershed Assessment came about by recognizing the creek as an important fish stream on Bainbridge Island and that certain actions were needed to care for and improve this resource, but a science-based decision-making matrix to guide near and future term actions was lacking. Following the 2013-2014 Wild Fish Conservancy (WFC) stream surveys (SRFB project 13-1143), which was supported by Bainbridge Island Land Trust, a number of willing landowners provided access to their properties and were deeply engaged in discussions about the history of the stream and current conditions and uses. In 2014 the City of Bainbridge Island proposed two culvert repair projects on Springbrook Creek hoping to use Salmon Recovery Funding Board (SRFB) funds. As a result of that proposal, the West Central Local Integrating Organization (LIO) and the West Sound Watersheds Council (WSWC) recommended that a systematic assessment and evaluation of the watershed be done to guide prioritization of restoration and protection actions. Given the positive energy that had been expressed by landowners during the 2013-2014 WFC survey and the request of the WSWC, a collaboration of the Bainbridge Island Land Trust, Bainbridge Island Watershed Council, City of Bainbridge Island, and Wild Fish Conservancy was formed resulting in grant proposal being submitted for an assessment project.

The grant was funded in 2014 by the SRFB. Work took place from 2015 - 2018. The collaboration of entities that applied for the grant formed the project team that oversaw all aspects of the project: project management, collection of historical data, collection of and securing new field and analytical data, landowner outreach, volunteer coordination, synthesis of analysis, and formulation of watershed priorities and projects. Washington Department of Ecology was added to the project team to complete a watershed characterization. An abundance of assistance from other stakeholders, landowners and volunteers was provided throughout all phases of project.

This project is West Central Local Integrating Organization Near Term Action WC 15, and therefore a priority of the Puget Sound Partnership Action Agenda, which is the State's directive for recovering listed species such as Puget Sound Chinook Salmon and resident orcas, and for addressing pollution of Puget

Sound. It is hoped that projects identified in the assessment will result in local, regional and state financial support.

An important element of the project included landowner and community interaction to learn from those living in the watershed about stream function and use, to engage them in caring for stream and watershed resources, and to share information developed during the project. One hundred and twenty three landowners who lived along the stream were contacted about the project. During the project over 54 properties were visited encompassing over 240 acres. By the end of the project, about 65% of the watershed's stream length was field surveyed (about 4.7 miles of 7.2 miles of stream). Landowners were contacted by mail email, or by phone informing them of the project, and many individual meetings took place. Landowners were invited to join us on the land to show us their property so we could learn from them and learn about the history of the land. Communications with landowners were ongoing throughout the project. Those private lands where projects were identified for conceptual designs had landowners that were deeply involved in and committed to the development of restoration or protection projects. While all members of the project team were engaged with landowners Wild Fish Conservancy and the Land Trust took the lead on these endeavors.

A comprehensive inventory of stream and riparian conditions throughout the watershed was achieved through the project, including a comprehensive inventory of fish passage barriers accomplished by Wild Fish Conservancy and Washington Department of Fish and Wildlife. A total of 46 culverts were identified: 8 on city-owned property and 38 on private property. Of the 30 on fish habitat streams, 10 (33%) were full passage barriers, 15 (50%) were partial barriers, and 5 (17%) were completely unknown passability. None of the assessed culverts on fish habitat streams were found to be fully passable, and about 1.8 miles of fish habitat exist upstream of what are considered full barriers. Additionally, fish utilization and fish presence surveys were conducted by Wild Fish Conservancy and BI Watershed Council spawning surveys.

Water quality and quantity monitoring was performed to identify limiting factors such as temperature, sediment, and fecal coliform. A total of 14 sites were selected and monitored for one or more parameters, with the City of Bainbridge Island and a team of volunteers performing monitoring and data collection tasks.

Additionally, a watershed characterization was performed by Washington Department of Ecology using their Puget Sound Watershed Characterization model (Appendix I). This work led to the identification of specific Assessment Units within the watershed in order to provide information on conditions within sub areas of the watershed. The results of this work provided information on the functionality or degradation of important watershed conditions or functions such as areas for sediment sources, water flow, surface recharge, surface water storage and water discharge. The result of this work not only helped understand which areas of the watershed provided which important watershed functions, but also what actions (protection or restoration) might need to occur to protect or improve these functions.

As a result of the all the assessment and on the ground work performed, the Springbrook Creek Watershed Assessment Report contains a compilation of watershed resource information, identifies limiting factors, appropriate, feasible, and cost-effective solutions to address limiting factors in the watershed (see Section 4). Many areas of the stream and watershed are in poor or compromised condition.

Restoration opportunities such as removing fish passage barriers and enhancing riparian habitats, evaluating the possibility of returning the stream to its historical path, and protecting intact fish habitat through acquisition or conservation easements were identified as proposed action items for the future. Watershed-wide efforts, such as landowner outreach to share tips for caring for streams and associated vegetation, are also recommended. Prioritization of projects considered the number of limiting factors a project would address, landowner agreement and participation, position of the project within the watershed, and likelihood of success of the project protecting or recovering natural watershed processes.

Conceptual designs for five high-priority projects were created. Project development was a multi-year endeavor and included much on-site consultation with landowners, surveys, development of design options, examining title issues, adjusting designs to meet ecological and landowner concerns, and final drawing and cost estimate compilation. The project design process was led by Wild Fish Conservancy and Bainbridge Island Land Trust and was done in close coordination with landowners, or in the case of the project involved City property, the City of Bainbridge Island. Wild Fish Conservancy and City of Bainbridge Island assisted with on the ground survey work, and when engineered drawings and costs estimates were needed on restoration concepts, Wild Fish Conservancy performed these tasks.

Of the five conceptual designs produced, four involve culvert removal, all five improve riparian conditions, and one project is protection focused. The five conceptual projects included in Appendix III are:

Fletcher Bay Culvert and Weir Removal and Stream Restoration Project (Project 1): Removes culvert, weirs and streamside armor and replaces culvert with bridge. Streamside and native vegetation are enhanced for more naturalized stream flow. This project is the lowest in the stream system and addresses the first fish passage barrier in the Springbrook Creek watershed, improving access to over 4.7 miles of stream habitat, while also providing more room for the stream to accommodate high flow events (this culvert receives stream drainage from most of the 999 acre watershed).

Eddy Culvert and Armor Removal, Bridge Replacement, Stream Restoration (Project 2): Removes culvert and streamside armoring with a bridge and enhances the riparian area through invasive plant management and native plant installation. This project addresses the second fish passage barrier fish encounter in the system. This project is just upstream of Project 1 and just downstream of Project 3.

Rekow Stream and Riparian Restoration (Project 3): Removes derelict culvert and improves riparian condition by removing invasive plants and enhancing with more native vegetation. This project is just upstream from Project 2 and downstream from project 4.

Nickum Stream and Riparian Restoration (Project 4): Improves stream and riparian condition through removal and management of invasive vegetation, planting native vegetation and enhancing the stream channel. This project is just upstream of project 3.

Upper Springbrook Protection Project (Project 11 on map): Acquires for protection nearly 23 acres of undisturbed forested wetland, stream and associated riparian habitat in assessment unit 6, which was identified as the area of high priority for protection in the watershed.

A substantial list of other potential actions that would improve stream and watershed conditions in the future were also identified and are included in the report (see Appendix II and Sections 5 and 6).

$61,628.00 of in-kind support was contributed by Bainbridge Island Land Trust, Bainbridge Island Watershed Council, City of Bainbridge Island, Washington Department of Ecology, Wild Fish Conservancy, and many volunteers and was matched with the $61,625.00 Salmon Recovery Funding Board grant, administered by the Washington State Recreation and Conservation Office.

The Springbrook Creek Watershed Assessment is the first watershed scale assessment conducted on Bainbridge Island. This project may act as a model for future stream and water resource planning efforts on Bainbridge Island.

2. Introduction

Folks made their living from the land. The stream was where cows got their water and where dams formed irrigation ponds. They were also: where Maldur Flodin in the 1910's could seasonally spear salmon; where a generation later, his son Lyle saw two salmon, the largest being 28 inches!; where Adelena Narte remembers her father catching a steelhead; and where Wayne Loverich's dog periodically brings home a chum, or dog salmon!

Excerpt from Island Center (Springbrook Creek) section of Gerald Elfendahl's Streams of Bainbridge Island, 1996

992.1 Overview

The Springbrook Creek Watershed is located on Bainbridge Island, in Kitsap County Washington. Bainbridge Island encompasses 18,368 acres, has 12 major watersheds, hosts 53 miles of shoreline and lies within Puget Sound, one of the nation's largest estuaries. Springbrook Creek Watershed (Watershed) encompasses 999 acres (1.56 mi^2), and drains to Fletcher Bay. The Watershed lies within the Fletcher Bay Watershed, drains the southern half of the Fletcher Bay Watershed, and comprises approximately 47% of the Fletcher Bay Watershed. Springbrook Creek (also known as Springridge Creek and Fletcher Creek) flows from north of Gazzam Lake through Island Center to Fletcher Bay. It is one of the Island's largest and most productive salmon-bearing streams.

Figure 1. Context of Springbrook Creek Watershed in Puget Sound, on Bainbridge Island and within the Fletcher Bay Watershed

Seven miles of stream exist within the watershed, with approximately 4.7 miles typed as fish habitat. Springbrook Creek contains one of only two stream reaches on Bainbridge Island designated under the Endangered Species Act as Critical Habitat for Endangered Puget Sound steelhead. The stream currently hosts populations of a number of fish species including cutthroat trout, coho and chum salmon, sculpin, Western brook lamprey, and more.

The Island lies within the homelands of the Suquamish people, and a summer village at Fletcher Bay provided a base from which tribal people used the abundant natural resources of the watershed and vicinity. The watershed is now predominantly low-density residential housing in a patchwork of second-growth forest, farmland, open pastures, and lawns. Island Center, one of five service centers on Bainbridge Island, lies in the northern part of the study area and hosts a gas station, restaurant, and a few businesses.

2.2 Project Purpose, Elements and Previous Assessments

Purpose:

The Springbrook Creek Evaluation and Feasibility (Assessment) Project assessed the condition of the stream and watershed using historical and new information to recommend actions that could improve the condition of the function of the stream to support fish populations and improve watershed functions. The project identified limiting factors affecting ecosystem functions, reported on those conditions for planning activities within the watershed, conducted a watershed restoration and protection project feasibility analysis, and identified and prioritized potential protection and restoration projects addressing ecological health and fish passage limitations in the Springbrook Creek Watershed. An important element of the project included landowner and community interaction to learn about their experience with stream function and use, and to engage with them in caring for stream and watershed resources. As a result of the work performed, this report compiles watershed resource information, identifies appropriate, feasible, and cost-effective solutions to limiting factors in the watershed, and presents conceptual designs for five high-priority projects.

The Springbrook Creek Watershed Assessment is the first watershed scale assessment conducted on Bainbridge Island. Previous work on an island-wide basis focused on ground water, water monitoring, shoreline, geologic features, and transportation planning, this project is the first to conduct a comprehensive study of a stream and associated water resources within a specific Island watershed. This project may act as a template for future stream and water resource planning efforts on the Island.

The Springbrook Creek Watershed Assessment recognizes the creek is an important fish stream on Bainbridge Island and to care for this resource a science-based prioritization matrix was needed to guide near and future term actions. Following the 2013-2014 Wild Fish Conservancy (WFC) stream surveys (SRFB project 13-1143), supported by Bainbridge Island Land Trust, a number of willing landowners provided access to their properties and were deeply engaged in discussions about the history of the stream and current conditions and uses. In 2014 the City of Bainbridge Island proposed two culvert repair projects on Springbrook Creek hoping to use Salmon Recovery Funding Board (SRFB) funds. As a result of that proposal, the West Central Local Integrating Organization (LIO) and the West Sound Watersheds Council (WSWC) recommended an assessment and evaluation of the watershed to guide prioritization of restoration and protection actions. Given the positive energy expressed by landowners during the 2013-

2014 WFC survey and the request of the WSWC, a collaboration of the Bainbridge Island Land Trust, Bainbridge Island Watershed Council, City of Bainbridge Island, and Wild Fish Conservancy formed and submitted a grant proposal for an assessment project. The SRFB funded the grant in 2014. This project is West Central Local Integrating Organization Near Term Action WC 15 and therefore a priority of the Puget Sound Partnership Action Agenda, the State's directive for recovering listed species such as Puget Sound Chinook Salmon and resident orcas. Projects identified in the assessment could result in local, regional and state financial support.

Project Elements:

While a number of project elements and tasks were a part of this project (see below), the main objective of completing a watershed scale assessment of Springbrook Creek was to identify, prioritize, and sequence) conceptual designs for future habitat improvements and/or protection projects. Projects could include restoration opportunities such as removing anthropogenic fish passage barriers, enhancing riparian habitats, evaluating the possibility of restoring the stream to its historical path, managing and treating stormwater runoff, and permanently protecting intact fish habitat and riparian functions through acquisition or conservation easements. The evaluation of existing watershed and stream data, collection of new stream data, and a geomorphic and hydrologic assessment helped guide project partners in understanding the dynamics of the stream.

Tasks Achieved:

1. Form a Project Team: A project team comprised of experts in water resources, fish ecology, watershed processes, GIS, engineering, and communications was formed. Over the course of the 36 month project, the team met over 15 times as a group, oversaw project tasks, collected new data and information, synthesized information, conducted landowner and community education, developed project selection criteria and project designs. This project did not hire a consultant to oversee and perform project management and relied instead on the project team to help complete project tasks. Members of the project team included:

Bainbridge Island Land Trust (Land Trust): The Land Trust is a non-profit conservation organization with a 29 year history of protecting, restoring, and stewarding conservation lands on Bainbridge. The Land Trust is a member of the West Sound Watershed Council Technical Advisory Committee and is the primary land protection and conservation organization on Bainbridge Island, bringing landowner outreach, landowner negotiation, conservation strategy and Geographic Information Systems (GIS) expertise to this project. As co-project manager of the grant with Wild Fish Conservancy, the Land Trust performed field assessment, facilitated and conducted community and landowner communications, generated GIS analysis and maps, performed data management, and helped develop the conceptual designs and final report.

Wild Fish Conservancy (WFC): WFC is a non-profit organization who works to ensure healthy and protected fish resources through its scientific, restoration and outreach endeavors. WFC is a member of West Sound Watershed Council Technical Advisory Committee and actively engaged on Bainbridge Island since 2014 conducting stream inventory and assessment work. WFC was project co-manager and brought substantial expertise and knowledge of salmonid life histories and habitat assessment practices and conducted extensive field work, participated in landowner outreach, assisted in project identification, provided engineer services and project designs, and helped produce this report.

Bainbridge Island Watershed Council (BIWC): The BIWC is a citizens' advisory group with knowledge of watershed conditions on the Island and has extensive experience managing volunteers who conduct salmon spawning surveys, collecting and synthesizing survey data, interacting with landowners, and policy makers. BIWC salmon monitoring data were used in this project. BIWC provided assistance with landowner outreach, project evaluation and selection, and report writing. The BIWC's Chair is a member of the West Sound Watershed Council Technical Advisory Committee.

City of Bainbridge Island (COBI): The COBI constructs and manages public works projects and many projects identified in this report will involve COBI design, permitting, and construction involvement. Additionally, COBI's Water Resources division has extensive experience and knowledge of water resource on the Island and in Springbrook Creek through a long-term (since 2000) monitoring program in the watershed. COBI oversaw the extensive water monitoring element of this project, utilizing volunteers and staff resources, managed monitoring data, synthesized the results, and contributed to elements of this report. City engineering/public works and water resources staff spent considerable time in the field assisting with surveys and data collection, and evaluating project proposals. COBI employees contributed over $26,609 in value of professional services and over $15,059 in equipment value towards the project. COBI is an active participate in the West Central Local Integrating Organization (LIO).

Washington Department of Ecology (WDOE): The WDOE is the state agency that oversees the management and care of the state's water resources. WDOE created the Puget Sound Characterization Model in 2016 with funding support from the U.S. Environmental Protection Agency National Estuary Program, a non-regulatory program that helps support efforts to improve the waters, habitats and living resources of the nation's estuaries. WDOE was brought into the project team to lend their expertise to the project by performing a watershed characterization of the Springbrook Creek Watershed using their model, with specific emphasis on water supply, water storage, and sediment transport. WDOE performed site reconnaissance, data synthesis, and report writing tasks. Their considerable efforts contributed a large amount of in-kind contributions towards the project. WDOE provided services completely in-kind and contributed over $31,142 in value for professional services.

2. Develop a Study Design: A number of local watershed assessments previously completed and funded by the Washington Recreation and Conservation Office Salmon Recovery Funding Board (SRFB) program were examined for content and design to inform the Springbrook effort. Due to the fish focus of the project's funding source, a strong emphasis of the study design was to focus gathering information on stream and watershed health issues in order to identify possible solutions to support healthy fish populations. Additionally, specific outcomes as required by the project funder required certain elements of the study to take place. The study design chosen needed to lead the project team towards the goal of identifying protection and restoration actions, and prioritizing those actions. The tasks described in this section reflect the elements of the study design the project team felt were necessary in order to achieve project goals.

3. Engage Landowners, Stakeholders, Volunteers, and the Public: An important element of the project was to engage those that live and work in the watershed. This project element included landowner outreach, engaging organizations and agencies that work in or have an interest in the watershed, engaging volunteers, and to provide public education about the project.

Landowners: In order to gather information from those living within the watershed to learn the history of stream and land use, understand existing stream conditions and land uses, and to engage the landowners in helping care for the stream and watershed, a robust outreach endeavor took place. Over 123 landowners were contacted by mail, phone and/or email who live adjacent to the main stem or tributaries of Springbrook Creek. Seventy five landowners responded to those inquiries, with 54 of them granting the project team access to their property and the stream in order to assess the condition of the stream, riparian area and more. All 54 properties where permission was granted were visited, sometimes multiple times, and on many of those visits, landowners participated, or engaged in phone discussions about their property. Through these interactions, 294.2 acres were visited to gather information about the existing features of the stream. This information was used to assess the overall condition of the watershed and project ideas were formulated and discussed. Most communications with landowners was with owners of individual parcels, with some project team group meetings with clustered landowners in certain segments of the watershed. One such example was a meeting hosted by the Land Trust on June 12, 2018 of six property owners who live at the corner of High School Road and Fletcher Bay Road.

<u>Stakeholders (non landowners):</u> Early in the project, efforts were made to learn from those working in the watershed, collect data and information, and to engage those interested in improving watershed conditions. Two stakeholder meetings took place early in the project on April 27, 2015 and May 19, 2015 with the following organizations (and their role) participating:

- BI Watershed Council* - salmon spawning surveys and overall watershed health/management work
- City of Bainbridge Island *+ - long term water monitoring program, management of public roads and infrastructure
- Kitsap Conservation District – technical assistance and cost share program for implementing best management practices on agricultural/farm lands
- Kitsap County Natural Resources - natural resources data, GIS, technical assistance
- Kitsap Health District – water pollution prevention and septic permitting and inspections
- Mid Sound Fisheries Enhancement Group – stream survey work

- Suquamish Tribe *+ - permitting and technical assistance in tribe's usual and accustomed jurisdiction
- Washington Department of Fish and Wildlife*+ - permitting of activities and technical assistance
- Wayne Daley - involved in past restoration efforts
- Wild Fish Conservancy*+ - stream assessment surveys
- Friends of the Farms* - manager of public farm lands in watershed
- Washington Department of Ecology* - oversees 303(d) program

Those entities with an "*" participated in a Walk the Springbrook Watershed day from the headwaters to Fletcher Bay on May 10, 2018 to view existing conditions and provide feedback on proposed restoration actions. Those entities with a "+" also participated in a March 16, 2018 examination of proposed culvert projects at the corner of High School Road/Miller Bay Road and Fletcher Bay Road.

Ongoing interaction with these stakeholders took place throughout the project.

Volunteers: By engaging volunteers in the project, more people were able to gain knowledge about the watershed and become ambassadors of the stream and its resources. This project engaged over 40 individual volunteers (in addition to the above listed stakeholders) who contributed over 240 hours of time (equaling $3,632 in value) performing water monitoring at specifically identified monitoring sites (see Section 3.6), salmon monitoring, and on-site work with landowners.

Public Outreach: The project included several approaches to make information about the project available to the community and the public at large (in addition to meeting one to one with individuals). Some of the larger outreach endeavors included:

- The Bainbridge Island Land Trust hosted a project webpage: https://www.bi-landtrust.org/protected-spaces/springbrook-creek/
- The Bainbridge Island Land Trust featured the project in their Spring 2017 newsletter which reaches 1500 people.
- The City of Bainbridge Island hosted a project webpage: https://www.bainbridgewa.gov/868/Springbrook-Creek-Watershed-StudyIsland Center Sub Area Planning Meeting February 20, 2018 presentation by Cami Apfelbeck, City of Bainbridge Island to talk about the water quality issues in the watershed.
- Island Center Sub Area Planning Meeting June 20, 2018 (attended by the public, sub-area planning members, City staff)A presentation about the project results was provided to the West Sound Watersheds Council August 7, 2018.
- The project team presented several updates to the West Sound Watersheds Council Technical Advisory Group.

4. Examine historical information about the watershed, including past studies

The project team compiled and synthesized existing watershed data and engaged landowners and stakeholders to assist in evaluation of current and historic in-stream riparian, sediment transport, and hydrologic conditions. Existing baseline monitoring and assessment efforts within the watershed included:

- City of Bainbridge Island Water Quality and Flow Monitoring Program's long-term status and trends monitoring in the lower watershed (2010 - present). Parameters include continuous automated flow monitoring and precipitation, grab sampling for bacteria (monthly) and nutrients (semi-annually) with in-situ physiochemistry; annual benthic macroinvertebrate sampling; sediment sampling of substrate; and targeted storm event sampling. The program conducted focused dry-season bacteria source monitoring in the middle and lower watershed in 2011.
- Sinclair and Dyes Inlets Fecal Coliform Bacteria Total Maximum Daily Load TMDL and Water Quality Implementation Plan
- King County Department of Natural Resources and Parks, Water and Land Resources Division, Science and Technical Support Section 2015 Stream Benthos and Hydrologic Evaluation for the City of Bainbridge Island (DeGasperi and Gregersen, 2015). This assessment of the city's status and trends monitoring data compared streamflow characteristics to land use/land cover and benthic macroinvertebrate health to identify land use and flow alteration impacts to the stream benthos community.
- Initiated in 2005, the Bainbridge Island Watershed Council's annual monitoring program tracks juvenile fish use and adult salmon returning to four streams on Bainbridge including Springbrook Creek. Data is collected for observed juvenile fish and resident cutthroat, returning spawning salmon (alive and carcasses) and redds observed annually in the fall from 2005-2014, as well as a stream substrate (sediment) survey. This project uses monitoring data as a baseline for salmon productivity, and continued monitoring by BIWC will enable the project to evaluate changes in salmon productivity moving forward.
- West Sound Water Type Assessment, Phase III 2014-2015. http://wildfishconservancy.org/ Wild Fish Conservancy, with partner Bainbridge Island Land Trust, completed initial stream typing for the majority of Bainbridge Island streams in 2014. Springbrook Creek was one of the streams assessed. The Washington State Recreation and Conservation Office Salmon Recovery Funding Program funded the project (Project 13-1143) and the West Sounds Watershed Council supported the project. The assessment documented both cutthroat and coho juveniles throughout the Springbrook Creek watershed where fish had access. The identification of 3.71 miles of total additional stream length and 3.12 miles of fish habitat, as well as a more comprehensive inventory of fish passage barriers, resulted from the 2014 assessment. During the 2014 efforts, WFC and BILT received a favorable response of landowner permissions to access the stream through private property, therefore providing initial opportunities to build landowner relations in this watershed and understand the condition of not only the stream, but the associated riparian and uplands.
- Washington State Department of Fish and Wildlife initiated a culvert inventory and assessment for the watershed as a whole in 2014. This work complements Wild Fish Conservancy stream assessment work.

- Fletcher Bay Pollution Identification and Correction Project (PIC) (2013-2015), Kitsap County Health District in collaboration with City of Bainbridge Island Water Resources Program. Project conducted bacteria source tracking along Issei Creek, Springbrook Creek and Fletcher Bay shorelines to identify and address threats to shellfish habitat in and around Fletcher Bay. Landowner outreach to inspect septic systems and communicate information on septic maintenance, pet waste management, and natural yard care was an important component of this project, resulting in a 12.2% increase in septic tank inspection/pumping in Fletcher Bay.

5. Identify information gaps, perform new assessments, or procure needed data.

Based on the examination of landowner information, stakeholder feedback, and historical information, the project team identified the types of information needed in order to complete the watershed assessment and develop projects. A strong emphasis was placed towards performing on the ground assessment and information gathering and landowner outreach. The assessment project accomplished the following actions:

- Gaining more landowner permissions and visiting more properties allowed for stream and riparian condition assessment for nearly all portions of the stream. Field work performed by all project team members, with Wild Fish Conservancy documenting conditions. By the end of the project, about 65% of the watershed's stream length was field surveyed (about 4.7 miles of 7.2 miles of stream). The project team visited over 294 acres as part of this project.
- A comprehensive inventory of fish passage barriers in the watershed. Performed by WFC in consultation with WDFW.
- Additional water quality and flow information (including storm events) was collected to get a better picture of conditions basin-wide in order to supplement data already collected. Establish monitoring sites and obtain landowner permission. Performed by the City of Bainbridge Island and volunteer monitors.
- Assessment of the overall watershed geomorphological, hydrology, sediment, storage, and condition. This resulted in the hydrologic analysis of the watershed by the Washington Department of Ecology using their Puget Sound Characterization Decision Support Tool (Stanley et. al. 2016).
- Better understanding of ecosystem characteristics and land use. GIS analysis performed by the Land Trust.
- Ongoing and additional landowner and stakeholder outreach to learn more about historical land use, and explore restoration and protection opportunities. Performed by all project team members and some volunteers.
- Utilize spawning surveys performed by BIWC.
- Utilize topographical survey and LIDAR data (watershed-wide and project specific) to inform a number of project elements, including understanding the stream's historical flow and hydrology.

6. Review and synthesize all data collected: This project brought together historical and new data/information in the form of this report, providing for an opportunity to look at the conditions of the stream and watershed from a multi-faceted perspective.

7. Identify limiting factors: Based on the information gathered, the project team identified "limiting factors" - conditions that limit the ability of the stream or watershed to fully sustain populations of salmon and provide other important functions (such as storm water retention).

8. Develop a rationale for developing and selecting projects (Project Selection Framework).

Guidance outlined in the document "Setting River Restoration Priorities: a Review of Approaches and a General Protocol for identifying and Prioritizing Actions" (Beechie, et. al 2008) provided a basis for identifying, developing and selecting projects in Springbrook Creek. The project adopted both a logical and analytical strategy for prioritizing restoration or protection actions.

9. Identify potential projects and actions to address limiting factors

10. Prioritize five projects and develop final conceptual plans in consultation with landowners

11. Synthesize project data and findings into a report

3. Watershed Characteristics and Assessment Findings

3.1 History, Land Use and Development

Before European settlement, dense old-growth Western red cedar, Douglas-fir, and western hemlock forests dominated the Bainbridge Island landscape, with a few seasonal Suquamish settlements. However, by the late 1800s the Island was home to the world's highest-producing lumber mill and a thriving shipbuilding industry, and the entire Island had been clearcut by the early 1900s. Much of the cleared land converted to agricultural use. The Springbrook Creek part of the Island became a center of agricultural called Island Center, with two dairies, two greenhouse operations and several farms and small livestock operations. Local farmers (led by farmers of Japanese descent) pioneered rhubarb, raspberry, loganberry, and especially strawberry production in Kitsap County (Elfendahl 1996). Ranchers and farmers used the stream, with cattle and other livestock allowed free access to the stream and numerous dams constructed to create irrigation ponds.

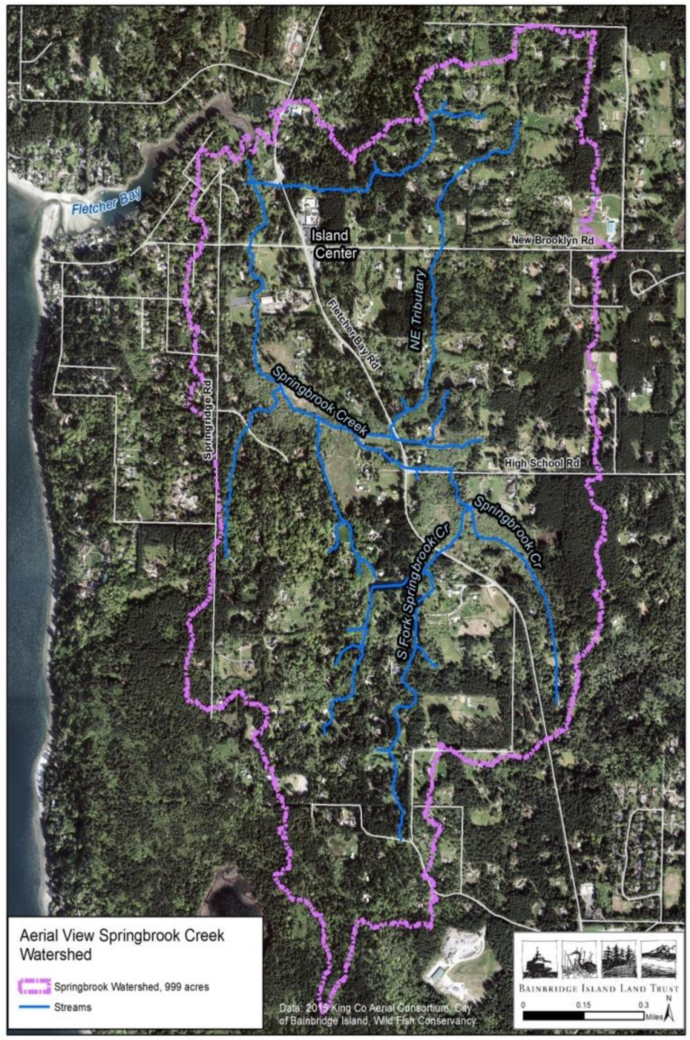


Figure 2. Aerial view of Springbrook Creek Watershed

Agricultural lands are now greatly reduced and on the scale of hobby farms than commercial operations, although several irrigation ponds persist in the Springbrook Watershed. The historic Johnson Farm is within the Springbrook Creek and is owned by the City of Bainbridge Island and managed by the non-profit Friends of the Farm. Forest cover has made substantial recovery and now over 70% of the land area is in second-growth trees (Figures 2, 5, Table 1). Douglas-fir, western red cedar, bigleaf maple, alders, and Pacific madrone are common species. The Island Center service area is predominantly low-density residential housing in a patchwork of forest and open pastures and lawns. Near Fletcher Bay the Island Center "service center" is one of five such commercial centers designated under Bainbridge Island's Comprehensive Plan, with a gas station, restaurant, auto repair shop, a retail nursery Bainbridge Gardens and a few other small businesses. The service center contains the majority of impervious surface in the Springbrook watershed.

Fletcher Bay Road NE/Miller Road is one of the Island's main transportation corridors providing north to south access to the west side of the Island. The road runs from its intersection with Highway 305 to the north, down to its intersection with Lynwood Center road to the south. New Brooklyn and High School Roads are primary east/west roads which feed into Fletcher Bay Road NE. As Highway 305, the main road that connects the Island with the Seattle-Bainbridge Washington State Ferry and the Kitsap Peninsula, becomes more congested, use of Fletcher Bay Road NE as a north south quasi-arterial for vehicular traffic increases. The City of Bainbridge Island 2012 Traffic Study documented that during peak times (4:00 p.m. – 6:00 p.m.) over 300 cars traveled in the proximity of the corner of High School Road and Fletcher Bay Road NE while an average of 400 cars traveled through the intersection of New Brooklyn and Miller Road. Road improvements to address traffic volumes and bike and pedestrian safety are in planning and current implementation stages. Road impacts on stream health, water quality (particularly stormwater run-off), and fish passage where roads cross streams will be of growing concern.

Zoning across the majority of the watershed is R-0.4, allowing one housing unit per 2.5 acres. As further discussed in Section 3.4.2, the watershed was divided into sub-basins called assessment units (AUs). The areas zoned for higher housing density and commercial uses (Neighborhood Service Center) are concentrated near Fletcher Bay in sub-watershed assessment units (AUs) 1 and 2 (Figure 3). There are a total of 154.2 acres in the watershed with some level of protection afforded by Kitsap County property tax designations such as General or Agricultural Open Space, representing 15% of the watershed area. There are 68.4 acres in the watershed owned by the City of Bainbridge Island and/or protected under a Bainbridge Island Land Trust conservation easement that have a high-level of permanence in management as forest lands, parks (including the northern portion of the large Gazzam Lake Preserve overlapping the southern watershed area), and a farm (Figure 7). There are an additional 17.4 privately-owned acres managed under a separate conservation easement which allows for management for agricultural uses. Within the study area, 62% of the parcels have some form of development, while 18% remains undeveloped and unprotected. Closer examination of properties with no buildings and a predominance of natural vegetation finds that these types of undeveloped parcels (regardless of protection status) comprise 22% of the watershed. Based on land use and zoning, increased development within the watershed is possible. The COBI Island Center Subarea Planning effort currently underway is examining a number of items related to supporting and managing activities in that part of the watershed.

The City of Bainbridge Island ‘s 2017 Critical Areas Ordinances (CAOs) protects wetlands and riparian areas, with buffers generally 75-125 feet wide on wetlands in this watershed and 200-foot buffers on fish-habitat streams. A 2018 Native Vegetation Protection Area ordinance applies to R-0.4, R-1 and R-2 zones, (nearly all of Springbrook Watershed), with the intention of protecting groundwater resources by requiring retention of up to 65% of native vegetation when development or redevelopment results in greater than 800 square feet of hard surfaces or greater than 7,000 square feet of land disturbing activity (City of Bainbridge Island 2018).

Aquifers provide all of Bainbridge Island’s drinking water. The entire Springbrook Creek Watershed is mapped by Kitsap County as a Category 2 Critical Aquifer Recharge Area (vulnerable to contamination by some land use activities). Category 1 Critical Aquifer Recharge Areas occur in the northwest and southeast portions of the watershed (indicating that potential for certain land use activities to effect groundwater is high). The City of Bainbridge Islands (COBI), Winslow Water Service Area (WSA), and private wells provide water used for residential and commercial use (drinking water) in the Island Center area. The existing WSA lies primarily west of Fletcher Bay Road NE and north of NE High School Road and supplies about 90 households in the Springbrook Watershed study area. According to the COBI's 2017 Water System Plan, there is a goal within the next 20 years to expand water delivery to all residences within expanded Retail Water Service Areas. According to the plan, the water system has sufficient water rights to last well into the future, and Island groundwater resources will benefit from expanding public and private water systems in preference to shallow or individual residential wells. Kitsap County GIS data show 88 individual wells in the watershed, which is likely an underestimate given that private wells supply roughly 240 households (> 70% of the total number of households) within the study area. There is no sewer district serving the watershed, with site specific septic drain fields serving residential and commercial purposes. Power, telephone, cable and cell services are all available within the watershed.

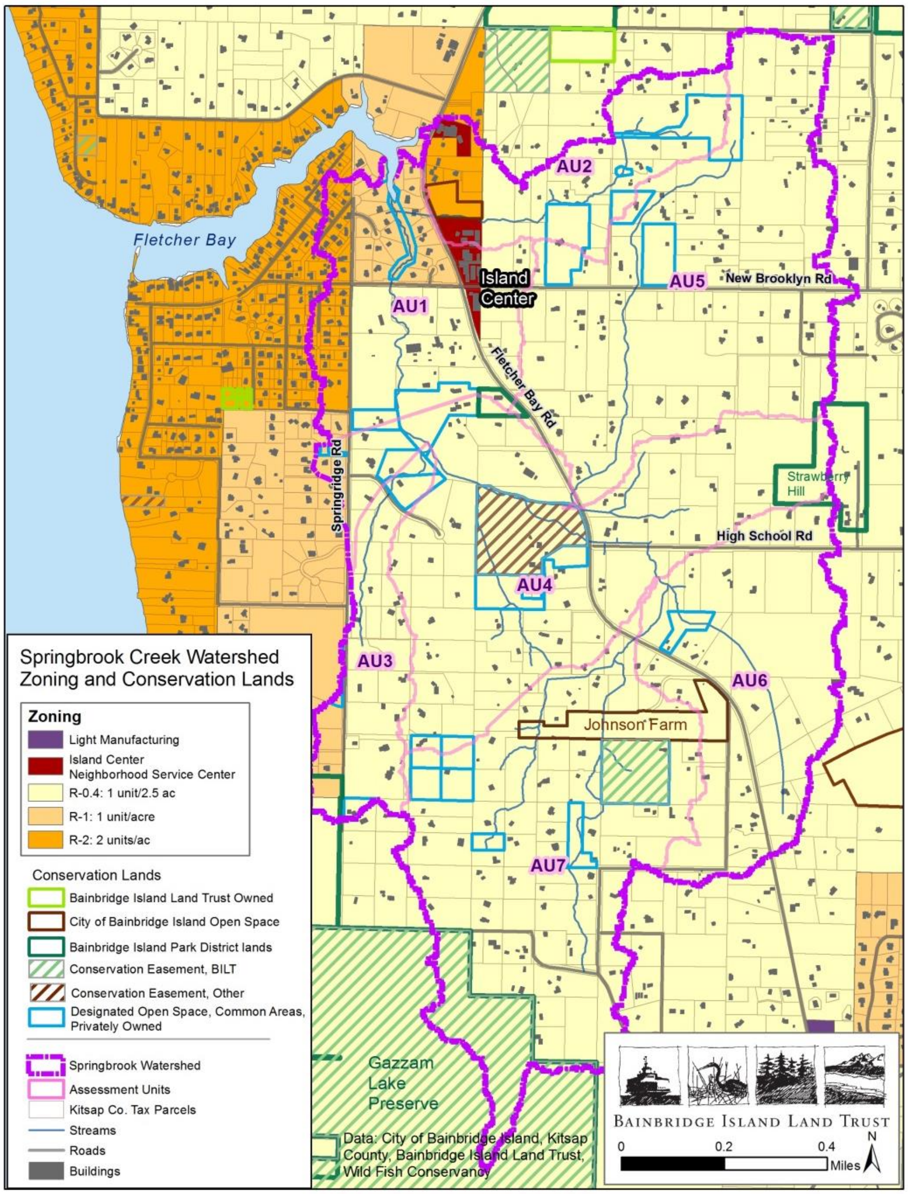


Figure 3. Zoning, conservation lands, buildings, and parcels in Springbrook Creek Watershed.

In an effort to understand recent trends in land use within the watershed, we obtained land cover data from 1999 and 2015 to quantify changes that had occurred in that time. Unfortunately, it proved difficult to make valid comparisons even of what seem to be comparable land cover types, due to differences in the methods and quality of data utilized: classification from 25m^2 pixel satellite imagery in 1999, versus 1m^2 LIDAR (the more precise laser-based Light Detection and Ranging) in 2015. In particular, considerable misclassification occurred between the bare ground, low ground cover, and impervious surfaces categories in 1999. We did find that both years show about 17-18% of the watershed in combined bare ground or low ground cover, which examination of aerial photos from the same time frames suggests may be fairly accurate. However the comparison shows a decline in impervious surfaces in the watershed, from 7.9% in 1999 to 6.5% in 2015. Closer examination of aerial photos reveals that the 1999 classification erroneously assigned areas of bare ground or low vegetation as impervious. Given the building of homes and infrastructure rather than removal in this time span, we believe a slight increase in impervious surfaces has more likely occurred. The land cover classifications presented by Assessment Unit in Figure 6 illustrate differences within subareas of the watershed as will be further discussed in Section 3.4.2.

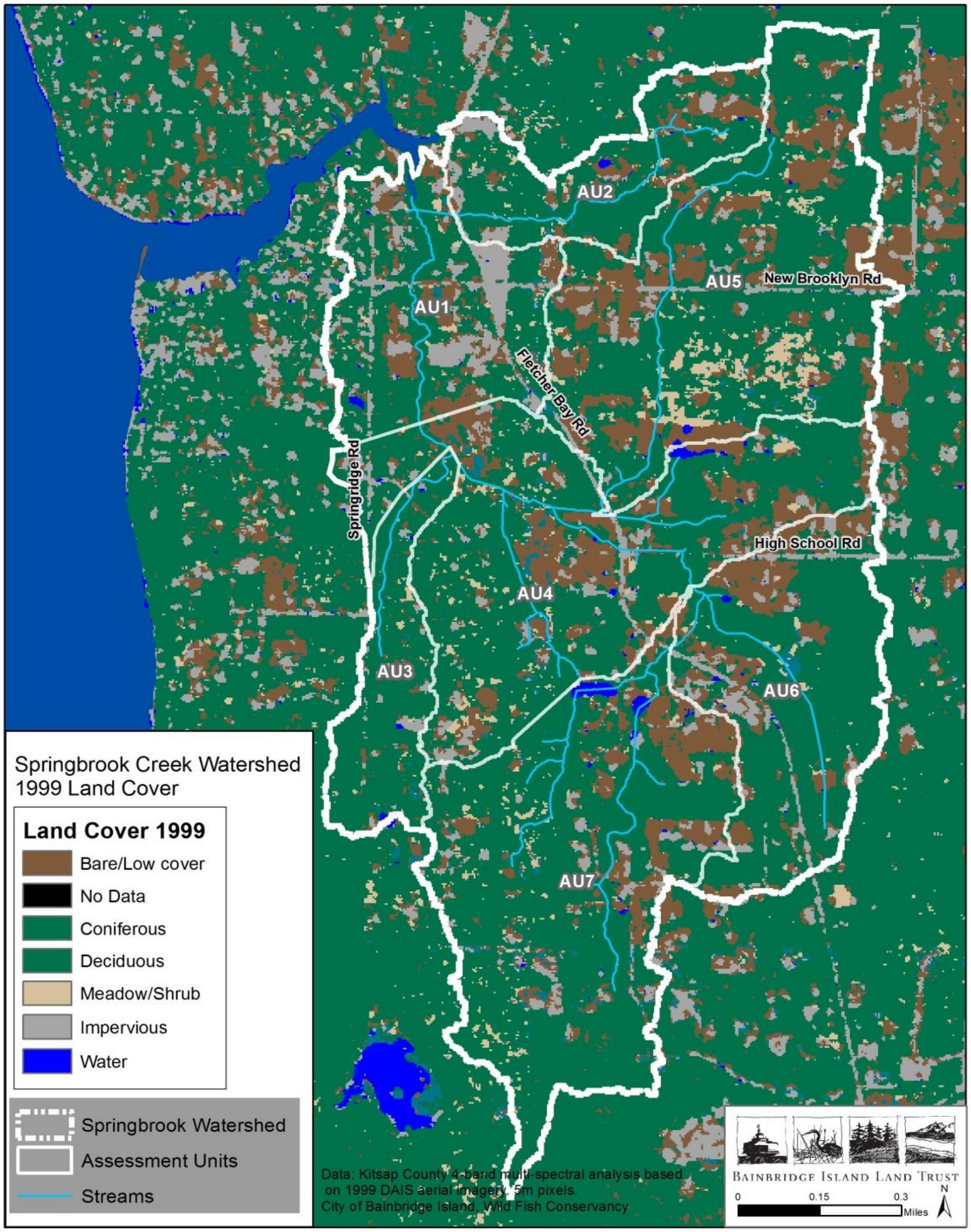


Figure 4. 1999 Land Cover from satellite imagery (25m^2 pixels).

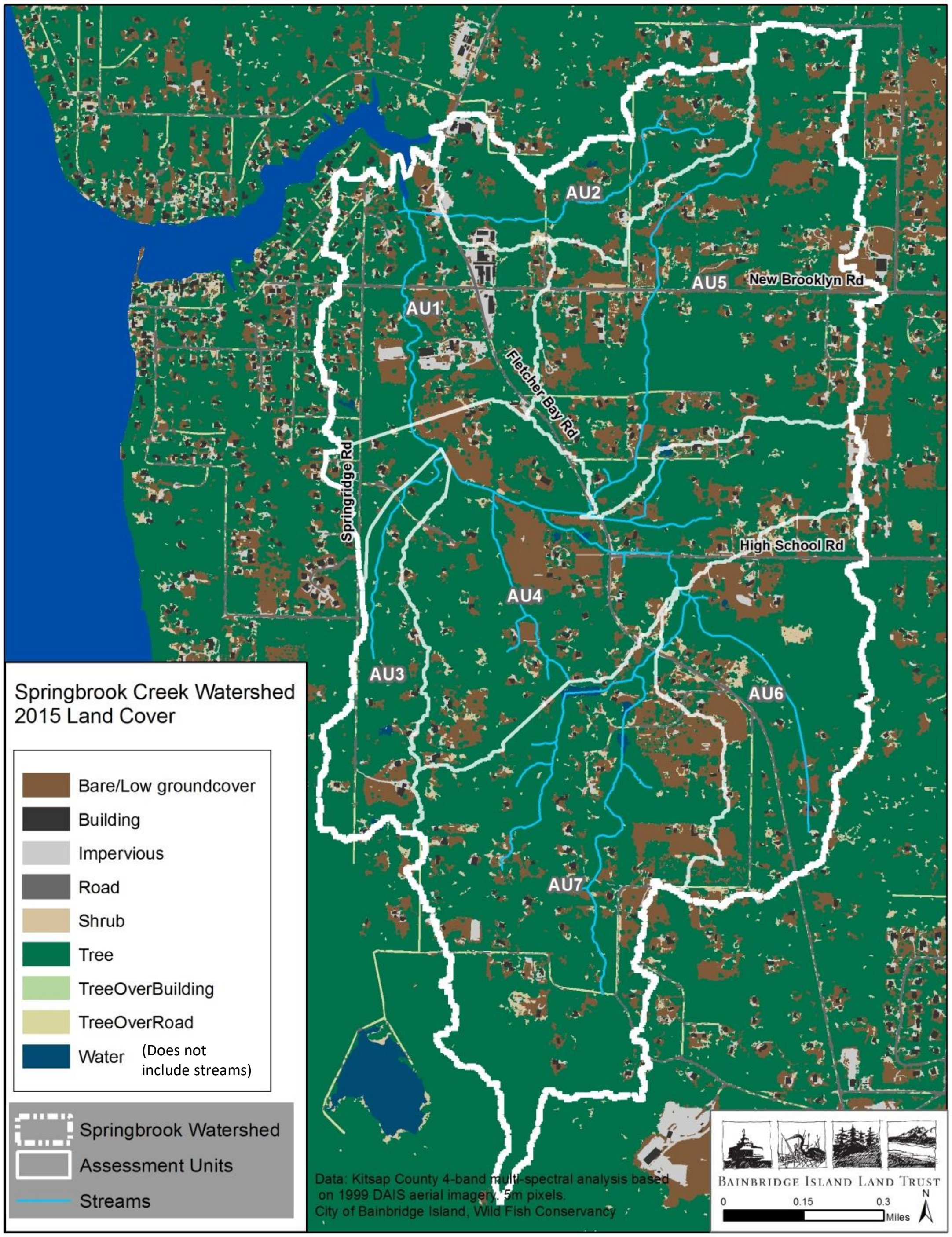


Figure 5. 2015 Land Cover from LIDAR (1m^2 pixels).

Table 1, Chart 1. Changes in watershed land cover 1990-2015.

Categories combined to reflect inaccurate distinctions between bare ground and ground cover in 1990. Note that neither mapping accurately maps emergent vegetation or wetlands.

Cover type	1999	2015
Buildings, impervious, trees over impervious	7.9%	6.5%
Bare ground/low groundcover	17.9%	17.5%
Shrub	3.5%	3.2%
Trees	68.9%	72.5%
Water categories	0.6%	0.3%

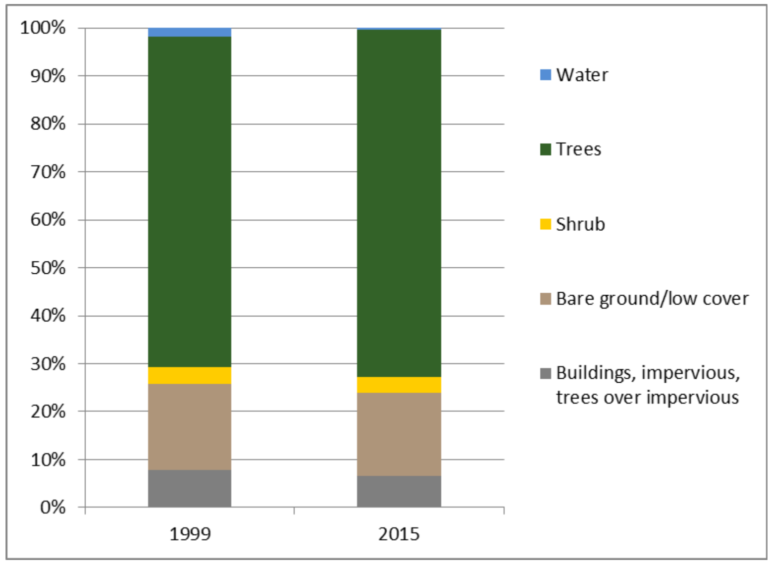


Table 2. 2015 land cover by Assessment Unit.

Cover type	AU1	AU2	AU3	AU4	AU5	AU6	AU7
Buildings, impervious, trees over impervious	15.9%	8.5%	5.3%	5.0%	6.0%	5.6%	4.1%
Bare ground	0.5%	0.2%	0.3%	0.1%	0.1%	0.1%	0.2%
Low ground cover	17.7%	12.4%	10.0%	19.8%	20.4%	17.9%	14.8%
Shrub	4.0%	2.5%	1.6%	2.9%	3.4%	4.4%	2.9%
Trees	61.6%	76.2%	82.1%	71.9%	70.0%	71.8%	77.3%
Water, emergent veg	0.3%	0.2%	0.7%	0.3%	0.1%	0.1%	0.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

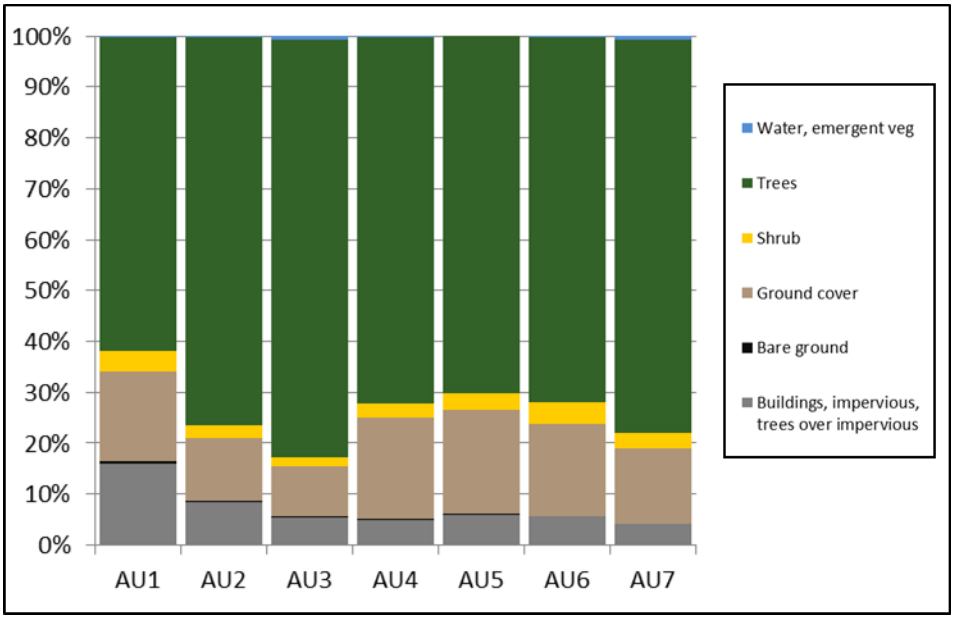


Figure 6. Land Cover by Assessment Unit

Knowledge of wetlands within the overall watershed and subareas is important to understand watershed functioning, but the 1999 classification did not accurately map wetlands and they were not a category in 2015. These were therefore calculated by Assessment Unit only for 2015 (Figure 7). GIS data by COBI and the Land Trust map wetlands based on rough delineations from aerial surveys combined with some ground delineations, shown as mapped wetlands throughout this report. As ground verification occurred on only portions of the Island, this mapping suffers from some omissions and boundary errors and is constantly being updated. For instance, the reach description for SB01A below describes wetlands observed along the stream in Assessment Unit 2, although the GIS mapping shows no wetlands in this area. The mapped wetland areas do show significant variation between subareas of the watershed in wetland percentage (Figure 7). Freshwater Wetlands, designated as Priority Habitat by the WDFW, cover 7.8% of the overall watershed.

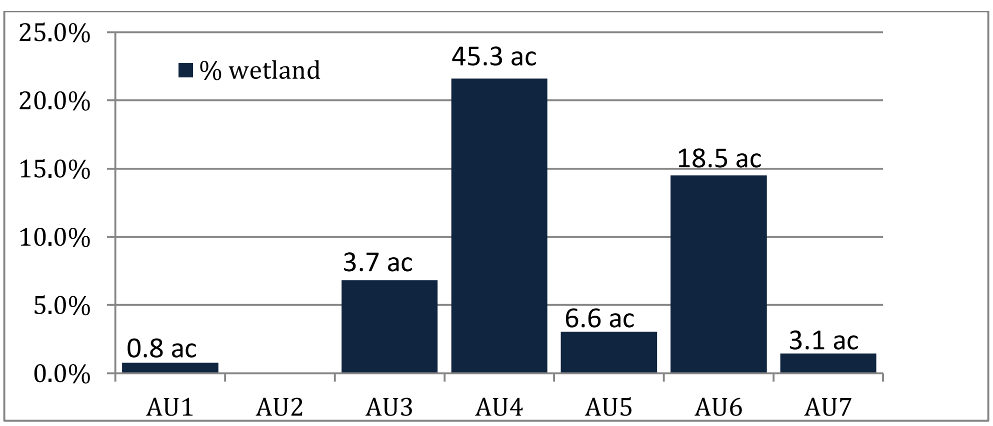


Figure 7. Percentage and acres of each Assessment Unit in wetlands.

Road densities are highly impactful on watershed functioning as they contribute sediments and pollutants into streams and change water flow patterns. NOAA Fisheries has defined road densities of less than 2 mi/mi^2 as contributing to “properly functioning” watershed conditions, 2-3 mi/mi^2 as “at risk” and over 3 mi/mi² as "not properly functioning" (NOAA 1996). We calculated road densities based on an Island-wide roads layer (including only paved city roads) and again based on roads combined with COBI-mapped driveways, which includes a much more extensive network of private paved, gravel, and dirt roads. The standard of 3 mi/mi² is not realistic within an area with the housing densities of Springbrook Watershed, but the overall density of 16.15 when all roads are included is quite high, and with clear differences between assessment units within the watershed (Table 3).

Table 3. Road density by Assessment Unit.

Area	City Road Density (mi/mi²)	City Roads and Driveways[1] (mi/mi²)
AU1	10.03	24.84
AU2	3.02	19.00
AU3	4.21	18.89
AU4	3.75	13.70
AU5	5.13	15.30
AU6	6.73	15.21
AU7	3.55	14.09
All Springbrook	5.01	16.15

[1]May be gravel, paved, or dirt.

3.2 Climate

The Puget Sound area has a mild, marine climate, with average daily temperatures on Bainbridge Island ranging from ~50-70°F in summer and ~35-50°F in winter. Although summers are much drier and sunnier than winters, skies are cloudy an average of 225 days of the year and total precipitation averages 37 inches, almost exclusively in the form of rain rather than snow. When snow falls, it tends to melt rapidly.

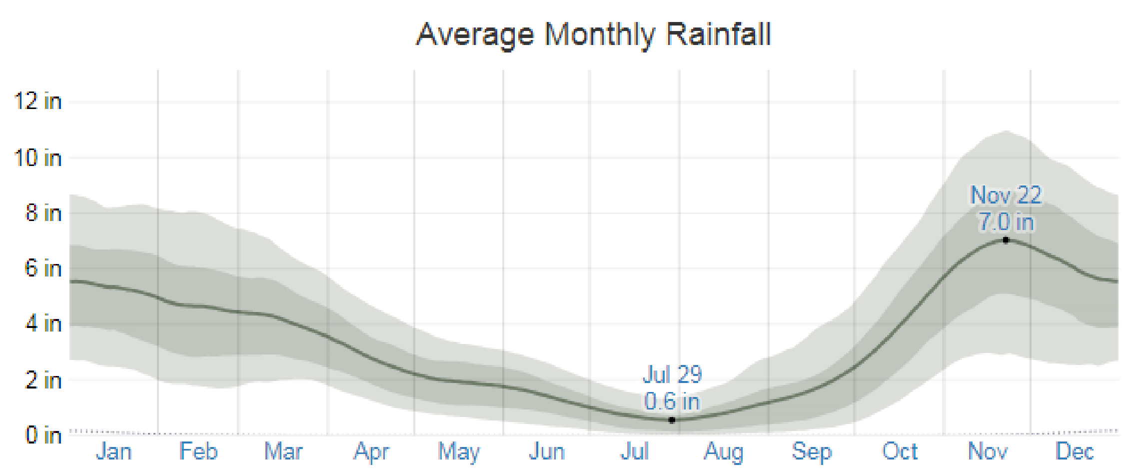


Figure 8. Average monthly rainfall on Bainbridge Island, with 25th-75th percentile inner and 10th-90th percentile outer band.

From Weatherspark.com, distance-weighted averages of weather stations at: King County International Airport (48%, 20 km SE); Bremerton National Airport (30%, 24 km SW); Snohomish County Airport (17%, 36 km NE); and William R Fairchild International Airport (4.8%, 91 km NW).

According to a 2016 Bainbridge Island Climate Change Assessment (Hansen et al. 2016), analysis suggests that temperature increases will affect all seasons, with the greatest increase in summers. Precipitation is anticipated to become more variable, with more intense winter rain events, but decreased summer precipitation. The increased temperature combined with decreased precipitation in summer is anticipated to increase human demand for water for household use and maintenance of landscaping, as well as stressing natural vegetation and changing vegetative communities (Hansen et al. 2016). Warmer, drier conditions increase evaporation rates. Dry conditions result in reduced stream flow and diminished aquifer recharge. Warmer and drier conditions can also reduce water quality, both by increasing in-stream temperatures and concentrating contaminants in smaller volumes of water. Climate changing conditions can elevate wildfire risk.

The increased intensity of winter storm events may overwhelm stormwater infrastructure capacity as more intense and frequent storms or heavier rainfall events cause infrastructure inundation, localized flooding, chronic flooding, non-infiltrated run-off, erosion and landslides (COBI Comp Plan 2017). More delivery of precipitation in high-intensity events decreases groundwater recharge rates as water does not have time to infiltrate into saturated soils, and impacts surface water quality by carrying contaminants and sediments into streams (Hansen et al. 2016).

Specific to streams, and their interactions with road crossing through culverts, it is anticipated that climate change will cause major changes in stream hydrology and channel morphology across Washington State. Culverts built today may not accommodate future channel conditions without careful analysis. In the Pacific Maritime ecoregion, is it projected that bankfull width will increase 12.1% by 2080 (Wilhere, George F., et al. 2017).

Another impact to water quality may come from increased septic system failures due to either too much or too little water for proper functioning. All of these factors will negatively impact in-stream fish habitats in terms of water quantities and quality. The anticipated 14-54" increase in sea level in this region will greatly impact shorelines, estuaries such as Fletcher Bay, and the lower reaches of Island streams (Mauger et al. 2015). Increases in frequency and intensity of harmful algal blooms may impact nearshore foodwebs.

3.3 Ecological Systems and Critical Areas

A combination of climatic factors as well as soil attributes, ecological processes such as flooding and fires, and human management shape the Island's vegetation. Washington Department of Natural Resources' mapping of plant communities using NatureServe's Ecological Systems classification (Figure 9) identifies a majority of the natural vegetation within Springbrook as North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest followed by North Pacific Maritime Dry-Mesic Douglas-fir Western Hemlock Forest (Rocchio and Crawford 2015b; Figure 9). These forests have been influenced by a low rate of natural disturbances (such as moderate-severity fires occurring at long intervals and occasional bark beetle attacks) and were historically characterized by giant Douglas-fir with western hemlock and western red cedar co-dominant. Bigleaf maple and red alder are common canopy or sub-canopy dominants, especially where disturbance has occurred, and broadleaf trees may dominate stands regenerating after fire and/or logging for decades.

A substantial area of marshy to forested wetland communities (indicated as 'wetland types' on Figure 9) are mapped along the creek in the mid-watershed. Much of this is North Pacific Lowland Riparian Forest and Shrubland Ecological System, which is categorized as State imperiled (S2, Rocchio and Crawford 2015a). Impacts cited as contributing to this status in Washington include development, agricultural uses, alterations in hydrology, and degradation by invasive species, and few of these systems assessed region-wide by WDNR had good ecological integrity. All of these stressors impact these lowland riparian habitats in Springbrook Watershed, as further detailed below.

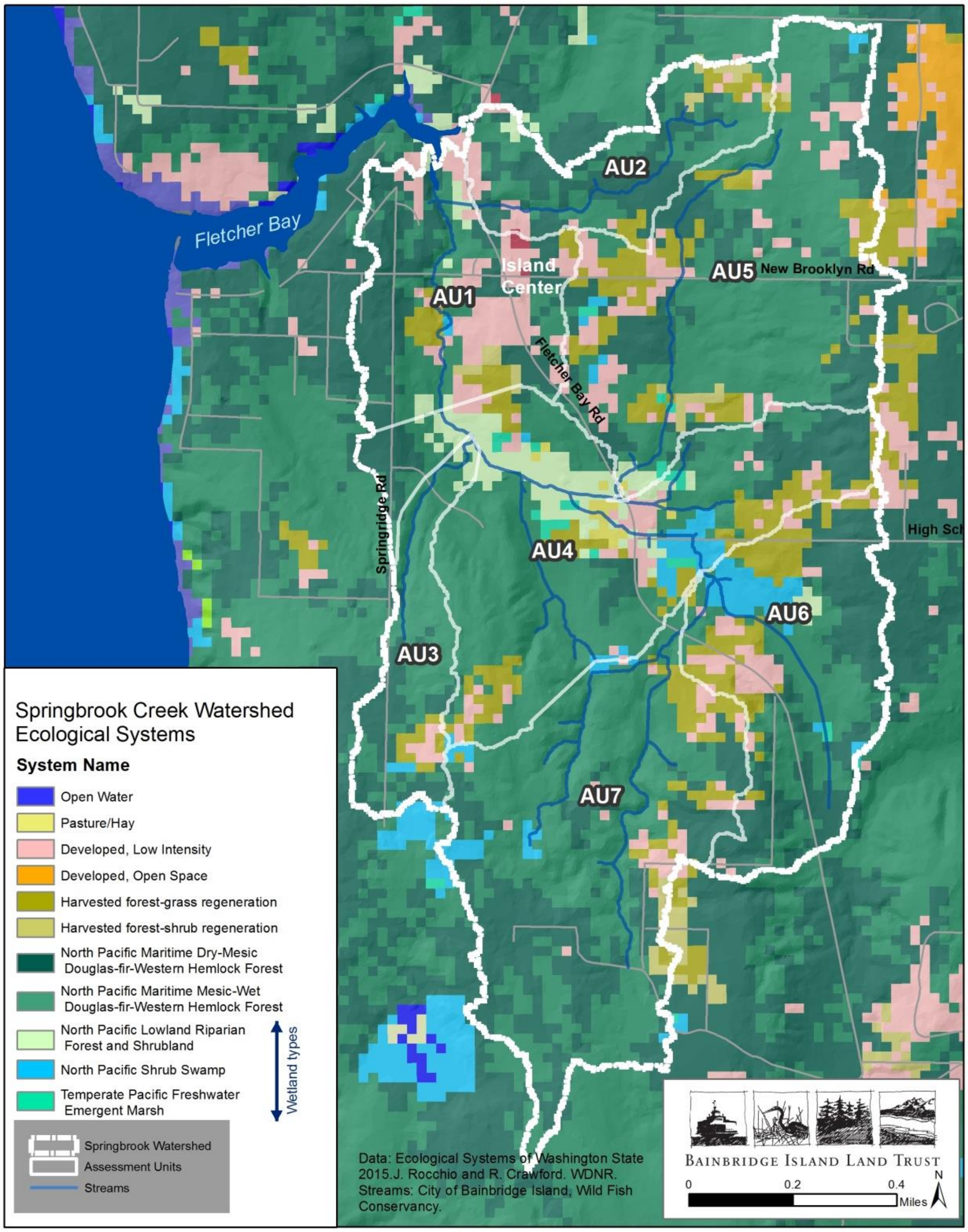


Figure 9. Ecological Systems of Springbrook Creek Watershed.

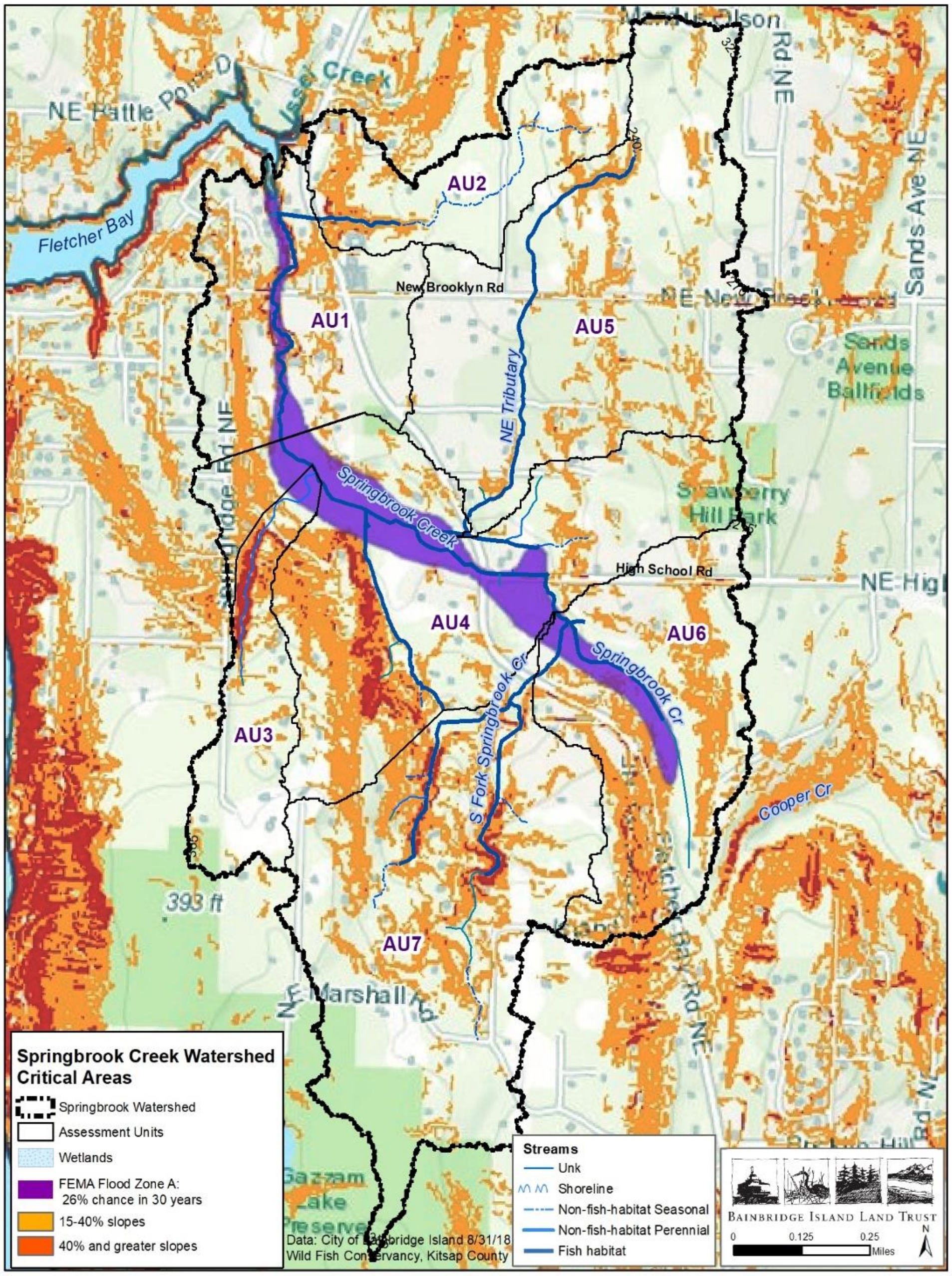


Figure 10. Springbrook Creek Watershed Critical Areas.
Note that stream and wetland buffers are not depicted.

Critical area designations within the watershed include shoreline, streams and their associated riparian areas, wetlands, critical aquifer recharge areas and steep slopes. Each designation reflects the diversity of ecosystem functions within the watershed. The watershed has an overall bowl shape sloping down to Fletcher Bay, with the highest elevations of just over 380 feet in elevation in the southwest, and with often steep-sloped upper watersheds of tributaries around the south, east, and northeast fringe. The Springbrook Creek floodplain forms a flat valley through the center of this watershed, flowing from the southeast to northwest (Figure 10). As mentioned under Section 3.1 above, the entire watershed is classified by Kitsap County as a Category 2 Critical Aquifer Recharge Area, indicating vulnerability to contamination by some land use activities, and the Category 1 Critical Aquifer Recharge Areas in the northwest and southeast have high potential for certain land use activities to affect water quality (Figure 10). The City of Bainbridge Island classifies the entire island as a critical aquifer recharge area based on current data.

3.4 Watershed Features: Geology, Assessment Units, Stream Networks

3.4.1 Surficial Geology

(Excerpted from Washington Department of Ecology Springbrook Characterization 2018, contained as Appendix I. Stephen Stanley, et.al 2018)

Surficial geology determines where infiltration, recharge, and discharge of groundwater occurs in a watershed and is a key control for these watershed processes. The surficial geology of Bainbridge Island is, in part, the result of glaciation originating in Canada approximately 18,000 years ago and by surface erosion occurring over the last 14,500 years after the glacier's retreat. The weathering and erosion of the glacial surface deposits has been caused by the movement of surface and shallow subsurface flows and discharges, which have, in turn, created the present day stream network within the Springbrook Creek Watershed.

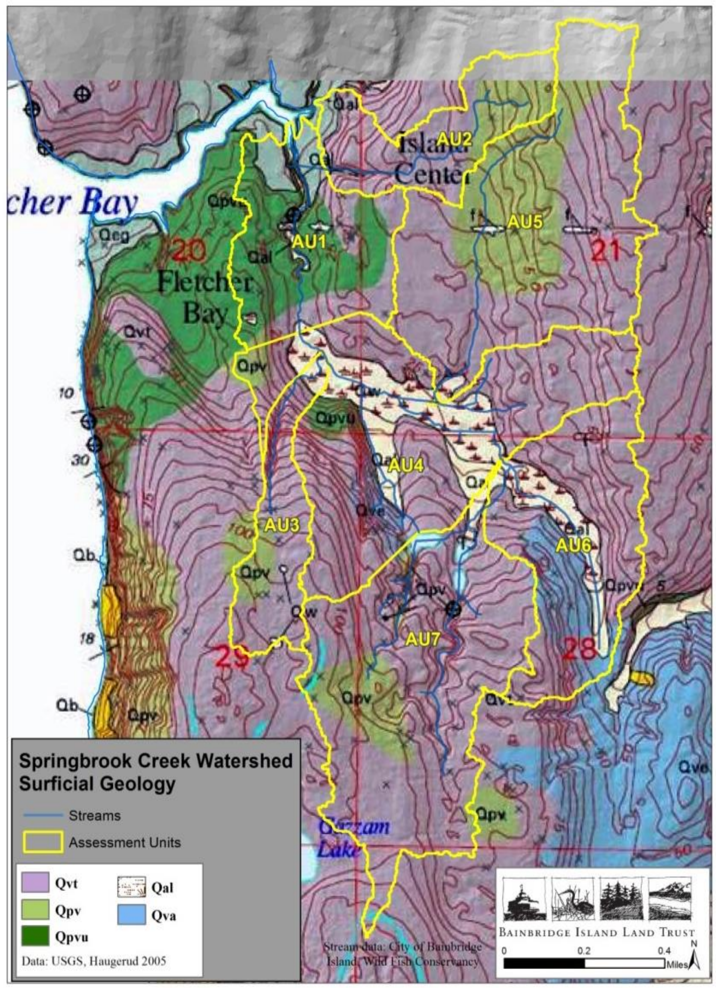


Figure 11. Surficial geology map of Springbrook Watershed

Note that the watershed is comprised primarily of low permeability till deposits (purple color: Qvt), but also contains areas of higher permeability "advance outwash" deposits (green color: Qpv) that are important for water flow processes and are primarily located in the upper watershed of Project Assessment Unit (PAU) 3 and 7 as well as in PAU 2 and 5. The "white" Qal polygon is the location of depressional wetlands (PAU 4) which play an important role in the storage of surface waters and is also an area of groundwater discharge. Source USGS, Haugerud, 2005.

The glacial deposits on the island consist primarily of till, advance outwash and recessional outwash (Figure 11). Till is a highly compacted glacial deposit that has relatively low permeability and low potential for erosion. Advance outwash consists of sorted sands and gravels that were washed out in front of the advancing glacier. Due to compaction by the advancing glacier, advance outwash deposits are considered to have moderate permeability and water holding capacity. Because recessional outwash was not compacted by the retreating glacier, it is highly permeable and also has the highest capacity for storing groundwater.

Thus both the advance and recessional outwash deposits are present in the uplands areas of the watershed and are important for maintaining stream and wetland hydrology. These outwash deposits, however, are also susceptible to erosion due to their composition of sands and gravels. [End of excerpt.]

Throughout the project, landowners and those who are familiar with the watershed shared their observations of accumulated amounts of sediment building up in certain areas of the watershed where the stream had been constrained or the hydrologic regime had been altered. The role of fine sediments is discussed in the water quality section of this report as well as within the WDOE Stream Characterization (Appendix A).

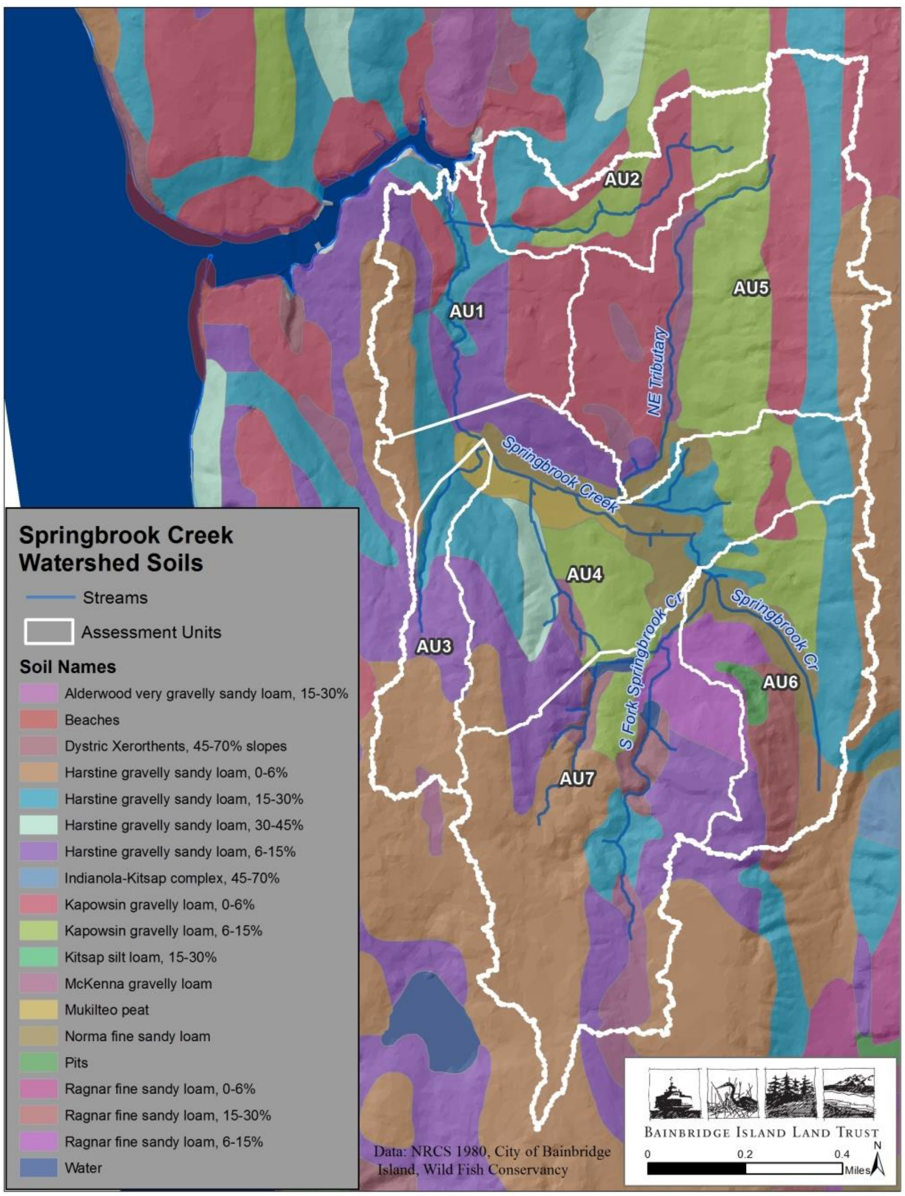


Figure 12. Springbrook Creek Watershed Soils.

3.4.2 Assessment Units and their Characteristics

To facilitate weighing the value derived from certain natural processes against the level of degradation of those processes it was necessary to divide the watershed into distinct areas known as Assessment Units (AU). These Assessment Units consist of smaller sub-basins, grouped based on their contribution to major tributaries of the mainstem of Springbrook creek. AU 1 and AU4 comprise the lower and middle watershed respectfully with AU1 characterized by a more incised, increased gradient stream channel, and AU4 served by a relatively flat, wetland dominated landscape. AUs 2, 5, 6, 7, and 3 are generally upper watershed areas. (Fig. 13).

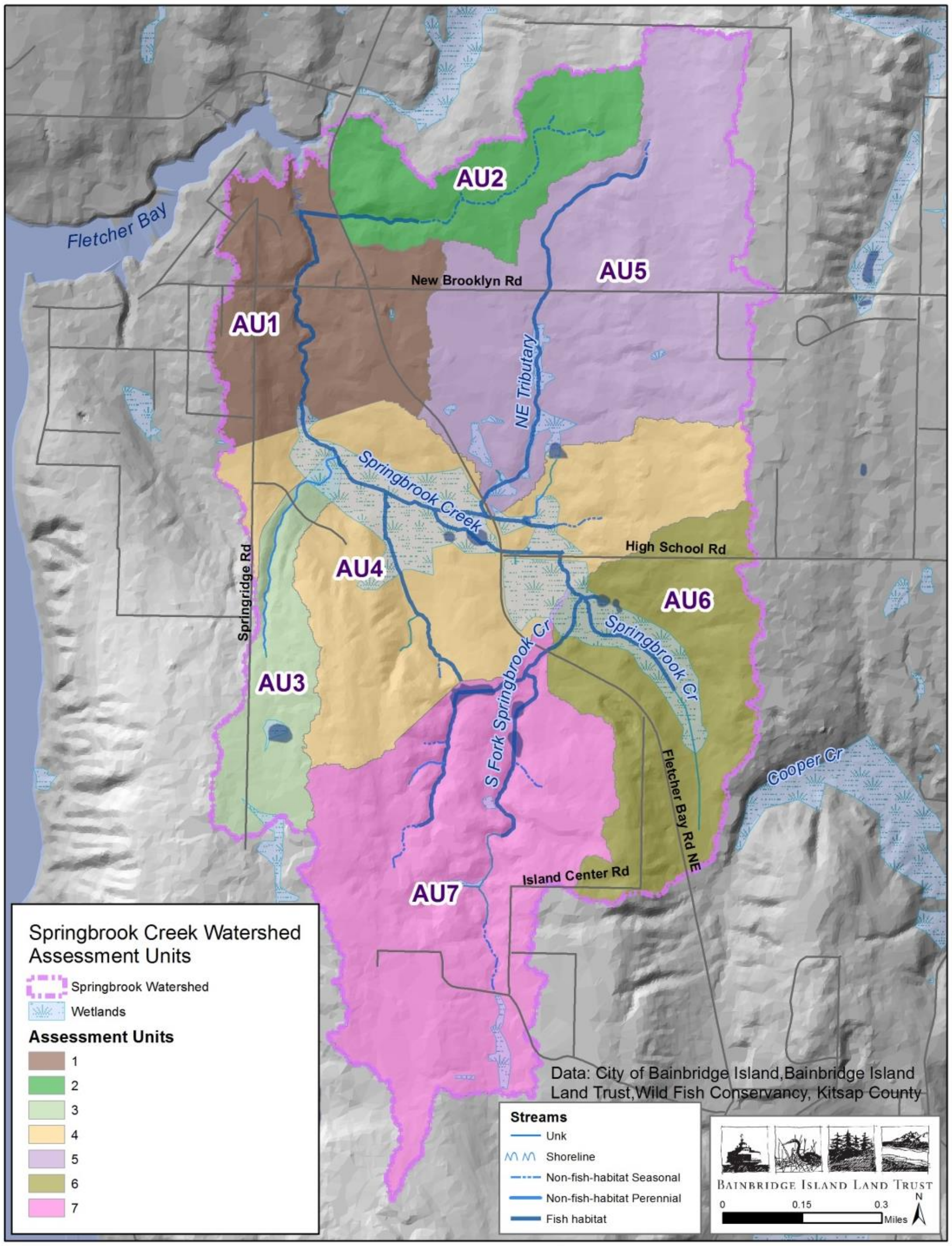


Figure 13. Springbrook Watershed Assessment Units and stream network for WDOE Springbrook Creek Characterization July 2018, Publication 18-06-006.

Table 4. Assessment unit characteristics

Unit	Drainage Area (ac)	Topographic Relief (ft)	Min (ft)	Max (ft)
1	103.4	40	0	40
2	71.8	68	8	76
3	54.8	100	18	118
4	209.7	86	20	106
5	215.9	78	22	100
6	127.6	60	24	84
7	216.0	92	24	116
Watershed Total	999.2	118	0	118

In **AU1** the mainstem of Springbrook Creek (reach SB01 in the Section 3.4.3 reach descriptions) flows down an increasingly steeply incised channel as it passes north through a large culvert and weir system and into the broad estuary shared with Issei Creek at the eastern tip of Fletcher Bay. This AU contains the Island Center Neighborhood Service Center, and therefore the densest residential and commercial uses in the watershed. Impervious surfaces and buildings cover 16% of the area, with a road density (including driveways) of nearly 25 mi/mi^2, as well as over 18% is in bare ground or low ground cover in horse pastures, lawns, etc. (Tables 2 and 3). The 62% in tree cover is the lowest for the watershed.

AU2 and **AU3** are smaller upper watershed units delineated around single tributaries (SB01A for AU2 and SB01B for AU3 in the Section 3.4.3 reach descriptions). Land uses are largely residential in AU2 on the northern edge of the watershed just north and east of Island Center, with the second-highest proportion of impervious surfaces in the watershed (8.5%, Table 2), and a road density at 19 mi/mi^2 (Table 3). However, it also has healthy intact forest sections and trees cover 76% of the area and little bare ground or low ground cover. It has no wetland areas. AU3 is higher in elevation and includes the highest point in the watershed at 118 feet (Table 4). Like AU2, AU3 is largely residential but with only 5% impervious surfaces, a few small wetlands (Figure 7), and the highest percentage of forest at 82% (Table 2). However, road density is surprisingly high at nearly 19 mi/mi^2 (Table 3).

AU4 comprises the majority of the mid-watershed, and is dominated by a large depressional wetland complex with historic and current land use as pasture. This wetland complex is along the mainstem of Springbrook Creek (reach SB01-1 in the Section 3.4.3 reach descriptions) as well as the lower, flatter portions of two seasonal tributary streams; one to the south (reach SB01C) and one to the east (reach SB01E). Over 45 acres of wetland fall within AU4, nearly 22% of the area (Figure 7). About 20% of the area is in low cover and bare ground (Table 2), largely reflecting past and present agricultural use, and ditching and ponding for agriculture and to accommodate roads is readily apparent. Other areas previously cleared for farms have regrown into stands of willows and red alder in wetland areas and conifers in uplands. Trees now cover 72% of the assessment unit. Impervious surfaces are moderate for the watershed at 5% and road densities are the lowest at just under 14 mi/mi^2.

The upper watershed assessment units of **AU5** was delineated based on a single tributary (SB01D) like AU2 and AU3, it is a much larger drainage basin (Table 4). The Northeast Tributary in AU5 was unmapped prior to the WFC 2014 water typing assessment. This AU is characterized by a mix of forest and cleared areas with some remnant pockets of the agricultural uses that used to dominate the hillside. The proportion of low ground cover and bare ground is the highest in the watershed at over 20% (Table 2). However, the proportion in impervious surfaces is close to the overall watershed average (6%, Table 2). The road density is moderately high at 15 mi/mi^2 (Table 3). With very little area of wetland in the assessment unit (Figure 7) the tributary tends to be seasonal but can contribute almost a third of the total stream volume during the wet season.

Upper watershed assessment unit **AU6** carries the mainstem of Springbrook Creek (SB01-2) as well as flow from the southernmost tributaries (SB01G and SB01F, the lowermost portion of which is within AU6) into AU4. AU6 contains the southeast portion of the same forested wetland complex extending across AU4 and wetlands cover a large portion of this assessment area (over 18 acres, comprising 14% of the area, Figure 7). During summer months, AU6 is an important contributor to summer time baseflows for the mainstem, as the Upper Springbrook Creek provides a good steady baseflow of water meeting water temperature criteria. This basin encompassing the most south-easterly extent of Springbrook Creek is relatively low gradient with low density residential uses, and a moderate proportion of impervious surfaces, bare ground, and low cover (5.6%, 0.1%, and 17.9%, Table 2) and moderately high road density (15 mi/mi^2, Table 3).

Upper watershed assessment unit **AU7** originates in the high-elevation area northeast of Gazzam Lake, encompassing a portion of the Gazzam Lake Preserve (Figure 3), and topography drops steeply to the north down into AU4 (Figure 10). This assessment unit was created based on the drainage area of two tributaries in the southern extent of the watershed (SB01G and SB01F). The northern boundary of this unit follows the drainage to the artificially-diverted flow path of the westerly tributary (SB01G) as redirected to the larger central tributary (SB01F, South Fork Springbrook Creek). This assessment unit has the highest proportion of tree cover (over 77%, Table 2), lowest impervious surfaces (4%), bare ground and low ground cover (15% combined), and second lowest road density (just over 14 mi/mi^2, Table 3) in the watershed. However, the hydrology has been altered dramatically and the agricultural ponds and clearing have significantly impacted the northern portion of the assessment unit. There are only about 3 acres of wetlands in AU7, which is unsurprising given the steep terrain.

3.4.3 Stream Network, Characteristics, and Barriers

Springbrook Creek is one of the largest and most productive salmon-bearing streams on Bainbridge Island. Approximately 4.7 miles, or about ⅔ of the total stream miles, are typed as fish habitat as a result of 2014-2018 WFC stream assessment work (http://www.moonlitgeo.com/wfc/).

Springbrook Creek has many unnamed tributaries, and there seems to be some confusion as to which streams represent the true “Springbrook Creek”. Figure 13 shows the generally accepted designation of

Springbrook Creek being the main channel flowing from the far southeast of this watershed to Fletcher Bay. South Fork Springbrook Creek refers to a main tributary flowing from the south-central watershed, and a previously unmapped seasonal stream flowing from the north is identified here as the "NE Tributary" (Figure 13).

Between 2014 and 2018, Wild Fish Conservancy had the opportunity to walk much of the Springbrook watershed where permission to access the stream was granted by landowners (Figure 14). Field staff measured bankfull widths and channel gradients, described instream and riparian habitat conditions, and documented potential protection and restoration opportunities observed during the surveys. Water type classification were assigned based on fish observations and the physical habitat characteristics associated with presumed fish use provided in WAC 222-16-031; channels greater than 2' wide at bankfull width, and less than 20% average gradient, are presume to provide fish habitat (Type F). Channel reaches exceeding those criteria were identified as Type N (non fish-habitat reaches, further characterized as Np (perennial) or Ns (seasonal)). Reaches where survey access was insufficient to make a determination were identified as Type U (unknown). The extensive point and reach-scale data and photographs collected during the Wild Fish Conservancy water type assessment are available in an interactive web map: http://www.moonlitgeo.com/wfc/

Over 70% of the watershed was assessed with boots on the ground providing the opportunity for developing detailed descriptions and documentation about stream conditions, including areas of the stream that had not previously been mapped. Stream condition, fish barriers, and associated riparian conditions were documented. Additionally, in 2014 Washington Department of Fish and Wildlife (WDFW) conducted culvert assessments on portions of Springbrook Creek, providing priority indexes (as further defined below) to many of them. WDFW was helpful during this project in examining up-to-date field information and topographical information to help update priority index ratings.

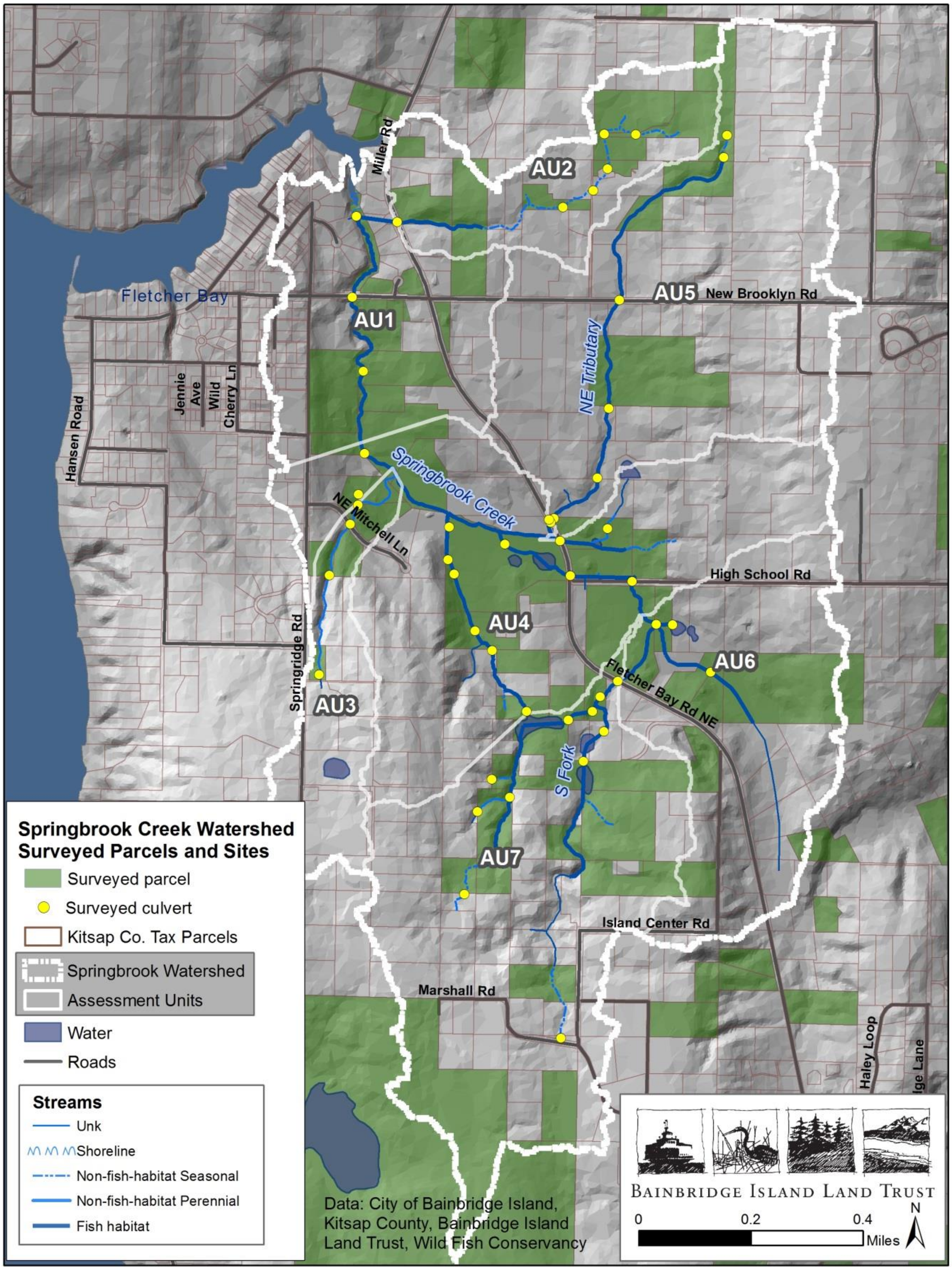
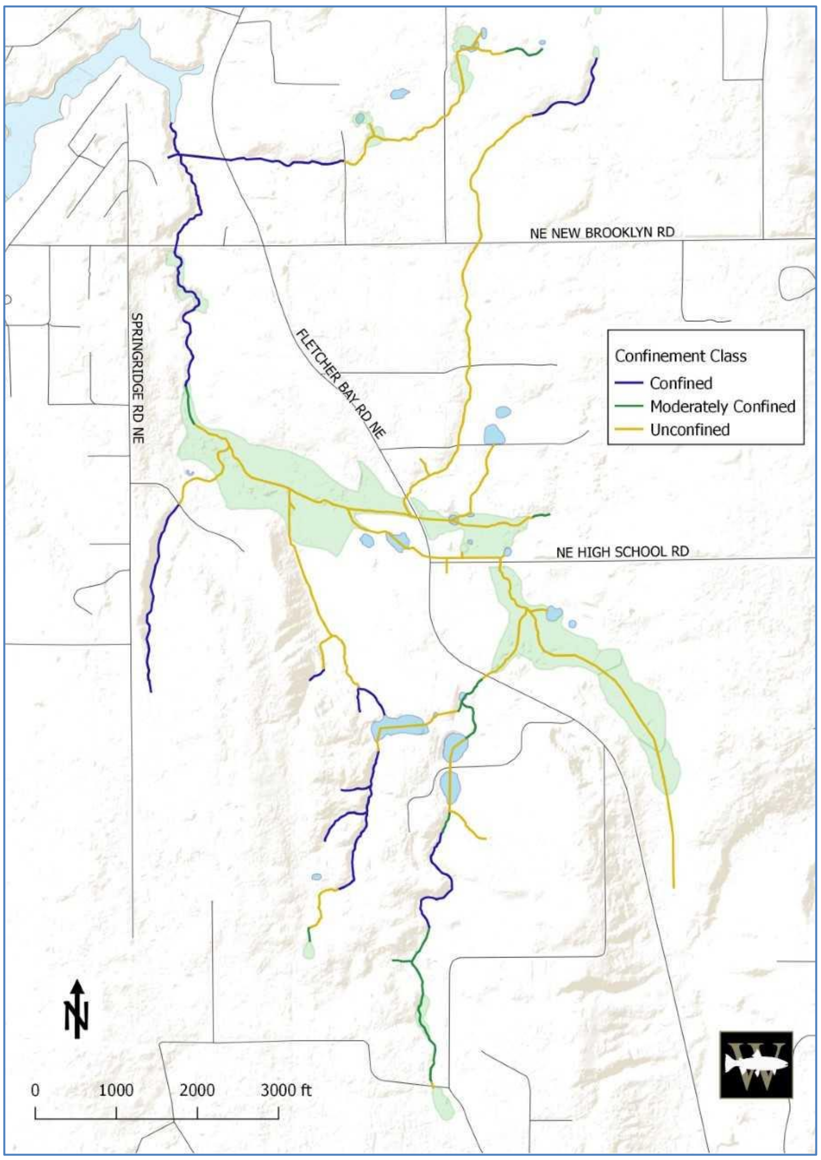


Figure 14. Extent of area surveyed as part of this assessment project.

Based on field surveys' comparisons with LIDAR and aerial maps, channel confinement classes were assigned. The classes are based on statewide criteria and guidance. Channel confinement may be considered to be the ratio of the valley or flood plain width (VW), to the channel width (CW). Confinement is an important control on potential channel response. Channels with wide flood plains may shift laterally over the valley bottom, changing course, sinuosity, or pattern (e.g., meandering, braided) in response to disturbance, whereas channels confined by bedrock valley walls can only respond in other ways (e.g., bedform modification or channel armoring). Channel confinement generally cannot be measured directly from topographic maps, especially for small channels, because channel widths are not portrayed accurately. With the large amount of on the ground work in Springbrook creek confinement estimates from topographic/aerial maps were confirmed with field observations. Each channel reach is classified as confined (VW < 2CW), moderately confined (2CW < VW < 4CW), or unconfined (VW > 4CW) (Figure 15).



Confinement Class	Definition
Unconfined	Valley width > 4 channel widths
Moderately Confined	Valley width = 2 to 4 channel widths
Confined	Valley width < 2 to 4 channel widths

Figure 15. Stream channel confinement based on statewide criteria**.**
WA Dept. of Natural Resources: https://www.dnr.wa.gov/publications/fp_wsa_manual_appe.pdf

Multiple full and partial fish passage barriers throughout the system compromise fish access to some fish habitats. Partial barriers may limit fish use on a seasonal basis when flows are too low to overcome the physical barrier or too high, making the force of flow through a culvert, for example, high enough to deter passage. WFC identified 46 culvert stream crossings, eight on city-owned property and 38 on private property. Of the 30 on fish habitat streams, 10 (33%) were full passage barriers, three (10%) were rated 33% passable, six (20%) were rated 67% passable, six (20%) were partial barriers with no passability rating assigned, and five (17%) were completely unknown passability. None of the assessed culverts were found to be fully passable, and about 1.8 miles of fish habitat are upstream of full barriers (Figure 16). The WDFW also inventoried 13 culverts within the watershed. For culverts where it has been calculated, Figure 16 shows the WDFW Priority Index (PI)– a number calculated based on the severity of the barrier, the amount of habitat blocked, species mobility (anadromous vs. resident), fish stock status, and the projected cost of the project (WDFW 2009). A higher PI indicates higher priority for repair or replacement. The culvert and weir system at Fletcher Bay Road PI of 24.06 is the second highest rating on the Island.

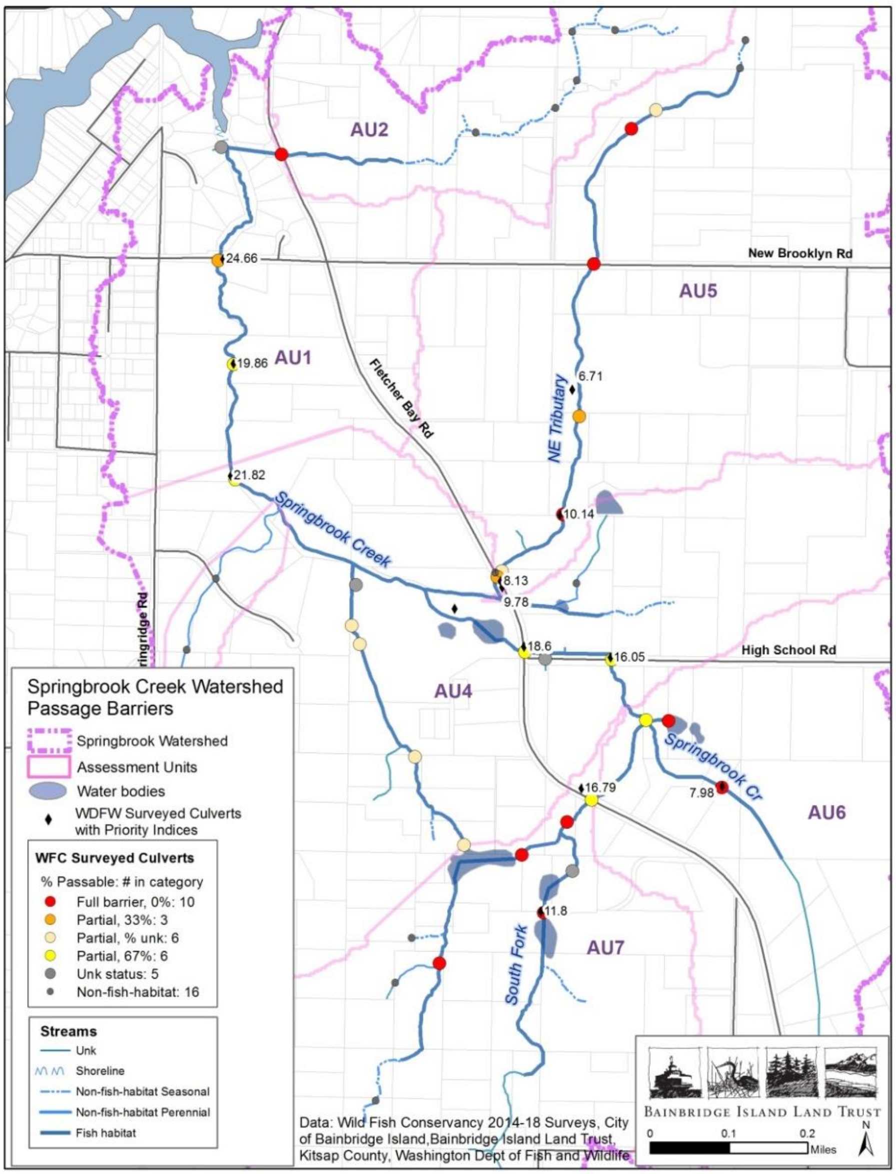


Figure 16. Documented Fish Passage Barriers Springbrook Creek Watershed

3.4.4 Stream Reach Descriptions

The following section provides a reach by reach description of the physical and biological characteristics of Springbrook Creek based on field assessments by Wild Fish Conservancy, Bainbridge Island Watershed Council and other project team observations. Limiting factors within each reach are also listed. Left-bank and right-bank notes are provided using the convention that the observer is facing downstream.

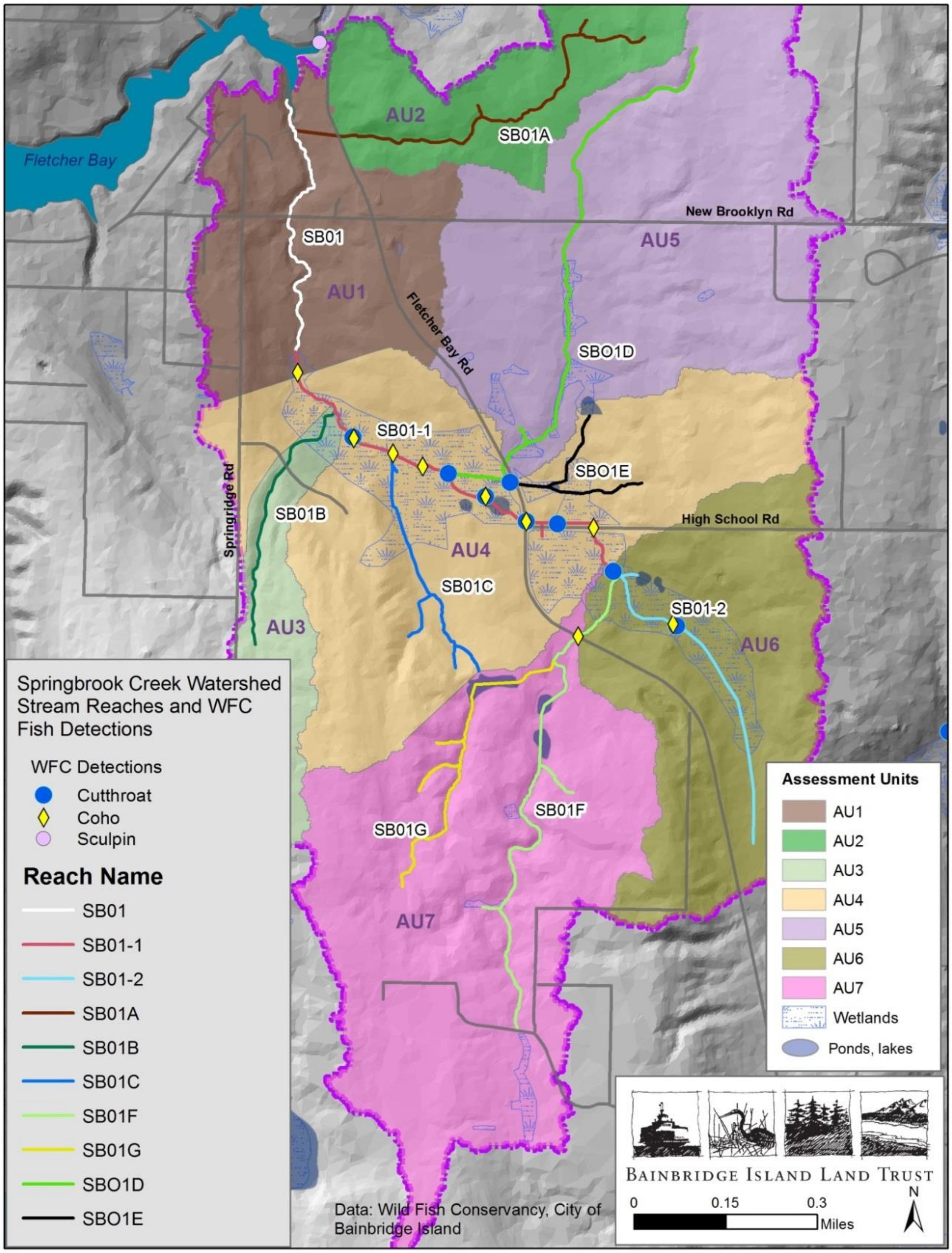


Figure 17. Reaches of Springbrook Creek and fish detected during surveys.

Tributary SB01A

Intact forest habitat

Tributary SB01A runs through Assessment Unit 2 (AU2) and consists of approximately 4,000 ft. of stream channel, of which 1,500 ft. meet physical criteria for type F (fish) habitat. The stream originates from a seasonal spring head in a shallow forested ravine. It runs down the ravine with an average bankfull width of 2.8 ft. with an average gradient of 10%. The stream then leaves the ravine, passes under a private drive, and feeds into a small man-made pond. The pond's outflow flows back under the same private drive emptying into a downstream wetland (which is not mapped in the City of Bainbridge Island's GIS wetland layer). This wetland drains into a ditch which passes under Holly Farm Lane NE. Below the crossing SB01A runs down a forested hillside with an average bankfull width of 1.9 ft. with an average gradient of 4%. The stream then flows under another private drive, is ditched along a lawn, and then feeds into a small forested wetland (also unmapped). Below the forested wetland, the stream's average bankfull width increases to 2.7 ft. running with an average gradient of 6%. This section of stream meets the physical characteristics of type F habitat. The type F channel runs down a forested valley though dense patches of English ivy. It then passes under Miller Rd NE. in a full barrier culvert. The outlet to this crossing was found 400 feet to the west of the culvert inlet where it empties directly into the right bank of Springbrook Creek at stream mile 0.06 with a 1.7 ft. tall perch. No fish were found in this stream.

- Limiting factors include poor stream and riparian conditions, altered hydrology, fish passage barriers, commercial use. This reach provides marginal fish habitat and seasonal flow and stream restoration efforts would have minimal impact on fish resources. Low impact development practices and retaining vegetation to assist with stormwater runoff will help reduce water quality impacts to the lower section of SB01 (the main stem). See Project 18, Section 6.1.2. No instream fish restoration actions are recommended in this reach of the stream.

Tributary SB01B

Tributary SB01B runs through Assessment Unit 3 (AU3). This tributary is approximately 2,000 ft. long, providing perennial type N waters to mainstem Springbrook Creek. The stream originates in a forested ravine where it passes under two private driveways. Below the crossings SB01B continues down the forested ravine becoming incised in a naturally confined channel with an average bankfull width of 2.5 ft. running over an average gradient of 18%. Approximately 1,000 ft. below the headwaters the stream flows under a derelict forested access road in an undersized culvert which is perched 9.3 ft. The channel below the culvert is deeply incised with mass wasting present on both banks. The average bankfull width in this lower section of the forested valley is 3.1 ft. with an average gradient of 10%. Flows were intermittent during the time of survey on March 3rd 2014. Approximately 600 ft. below the derelict culvert the stream passes under NE Mitchell Ln. Below this crossing the stream runs over 300 ft. of steep gradient averaging 18% with an average bankfull width of 3 ft. Below the steep section of channel the stream disperse into a forested wetland before it enters the left bank of Springbrook Creek (SB01-1).

- Limiting factors include high road density, and sediment inputs caused by a 9.3 ft perched derelict culvert which is responsible for severe down-cutting and erosion. Intact habitat prior to entering SB01-1 provides wetland function protection opportunities. See Project 3a.

Tributary SB01C

Tributary SB01C runs through Assessment Unit 4 (AU4). This stream is approximately 2,100 ft. long, and considered type F habitat. The stream's main source of water is a seasonal, secondary outflow of a manmade pond located in AU7. The primary outflow of the pond is located on the east end and feeds into a separate drainage of Springbrook Creek (SB01G and SB01F). The seasonal SBO1C outlet channel runs down a forested hillside with a gradient of 6% and an average bankfull of 2.1 ft. This channel is joined by a small seasonal type Ns channel which emerges from a spring seep near the outlet of the man-made pond. A second small Type N tributary joins the combined flows before crossing a private driveway via an underground pipe. Directly below the private driveway the stream enters a pair of pipes carrying the flows

West of horse pastures

Pipes carrying stream under fence

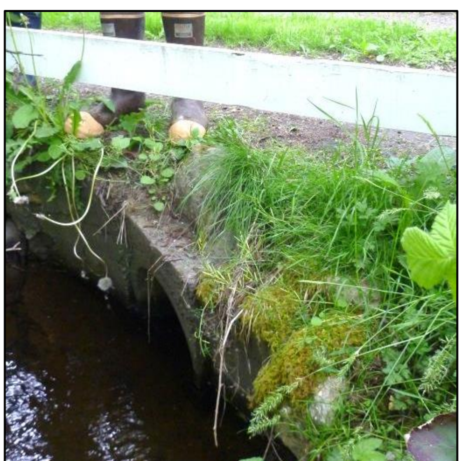
under a fence line. Below this crossing the stream runs down the west side of a horse pasture with an average bankfull of 4 ft. and an average gradient of 2%. This channelized section of stream lacks large woody debris and instream habitat complexity. This reach passes under two field access road crossings, both of which are partial barriers to fish migration. The stream then enters a wetland complex on the left bank of Springbrook Creek. The wetland flows feed into the left bank of the mainstem without a well-defined channel. No fish were observed in SB01C during the water typing survey on 05/01/2014. Historically, this tributary likely connected with SB01G prior to the construction of manmade ponds in AU7 providing good fish habitat, and landowners reported that Islanders fished for salmon in the stream before the ponds were constructed.

- Limiting factors include dramatic alteration of stream hydrology, structure and function. In the upper extent of this tributary restoration would be very expensive due to the dramatic alterations caused by ponds and dams in AU7. Fish barriers, riparian alterations, lack of stream complexity, and number of ill- designed and constructed culverts constrain fish utilization. Removal of newly installed culverts on parcel 047 and replacement of two downstream culverts on parcel 047 with new fish-friendly culvert, reintroducing large woody debris, and managing land use within the stream, riparian and wetland buffers could provide fish use to the lower portion this tributary, which was likely one of the main historical channels of Springbrook Creek. See Project 13.

North East Tributary SB01D

Just N of Berganio Lane

North East Tributary SB01D runs through Assessment Unit 5 (AU5). The total length of this stream is 5,100 ft. of which 4,900 ft. meet physical criteria for type F habitat, but was not mapped or regulated as a stream until 2014. A seasonal headwater wetland feeds SB01D. This wetland feeds a small type Ns channel that runs down a forested ravine with an average bankfull width of 1.9 ft. and an average gradient of 5%. Approximately 200 ft. below the headwaters, the stream's bankfull width averages 2.2 ft. and meets the physical characteristics of type F habitat. The seasonal type F stream continues down the forested ravine. This section of stream ran with intermittent flows during a site visit on 12/13/2017. The stream then flows through a partial barrier culvert on a private driveway. Below this crossing the ditched and channelized stream runs through numerous private properties. The stream then passes under NE New Brooklyn Road in a partial barrier culvert. Below this crossing, SB01D meanders down a wide valley through a stand of second growth conifers with an average bankfull width of 5 ft. with a 2% average gradient. This section of creek provides excellent potential rearing habitat for juvenile salmonids.



Undersized culvert, private driveway

At the lower end of the unconfined forested valley the stream passes under Berganio Lane in a partial barrier culvert. The stream then continues down a confined forested valley for 300 ft. before it enters a cleared field where it is channelized for 350 ft., lacking shade and stream complexity. The channelized stream then flows under Greg Farm Ln. in a culvert that Mid Sound Fisheries Enhancement Group identified as a full barrier in 2008. Below this full barrier culvert, SBO1D continues down a forested valley to a crossing on a private driveway (Project 7). The private driveway culvert is undersized for managing the flow from 5,100 ft. of stream draining the 215 acres of AU5, and forms yet another partial barrier to fish passage. Below the driveway the stream flows through Fletcher Bay Road NE in the lowest culvert in the system. Below this partial barrier culvert the stream is ditched along the west side of Fletcher Bay Road. A local landowner recently cleared the ditch of all vegetation. The stream then leaves the ditch turning west where it is channelized along the north side of a sheep pasture for 500 ft. Here, the stream runs with a bankfull width of 6 ft. with a gradient of 1%. The substrate in this reach is sand, mud and gravel. The stream then enters the right bank of Springbrook Creek. Cutthroat trout were netted in the lower 500 ft. of stream, below the partial barrier culvert on Fletcher Bay Road.

- Limiting factors include fish passage barriers, culverts undersized for flow, lack of stream complexity, and extensive riparian vegetation clearing, as might be expected given the fact the stream was until recently not mapped or regulated. Multiple landowners commented that they did not regard the channel on their property to be a 'stream' and education of streamside landowners will be an important component of successful management. There are multiple opportunities for restoration of a more natural channel and riparian vegetation (see Project 16 and 7), and for protection of high-quality habitat where it still exists (Projects 15 and 17). There are several partial barrier culverts in need of replacement. Those near the junction of this tributary and SB01E, in the High School Road x Fletcher Bay Road NE area, should be considered in conjunction with channel realignments as described in Project 7.

Tributary SB01E

A manmade pond and adjacent pasture

Tributary SB01E runs through Assessment Unit 4 (AU4). Two small streams and their associated wetland complex feed this tributary. The left bank stream emerges from a springhead on a forested hillside. This spring feeds a type Ns stream that runs down the forested hillside with a discontinuous channel and intermittent flows. The average bankfull width of this reach is 1.7 ft. and the average gradient is 4%. The stream definition is completely lost at the base of the hill where it enters a wide forested wetland with a dense brushy understory. The forested wetland drains into a long glide which feeds into a small 0.1 acre manmade pond. This lower section of channel is type F habitat with a 20 ft. wide unconfined bank and a gradient less than 1%. A right bank stream also feeds the small manmade pond. The headwaters of this stream were not surveyed and their exact location and extent are unknown. Where the stream was surveyed it ran down a ditch-line in a field with an average bankfull width of 1.9 ft. and an average gradient of 4%. The ditched section of stream feeds into a small manmade pond approximately 0.03 acres in size. This stream then continues down a second ditch-line on the south side of the field to where it feeds into the 0.1 acre manmade pond, joining the left bank channel. The combined flows then drain out of this pond and down a forested wetland without a defined channel. The wetland complex then drains under Fletcher Bay Road in a partial barrier culvert. Below the road crossing the stream passes under a walking trail culvert installed in 2017 by a local landowner. Below this second crossing the stream feds into the right bank of the type F tributary SB01D. Juvenile salmonids were observed in the outlet pool of the Fletcher Bay Road crossing during a site visit in the spring of 2018.

- Limiting factors include loss of natural in-stream and riparian habitat in the ditched portion and the partial barrier culvert under Fletcher Bay Road NE. Restoration of the ditched channel would be beneficial, particularly in conjunction with addressing the Fletcher Bay Road NE culvert as part of the Project 7 High School Road x Fletcher Bay Road NE area culvert and stream improvements.

Tributary SB01F South Fork Springbrook Creek


Good fish habitat near the headwaters


Johnson Farm pond

South Fork Springbrook Creek SB01F runs through Assessment Unit 7 (AU7). The total length of this stream is 4,500 ft. with 2,800 ft. providing type F habitat. The stream originates in headwater wetlands on the south side of NE Marshall Road The wetlands drain under the road and feeds into a small type Ns stream running down a forested valley with a dense brushy understory and an average bankfull width of 1.7 ft. with a 4% average gradient. As the stream continues down the forested valley the bankfull width increases in size. Approximately 1,800 ft. below the headwater wetlands the channel runs through a forested ravine with an average bankfull width of 6.5 ft. and an average gradient of 6%. This reach flows through an intact riparian corridor, providing pool - riffle habitat, large woody debris, and excellent cutthroat spawning gravels. Then, 2,700 ft. downstream from the headwaters the stream leaves the ravine and enters a 0.72-acre shallow manmade pond on the Johnson Farm. This pond drains under NE Twin Ponds Road via an enclosed pipe and catchment basin into a second 0.71-acre manmade pond through a stand pipe which functions as a full barrier to fish passage. The outlet of the lower pond was not surveyed and its barrier status is unknown. Below the second pond, the channel is incised with an average bankfull width of 4 ft. as it runs through a stand of alders infested with English ivy. SB01F then feeds into yet another man made pond 0.08 acres in size. Here, it joins the type F tributary SB01G. The pond drains onto a thick plastic sheet armored with riprap forming a cascade approximately 5 ft. tall. Below the pond, the stream is channelized along the edge of a lawn with riprap armor along both the left and right banks. The stream is artificially narrow in this stretch with an average bankfull width of 3.8 ft. and an average gradient of 4%. The stream then flows under Fletcher Bay Road NE in a partial barrier culvert. Two coho were netted in the culvert plunge pool during a site visit on 10/31/2013. Below the road crossing SB01F is braided down a forested hillside with a combined average bankfull width of 7.2 ft. This tributary then feeds into the left bank of the headwater reach of Springbrook Creek.

- Limiting factors include significant alteration of the stream's hydrology through the construction of ponds, drainage control systems, underground piping, partial and full fish passage barriers, and degradation of the natural channel and riparian vegetation. Large manmade ponds contribute to increases in stream temperatures and decreases in dissolved oxygen. These factors (as further described in Section 3.6) fall outside acceptable parameters for fish in the summer months throughout most of this stream system. In-channel and riparian restoration of the degraded stream just south of Fletcher Bay Road NE would be beneficial. Replacement of the partial barrier culvert on Fletcher Bay Road NE and correction of the barrier outlets from the ponds would be very important for restoration of access to the high-quality spawning habitat above these ponds, and mechanisms for addressing the temperature increases from the large ponds should be explored (Project 14).

Tributary SB01G

Forested valley habitat

Tributary SB01G runs through Assessment Unit 7 (AU7) with a total stream length of 2,800 ft. of which 2,200 ft. provide type F habitat. The stream is fed by a small wetland that drains into a ditched and straightened channel running along a private driveway. The channel flows under the driveway then enters a forested valley. This headwater reach is type Ns with an average bankfull width of 1.8 ft. with an average gradient of 4%. As the stream runs down the forested valley the bankfull width gradually increases as additional springs feed into the channel. At approximately 600 ft. below the headwaters the streams physical measurements qualify it as type F habitat. Below this point the stream averages a bankfull width of 5 ft. with a gradient of 11%. Then, 1,350 ft. below the spring head the type F channel is joined by a type Np left bank tributary. The combined flows cross a private road in a full barrier, undersized, culvert perched 2.2 ft. Below this culvert the stream continues down a forested ravine with an intact riparian corridor, providing pool riffle habitat, large woody debris, and excellent cutthroat spawning gravels. A second left bank tributary joins SB01G approximately 200 ft. downstream from the crossing. 400 ft. below this confluence the stream enters a 1.4-acre manmade pond surrounded by developed and landscaped private residences. This pond has two outflow locations. The primary outflow is located on the eastern end of the pond where water enters a stand pipe with an old control valve. This stand pipe is a full barrier to fish migration. Below the pond outlet the stream runs down a lawn in an armored and landscaped channel completely devoid of instream complexity and canopy cover. The landscaped section of channel runs for 300 ft. before feeding into a small 0.08 acre manmade pond where it joins with SB01F. The secondary outflow to the 1.4-acre pond is located on the northern edge pond and drains into SB01C. The entirety of SB01G and SB01C was likely the historic drainage path of this stream prior to the construction of the pond.


1.4-ac. manmade pond

- Limiting factors include significant alteration to the natural hydrology of the stream, full and partial passage barriers, a large manmade pond that increases water temperature, blocks fish passage, and alters the historic water flow, and degradation of habitat below this pond. Planning for restoration of habitat in this area requires consideration of long-term goals and consequences of retaining the current configuration which funnels the majority of year-round flow to the northeast to join with SB01F and flow into the mainstem of Springbrook Creek east of Fletcher Bay Road NE, versus restoring the historic flow path into SB01C and into the main channel over 2,500 feet further northwest (Projects 13abc). Replacement of the perched partial barrier culvert on the private drive upstream of the pond could be beneficial to resident fish, and to anadromous fish if the downstream barriers are first addressed.

Upper Springbrook Creek SB01-2

Low gradient wetland

While a good majority of Upper Springbrook Creek mainstem was surveyed, the headwaters were not, due to lack of landowner permission. Their full extent and habitat characteristics remain unknown, although the Washington Department of Natural Resources has an additional 1,500 ft. of type N channel mapped above the uppermost surveyed reach (just upstream of the adjacent coho and cutthroat detections in SB01-2 in Figure 17). The upper extent of water typing surveys conducted by WFC found Springbrook Creek meandering down a low gradient forested wetland valley with an average bankfull width of 5 ft. and an average gradient of 1%. This section of channel provides excellent potential rearing habitat with sandy sediments, undercut banks, and large woody debris. Approximately 500 ft. downstream from the upper end of the survey the stream flows under a derelict forest access road crossing. The culvert at this crossing is very steep, forming a full barrier to fish migration. Below the crossing the stream continues down the wide valley bottom with a deciduous canopy and a dense understory dominated by salmonberry. A coho was netted in this reach during a site visit in the spring of 2016. Downstream 600 ft. from the derelict road crossing Upper Springbrook Creek enters an 80 ft. long section of channelized and armored stream channel. This short section of stream is artificially narrow with a bankfull width of 1.8 ft. Below the armored channel the stream is joined by a right bank tributary draining two man-made ponds. The combined flows cross a horse trail in two side by side partial barrier culverts. Below the crossing SB01F merges with the left bank of Springbrook. The combined flows run down a forested valley with an average bankfull width of 6.5 ft. and an average gradient of 2%. This section of channel provides excellent fish habitat with numerous pools, undercut banks, and excellent spawning gravel. This stream reach is the upper extent of documented coho spawning and is the transition point from AU6 to AU4. Below this point the stream is described as SB01-1, Middle Springbrook Creek.

- This is largely an intact, functioning stream reach with good habitat protection opportunities (see Projects 11 and 12). Limiting factors for fish access to habitat are a partial barrier culvert and full barrier culvert. The former is proposed for replacement under Project 9 (Section 3.4.5) and the latter for removal under Projects 10 and Project 11 (Conceptual Design Project Rolling Bay Property Culvert Removal and Riparian Protection).

Middle Springbrook Creek. SB01-1

S of High School Road

The middle section of Springbrook Creek flows through Assessment unit 4 (AU4) through a wide unconfined valley with a large wetland corridor. The total stream length of middle Springbrook Creek is 2,800 ft., all of which is Type F habitat. The reach begins on the south side of High School Road, where the valley becomes unconfined and flows meander through high-quality forested wetlands with an average bankfull width of 7 ft. and an average gradient of 1%. The substrate here is dominated by gravel (0.1-2" diameter pebbles), with sand increasing as the stream nears the road. The stream then passes under High School Rd in a partial barrier culvert. Below the crossing the stream is ditched along the north side of the road for 550 ft. with a predominantly sand and silt substrate and dense overgrowth of blackberry thickets. Scouring of the ditch banks is evident. The stream passes under Fletcher Bay Road NE in a 3' diameter culvert which is beginning to rust out. The frequent flooding of the adjacent property to the north evidences the size deficiency of this culvert. Coho and cutthroat trout were netted in the outflow pool below this Fletcher Bay Road culvert. Continuing down from the culvert, the stream is channelized down a narrow strip of alders for 175 ft. before feeding into a 0.5 acre man-made pond. At the pond outlet there is a fully fish-passable log weir control structure. Below the pond the stream continues down a narrow strip of alders, with an average bankfull width of 7.5 ft. and an average gradient of 1%. This reach is homogenous, lacking instream complexity. Approximately 450 ft. below the pond the SB01D tributary enters the right bank of Springbrook creek.

N of High School Road

The combined flows continue down the channelized stream corridor on the north side of a horse pasture. Springbrook Creek is then joined by SB01C, a left bank type F tributary 500 ft. downstream of the confluence with SB01D. In this area the landowner planted trees to help provide shade to the stream. Below the confluence with SB01C Springbrook Creek meanders down an unconfined low gradient valley bottom through adjacent wooded wetlands with an average bankfull width of 6.3 ft. and an average gradient of 1%. Here, the left bank of the valley floor is densely forested with an over story of alder, ash, mature willow, and red osier dogwood. The right bank of the valley has been cleared of native vegetation and is currently dominated by invasive reed canary grass. Springbrook Creek runs within the left bank forested section for 450 ft. providing excellent low-gradient salmonid rearing habitat with undercut banks and instream large woody debris. The stream then leaves the forested habitat running into the recently cleared valley bottom. For approximately 250 ft. the stream is choked with reed canary grass. Below the cleared section of stream Springbrook Creek flows under a wire mesh fence and enters wooded wetlands densely populated with alder, mature willow, and red osier dogwood. Approximately 400 ft. below the cleared area the creek flows under a derelict field access road in a partial barrier culvert. Below this crossing the valley becomes more confined and the stream gradient increases from an average of 1% to 3%. Here the substrate changes from sand and silt to gravel and cobble. This demarks the transition from middle Springbrook Creek SB01-1 to lower Springbrook SB01.

- Limiting factors in this mainstem reach include clearing of native riparian vegetation and replacement with invasives, alteration of stream channels and funneling into a ditch alongside a major road and under an intersection of two main Island arterials (with associated pollutants), loss of stream complexity in additional areas, and partial fish passage barrier culverts. As noted under section 3.6 below, there were also detections of human fecal bacteria in this reach, and actions to find and address these sources are needed. There are many opportunities for riparian restoration (including Conceptual Design Projects 3 and 4), and protection of important wetland functions. It is recommended that the entire High School Road x Fletcher Bay Road NE area be considered as a coordinated suite of culvert and stream improvements as per Project 7.

Lower Springbrook Creek SB01

The lower section of Springbrook Creek runs through AU1, our most highly-developed assessment unit, in a confined forested valley with faster moving waters and excellent spawning gravels. This reach is approximately 2,600 ft. in length, all of which is Type F. The upper section of this reach flows through a stand of conifers with a bankfull width of 7.5 ft. and an average gradient of 2%. It then flows under a field access road in a partial barrier culvert. Approximately 100 ft. downstream from the culvert there is a long section of riprap armoring protecting a picnic area on the right bank of the creek. This armored section of channel is artificially narrow and has caused substantial scour of the left bank. The armored channel also lacks instream complexity forming a 70 ft. long continuous riffle with neither pools nor large woody debris. Below the artificially confined channel, Springbrook Creek re-enters a natural intact riparian corridor with an average bankfull width of 9.5 ft. and an average gradient of 3%. This section of stream provides excellent spawning habitat with numerous pools and instream large woody debris, and a substrate dominated by cobble (2-10” diameter rocks) and gravel (0.1-2” pebbles). Then, 800 ft. below the armored section of channel, Springbrook Creek passes under Fletcher Bay Road NE, the first road crossing on the mainstem. This partial barrier crossing is comprised of eight concrete weirs and a 100 ft. long culvert. The downstream-most weir below the culvert is failing and water now passes through a crack in its foundation and through the large rocks armoring the bank rather than spilling over the top of the weir. The City of Bainbridge Island has installed plastic sheeting and sandbags to temporally restore function to this lower weir. Below the failing weir the channel is incised and scoured down to hardpan for approximately 200 ft. WDFW identifies this structure as 33% passable and has assigned it a Prioritization Index of 24.66; this crossing affects fish access to 3.6 miles of fish habitat. Outside of the influence of the Fletcher Bay Road NE crossing Springbrook Creek continues down a forested ravine dominated by large second growth cedar with an average bankfull width of 15 ft., average gradient of 2%, and a substrate of primarily cobble and gravel. Approximately 1,100 ft. downstream of the Fletcher Bay Road NE crossing the mouth of Springbrook creek enters Fletcher Bay.

Weirs below Fletcher Bay Rd NE culvert

Stream further below culvert

Springbrook Creek enters Fletcher Bay Estuary at its southeastern extent, with Issei flowing in just north of this confluence. Sediment from these two streams contribute to a large mudflat area exposed at low tides, with lesser contributions from the smaller seasonal creeks entering closer to the mouth of the estuary (North Fletcher Bay Creek flowing from north and Foster's Creek from the south). Fletcher Bay Estuary was placed on the State's 'Threatened' list of shellfish growing areas in 2013 due to high levels of fecal bacteria. Subsequent work by Kitsap Public Health found decreasing levels of bacteria from 2013-2016 (Walther 2016), and as reported under Water Quality (Section 3.6), most recent samples detected moderate levels of human and ruminant source fecal bacteria in this reach.

Springbrook Creek/ Fletcher Bay estuary

- Limiting factors for this reach include streamside armoring, loss of channel complexity, and an undersized culvert and failing weir system acting as a fish passage barrier, and one additional fish passage barrier culvert. Given the concentration of development within this watershed, additional limiting factors include high road densities and high proportion of the area in impervious surfaces. Although water quality monitoring (Section 3.6) did not detect high levels of metals during the monitoring period, this is an area with high risk of contaminants flushing into the stream in stormwater events, and bacterial contamination persists. Removal of armoring and streambank restoration (see Project 2, Appendix III: Eddy) and replacement of undersized culverts and the failing weir system (Project 1, Appendix III: Fletcher Bay Culvert) would be very important actions given the location near the outlet of the stream system. Protection of intact habitat is also important here, as are actions to improve stormwater infrastructure to prevent pollutants from reaching the stream system (Project 18).

3.5 Salmonid Life History and Distribution

A 1982 study of fish life in Springbrook Creek found juvenile coho, steelhead, and cutthroat trout downstream of the Fletcher Bay Road crossing, and coho and large numbers of cutthroat trout upstream of the crossing (Fiscus 1982). Recent surveys within Springbrook Creek have documented that salmonid species currently present include cutthroat trout and coho salmon, salmonids that are well adapted to small stream systems in Puget Sound. Chum salmon also use this system, but only very low numbers of adults have been recorded in recent years (Section 2.4.2). Springbrook is identified by NOAA as critical habitat for ESA-listed Puget Sound steelhead, though their presence has not been observed recently. NOAA classifies the shorelines and associated nearshore habitats of Fletcher Bay, as well as all of Bainbridge Island shoreline, are classified by NOAA as critical habitat for ESA listed Puget Sound Chinook salmon, supporting a number of life history stages. Below is a description of the life histories of species who currently or have historically utilized Springbrook Creek for a number of life stages. Figure 18 illustrates recently observed fish presence.

3.5.1 Salmon Life History

<u>Coho</u>

Puget Sound coho (*Oncorhynchus kisutch*) typically display a three year life cycle, with the freshwater first phase of life generally lasting about a year before the young salmon migrate to sea in spring. However, some coho may use a seasonal strategy of down migration to the estuary for rearing in their first year (age 0) and may either directly outmigrate in fall, or move back into streams to overwinter before outmigrating at age one (Roni et al. 2012). It is unknown what range of life history strategies are undertaken by juvenile Springbrook Creek coho.

The importance of even intermittent streams to coho is well documented. *"[W]e found that intermittent streams were an important source of coho salmon smolts. Residual pools in intermittent streams provided a means by which juvenile coho could survive during dry periods; smolts that overwintered in intermittent streams were larger than those from perennial streams. Movement of juvenile coho into intermittent tributaries from the mainstem was another way in which the fish exploited the habitat and illustrates the importance of maintaining accessibility for entire stream networks. Loss of intermittent stream habitat would have a negative effect on coho salmon populations in coastal drainages, including downstream navigable waters,"* (Wigington, et. al 2006).

Coho typically spend one year at sea before returning to spawn in fall and early winter. Returning coho may gather at the mouths of streams and wait for flow to rise once the fall rains return and the base flow of the streams increase. River entry timing in Springbrook Creek is generally from late October through late November, with the majority of spawning observed from mid- through late-November. Spawning adult coho average around 10 lbs but may range in size up to 30 lbs (WDFW 2018).

In freshwater habitat, coho are strongly associated with slow water and areas with high channel complexity and physical cover, including in-channel wood, vegetated and overhanging banks, and side channels. Coho require cool temperatures, ideally below 14 °C (USFWS 1986). Low turbidity and siltation rates, and high oxygenation, are important to the survival of eggs and juveniles (USFWS 1986). Summer low flow is a significant limiting factor for young coho in Puget Sound streams, as it reduces habitat quantity and is associated with higher temperatures, and greater competition and predation rates (Woodward et al. 2017). High winter flows can also negatively affect juvenile overwintering salmon, and in periods of high discharge, side-channel or floodplain access is important so that coho can take refuge in slower moving waters.

Coho in streams feed primarily on aquatic and terrestrial insects, and once they transition to estuarine and ocean water, and are larger, eat more crustacea and other fish (USFWS 1986). Coho are an important species for both commercial and sport fisheries. They are fished using nets and trolling gear, and sportfishing is by hook and line in saltwater habitat. Fishing regulations for salmon change year-to-year or even on a weekly basis depending on population status. Fishing is not allowed on Bainbridge Island for returning salmon once they have re-entered freshwater streams to spawn.

Chum salmon

Chum salmon (*Oncorhynchus keta*), sometimes referred to as dog salmon, are one of the most abundant and widespread salmon in Washington state, and are one of the larger salmonids found in Puget Sound. Chum spend very little time in freshwater, heading towards salt water soon after emergence from the gravel. Young chum salmon may make extensive use of intertidal and nearshore areas adjacent to their natal streams in order to feed and grow (WDFW 2018b). In total they typically spend between two and four years in the open ocean before returning to streams to breed. Three different races that have different return times are found in Puget Sound: summer, fall, and winter. Fall chum are the most abundant and widespread race in Puget Sound, and are the race found in Bainbridge Island streams, though only a few have been recorded in Springbrook Creek.

Chum salmon are less affected by some in-stream stressors such as high summer temperatures and low oxygen compared to coho, because chum spend so little time in freshwater habitat. However, passage barriers may pose an even greater threat to chum than coho, as chum salmon are not as strong swimmers/jumpers, and have limited ability to navigate vertical barriers that other salmon like coho may be able to overcome.

Cutthroat Trout

Coastal cutthroat trout (*Oncorhynchus clarki clarki*) are a salmonid found throughout a great number of Puget Sound streams including many perennial and seasonal streams of Bainbridge Island. These fish are in the range of 1 to 4 lbs as adults. Cutthroat trout display a wide variety of life history, and are variously anadromous, with some in a population that may migrate to sea after two to three years of freshwater rearing, while others remain residents in fresh water throughout their life. Sea-run cutthroat generally spawn in winter months through to spring. They are found in a wide variety of streams but are known in particular for accessing the shallow headwaters of streams that larger salmonids cannot access, and resident populations can be found above natural or man-made barriers to anadromous fish (WDFW 2018c).

Sea-run cutthroat that leave the stream are generally found within a few miles of their natal stream, following food resources wherever it is, be it estuarine or freshwater habitat. They are opportunistic predators on a wide variety of invertebrates and, at larger sizes, small fish. Protected bays and estuaries provide excellent habitat for cutthroat.

Chinook Salmon

Puget Sound Chinook (*Oncorhynchus tshawytscha*) were listed as Threatened under the Endangered Species Act in 1999. Adult Chinook salmon have not been documented in Springbrook Creek, but it is very likely that juvenile chinook from other watersheds rear in the Springbrook/ Fletcher Bay estuary and may travel some distance upstream from the mouth as they acclimate to salt water (Beamer et. al, 2013).

Steelhead:

Puget Sound steelhead (*Oncorhynchus mykiss*), or sea-run rainbow trout, were listed as Threatened under the Endangered Species Act in 2007. Typical steelhead life histories include two years of freshwater rearing followed by two years at sea, after which adults return to spawn in their natal watersheds. However, wild steelhead demonstrate a wide range of variations on this typical life history, as they are locally adapted to the conditions within their natal watersheds. Unlike salmon, many steelhead survive spawning and emigrate to the sea for another before returning to spawn a second (or more) season.

Springbrook is identified by NOAA as critical habitat for ESA-listed Puget Sound winter steelhead. The WA Dept. of Fish and Wildlife has documented presence of steelhead in Springbrook Creek (ID 155186377 in SalmonScape). The 1995 Bainbridge Island Watersheds Report (Puget Sound Cooperative River Basin Team 1995) listed steelhead as occurring in Fletcher Bay Watershed , possibly based on the 1982 surveys that found juvenile steelhead in Springbrook Creek downstream of the Fletcher Bay Road crossing (Fiscus 1982). Given its size and habitat characteristics, it is likely that Springbrook Creek historically supported a small population of steelhead; with the population of Puget Sound steelhead at less than 3% of its historical abundance, it is not surprising that steelhead have not been observed there recently. Protecting and restoring habitat and natural processes in small watersheds like Springbrook is important for steelhead (and other fish) recovery, as spatial structure and diversity are two critical components of viable salmonid populations (VSP, McElhany et. al. 2000).

Other Fish Species

Several other fish species likely use habitats within Springbrook Creek or its estuary. Freshwater fish species include several native sculpin (*Cottidae*) species, and Western brook lamprey (*Lampetra richardsoni*). Estuarine and marine species may include numerous Puget Sound nearshore fishes, including forage fish (surf smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*)).

3.5.2 Fish Distribution

Based on field observations by Wild Fish Conservancy, Washington Department of Fish and Wildlife, Bainbridge Island Watershed Council salmon survey monitors, and state databases of fish resources, Figure 18 shows fish species distributions within the watershed.

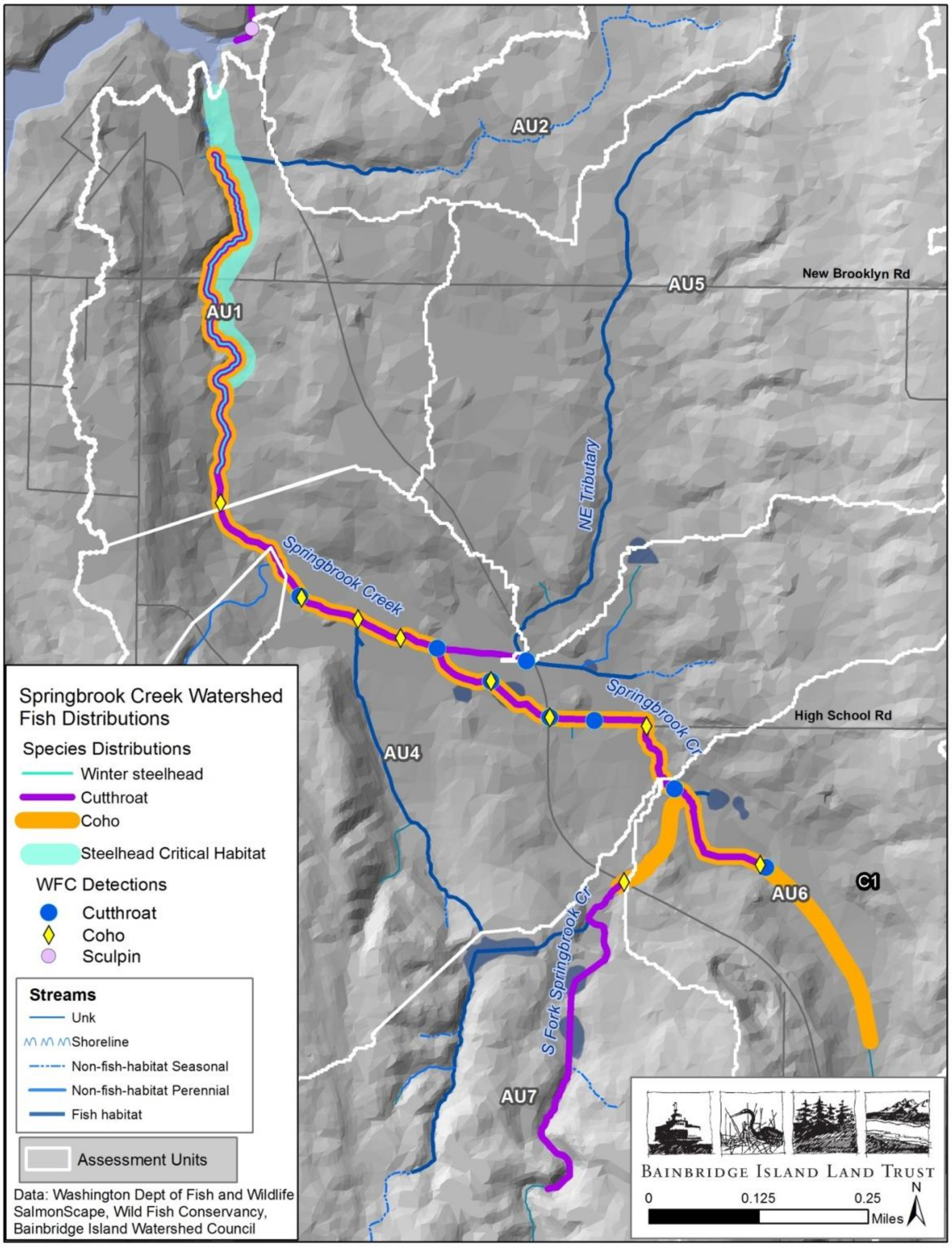


Figure 18. Fish Species Distribution Springbrook Creek Watershed

Annual fall salmon monitoring conducted between 2005 and 2017 confirms that Springbrook Creek hosts a small population of spawning coho salmon. In most years of monitoring, about a dozen adult spawning coho have been observed in the lower portion of Springbrook Creek from the mouth of the stream up just past Fletcher Bay Road (Figure 20). In 2011, a particularly abundant year, 58 observed spawning adults were observed. These numbers may have been boosted relative to other years by strays associated with the Suquamish Tribe's Agate Pass net pens which restarted operation in 2010. Redd production on Springbrook Creek is consistently among the highest of the four streams that the Watershed Council monitors (Figure 21). The number of juveniles observed, however, has been fairly low and inconsistent across the monitoring period, with no juveniles sighted in some years (Figure 22), though this may be in part because Springbrook is one of our wider streams with more hiding places, making detection of small fish a challenge.

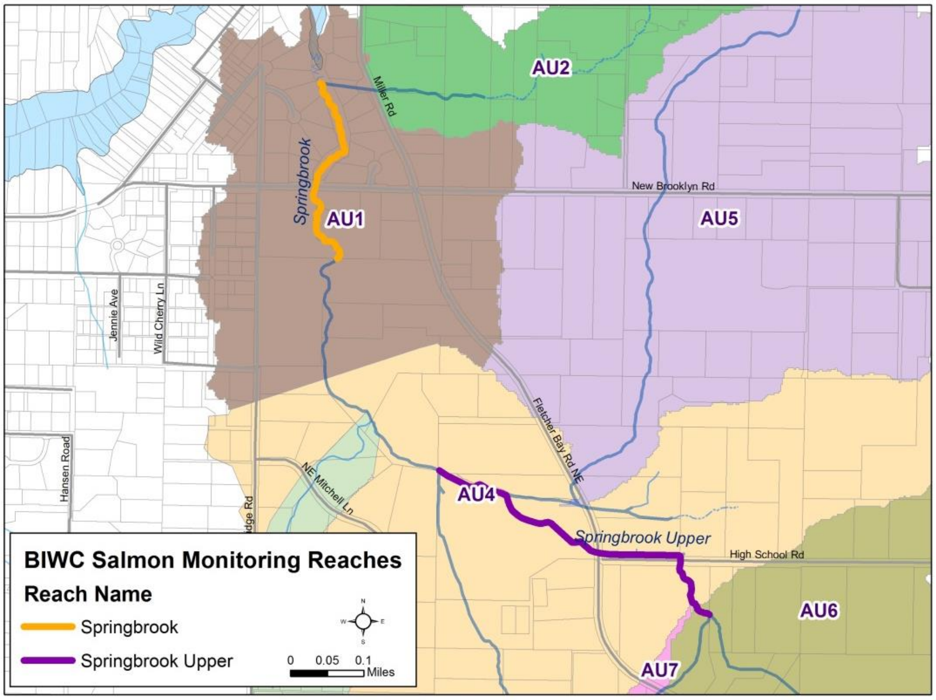


Figure 19. Bainbridge Island Watershed Council Springbrook Creek salmon monitoring reaches. The lower reach was monitored in 2006-2017 and the upper reach in 2014-2017.

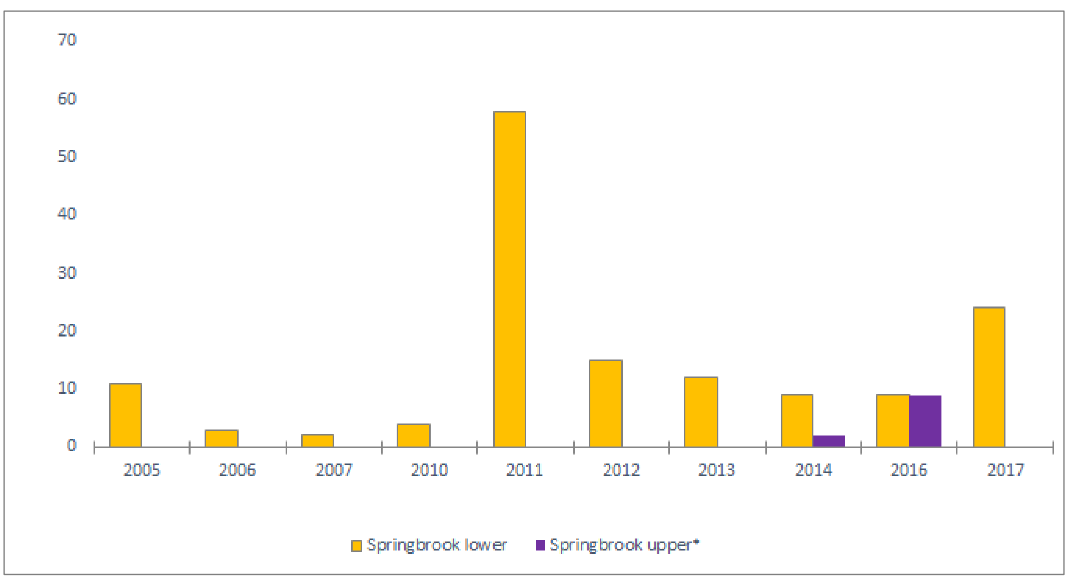


Figure 20. Adult spawning salmon observed on Springbrook Creek by year.

(sampling reaches as per Figure 19). Springbrook Upper was monitored in 2014-2017.

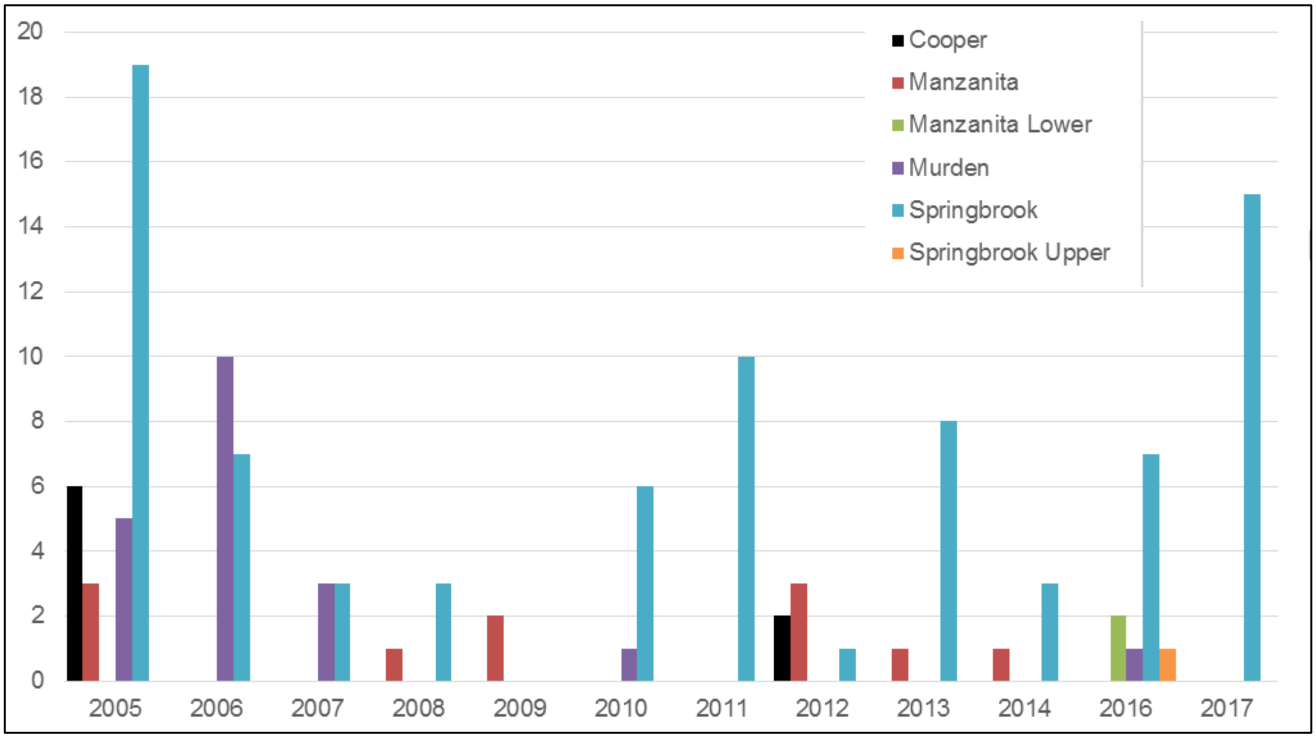


Figure 21. Annual salmon redd tally by stream, Bainbridge Island. Springbrook Upper was monitored in 2014-2017.

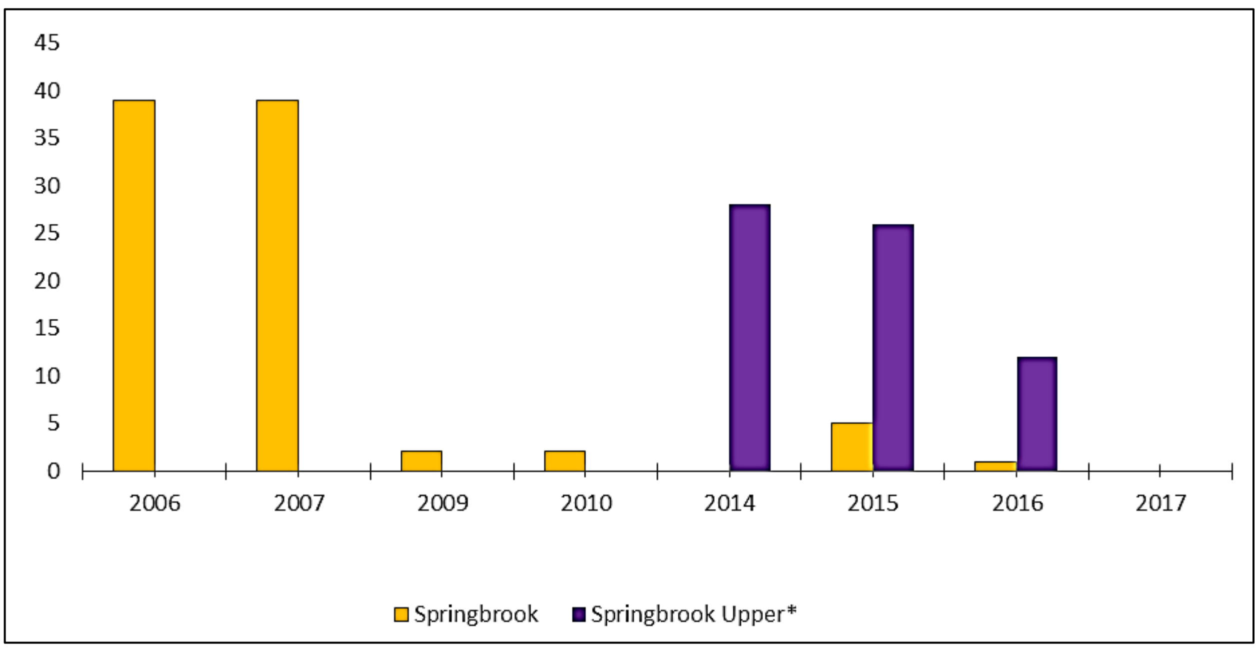


Figure 22. Juvenile salmon and cutthroat trout observed in Springbrook Creek by year. Volunteer salmon monitors were not asked to identify to species. Springbrook Upper was monitored in 2014-2017.

3.6 Water Quality and Flow Monitoring

Baseline water monitoring was conducted during water year 2017 (Oct. 2016 - Sep. 2017) to assess in-stream aquatic life conditions, aquatic life status, water quality, water flow, and human health conditions throughout the watershed. The project team selected monitoring locations and parameters based upon habitat characteristics, tributary confluences, suitability for monitoring, representativeness of habitat and land use types, ease of access, landowner permission, findings from historic assessments, and previous or ongoing monitoring locations.

A total of 14 sites were selected and monitored for one or more parameters (Figure 23 and Table 5). Monitoring included routine monthly flow and physiochemistry field measurements; continuous flow (site A only); continuous conductivity, temperature and dissolved oxygen monitoring; and storm event monitoring (1.39" of rain in a 24-hour period on March 17th and 0.93" of rain in a 24-hour period on April 12th).

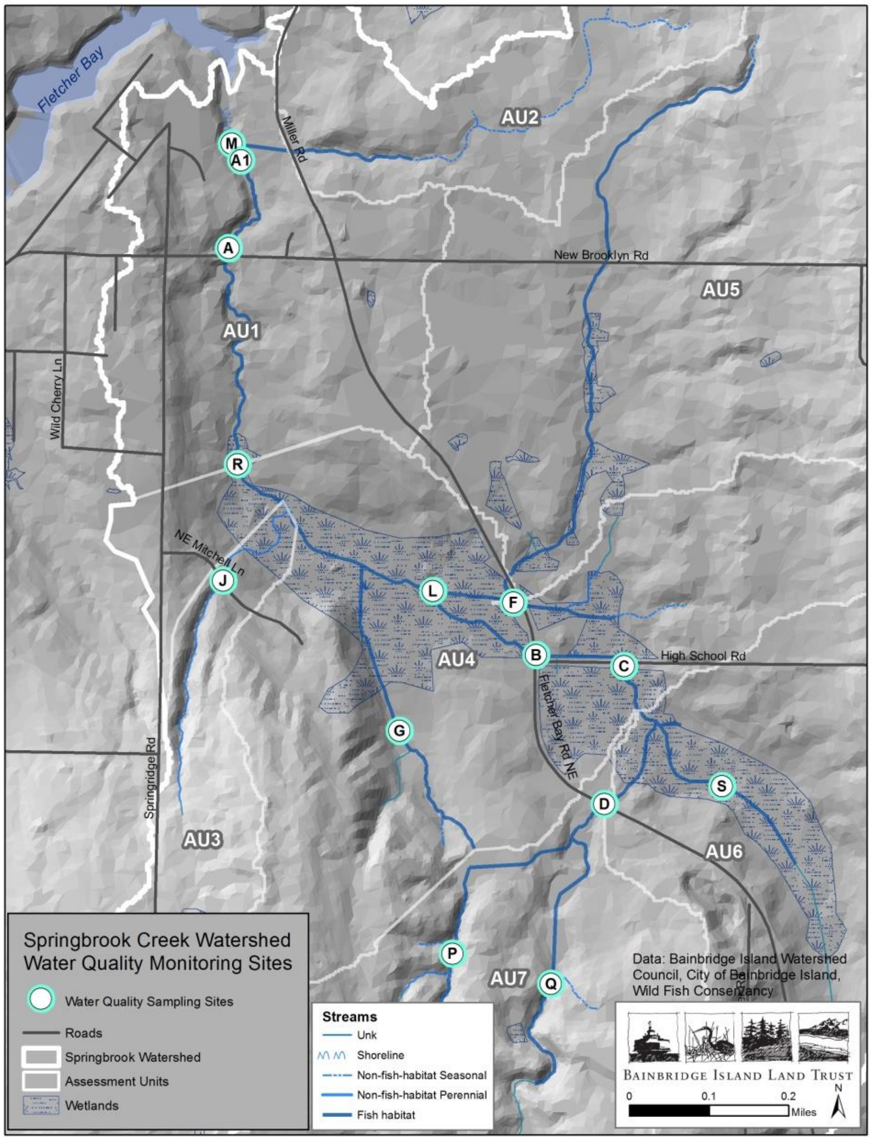


Figure 23. Baseline Water Quality Monitoring Locations, Springbrook Creek Assessment

Table 5. Monitoring Parameters and Frequency

Site	Continuous	Monthly	Annual Dry-Season	Targeted Storm
A	Flow, conductivity, temp	Physiochem	Bacteria, MST, macroinvertebrates	Dissolved metals, hardness, TSS
A1	Dissolved oxygen, temp	----	----	----
B	----	Flow, physiochem		Dissolved metals, hardness, TSS
C	----	Flow, physiochem	Bacteria, MST	Dissolved metals, hardness, TSS
D	Conductivity, temp	Flow, physiochem	Bacteria	Dissolved metals, hardness, TSS
F	----	Flow, physiochem	----	Dissolved metals, hardness, TSS
G	----	Flow, physiochem	----	Dissolved metals, hardness, TSS
J	----	----	----	Dissolved metals, hardness, TSS
L	Conductivity, temp	Flow, physiochem	Bacteria, MST, macroinvertebrates	Dissolved metals, hardness, TSS
M	----	----	----	Dissolved metals, hardness, TSS
P	----	Flow, physiochem	----	Dissolved metals, hardness, TSS
Q	----	Flow, physiochem	----	Dissolved metals, hardness, TSS
R	Dissolved oxygen, temp	----	----	----
S	Dissolved oxygen, temp	----	Bacteria, MST	----

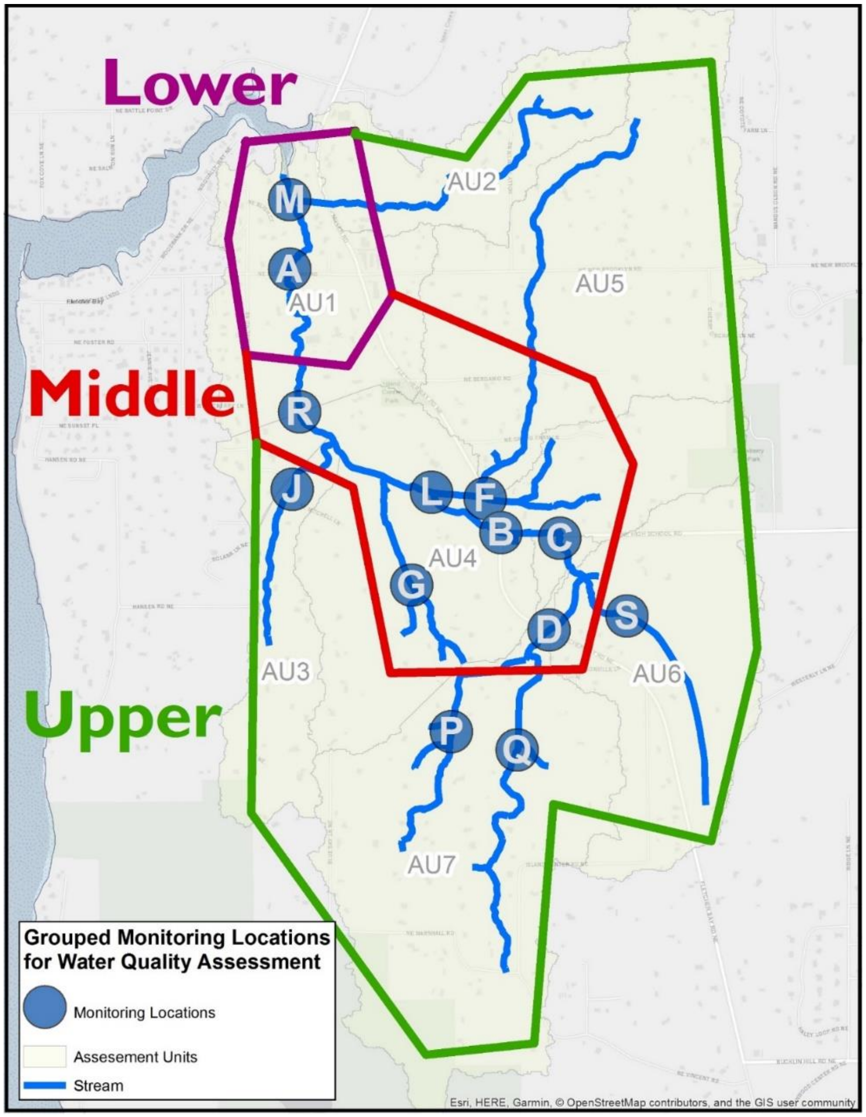


Figure 24. Upper, Middle and Lower Watershed Groups for Water Baseline Monitoring Locations

For water monitoring assessment purposes, the watershed was divided into three sections: upper, middle, and lower watershed areas. Monitoring locations were grouped according to location along the associated mainstem or tributary (Figure 24). Sites P, Q, J, and S fell in the upper watershed area. Sites G, D, F, C, B, L and R fell in the mid-watershed area, and sites A and M fell in the lower watershed area. Monitoring results are summarized in Table 6 and discussed in more detail below.

Table 6. Springbrook Creek Watershed Baseline Conditions

Springbrook Creek Baseline Conditions			
	Upper Watershed	**Mid Watershed**	**Lower Watershed**
Aquatic Life Conditions			
In-stream physical chemistry	**Fair -** generally adequate levels of dissolved oxygen Temperature standards met	**Poor -** low dissolved oxygen and high temperatures (Core Summer Salmonid Habitat Season: May - September)	
Metals	**Good**	**Good** (no lead or copper; only zinc detected, but did not exceed acute or chronic criteria)	**Good** (no lead or copper; only zinc detected, but did not exceed acute or chronic criteria)
Sediment	**Good**	**Poor**	**Fair**
Flow (mean cfs)	Dry Season Baseflow = 0 - 0.04 Wet Season Baseflow = 0.15 - 0.43 Storm Flow = 0.35 - 0.85	Dry Season Baseflow = 0.03 - 0.44 Wet Season Baseflow = 0.39 - 2.26 Storm Flow = 1.05 - 7.86	Dry Season Baseflow = 0.90 Wet Season Baseflow = 4.19 Storm Flow = 6.16 - 9.49 (peaks = 21 and 11)
Aquatic Life Status			
Macroinvertebrates	No monitoring due to lack of suitable site and lack of landowner permission	**Poor** (likely stressors include animal and human waste, fine sediment, metals, low dissolved oxygen and high temp)	**Fair to Good** (likely stressors include animal and human waste, fine sediment, low dissolved oxygen, and high temp)
Human Health Conditions			
Fecal Coliform Bacteria	**No concern**	**High concern**	**Moderate concern**
Microbial Source Tracking	**No sources detected**	**Human source detected**	**Human and ruminant source detected** (possibly sheep, goat, or wildlife; no horse or cattle)

3.6.1 In-Stream Aquatic Life Conditions

In-situ physiochemistry, metals toxicity, suspended sediment, and flow were used to assess in-stream aquatic life conditions. Physiochemistry such as pH, dissolved oxygen, temperature, and suspended sediment can have significant impacts on in-stream aquatic animals' ability to feed, breathe, and reproduce. Dissolved metals concentrations can become toxic to aquatic life depending upon the hardness and pH of the water, and streams require sufficient cool, well-oxygenated flow to sustain aquatic life throughout the core summer salmonid habitat season (May through September).

Lower watershed aquatic life conditions were generally fair. Flows were sufficient for sustaining aquatic life year-round, and no lead or copper were detected. Zinc was detected, but concentrations were well below acute or chronic criteria. Monthly ambient turbidity measurements were well below 25 nephelometric turbidity units (NTU) (the level at which aquatic impairment begins), and site A barely peaked above 25 NTU (29.4 NTU) during one of the two storms sampled. Total suspended solids concentrations (TSS) were low, ranging from one to 14 milligrams per liter (mg/L). However, dissolved oxygen and temperature did not meet aquatic life protection criteria throughout the core summer salmonid habitat season (Table 6, Figures 25 and 26).

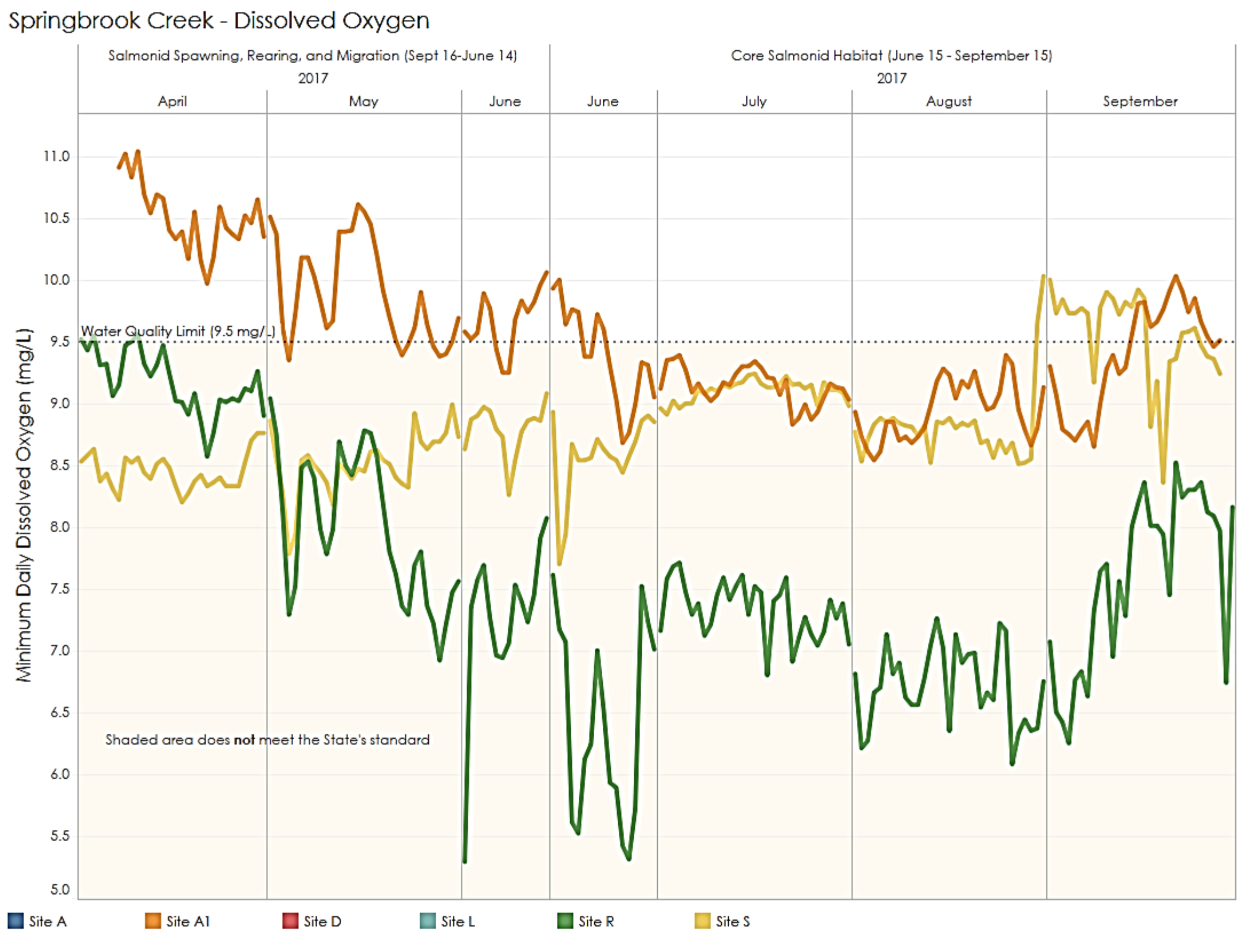


Figure 25. Continuous Dissolved Oxygen Data

Site A in the lower watershed was the only site in the project area with continuous flow gaging. A recent King County assessment of flow "flashiness" at this site indicates potential moderate impacts from development in the basin on High Pulse Count (numbers of times each water year that discrete high flow pulses occur), TQmean (the fraction of time during a water year that the daily average flow rate is greater than the annual average flow rate of that year), and R-B Index (Richards-Baker Flashiness Index-A dimensionless index of flow oscillations relative to total flow based on daily average discharge measured during a water year) (DeGasperi and Gregerson, 2015).

Aquatic life conditions in the mid-watershed were relatively poor. Although flows were sufficient, metals sampling results were well below acute or chronic conditions, and monthly ambient turbidity measurements were well below 25 NTU, sites B and G exceeded 25 NTU during targeted storm sampling with site G having the highest level of any site at 46 NTU. Total Suspended Solids (TSS) concentrations at most of the mid-watershed sites were generally higher than upper or lower watershed sites. Concentrations ranged from five to 39 mg/L with the highest concentration in that range measured at site G. Dissolved oxygen and temperature did not meet aquatic life protection criteria throughout the core summer salmonid habitat season (Table 6, Figures 25 and 26).

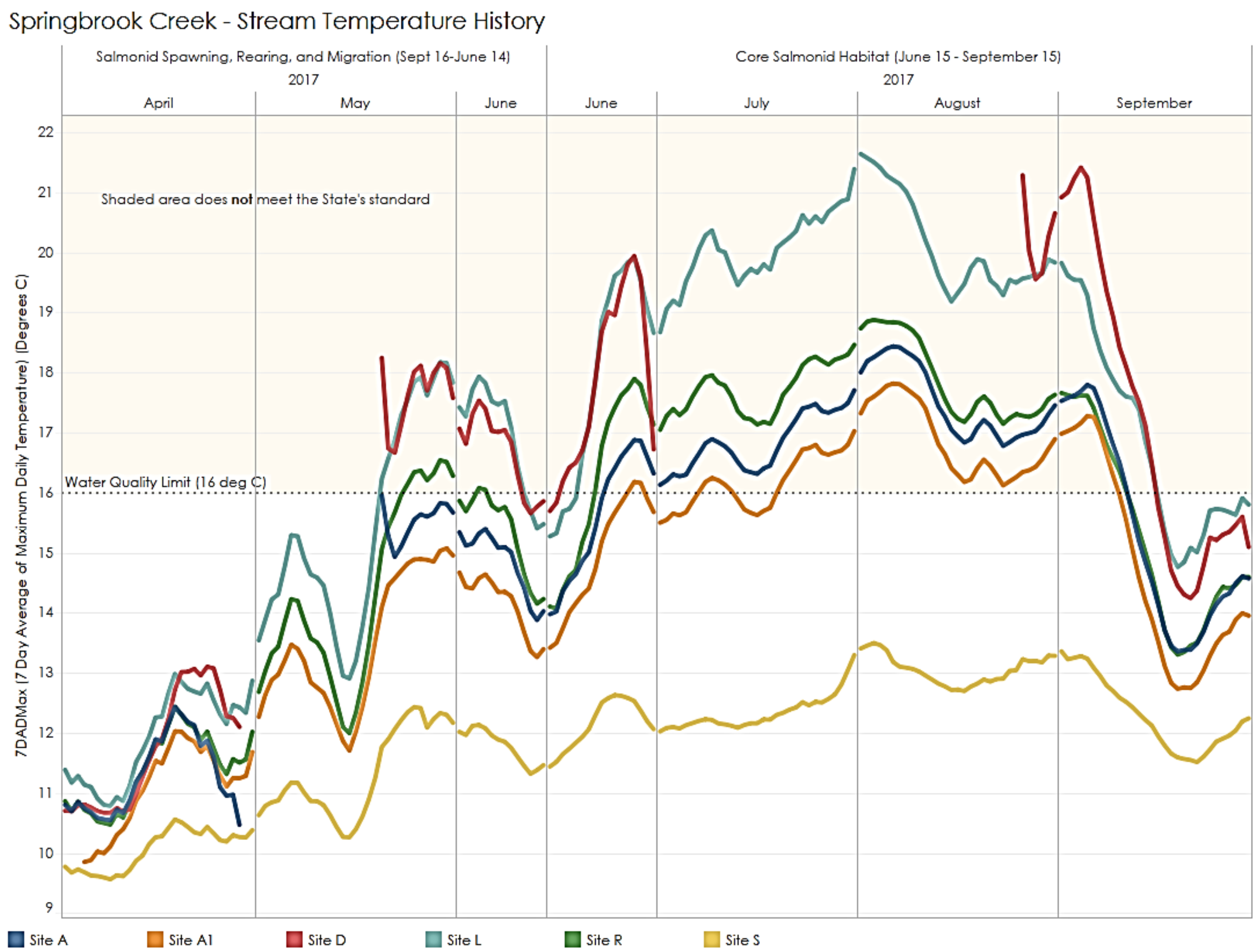


Figure 26. Continuous Temperature Data

Aquatic life conditions in the upper watershed were generally better, though summer flows were fairly low in most headwaters areas and likely not sufficient for sustaining fish year-round. Sites P and Q are in forested draws upstream from artificial ponds, and monthly monitoring (not depicted in Figures 25 and 26) found that conditions did meet aquatic life protection criteria (low temperatures and high dissolved oxygen) during the core summer salmonid habitat season. Site S along the southeastern stream reach in the upper watershed, which has a heavily-forested, healthy riparian buffer, met temperature criteria during the summer months but hovered just below the ideal dissolved oxygen standard year-round; Table 6, Figures 25 and 26).

3.6.2 In-Stream Aquatic Life Status

Four stream benthic macroinvertebrate health indices were used to assess in-stream aquatic life status: Benthic-Index of Biological Integrity (B-IBI), Hilsenhoff Biotic Tolerance Index, Metals Tolerance Index, and Fine Sediment Sensitivity Index.

The B-IBI is calculated from ten metrics of overall species diversity and relative proportions of pollutant-tolerant and intolerant species. In terms of the overall B-IBI score, the lower watershed conditions at site A scored “fair to good” similar to a reference site in the adjacent Cooper Creek basin. The Cooper Creek basin is relatively undeveloped and generally has excellent water quality. Mid-watershed conditions at site L scored poor based on macroinvertebrate sampling in December 2016. Upper watershed in-stream aquatic life status was not assessed due to lack of landowner permissions.

The Hilsenhoff Biotic Tolerance Index measures sensitivity to labile organic matter pollution (i.e. animal waste including human waste). The scale is from 0 - 10 with higher values indicative of likely organic matter pollution. The lower watershed scored 4.1 while mid-watershed scored 5.3. The Cooper Creek reference site scored 3.0.

The Metals Tolerance Index measures the likelihood of metals impacts through the relative proportion of metals-tolerant species. Elevated metals in streams not due to natural conditions can be an indication of human impacts through stormwater runoff. The scale is from 0 - 10 with higher values indicative of likely elevated metals concentrations. The lower watershed scored 1.8 (same as the Cooper Creek reference site), but mid-watershed scored 4.3.

The Fine Sediment Sensitivity Index measures sensitivity to fine sediment from both natural and human factors. Puget Sound Lowland streams range from 0 to ~200 with lower scores indicative of likely impact (with the caveat that the model may not be well-calibrated to this region due to inclusion of only 7 Puget Sound Lowlands in the original model; Sean Sullivan, Rhithron Associates Inc, pers. comm. 2018). The lower watershed scored 20. The mid-watershed scored only five, with only one species of “slightly fine sediment sensitive” taxons detected. The Cooper Creek reference site scored 40.

3.6.3 Human Health Conditions

Though bacteria in waterbodies do not directly impact aquatic animals, bacteria and other pathogens usually associated with bacteria are a threat to human health and can contaminant downstream shellfish harvest areas. Bacteria can originate from numerous sources to include leaking septic systems, agriculture, or wildlife.

The lower reach of Springbrook Creek was State-listed as impaired by fecal coliform bacteria in 2004, and Fletcher Bay was State-listed as a Threatened Shellfish Growing Area in 2013 due to continued high bacteria counts. This reach is currently covered by the Sinclair and Dyes Inlets Fecal Coliform Bacteria Total Maximum Daily Load TMDL and Water Quality Implementation Plan. Fecal coliform bacteria concentrations at site A have decreased since routine monitoring began in 2010, but middle to lower watershed reaches continue to fail to meet criteria.

Baseline monitoring for this project utilized both fecal coliform bacteria and microbial source tracking (MST) to try to identify type and location of sources in the watershed. The State recognizes and regulates fecal coliform bacteria as the indicator species to determine impairment in a waterbody. However, fecal coliform bacteria is ubiquitous to all warm-blooded animals, so is less helpful in identifying the source of the bacteria. MST, however, is a set of DNA-based methods used to determine the host (different animals or Human) that contributes to fecal pollution.

Of highest concern are elevated bacteria concentrations in the mid-watershed, particularly along the mainstem at High School Road (site C) which does not meet the standard and where fecal coliform bacteria level is approximately 24 times greater than the level measured at site L which met the standard. MST indicated a human source for these bacteria, which were not detected at either of the two upstream sites from this location (D or S). The source was therefore between these monitoring locations, south of High School Road.

Of moderate concern are elevated bacteria concentrations in the lower watershed at NE Fletcher Bay Road (site A) which does not meet the standard (bacteria level approximately six times greater than level at site L which met the standard). A possible human source was detected at site A, though detection may simply be the signal from site C upstream. A ruminant source was detected at site A as well, but cattle and horse were ruled out, leaving possibly sheep, goat, or wildlife as the source.

Human health conditions in the upper watershed were very good. Bacteria concentrations were extremely low and easily met State criteria. Further, there were no human or animal microbes detected in these waters.

3.6.4 Summary of Water Quality Conditions

In regards to water quality, the mid-watershed (AU4) needs the most work in all categories - aquatic life condition and status and human health condition. Improvements here should have a positive impact on lower watershed conditions, as well.

Stormwater runoff from roads, construction sites, and other denuded areas are potential sources of fine sediment likely impacting aquatic life status. In-stream sediment from either or both natural conditions or historical land use such as forest clearing and agriculture can also be a source of fine sediments when they are eroded and carried downstream during flashy high flow events. Therefore, it is important to use low impact development practices to reduce or eliminate stormwater runoff as much as feasible, and to protect and restore wetlands and floodplains to attenuate storm flows.

The most critical challenge in terms of salmonid habitat is summertime temperature and dissolved oxygen. Temperature and dissolved oxygen are inversely proportional - the higher the temperature, the lower the oxygen, so stream shading is important. Other than runoff from small, infrequent summer storms, summertime flow in the watershed is solely fed by groundwater. As groundwater is cool and usually well-oxygenated, well-shaded reaches with a healthy riparian buffer usually meet summertime temperature and dissolved oxygen criteria such as at site S (AU 6) in the upper watershed. Therefore, it is important to maintain groundwater levels to sustain flow and protect and restore healthy riparian buffers to shade stream channels.

In regards to human health protection, bacteria remains a recalcitrant problem. The sources of human bacterial contamination have not been identified and Kitsap County Health Department has not been working on projects such as this in the watershed since 2015. **Follow up investigation to find and address the human sources south of High School Road (site C) and the source(s) of the detected sheep, goat, or wildlife fecal contamination upstream of site A is recommended, whether by the City of Bainbridge Island or Kitsap County Health District.**

3.7 Puget Sound Characterization Decision Support Tool Modeling Results Summary

The Washington Department of Ecology analyzed watershed characteristics utilizing their Puget Sound Characterization decision support modeling system (Stanley et al. 2016) using GIS data for assessment unit boundaries, hydrography, surficial geology, land cover, wetlands, and stream confinement provided by the City of Bainbridge Island and Wild Fish Conservancy. The report findings were supplemented by Stephen Stanley's observations from a May 10, 2018 tour of the watershed with the Project Core Team. Appendix I contains the full report: Characterization Results for Springbrook Creek Watershed, Bainbridge Island, Washington, and WDOE Publication 18-06-006. This tool models relative importance of the individual assessment units to the delivery, movement, and loss of water and to the input and capture of sediments. It also models relative degradation of the landscape features that regulate those processes (such as loss of depressional wetlands decreasing surface storage of water). The Importance score and Degradation score are then combined in a Management Matrix to identify prioritization for protection and restoration based on these water flow processes (Figure 27). Note that important stressors such as water quality impairments and fish passage barriers were outside of the scope of this modeling, and these results are just one input to the Springbrook Project's overall assessment process.

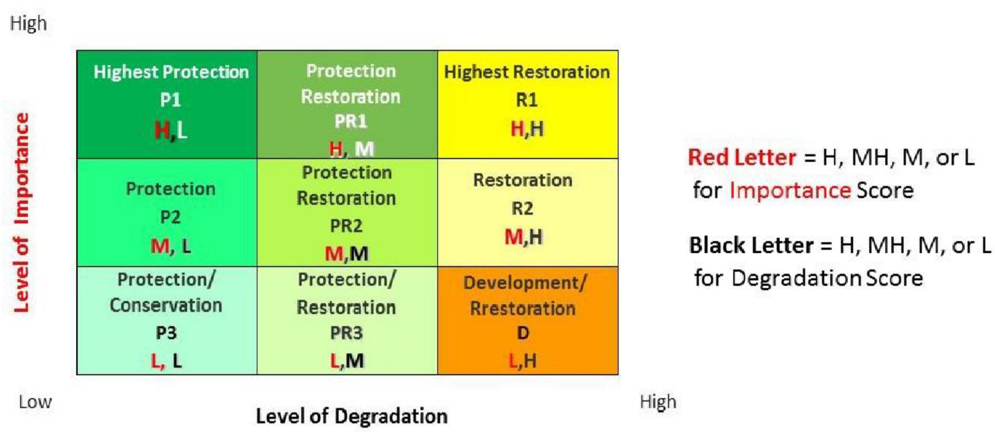


Figure 27. WDOE Watershed characterization management matrix for prioritization of assessment units**.**

The water flow characterization portion of the analysis includes delivery, movement, and loss components. Recharge refers to the downward movement and influx of water into the underlying aquifer, while discharge is the movement back out of the aquifer to the surface. Recharge areas tend to be places such as ephemeral stream bottoms and wetlands, while natural discharge might occur in springs or perennial streams and artificial discharge from wells. The analysis showed that the southern, steeper half of the watershed in AUs 3, 6, and 7 are important areas for interception and infiltration of precipitation to recharge groundwater and both shallow groundwater and surface flow in these areas support stream flows (Figure 28). The intact forest cover and low development impacts in these areas result in good condition and emphasis of protection of stream systems rather than restoration.

Where these slopes level off in the center portion of the watershed in AU4 and lower portions of AUs 5 and 6 is the primary area where deeper groundwater flows from the upper reaches discharge into and are temporarily stored in both the wetlands and stream systems (Figure 28). As a result, this area has historically been very wet. This area functions to help maintain low flows during summer and fall months and also assists in retaining and attenuating high surface flows during storms and reducing downstream flooding, erosion and transport of sediment, and also traps sediments. This portion of the watershed is also highly altered by activities such as vegetation clearing, artificial ponding, and ditching. Therefore AU4 was classified as highest priority for restoration (Figure 28).

The northern half of the Springbrook Watershed contributes relatively less to the overall water flow and water quality processes. This portion of the watershed is generally more degraded than the southern portion of the watershed, particularly in the neighborhood service center area (designated for meeting the Island's future needs for housing, goods, services, and jobs). Concentrating development within this lower part of the watershed, where there is less potential to attenuate stream flows, serves to protect and maintain the more important assessment units (referred to in the WDOE report as Project Assessment Units or PAUs) in the central and southern portion of the watershed. It is also critical, however, that Low Impact Development measures be required for new development in these AU's in order to minimize impacts to water flow and water quality processes including protection of floodplain storage in AU 2.

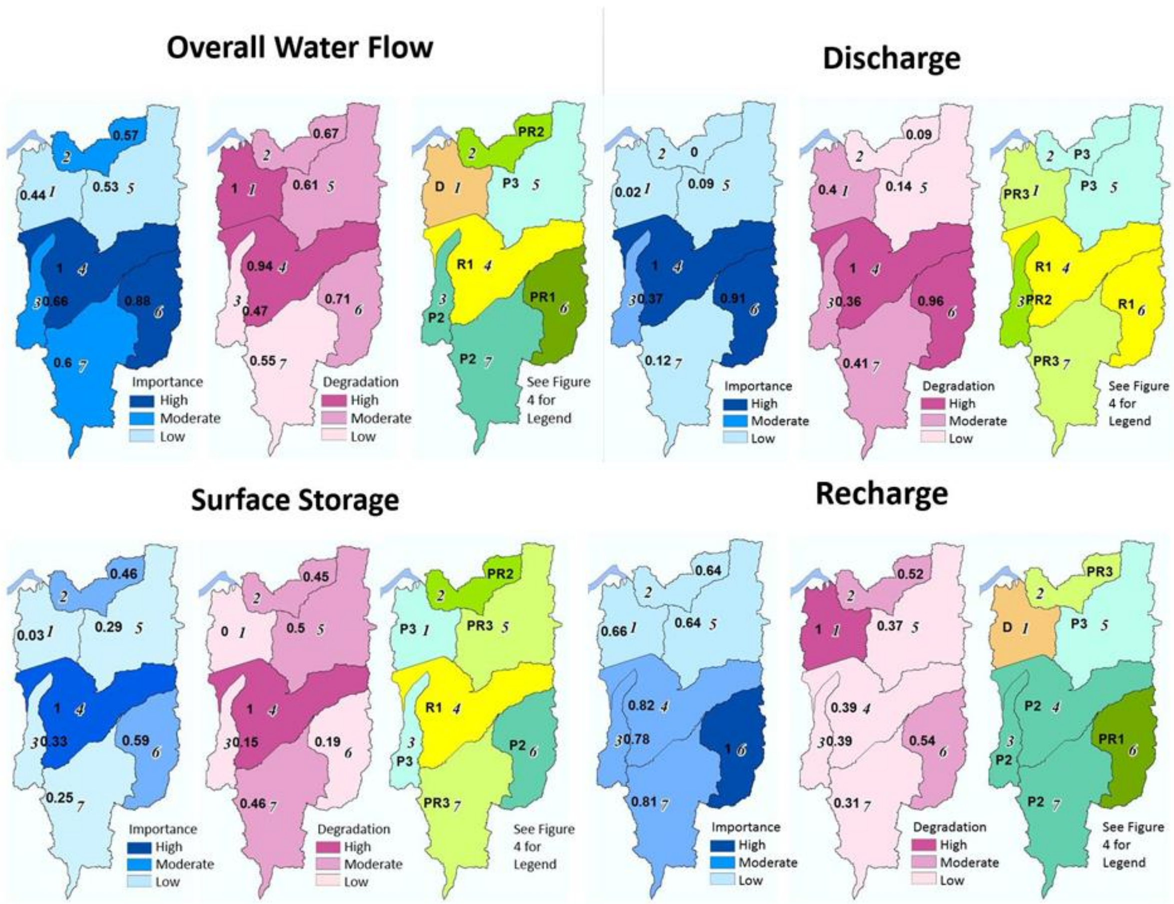


Figure 28. WDOE Springbook Creek Watershed Characterization results 2018.

Bold numbers from 0 to 1 are the normalized scores, with a higher score indicating a higher level of importance or alteration. The numbers 1 through 7 are the assessment unit numbers. The blue basins represent the output of the importance model; the pink basins represent the output of the degradation model and the green/yellow basins represent combined output of the two previous models using the management matrix in Figure 27.

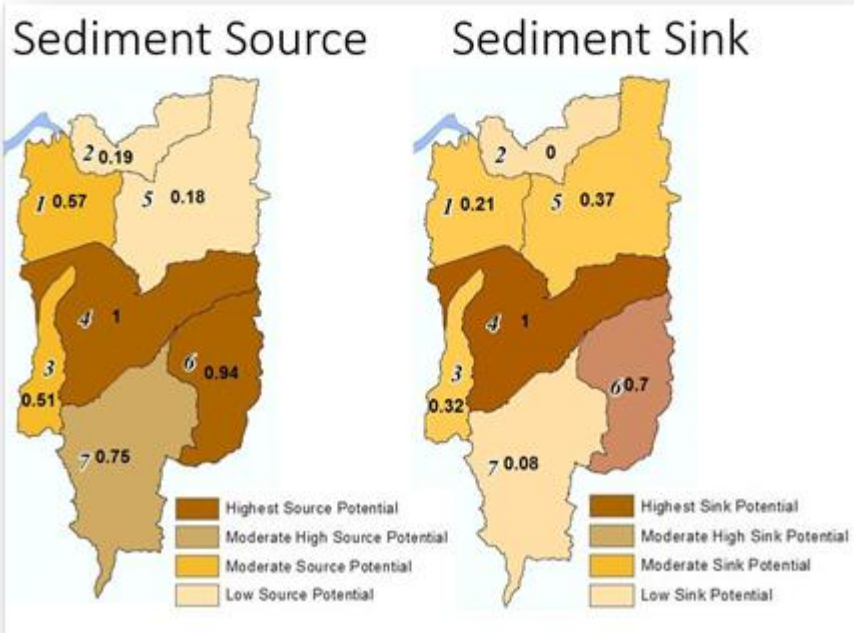


Figure 29. Results of WDOE Springbrook Creek Watershed sediment model 2018.
The left graphic shows the areas with the highest potential for generating sediment (darker colors), such as assessment units 4, 6 and 7. The right graphic shows the areas with the highest potential for retaining sediment (darker colors) such as assessment units 4 and 6.

The Characterization Results for Springbrook Creek Watershed provided the following summary/synthesis of all findings and recommendations from the Washington Department of Ecology based on modeling results and a May 10, 2018 field visit to some key areas of the watershed:

1) Maintain native forest and scrub-shrub cover and minimize impervious surfaces in the headwater assessment units. This will help minimize erosion in the upper watershed particularly in assessment units 6 and 7 and minimize transport of sediment downstream.

2) Encourage gradual "natural" restoration of agricultural ponds in PAU 4, 5, 6 and 7 to wetland systems with emergent, scrub-shrub and forested components. This will allow trapping of sediment and creation of shading to reduce solar heating of open water areas.

3) Restore native forest and scrub-shrub cover within the depressional wetland systems in assessment units 4 and 6 and re-establish the stream channel. This includes providing adequate buffers widths to protect stream and watershed processes and functions.

4) Protect key groundwater discharge systems (slope wetlands) that are still intact, particularly in assessment unit 4 on slopes bordering the west boundary of the depressional wetland system.

5) Develop alternative "bio-engineered" solutions to replace culvert system at Fletcher Bay Road NE and downstream compound weir system.

Table 7. Washington Department of Ecology summary and recommendations by assessment unit.

PAU #	Overall Results[1]	Storage[1]	Recharge[1]	Discharge[1]	Restoration Priority	Protection Priority	Overall Condition of PAU and Key Issues	Recommendations
1	D	P3	D	PR3	7	6	Concrete compound weir and culvert in lower reaches impedes fish passage and affects stream fluvial dynamics. Homes have impacted the riparian corridor by removing native vegetation, introducing non-native vegetation and increasing erosion on creek banks. This PAU has lower importance and higher degradation of processes relation to other PAUs due to a relatively higher level of development and less opportunity to support watershed processes.	Concentrate development here using LID techniques. Investigate funding sources for removing compound weir and culvert system with bio-engineered alternative that re-establishes natural processes and historic longitudinal profile and gradient. Seek riparian conservation easements for properties along creek and restore native vegetation.
2	PR2	PR2	PR3	P3	4	4	Assessment unit has moderate level of urban residential development. Floodplain storage has moderate importance.	Seek riparian conservation easements for properties along creek & protect floodplain storage. Use LID techniques for development.
3	P2	P3	P2	PR2	5	3	Assessment unit is relatively intact with limited development	Seek riparian conservation easements for properties along creek.
4	R1	R1	P2	R1	1	1	Relatively widespread damage to storage & discharge processes in this assessment unit. Clearing of floodplain & wetland vegetation for rural residential farming operations and for access by owners to active stream channel. Most streams are diverted away from historic wetland areas. Clearing has encouraged growth of reed canary grass which is clogging stream channels.	This assessment unit presents the greatest opportunity for biological lift in the system and requires relatively extensive restoration measures. It is key to successful restoration of the overall system. Work with home owners to obtain conservation easement for purpose of restoring riparian and floodplain vegetation & protecting intact slope discharge areas. Existing areas of forested floodplain should be protected.
5	P3	PR3	P3	P3	6	6	Assessment unit has lower importance but moderate level of development could affect integrity of watershed. Depressional wetlands and floodplains present; important for flood storage.	Seek riparian and forest conservation easements to sustain native cover, protect wetland/stream ecosystems.

PAU #	Overall Results[1]	Storage[1]	Recharge[1]	Discharge[1]	Restoration Priority	Protection Priority	Overall Condition of PAU and Key Issues	Recommendations
6	PR1	P2	PR1	R1	2	1	Assessment unit is relatively intact and contains part of the large depressional wetland system in the adjacent assessment unit 4.	Maintain & restore forest cover; restore natural cover in wetland system. Seek riparian & wetland conservation easements.
7	P2	PR3	P2	PR3	3	2	Erosion of outwash deposits in upper watershed & transport downstream. Solar heating of water in artificial ponds may contribute to stream temperature increase.	Protect & maintain forest cover. Allow ponds to fill in and convert to shallow wetland systems which act as sediment trap & provide forested cover.

[1]See Figure 27 for interpretation of protection/restoration prioritization codes.

3.8 Landowner Willingness and Public Outreach

One reason the Springbrook Creek area was chosen for more thorough watershed analysis was the large number of interested and involved landowners in this watershed. Following the 2013-2014 Wild Fish Conservancy water type assessments (SRFB project 13-1143), supported by Bainbridge Island Land Trust, a number of willing landowners provided access to their properties and deeply engaged in discussions about the history of the stream and current conditions and uses. Between 2014 and 2018 over 120 landowners of 142 parcels received a request for permission or access, with 75 responding. In November 2017 we sought permission of 23 additional landowners for access for additional sampling (both stream assessment and water quality). As shown in Fig. 14 (Section 3.4.3) permission to access was granted by landowners across a very large proportion of Springbrook Creek and its tributaries. Through comments on the access permission forms, phone conversations, and in-person conversations on properties, many landowners expressed interest in maintaining healthy streams and offered their observations of stream changes they have either observed themselves or heard about from older friends and family. Some had thoughts on stressors they believe may be impacting the stream and ideas for improvements. These conversations were also very important in gathering information on landowners' use of creeks, riparian areas, and wetlands on their property and how they feel these should appear and function, and afforded us opportunities to share information with them about our findings and knowledge of best management practices.

As restoration and protection opportunities were identified, landowners and potentially affected neighbors were contacted about potential project areas and to further discuss changes they had observed over time, their land use practices, and their goals for the stream and wetland areas on their properties, while also sharing information about the assessment project and how land management practices affect watershed health. These were usually meetings with owners of one or two properties, and often involved walking along streams together to discuss the conditions and possible improvements. For discussions of the more involved potential reconfiguration of channels and culverts at the Fletcher Bay Road and High School Road intersection, we held a meeting for all six potentially involved properties on June 12, 2018. Landowners were briefed on the assessment findings and problem points, shown some potential designs for rerouting stream channels for more natural flow configurations and separation from roads, and there was extensive dialogue on pros and cons of the designs presented and other potential options. Many individual phone calls and meetings with landowners took place over the project period.

Compatibility between landowner goals and project goals was a major factor in assessing project feasibility. For a project to proceed to conceptual design stage, it needed landowner support and a level of assurance that any improvements made would be maintained over time.

Information about the project was shared to the public via Bainbridge Island Land Trust's website and newsletter, Wild Fish Conservancy's website, and the City of Bainbridge Island's website. Project team members attended the Harvest Fair September 2017, a public event at Johnson Farm, with a display about the project and to interact with the public. Presentations on the assessment and recommended actions were provided to the Island Center Subarea Planning Committee, West Sound Watersheds Council, and Land Trust Projects Committee and Board. Additional public presentations are planned in the future to share assessment results and to help keep restoration and protection actions in the forefront.

4. Summary of Findings and Identification of Limiting Factors

The results of the assessment and analysis work contained in Section 3 illustrates that the Springbrook Creek Watershed contains a range of natural and manmade conditions. The culmination of assessment and analysis resulted in the identification of many positive attributes as well as complex issues affecting stream and watershed conditions. Describing these issues and opportunities is important for identifying actions to provide a higher level of function to support fish resources and support water quality health, while supporting other uses in the watershed such as residential and commercial uses.

The analysis contained in Section 3 provides clear identification of areas of the watershed that are rural and natural, while others are highly impacted by land use and development. Sections of Springbrook Creek meander and flow freely and naturally through mature canopy of trees and native vegetation helping water temperatures remain cool all through the year and providing excellent habitat for fish and other species. There are other sections of the creek that have been channelized/straightened or ditched along roads or through private property where no natural stream side vegetation has been retained, contaminants from nearby roads drain into the stream, and culverts block fish from migrating upstream. The stream flows in its historic path in some stretches, while other parts of the stream have been re-routed so many times it is hard to know where the "natural" stream channel might be. Some wetland areas function fully, providing important stormwater, water quality, and habitat functions. In other areas ponds have been installed where wetlands used to be, warming water temperature and causing sediment input into the stream. A majority of the culverts under public roads are fish passage barriers and/or are in a state of disrepair, while many culverts on private properties are not functioning well (cannot accommodate the flow of water or are also fish passage barriers).

The challenge with Springbrook Creek is that sections of healthy habitat and watershed functions are disrupted by sections of highly disturbed or modified sections– there aren't large segments of the stream or watershed that provide contiguous fully functioning natural conditions.

There exists a long history of a myriad of land uses within the watershed leading to its present condition. Land uses range from residential and agricultural to commercial. Major vehicular transportation corridors exist within the watershed. Some land use modifications were done during a period when the stream was had an abundance of fish and cold, clear water, such that worries about land use impacts on the stream were not considered. Trees were cleared. Ponds were dug and streams were re-routed to accommodate agricultural or residential uses. Roads and culverts were installed without full consideration or knowledge of the stream's flow or design features necessary for fish to pass through.

Now more is known about ecosystem processes and how degradations affect processes and habitats, as illustrated in Figure 30. Better knowledge of how to care for these resources and about the functions they provide both humans and other species have led to improved regulations to guide activities to prevent or reduce impacts, such as the City of Bainbridge Island's Critical Areas Ordinance and Washington Department of Fish and Wildlife's hydraulic code for working in streams. Yet it is evident that, despite a general spirit of stewardship by many landowners in the watershed, the watershed has been considerably degraded and the decline of the condition of the stream and associated riparian area continues. Rules alone cannot protect and improve the stream and watershed conditions. Knowledge about stream conditions and functions and how to care for them needs to be shared widely to engage landowners in protection and restoration of these important streams and wetlands.

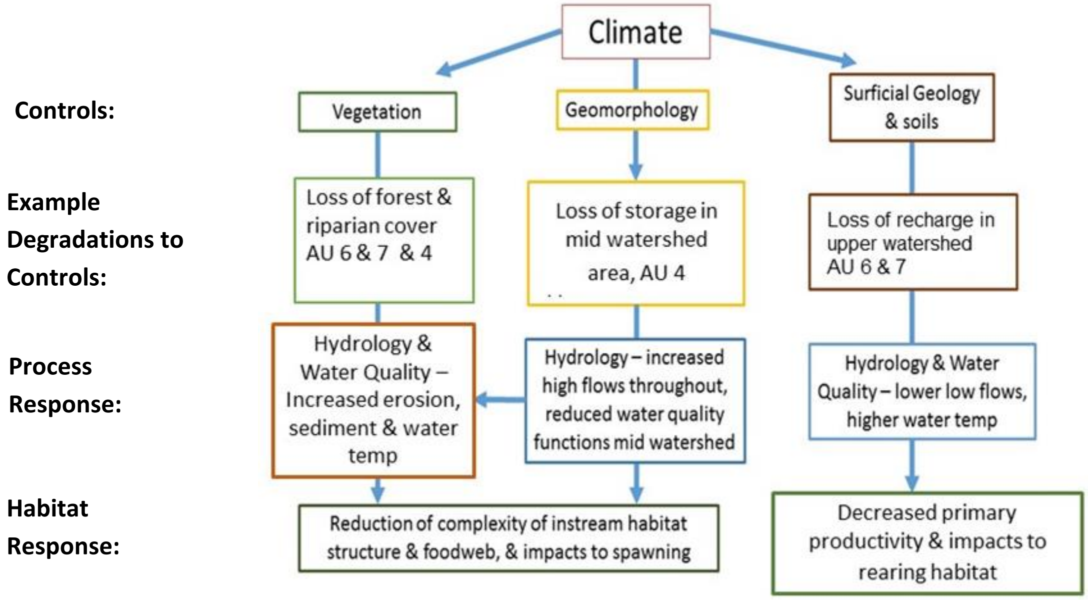


Figure 30. Effect of degradations on ecosystem processes and habitat.

Because each AU and stream reach has different factors influencing conditions within it, no single strategy can be applied towards "fixing" the issues. Identifying the limiting factors within each is needed in order to identify actions that can improve conditions.

Table 8 provide a summary of the limiting factors of each AU and stream reach as more comprehensively identified in Section 3, and broad recommended strategies for addressing these limiting factors. These are key factors that were used to identify specific action items that could be implemented to address limiting factors. These actions are outlined in Section 5 of this report.

Table 8. Summary of key AU attributes and recommendations.

PAU #	Reaches	Fish Passage Barriers	Stream Conditions	Salmonid Occurrence	% Impervious	Road density[1] (mi/mi²)	Land Uses/ Land Cover	WDOE Watershed Functioning Results: Overall and by Function	WDOE Restoration Priority	WDOE Protection Priority	Water Quality: Temp & O2	Water Quality: Metals & Sediment	Fecal coliform bacteria	Summary of key threats and opportunities	Overall Recommendations
1	SB01	1 Unk 2 Partial	Confined forested valley with faster moving waters and excellent spawning gravels (all Type F), before flowing into the Fletcher Bay Estuary. Some armored stretches, and non-native vegetation along the banks and erosion from clearing.The lowest two culverts in the system are within AU1 (including failing weir and culvert system on Fletcher Bay Road) and these restrict fish passage, constrain stream channel, and affect stream fluvial dynamics.	Critical Steelhead habitat. Currently occupied by cutthroat and coho. Important Island spawning stream. Possibly used by juvenile chinook and historically by chum.	15.9	24.8	Includes Island Center Neighborhood Center: densest residential and commercial uses in the watershed. Relatively low tree cover and little wetland area, with high % impervious and high road density.	**Degraded:** Low Importance, High Degradation **Importance reflects capacity to provide a function, while degradation indicates diminishment of this capacity.** Results reflect this AUs position at the bottom of the system, in an area with few wetlands. Storage: Low Importance, Low Degradation Recharge: Low Importance, High Degradation Discharge: Low Importance, Mod Degradation	7	6	Fair: Fails to meet standards in summer months	Fair	Mod concern	> Highest development impacts (roads, commercial/industrial uses, impervious surfaces). > Lower opportunity for supporting overall watershed processes than other AUs but highest priority for addressing fish passage. > Fish barriers low in system - particularly failing weir and culvert system on Fletcher Bay Road. > Important fish habitats (critical steelhead habitat, coho spawning beds, and access to entire system) > In-stream habitat degradation (armoring, loss of channel complexity). > Riparian habitat impacted by non-native vegetation and removal of vegetation in areas, but good intact habitat at south end and north of Fletcher Bay Road NE. > Bacterial contamination, inadequate stormwater treatment, and high risk of contaminants from impervious surfaces flushing into the stream in stormwater events.	Address fish passage barriers low on mainstem Springbrook Creek to improve fish access to approximately 4.6 miles of fish habitat. Improve riparian conditions through removal of streamside armor, and restoration of natural hydrologic connections, and through restoration of native vegetation. Protect high-quality habitat through riparian conservation easements. Concentrate development here since it is already highly disturbed and in accordance with Island's Growth Management Act, but implement Low Impact Development techniques and continued best management practices by farm landowners. Implement stormwater treatment improvements. Retain water monitoring program in lower watershed, and continue to engage Kitsap Health District in addressing fecal coliform. Educate landowners as to best management practices for healthy streams.
2	SB01A	1 Full	This stream originates from a seasonal spring head in a shallow forested ravine, with the lower 1,500' of the total 4,000' reach providing marginal fish habitat with seasonal flow through a confined channel. Issues include a full barrier culvert at the mouth, ditching, artificial ponding, and invasives.	No known current occupancy.	8.5	19	Primarily residential, with some commercial area. High impervious surfaces and road density. Average tree cover and no mapped wetlands.	**PR2:** Mod Importance, Mod Degradation Storage: Mod Importance, Mod Degradation Recharge: Low Importance, Mod Degradation Discharge: Low Importance, Low Degradation	4	4	No data	Good	Low concern	> Moderately impacted by development. > Poor stream and riparian conditions, altered hydrology, fish passage barriers, commercial use. > This reach provides marginal fish habitat and seasonal flow and stream restoration efforts would have minimal impact on fish resources. However floodplain storage has moderate importance.	Consider riparian conservation easements for properties along creek to protect floodplain storage. Use LID techniques for development to avoid degradation of water quality flowing in to Fletcher Bay. Continue water quality monitoring efforts. Educate landowners as to best management practices for healthy streams. The full passage barrier low in the system is not currently a high priority.
3	SB01B	Non-fish	Originates in a forested ravine, drops through a derelict culvert perched 9.3-ft high, below which channel is deeply incised, then becomes very steep. The channel is largely confined, but in a level area before the tributary joins Springbrook Creek the channel is unconfined within intact forested wetland habitat.	No known current occupancy.	5.3	18.9	Residential, low impervious surfaces, high road density, little wetland area, but high tree cover.	**P2:** Mod Importance, Low Degradation Storage: Low Importance, Low Degradation Recharge: Mod Importance, Low Degradation Discharge: Mod Importance, Mod Degradation	5	3	No data	Good	Low concern	> Limited overall development but high road density. > High sediment inputs from erosion caused by perched derelict culvert. > Intact habitat prior to entering SB01-1 provides wetland function protection opportunities.	Address perched culvert so as to halt further downcutting and erosion, decreasing sediment flow into the mainstem creek. Seek riparian conservation easements for properties along creek, particularly forested wetland at lower end.
4	SB01-1, SB01C, SB01E, end of SB01D	3 Unk 8 Partial	The SB01-1 mainstem reach includes some stretches of high quality habitat with unconfined, low gradient channel, but is highly impacted by stream modifications such as altering stream channels and ditching along major arterial roads, partial barrier culverts, riparian clearing for farms and pastures, manmade ponds, and invasives. A manmade pond in AU7 has diverted natural water flow that historically fed SB01C. This was previously a salmon stream and retains some high-quality habitat, but impairments include fish passage barriers, channelization, degradation of stream complexity and lack of woody debris. SB01E is also impacted by ponds, rerouting and ditching along major roads, and partial barrier culverts.	Cutthroat and coho (including spawning) within mainstem reach SB01-1, and cutthroat detected in lower SB01D below confluence with SB01E.	5.0	13.7	Residential, farms, and pasturelands, greatest concentration of wetlands, average tree cover and impervious surfaces and relatively low road density.	**R1:** High Importance, High Degradation Storage: High Importance, High Degradation Recharge: Mod Importance, Low Degradation Discharge: High Importance, High Degradation	1	1	Poor: removal of riparian shading and ponds increase water temps	Poor	High concern	> Highest priority for restoration of watershed processes due to highest importance and high degradation. > Degradations include diverted input flows, riparian alterations (including ditching away from wetlands and along major arterials) diminishing stream complexity, clearing of native riparian vegetation and replacement with invasives. > Fish passage severely impaired by a number of poorly designed culverts. > Active land use and many landowners requires multiple individualized protection and restoration efforts. > Unknown source of fecal coliform bacteria.	This assessment unit presents the greatest opportunity for biological lift in the system and requires relatively extensive restoration measures. It is key to successful restoration of the overall system. Address fish passage barriers. In particular, address culvert passage barriers and stream ditching/re-routing issues in the High School Road x Fletcher Road intersection as an interrelated complex. Tie in culvert issues in AU5. Restore degraded channels by examining opportunities to restore historic flows, conditions, and locations of streams. Improve riparian areas and seek conservation easements or acquisitions for protection of intact habitats. Explore opportunities to improve stream temperature through reestablishment of wetland function and riparian shading. Continue Kitsap Health District efforts to identify and address source(s) of fecal coliform bacteria. Educate landowners as to best management practices for healthy streams.
5	SB01D	3 Partial 3 Full	Previously unmapped or regulated seasonal stream with 4,900' now typed as fish habitat. Originates in a seasonal wetland with stretches of intact habitat along unconfined channel and good in-stream habitat but many areas of riparian vegetation clearing and ditching (with landowners explaining that they regarded the flow as 'run-off' rather than a stream) and multiple full and partial barrier culverts. Two undersized culverts low in the system cause stormwater and fish barrier issues.	Cutthroat detected at confluence of SB01D and SB01E. No known current occurrence higher in AU5.	6.0	15.3	Residential, with little wetland area, relatively high proportion cleared and moderate road density and impervious surfaces.	**P3:** Low Importance, Mod Degradation Storage: Low Importance, Mod Degradation Recharge: Low Importance, Mod Degradation Discharge: Low Importance, Mod Degradation	6	6	No data	Good	Low concern	> Ratings not high for watershed functions, but covers large area with high-quality stretches within the 4,900' of newly-identified fish habitat. > Limiting factors include fish passage barriers, culverts undersized for flow, constrained channel, lack of stream complexity, and extensive riparian vegetation clearing. > Landowner education could be highly impactful as this was a previously unmapped stream.	Educate landowners as to regulatory restrictions and best management practices for healthy streams. Address passage barriers and stormwater management problems created by undersized culverts low in system. Seek conservation easements or acquisitions of intact riparian forests and wetlands.
6	SB01-2, lower SB01F	1 Partial 2 Full	Upper Springbrook headwaters hosts some of the highest-quality stream and wetland conditions within the entire watershed. Excellent potential rearing habitat. Mature riparian vegetation hydrologically connnected to the stream. Full and partial fish passage barriers restrict fish access to habitat within portions of this AU. There is a short stretch of armored channel, and some vegetation clearing within adjacent wetlands.	Cutthroat and coho.	5.6	15.2	Residential with high concentration of wetlands, and moderate proportion cleared and in impervious surfaces, and moderate road density.	**PR1**: High Importance, Moderate Degradation Storage: Mod Importance, Low Degradation Recharge: High Importance, Mod Degradation Discharge: High Importance, High Degradation	2	1	Good: headwaters in intact wetlands	Good	Low concern	> This is largely an intact, functioning stream wetland reach with good habitat protection opportunities. High priority for protection of multiple stream and watershed functions. > Only area where water quality standards are met year-round. > Limiting factors include small segment of stream armor and some wetland vegetation clearing, as well as partial and full barrier culverts.	Address the full and partial barrier culverts. Seek conservation easements or acquisition for riparian forests and wetlands to sustain native cover and protect water quality and proper functioning. Restore natural cover in wetland system.
7	SB01F, SB01G	1 Unk 1 Partial 4 Full	SB01F flows from wetlands down a confined channel in largely forested ravine, with areas of excellent cutthroat spawning habitat, then flows down into two large manmade ponds (with clearing up to the banks of the lower pond) and into armored channels. The ponds and multiple culverts block fish passage. SB01G is similar, also flowing into a large manmade lake which diverts flow from the original channel (SB01C) over to SB01F. The outlet of this lake is also a full fish passage barrier with cleared and armored artificial channel.	Cutthroat in upper SB01F, coho in lower. No known current occurrence in SB01G.	4.1	14.1	Parks, residential, and farm on relatively steep terrain, with little wetland area but high forest cover and low clearing, impervious, and road density.	**P2:** Mod Importance, Low Degradation Storage: Low Importance, Mod Degradation Recharge: Mod Importance, Low Degradation Discharge: Low Importance, Mod Degradation	3	2	Poor: ponds increase water temps	Good	Low concern	> High priority for restoration and protection of watershed functions. > Significant alteration of the stream's hydrology has occurred through construction of large ponds, drainage control systems, and underground piping. > Ponds also heat water where headwater streams would normally provide conditions for cooling and oxygenation. > Other degradations include partial and full fish passage barriers, and degradation of the natural channel and riparian vegetation.	Consider developing an integrated long-term plan for addressing the fish passage barriers, water quality and habitat degradation, and hydrologic 'replumbing' of the system created by the manmade pond complex. Restore in-stream habitat and riparian vegetation where these have been degraded, such as around and downstream of ponds. Seek conservation easements to protect intact riparian habitat.

[1]Includes driveways

5. Protection and Restoration Strategies and Actions

In identifying recommended actions that could assist in maintaining and improving watershed and stream health, the project team was guided by the foundational belief “that river restoration is more likely to be successful at restoring individual or multiple species and preventing the demise of other species if there is careful consideration of the watershed or ecosystem context in which individual restoration actions are set (Beechie et al. 2008).”

The Springbrook Creek Watershed Assessment:

1. Collected sufficient data and information to identify needs within the watershed.
2. Identified restoration and protection strategies that attend to a number of ecological and community needs but specifically focused on the goal of restoring Springbrook Creek so that it supports documented and historical fish populations.
3. Adopted a logic approach informed by the analytics of the data collected to identify projects and chose priorities (Beechie, et al. 2008).

As provided for in Section 4 and Table 8 – the Summary of Findings – factors that limit stream and watershed health depend on the reach and assessment unit but also the context of the entire watershed. No one project type can address stressors in the watershed, so a suite of recommended actions is needed.

Prioritization of projects was an iterative process of synthesizing collected data, identifying problem areas and high-value areas within the watershed, conceptualizing projects to address or protect these, obtaining feedback from affected landowners and/or agencies, assessing feasibility, and gathering further information to cycle back into project proposals, etc.

The project team did not attempt to summarize these rating factors into a single prioritization score or other metric, but instead used them to guide development of a project-team consensus of projects to be developed to conceptual design in this phase of the overarching endeavor of restoring the watershed.

Including data driven factors, the following elements were those that were considered when recommending restoration, protection or other action items:

1. **Projects that address multiple limiting factors or protect values that are identified as priorities in the assessment were elevated in the selection process.** See Appendix II.

2. **Landowner willingness:** With the majority of the watershed owned by private landowners, engagement by private citizens is a key element in recommending an action. If a landowner is onboard, success in achieving restoration or protection actions is highest. The five projects that were elevated for developing conceptual designs all had written and verbal landowner willingness (four of them being private landowners). In the case where the landowner was the City of Bainbridge Island, their willingness to participate in talks of restoration actions was likewise necessary. For projects that were not developed into conceptual designs but are contained in this report as recommended actions, working with landowners to further develop projects in the future is needed.

3. **Fish Passage Barriers and stream armoring**: Fish passage barriers (culverts, vegetation blockages, other in-stream obstructions) and armor/structure along stream banks were identified as among some of the highest contributors constraining stream function and fish utilization. Removing these stream barriers (either completely or replacing them with bridges, improved culver t designs, or removing blockages such as reed canary-grass) are some of the highest priorities actions within the watershed. Removing armor, which constrains stream hydrology and function, also was an identified a high priority. Addressing fish passage barriers lower in the system first, then moving upstream to the next barrier was a strategy applied by the project team. The first four priority projects (Projects 1 -4) address the first four blockages in the stream in sequence of stream miles. In the case where a culvert constrained watershed processes in an otherwise intact reach (i.e. the stream and riparian habitat is in good condition but there is a fish barrier), those projects were also prioritized (such as Project 11). If a fish barrier project could also address storm water and utilities in need of upgrades, reduce maintenance needs (i.e. reducing the number of culverts), accommodate climate change patterns (such as more intense storm events), and other multiple needs, the project was elevated in priority.

4. **Riparian/wetland condition**: The condition of the riparian (the area next to and adjoining a stream) and wetland habitats of Springbrook Creek and its tributaries has been greatly diminished. Projects that improve these conditions and functions, including landowner engagement in understanding the value of a healthy riparian area, are of high importance. Where there are good to excellent riparian and wetland conditions, protection of these values is also key.

5. **Position of the project within the watershe**d: Connecting functioning stream segments and habitats, or restoring segments of the stream or watershed, to functioning habitats assists in the cumulative positive impact of actions. For instance, having one project that improves 5 acres and .5 miles of stream that is contiguous or near another 10 acres of habitat and stream already in good shape elevated interest in that project. Projects in areas isolated from other efforts were closely examined for overall benefit versus effort.

Projects were also evaluated within the larger watershed ecosystem context. Key actions include:

- Maintain and Protect Ecosystem Processes. Upper watershed (Primarily in AUs 7 and 6 and secondarily in AUs 5, 3 and 2) water flow processes are intact but key threats are the cumulative future impacts to these processes from removal of forest and riparian cover for urban and agricultural development. Removal of forest and riparian cover in these upper watershed AUs can increase the intensity and duration of peak flows downstream which in turn impacts the biological integrity of downstream reaches. Actions in this area should focus on protecting forest and riparian cover through the use of zoning and conservation easements.
- Restore Ecosystem Processes and Functions. Ecosystem processes and functions are the most degraded in AU 4 due to clearing of riparian and forest cover and the ditching and diking of wetlands and steams. Water quality assessments indicate that elevated water temperatures are due to lack of riparian cover and associated low dissolved oxygen. Additionally, septic systems and livestock are contributing to fecal coliform levels. Working with land owners, actions should include restoring riparian cover (lower temperatures) and historic wetlands (pollutant removal, attenuate storm flows, increase habitat diversity).

- Restore Natural Stream Bed Condition. The historic and natural stream bed gradient and channel structure has been altered by concrete weirs (AU1), stream culverts and roads, stream armoring and ditching. Many of these alterations have created barriers for fish accessing both the mainstem and tributaries of the Springbrook watershed. Recommended actions include removing these barriers and restoring natural stream bed and bank condition. Long term success of these actions is dependent on the protection and restoration actions outlined in priorities 1 and 2 above.

As potential projects were identified, they were placed into a matrix that identified the major priorities of the WDOE Watershed Characterization, Watershed Stressors, Water Quality Assessment, and elements such as landowner willingness and landowner education.

This matrix is contained within **Appendix II.**

It needs to be noted that Appendix II on its own should not be interpreted without the benefit of reviewing and reading Section 3 and 4 of this report.

Section 5.2 contains watershed-wide strategies, Section 5.3 contains summary descriptions of the 5 conceptual design projects as developed as part of this project (with full descriptions provided in Appendix III) and Section 6 outlines additional opportunities.

5.2 Watershed-wide Strategies

5.2.1 Education and Outreach

Although a primary project objective of the project was development of five Conceptual Designs for specific restoration or protection projects, there are strategies identified as important across the watershed as a whole. Primary among these is landowner education. The number of landowners removing vegetation in the riparian area in this watershed is significant, allowing for the establishment of invasive plants, reducing shade (and therefore increasing water temperature), reducing stormwater moderation function (vegetation retains soil and slows down waterflow), and reducing habitat functions for aquatic and terrestrial species. When the project team spoke to landowners who had cleared vegetation near streams or wetlands, the landowners generally expressed an appreciation for the stream and natural resources, but there was misunderstanding of how best to protect and care for these resources. There are good streamside-living practices that need to be shared with landowners, educating them about stream health and how it is influenced by their management actions. It also was evident that generally landowners need to be informed about Critical Area Ordinances (particularly changes made in 2018) and permits needed to work in the water or the adjacent riparian area. A recommended watershed-wide action is to work with partners such as Kitsap Conservation District, Wild Fish Conservancy, Washington Department of Fish and Wildlife, Washington Department of Ecology, the BI Watershed Council, the Land Trust, and others to research and develop effective approaches to landowner outreach and educations (e.g. distribution of a Living on the Stream pamphlet specific to Springbrook Creek Watershed, streamside living workshops, etc.) Also, communications with realtors, landscapers, and contractors hired to work on properties could be effective outreach efforts.

Continued and additional education and outreach focusing on onsite septic system maintenance, animal waste management, groundwater, and water conservation is recommended. A 2014 outreach effort by

Kitsap Public Health District (Walther 2016) in Fletcher Bay targeted older septic systems within 200' of shorelines or creeks and completed 82 inspections and found two failing septic system as well as eight with some concerns. The outreach results included information on pet and livestock waste management and reduction of pesticide use. Results were encouraging, as 89% of homeowners found these inspections to be helpful, and a large portion implemented actions such as septic pumping and implementation of natural yard care practices. This project recommends the expansion of these efforts to portions of Springbrook Creek Watershed not included in the initial Kitsap Public Health District project.

5.2.2 Restoration and Protection

There are ample opportunities for restoration and protection throughout this watershed, beyond those specifically discussed in this assessment, and the opportunities discussed in this assessment should by no means be considered an exhaustive list of potential restoration and protection actions. As discussed in Section 3.1 (History, Land Use, and Development) the City of Bainbridge Island has strong Critical Areas Ordinances (CAO's) protecting streams, wetlands, riparian areas, and native vegetation. However, improved communication and enforcement appears to be necessary, given the number of cases observed of recent vegetation clearing within stream or wetland buffers, or work within the stream (such as culvert installment), without a permit.

In prioritizing protections of wetlands, floodplains, and riparian buffers beyond those required under CAOs, the WDOE characterization report (Appendix B) indicates that actions in Assessment Units 4, 6, 7, and 3 are potentially of highest protection benefit. In prioritizing future habitat restoration actions, the characterization results indicate highest potential biological lift from actions in Assessment Units 4, 6, 7, and 2. Conversion of artificial ponds (particularly the larger of these) into shallow wetland systems could be especially beneficial in restoring some of the natural wetland extend, trapping sediments, reducing water temperatures, and providing forested cover.

5.2.3 Future Culvert Replacements/Removals and Prioritization

Forty six road crossing structures were identified within the Springbrook Creek watershed. Conceptual designs 1, 2,3 and 5 address four of these culverts through removal and restoration actions. Given that none of the 30 structures on fish habitat streams are categorized as 100% fish passable, further work is needed to improve fish passage throughout the watershed by replacing or removing culverts to enable anadromous fish to access suitable spawning and rearing habitat. The prioritization of culvert work logically follows the principle of moving up the stream network to fix passage issues sequentially from lowest to highest in the system, but is also planned in concert with landowner willingness, habitat restoration work, and any 'replumbing' or stream modification planned that may change water flow patterns.

To assist with future prioritization of addressing structures in the stream, the project team recommends a culvert removal/restoration prioritization process. Steps include: Reviewing the Washington Department of Fish and Wildlife Priority Index calculations for existing culverts, review Wild Fish Conservancy's comprehensive database on in-stream structures, examine the data aligned with WDFW PI's to determine if latest stream data was used to inform the PI (such as information gathered as part of the Springbrook Creek Assessment - i.e. amount of fish habitat available upstream), ask WDFW for updates of PI's if needed, determine landowner willingness to pursue options, identify a logical prioritization sequence (i.e. – lowest in the system to highest, remove culverts where surrounding habitat conditions are good, etc.), identify project partners, costs, funding sources, and implementation timetable.

The project team recommends that results of this prioritization help guide the inclusion of fish habitat and fish passage projects into the City's process for prioritizing capital improvement projects (CIP). Currently, culverts are included in the CIP typically on the basis of prioritization of road maintenance or stormwater needs. Having prioritization for fish passage factored in to the CIP closes a significant gap in planning from a resource standpoint, as this affects not only allocation of city funding, but also competitiveness for grants that might look to that CIP prioritization as indicative of the biological value of a culvert restoration project.

5.2.4 Growth Management

The City of Bainbridge Island's comprehensive plan focuses residential, commercial, and industrial growth in designated centers with urban services. Island Center is one of these designated centers that will accommodate new growth. The following recommendations should guide the Island Center Sub-Area planning process in progress at the time of this printing.

The Fletcher Bay Watershed, of which Springbrook Creek is a sub-watershed, is currently <10% effective impervious surface. It is recommended that zoning and development/re-development requirements should be designed to keep effective impervious surface at <10%. This can be done using low impact development practices that incorporate stormwater infiltration and treatment to the maximum extent practicable. The Island Center Sub-Area is an ideal location in which to develop and test a pilot Stormwater Control Transfer Program which allows for the transfer of stormwater management funding from heavily developed and impacted areas to areas with relatively minor impacts. Transferred funding can then fund restoration and/or retrofit projects to restore and protect hydrologic function in the watershed.

Other strategies for improving and protecting water quality include consideration of alternatives to individual septic systems such as small community treatment box plants, particularly those that incorporate water reclamation and reuse to reduce consumptive water use and protect recharge of aquifers that sustain summer stream flow. Purchase of properties for conservation can decrease development impacts, and purchase or transfer of development rights can prevent development of intact areas of ecological significance.

5.2.5 Water Quality Monitoring

In order to protect water quality and ensure efficacy of efforts to improve aquatic life and human health conditions in Springbrook Creek and Fletcher Bay, monitoring of water quality and follow-up to address any detected problems are necessary. This needs to occur at several of the established monitoring sites throughout the watershed to provide the information required to locate sources of contaminants. Monitoring water flow is also important for reasons including ensuring that infrastructure is adequate for handling peak flows and that flow is adequate to support salmon through each life cycle phase. At this time, neither COBI nor Kitsap Public Health have a plan for continuing monitoring beyond monitoring taking place at station A near the mouth of Springbrook Creek (as per Table 5).

5.3 Site Specific Conceptual Designs – Summaries

This section of the report provides an overview of projects that were identified as providing benefits to improved stream and watershed conditions. Five conceptual designs (circled on the Figure 31 map) were created for these highest priority projects and details of those designs are included in Appendix III.

Developing five conceptual designs was a requirement of the grant which supported this project. The project team used project grant funds to develop the conceptual designs which involved many landowner discussions, site visits and surveys, engineered drawings (in the case of restoration projects), and development of cost estimates. It is hoped that each of the five conceptual designs can be used as a basis for developing final designs, obtaining funding support, moving forward with permitting, and then ultimately being implemented. Much work was done in the development of these projects, especially those which would take place on private lands, where balancing restoration actions with land uses was imperative. Additionally, private landowners needed to consider their ongoing obligations to maintain restoration actions when deciding on restoration alternatives.

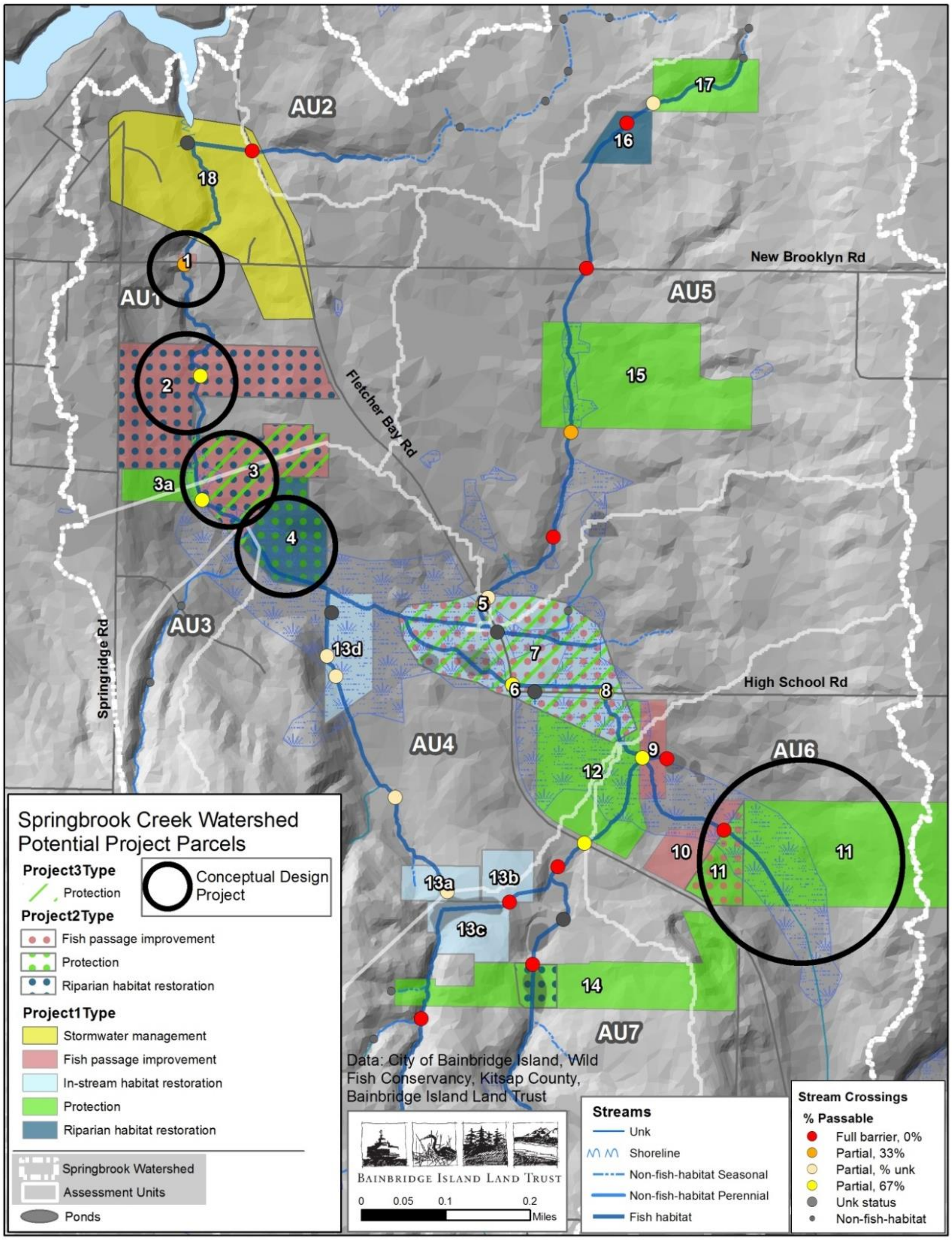


Figure 31. Location of Conceptual Design Projects

5.3.1 Fletcher Bay Road NE Culvert and Weir Removal and Stream Restoration Project Appendix III Project 1

Project team rationale for recommending this project as the #1 project to be done in the Springbrook Creek Watershed was that it addresses the following limiting factors: fish passage, riparian habitat, sediment transport, in stream complexity (large wood transport and restoring stream to its historical profile and gradient), water quality (temperature), stream hydrology, and landowner (COBI) willingness.

Additionally, the project team focused on sequencing projects moving upstream from Fletcher Bay. This project is the lowest barrier in the creek system, making it a priority to address in the near term in order to provide access to upstream habitat.

Approximately 1100 feet upstream from where Springbrook Creek enters Fletcher Bay, exists the first road crossing on the Springbrook Creek mainstem. This crossing, under Fletcher Bay Road NE, is a partial barrier which includes eight concrete weirs, 70 feet of armor along both sides of the bank, and a 5 ft. wide by 100 ft. long steel culvert. Upstream of the culvert are two weirs and approximately 30 feet of armor along both banks. The downstream-most weir below the culvert is failing and water now passes through a crack in its foundation and through large rocks armoring the bank rather than spilling over the top of the weir. The City of Bainbridge Island has installed plastic sheeting and sandbags to temporarily restore fish passage function to the lowest weir. WDFW identifies this complex as 33% passable and has assigned it a Prioritization Index (PI) of 24.66 (WDFW culvert ID #15-0340); this is amongst the highest PI's of 44 PI calculations that WDFW has performed on Bainbridge Island. This crossing affects fish access to 3.6 miles of fish habitat upstream. Below the failing weir the channel is incised and scoured down to hardpan for approximately 200 ft. potentially affecting spawning habitat. The entire 999 acre Springbrook Creek watershed drains to this location.

Project Goals:

The primary objective of this project is to replace an undersized culvert, failing weir complex, and bank armor with a crossing structure, allowing an unconstrained stream passage below Fletcher Bay Road and a naturalized stream and bank. Removing the undersized culvert and weirs will improve fish passage, the transport of sediment and large woody debris, and remove the need for ongoing maintenance/repair of the failing culvert and weir complex. Bank bioengineering and imported streambed material will be used to reconstruct the eroded channel features downstream from the existing undersized structure. Another goal is to avoid negative impacts from the undersized culvert and failing weir complex that will be exacerbated in the coming decades as intensity and frequency of hydrologic events occur as a result of climate change.

The project team, Washington Department of Fish and Wildlife, Suquamish Tribe and the City of Bainbridge Island examined the project site multiple times to discuss restoration options. The 1996 KCM, Inc. design drawings were obtained and examined as well as past survey information. Interviews with Wayne Daley, project manager for the 1996 culvert installation took place, as well as interviews with upstream landowners. As part of this project a total station survey was performed as well as examination of LIDAR data.

Two options were created: Option 1 replaces the existing culvert and weir system with a bridge and restore the stream bank by removing armor and, Option 2 would replace the existing culvert with a new larger culvert while also improving stream bank conditions.

The project team and the City of Bainbridge Island preferred the conceptual structure and channel modifications described in Option 1 in order to restore fish passage, remove substantial bank armoring, restore natural processes at the downstream-most crossing in the watershed and in this reach, remove the need of ongoing maintenance/repair needs of culverts, and accommodate potentially higher flow patterns in the watershed.

5.3.2 Eddy Culvert and Armor Removal, Bridge Replacement, Stream Restoration Project Appendix III Project 2

The project team rationale for recommending this project as the #2 project within the Springbrook Creek Watershed included: project's location low in the watershed, its adjacency to project #1 (Fletcher Bay Culvert/Weir Removal) and project #3 (Rekow Stream Restoration), improving the following limiting factors: fish passage, riparian habitat, sediment transport, instream complexity designed to support fish life stages (large wood transport and restoring stream to its historical profile and gradient and more pools and riffle), stream hydrology, and landowner willingness. Landowner Barb Eddy was deeply involved in the design discussions and allowed full access to her property in order to perform due diligence necessary for formulating restoration ideas. Additionally, the project team focused on sequencing projects moving upstream from Fletcher Bay. This project is the second lowest barrier in the creek system, making it a priority to address in the near term order to provide access to 3.4 miles of upstream fish habitat.

At river mile 0.39 Springbrook Creek crosses a field access road on a 14.58 acre parcel belonging to Barbara Eddy. Above the crossing, Springbrook Creek runs through a forested valley with an average bankfull width of 9.5 ft. and the average gradient of 2%. 3.4 miles of fish habitat exist upstream from this crossing. The stream is carried beneath the field access road in a 4 ft. round corrugated steel pipe 40 ft. in length. WDFW has identified it as a 67% passible partial barrier culvert due to the fact that it is undersized and has a slope of 1.68% and has established a priority index (PI) of 19.86. Approximately 100 ft. downstream from the culvert there is a long section of riprap armament protecting a picnic area on the right bank. This armored section of channel is artificially narrow and has caused substantial scour of the unprotected left bank. The armored channel also lacks instream complexity forming a 70 ft. long continuous riffle with neither pools nor large woody debris. A footbridge at the upper end of the right bank riprap has additional armor protecting its left bank foundation. Below the armored section of the channel, Springbrook Creek enters a lush forested valley with excellent pool-riffle habitat.

Project Goals:

The primary objective is to replace the undersized culvert with a crossing structure that improves fish passage and the transport of sediment and large woody debris. A secondary goal is to remove the downstream armoring from the right bank, increase instream habitat complexity, and widen this section of channel to reflect natural stream conditions. This project improves connectivity between the intact stream reaches adjacent to the existing undersized culvert.

Negative impacts from the undersized culvert and constrained stream (from the armor) are likely to exacerbate in the coming decades as a result of climate change impacts on hydrology (higher flows/storm events).

Design Development: Topographical and stream condition surveys were performed on site with the permission of the landowner by Wild Fish Conservancy. Three conceptual drawings and project narratives were presented to the landowner for review and revised based on her feedback. The project team and the landowner preferred a conceptual design to install a steel bridge over an arch culvert design due to the bridge's ability to accommodate potentially higher flow patterns in the watershed anticipated in the coming decades as a result of climate change. The landowner deliberated the footbridge options at length and in the end decided she was more comfortable maintaining the picnic area in its present location, though without the hard rock armoring and with the addition of riparian vegetation. Replacing the existing footbridge with a longer one will remove the flow constriction and hydromodification associated with the current footbridge.

5.3.3 Rekow Stream and Riparian Restoration Appendix III Project 3

This project was selected due to its being the next instream barrier upstream of Project 1 (Fletcher Bay Culvert Replacment) and Project 2 (Eddy Culvert Replacement), landowner willingness, and the opportunity to make modest improvements to a section of the stream that is in fairly good condition.

At river mile 0.33 Springbrook Creek crosses under a derelict field access road on the western edge of an 8.48 acre parcel belonging to Kenneth Rekow. At this crossing the top of a culvert is now fully exposed yet it still passes 100% of stream flow. The culvert is a 2 ft. round concrete pipe 9 ft. in length. There is a 3 ft. square concrete box at the culvert inlet which has become disconnected from the pipe. The combined length of the inlet box, the three inch gap, and the culvert is 13.3 ft. The combined slope of the culvert and the inlet box is 1.38% making it 67% passible. Washington Department of Fish and Wildlife has assigned a priority index of 21.82 to this culvert. A small type F stream feeds into the left bank of Springbrook Creek at the culvert outlet. Above the culvert crossing Springbrook Creek meanders down an unconfined valley bottom through adjacent forested wetlands with a bankfull of 6.8 ft. Below the culvert crossing the valley becomes more confined. The left bank of the downstream valley below the culvert is forested with a mixed stand of conifers and deciduous trees. The right bank valley below the culvert is primarily a grassy field with scattered pockets of skunk cabbage and other wetland vegetation, trees and a thin strip of shrubs growing along the creek. Some reed canary grass and other invasive plants are mixed in with native vegetation. Some native vegetation has been mowed or reduced on the right bank (perhaps by past livestock use).

Project Goals:

The primary objective of this project is to restore stream processes by removing the derelict culvert from the stream channel. The secondary objective is to improve the riparian habitat along the right bank of the stream by removing invasive plants and planting native tree and shrub species.

Limiting Factors Addressed: This project lies within Reach SB01-1 in the middle section of Springbrook Creek. Restoring channel complexity and fish passage and providing for stream complexity are addressed through the implementation of this project.

Design Development: Wild Fish Conservancy conducted stream assessment and on-site topographical surveys with permission of the landowner. Site visit with landowner and review of stream history and land use took place with Bainbridge Island Land Trust. The landowner reviewed conceptual plans. Adjustments to the proposed concepts were made after landowner input received.

5.3.4 Nickum Stream and Riparian Restoration Project Appendix III Project 4

The project team selected this project for a conceptual design due to it being upstream and in sequence with Projects 1, 2 and 3, landowner willingness, and the need to improve degraded stream, floodplain and riparian vegetation/habitat conditions in this segment of the stream.

From river mile 0.63 to 0.74 Springbrook Creek runs along the southwestern edge of a 5.88 acre parcel belonging to Will and Cathy Nickum. In this reach, the stream meanders down an unconfined low gradient valley bottom of approximately 1.5 acres with adjacent wooded wetlands with an average bankfull measurement of 6.3 ft. The left bank of the valley floor is densely forested with an over story of alder, ash, mature willow, and red osier dogwood. The Nickum property is located on the right bank of the channel. The right-bank portion of the valley has been cleared of native vegetation and is currently dominated by invasive reed canary grass. The stream exists wholly within the Nickum parcel at this time. The associated wetland forest and upland riparian area uphill of the left bank of the stream is owned by three separate landowners and is comprised of intact mature mixed forest and wooded wetlands.

Where Springbrook Creek enters the Nickum property it runs within the forested section of the valley floor. This upper section of stream extends for 450 ft. providing excellent low-gradient salmonid rearing habitat with undercut banks and instream large woody debris. Downstream from this section, a left bank avulsion diverges from the main stem, carrying a portion of the flow through the adjacent forested wetlands. At this point the right bank channel, carrying the majority of the flow, turns northeast toward a recently cleared section of the valley bottom which is now dominated by reed canary grass with lack of tree cover. At this point the channel runs along the edge of the tree line for approximately 150 ft. at which point the avulsed channel rejoins with the mainstem flows. Here, the combined flows turn north, leaving the edge of the tree line and entering the cleared valley floor. This lower section of channel is now chocked with invasive reed canary-grass for approximately 100 ft. The stream then exits the Nickum property under an existing fence that collects wood debris and reenters forested habitat at the property boundary. There are a series of small footpaths used by the landowners within the seasonal (avulsed) stream channel and riparian area.

Project Goals:

The main goal of Nickum property project is to improve the quality and quantity of salmon rearing habitat, improve fish passage in the stream (which is now compromised by reed canary grass), and improve water quality and large wood recruitment by restoring the associated riparian habitat in this unconfined low-gradient reach of Springbrook Creek. This will be accomplished by reestablishing an intact riparian corridor and natural channel processes in the section of stream now choked by invasive reed canary grass and replanting with native plant species. Options were developed between the project team and the landowners with a strong emphasis on the project team recommending the largest riparian buffer that the landowner was willing to support (understanding that greater buffer widths represent a more natural condition at the site and convey greater ecological benefits to the stream and riparian community).

Limiting Factors addressed by this project: High water temperatures, low dissolved oxygen, sediment, degraded conditions for benthic macroinvertebrates, degraded riparian habitat, and fish passage barriers.

Design Elements: Wild Fish Conservancy performed in stream and associated riparian assessments, examined LIDAR elevations, performed topographical surveys, discussed the restoration options with the project team and landowner. The selected restoration option was agreed to by the landowner.

5.3.5 Upper Springbrook Creek Protection Appendix III Project 11

This project proposes to protect by acquisition nearly 23 acres of mostly undisturbed and undeveloped forested wetland, stream and associated riprairan habitat in Springbrook Creek Assessment Unit 6 (AU).

During the Springbrook Creek Watershed Assessment the Upper Springbrook Creek tribuatary (SB01-2) was identified as hosting some of the highest quality stream and wetland conditions within the entire watershed. Water monitoring indicates temperatures in the stream are of high quality all year round – the only area within the watershed to meet temperature water quality standards year round.

Coho and cutthroat have been documented within this reach of the stream and downstream, and there is excellent potential for fish rearing habitat within the AU. There is mature riparian vegetation hydrologically connected to the stream.

The Upper Springbrook Creek tributary is characterized by a large wetland complex, native vegetation which provides shade to the stream and food for a number of birds and other animals. The stream width varies from 6 feet in width with a defined chanel to a narrow approximately 2 foot channel within a large wetland complex. The stream runs year round. Due to the large undisturbed wetland complex, the Washington Department of Ecology's Watershed Characterization identified this AU as particularly important for provding water recharge and discharge functions thus keeping this functioning wetland protected is important to overall waterhshed health.

During the Springbrook Creek Watershed Assessment, this property, and adjoining properties downstream were identified as a high priority for protection.

Project Goals:
This proposal is to acquire the property from the existing willing landowner (see Landowner Acknowledgment) for protection purposes and leave the property as is, for the most part, except for perhaps some well sited foot path for hikers, invasive plant and debris removal over time. There is a full fish passage barrier culvert on the northwest property boundary. There is an opportunity to remove the culvert after the acquisition takes place, to improve fish utilization of over .25 miles of stream habitat above the fish culvert.

There are two separate parcels:

Kitsap County tax parcel 282502-1-005-2006 (20.03 acres)
Kitsap County tax parcel 282502-2-001-2008 (2.96 acres)

The 2.96 acre parcel had an old home and outbuildings on it which have been removed by the existing landowner. The conceptual plan does reserve the opportunity to utilize approximately 1.16 acres of this parcel for flexible uses such as parking for public use of trails or an interpretive kiosk.

In discussing options for protection, the acquisition tool, versus a conservation easement, was chosen based on discussion with the landowner. The goal would be to have the property acquired by an entity such at Bainbridge Island Land Trust who is experienced in holding preserve property and who would would develop a stewardship and management plan for the property which would outline the care needed to retain and preserve the important stream and wetland functions the property provides to the entire Springbrook Creek watershed.

6.0 Additional Opportunities

As a result of the Springbrook Creek assessment work and interactions with landowners, several other additional opportunities for protection and restoration beyond the five conceptual designs were identified within the watershed. These opportunities are all deserving of further consideration for improvement of fish habitat conditions and watershed function, additional discussions with landowners, and (if landowners are interested) to work with project partners on further refining project designs and implementation.

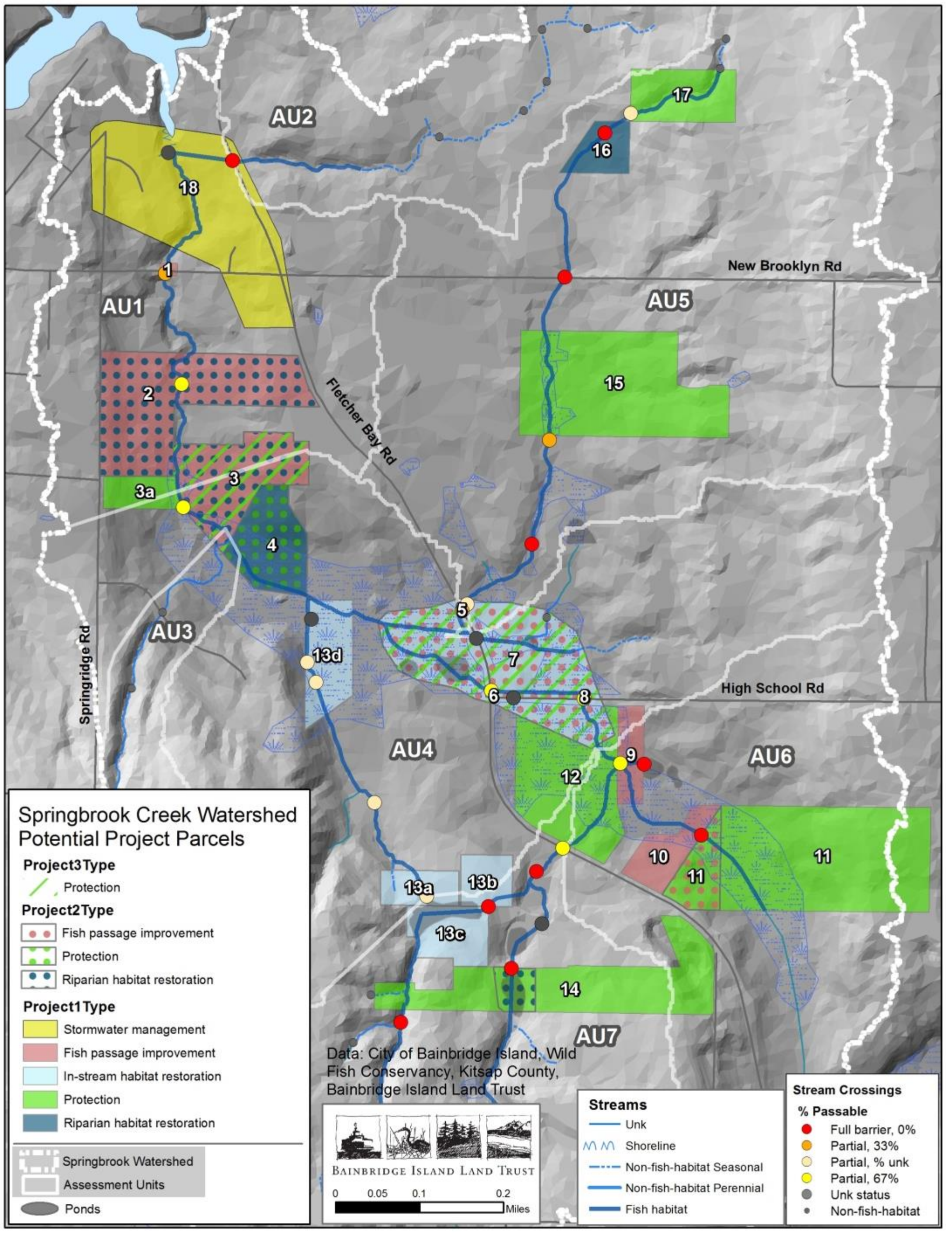


Figure 32. All potential projects evaluated.

6.1.2 Potential Project 18: Island Center Stormwater System Upgrades – AU1

The commercial nature and high traffic of the Island Center neighborhood service center coupled with its proximity to Springbrook Creek and the head of Fletcher Bay raise concern over potential water quality impacts from stormwater runoff. Though the project did not identify strong evidence of water quality impairment, field observations indicate there is a high probability that polluted runoff is reaching the public stormwater system via surface flow to catch basins and ditches (Figure 33). Currently the stormwater system servicing Island Center is limited in its ability to provide water quality treatment. Additional treatment facilities or increased maintenance of the current facilities could benefit the water quality entering Springbrook Creek and Fletcher Bay. The addition of on street parking could be coupled with bio-retention planters, bio-swales, or advanced treatments systems such as Contech's StormFilter or Filterra units. Ideas and challenges to resolving this issue is likely to be discussed in the Island Center sub-area planning process, currently underway at the City of Bainbridge Island.

Figure 33. Potential silt source: COBI road maintenance equipment lot.

6.1.3 Summary of Potential Project 7: Fletcher Bay Road NE and High School Road Culvert and Stream Improvements – Appendix IV

The intersection and proximity of Fletcher Bay Road NE and High School Road is a nexus of complicated problems arising from past engineered solutions, stream modifications, multiple stream channels, roads, and existing land use. The area includes drainage from four assessment units (AU 4, 5, 6, and 7) – draining approximately 600 acres of the 999 acre Springbrook Creek watershed. There are seven culverts (Figure 34) that partially or fully block fish passage under, adjacent or in proximity to the main roads in this intersection area, and several are in need of replacement to address fish passage, stormwater, and aging infrastructure. The stream reaches of SBO1D, SBO1E, SB01-2, SB01F and portions of SB01G and SB01-1 flow through this area. There are seven individual landowners who live on the stream or in the proximity of the stream.

Fletcher Bay Road NE and High School Road are major Island arterials, and as congestion has increased on State Highway 305 (the major road that serves the Seattle-Bainbridge Washington State Ferry and leads to Poulsbo off island to the North) these roads have become quasi secondary bi-ways for local traffic. The large paved area with a high number of vehicles traveling through or stopping to turn at the intersection of these two roads makes tire debris and other toxic pollutants a high concern.

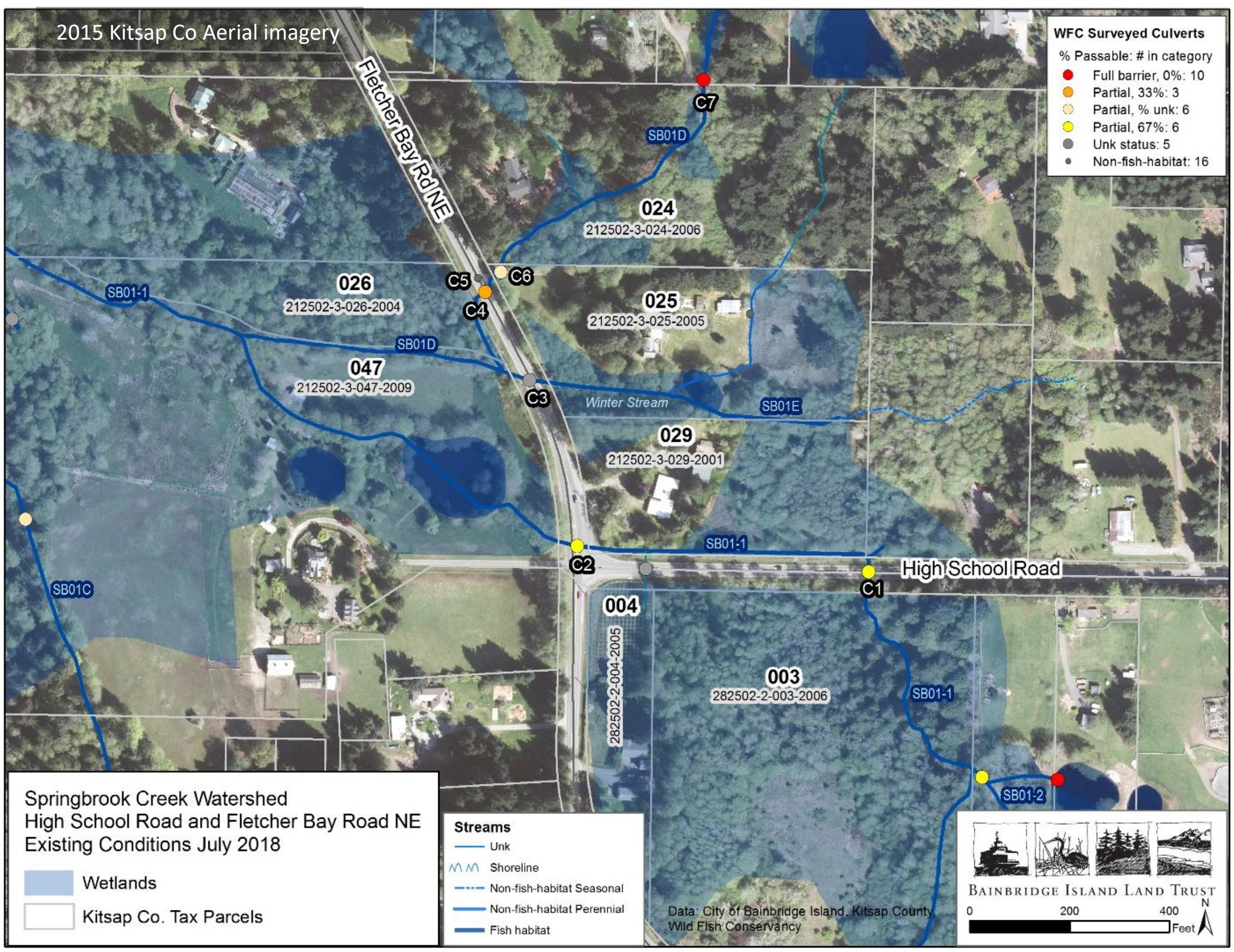


Figure 34. Existing Conditions

Instead of addressing a number of issues individually (Project id's 5,6,7,8 on Figure 32) the project team strove to formulate alternatives for addressing the entire suite of issues in this area as an interrelated whole. The project team had numerous site visits and conversations with affected landowners, and utilized data gathered on culverts, water quality, and historic channels in conjunction with high-definition elevational models (1m LIDAR). As further described in Appendix IIIF, four alternatives were designed to affect greater restoration of stream health and fish habitat quality by addressing limiting factors of: impeded fish passage; degraded riparian conditions; invasive plants; constrained floodplains; high stream temperatures; unfiltered stormwater runoff from roads to the stream; and degraded aquatic life conditions, while contributing to overall watershed function, meeting landowners' needs, addressing failing infrastructure, reducing the number of culverts, and restoring lost wetland habitat. These four alternatives all address major issues such as the channeling of the creek through a perched culvert under High School Road into a blackberry-choked ditch, and replace or obviate the need for undersized culverts (Figure 35), but differ in the degree to which they separate the stream from roads, the location and number of remaining culverts, and the patterns of water flow.

Figure 35. High School Road perched culvert C1 and undersized culvert C6.

It is of utmost importance that actions affecting the roads, stream channels, and culverts in this area not be taken piecemeal. However, planning for a comprehensive solution will require working closely with all potentially affected landowners to reach a mutually agreeable and biologically beneficial outcome.

6.1.4 Protection of Key Mid-watershed Wetlands and Riparian Areas

The Springbrook reach from Barnabee Farms to Fletcher Bay Road NE lies within a broad shallow bowl with a wide wetland zone along the creek. As mentioned in the Conceptual Designs section, the high concentration of the overall watershed's wetlands in this area is a driver of AU4's high importance rating for all watershed functions and overall top rating for both protection and restoration in the WDOE Watershed Characterization. In addition to the restoration opportunities carried forward into Conceptual Design phase there are multiple protection opportunities in this area. Particularly high-quality riparian habitat includes that on 2.23-acre Kitsap County Tax Parcel 6514-000-001-0005 (Figure 36, Potential Project 3a) and the next five parcels lying between NE Mitchell Lane and the creek to the south of this parcel (Figure 37). Intact wetlands encompass large portions of these parcels, and the tributary flowing into Springbrook Creek through parcels 6514-000-005-0001 and 6514-000-004-0002 drains AU3 to the southwest. These are all within the Rekow Valley Farm Division created in 1984. The owner of the parcel identified as Potential Project 3a expressed interest in preserving the natural values of her property, suggesting high potential for a conservation easement to add assurance of long-term protection. She has sadly passed away but this positive indication from the landowner led to inclusion of the parcel as an identified potential project within this project's time frame. Upon further investigation, we found that the protective covenants put in place by the Rekows on the Rekow Valley Farm parcels include prohibitions against grazing or clearing within a 25' green belt along the eastern property boundaries, and no building, impermeable surfaces, or clearing below the 60' elevation line. This encompasses much of the wetland area along the creek (Figure 37). Keeping these landowners engaged in maintenance of healthy stream and wetland conditions is recommended.

Figure 36. Intact riparian wetland habitat in Potential Project 3a.

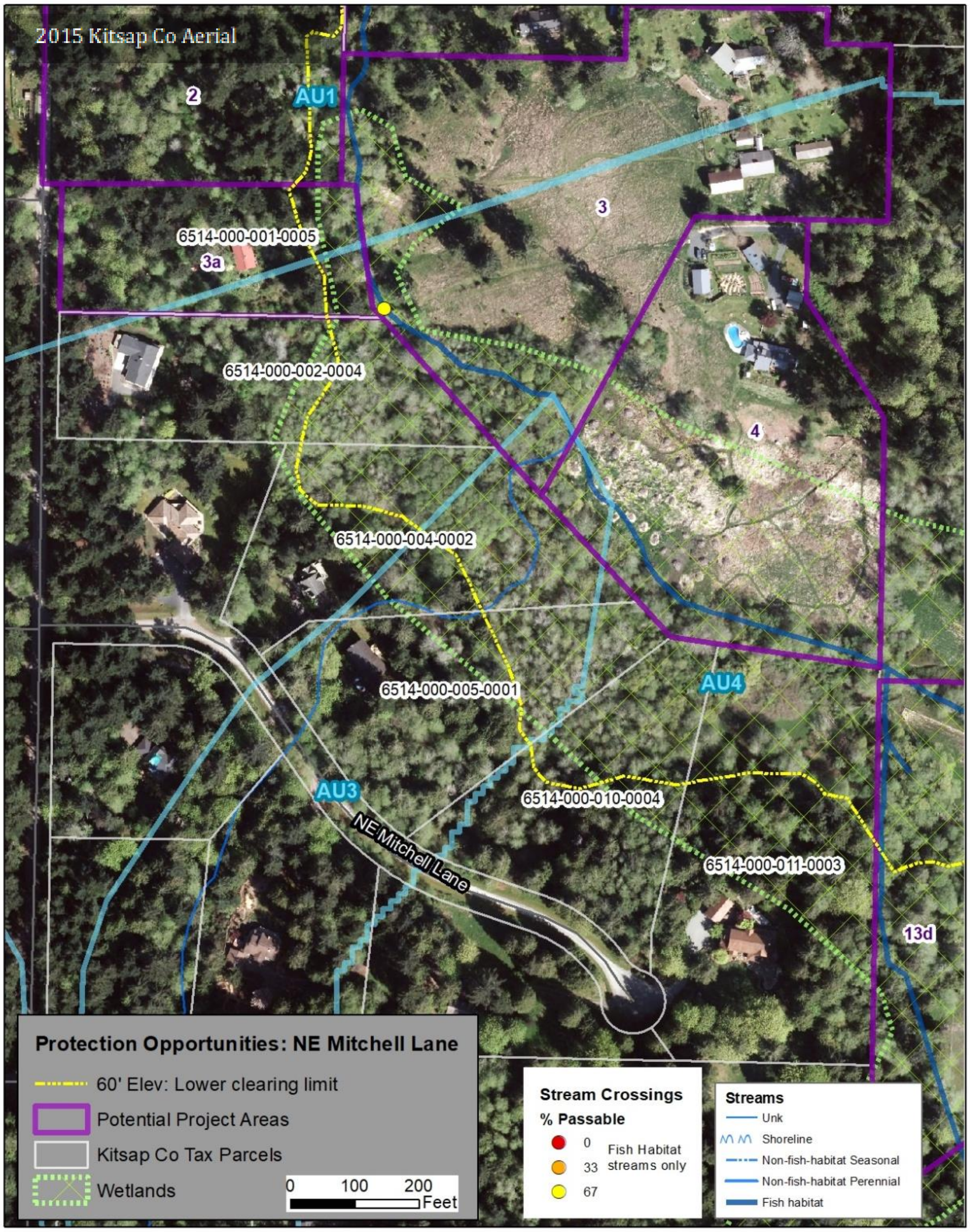


Figure 37. Potential protection opportunities north of NE Mitchell Lane.

Additional protection opportunities exist within AU4 and AU6 just up the system to the east, where the large wetland complex extends southeast of the High School Road and Fletcher Bay Road NE intersection (Figure 38). This area includes the only continuously monitored stream site (Site S, Figure 23) found by the project's monitoring efforts to meet guidelines for temperature year-round (Figure 26), and dissolved oxygen levels were generally just below the standard for high water quality (Figure 27). Potential changes to culverts and stream flow just north of here are discussed above (Project 7: Fletcher Bay Road NE and High School Road Culvert and Stream Improvements), and Potential Project 11 on Figure 38 is Appendix III Project 11: Upper Springbrook Protection Project Conceptual Design. In addition, there are parcels in this area with high-quality riparian and wetland vegetation and landowner interest in protecting these resources. There are also parcels where vegetation has been cleared but a cooperative restoration effort could be possible with the single landowner of these multiple parcels.

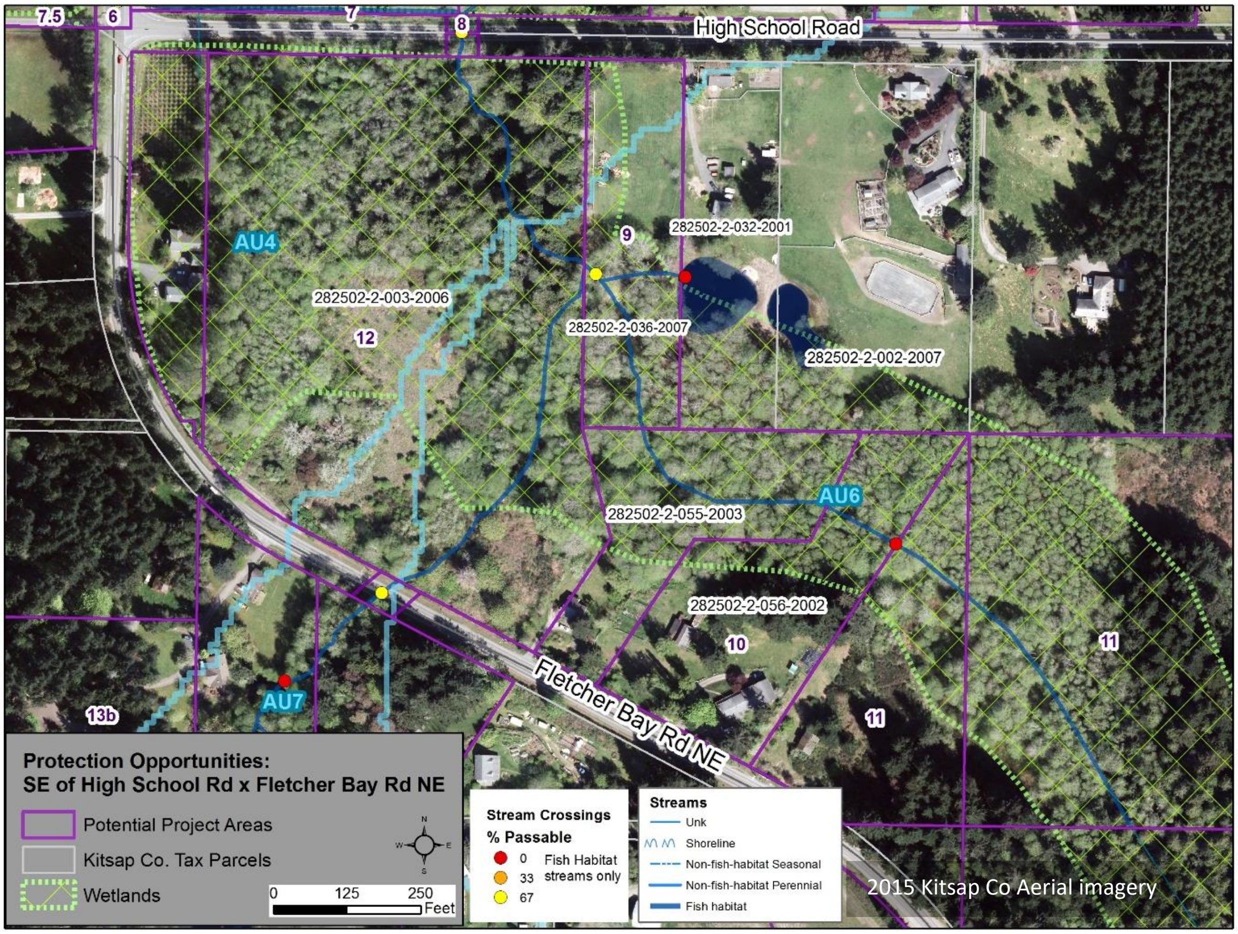


Figure 38. Potential protection opportunities SE of High School and Fletcher Bay Roads.

Potential Project 12 (Kitsap County Tax Parcel 282502-2-003-2006) is a 12.87-acre parcel owned by a conservationist landowner who has worked with the Land Trust in the past on purchases of, and Conservation Easements on, her properties. This property was once part of the Anderson Farm as well as a homesite, with just remnants of an old house next to an old clearing remaining. The riparian and wetland areas are in very good condition (Figure 39), with the stream meandering in braided channels through mature forests. Permanent protection mechanisms for the property we have discussed with the landowner could include a Conservation Easement with the conservation area covering the entire area, or retaining a development footprint to allow redevelopment of the southern portion around the old homesite.

Figure 39. High-quality stream conditions and riparian habitat on Potential Project 12.

Establishing more permanent protections for the wide wetland band between Potential Project 12 and Potential Project 11 (Appendix III Project 11: South East Fork Springbrook Creek Protection Conceptual Design) could be highly beneficial. Habitat on Kitsap County Tax Parcels 282502-2-055-2003 and 282502-2-056-2002 is in good, intact condition and both of these landowners have a high degree of interest in protecting the stream and wetlands. Working with these landowners to assist them in maintaining long-term habitat protections is recommended.

6.1.5 Project 9 Footpath Culvert Removal and Riparian/Wetland Vegetation Restoration

The three parcels immediately east of Potential Project 12 (Kitsap County Tax Parcels 282502-2-036-2007, 282502-2-032-2001, and 282502-2-002-2007, Figure 38) share a common landowner, also with a high interest in protecting fish and streams. South of the small manmade ponds, vegetation clearing inadvertently occurred within areas mapped as wetlands such that the dense deciduous forest shown in the aerial photograph (Figure 38) has been converted to scattered trees over lawn. There is also a short, small culvert passing under a footpath which was found to be 67% passable due to excessive slope (Figure 40) on Kitsap County Tax parcel 282502-2-036-2007. The stream merges with channels on Potential Project Parcel 12 immediately west of this point. The landowner wishes to enhance fish habitat and is willing to consider a project to replace or perhaps remove the culvert. Assisting the landowner with information on managing healthy riparian and wetlands is recommended, along with a vegetation restoration plan. Portions of the stream were also lined long ago with wooden boards in the wetlands south of the culvert (Figure 41), and another restoration opportunity exists in removal of the sideboards and a return to a more natural channel.

Figure 40. Surveyor just right of 67% passable culvert under path.

Figure 41. Old sideboards in channel upstream from culvert.

6.1.6 Project 14 Johnson Farm Pond Naturalization - AU7:

Ponds throughout the watershed have been identified as hindrances to water quality and quantity. The pond on the City-owned Johnson farm (Potential Project 14, Figure 42) is no exception. The water quality at site Q above the pond remained cooler and more plentiful than the water quality at site D below the pond (Figure 42). Increasing the amount of baseflow throughout the summer and reducing the water temperature could be achieved by allowing the pond to naturalize and encourage buffer plantings. The main hurdle to this idea is that the pond is currently being utilized by commercial farming on the site for an irrigation source. Water lines would need to be installed from the drilled well (existing onsite) to replace this water source if the pond were to be return to its natural state entirely.

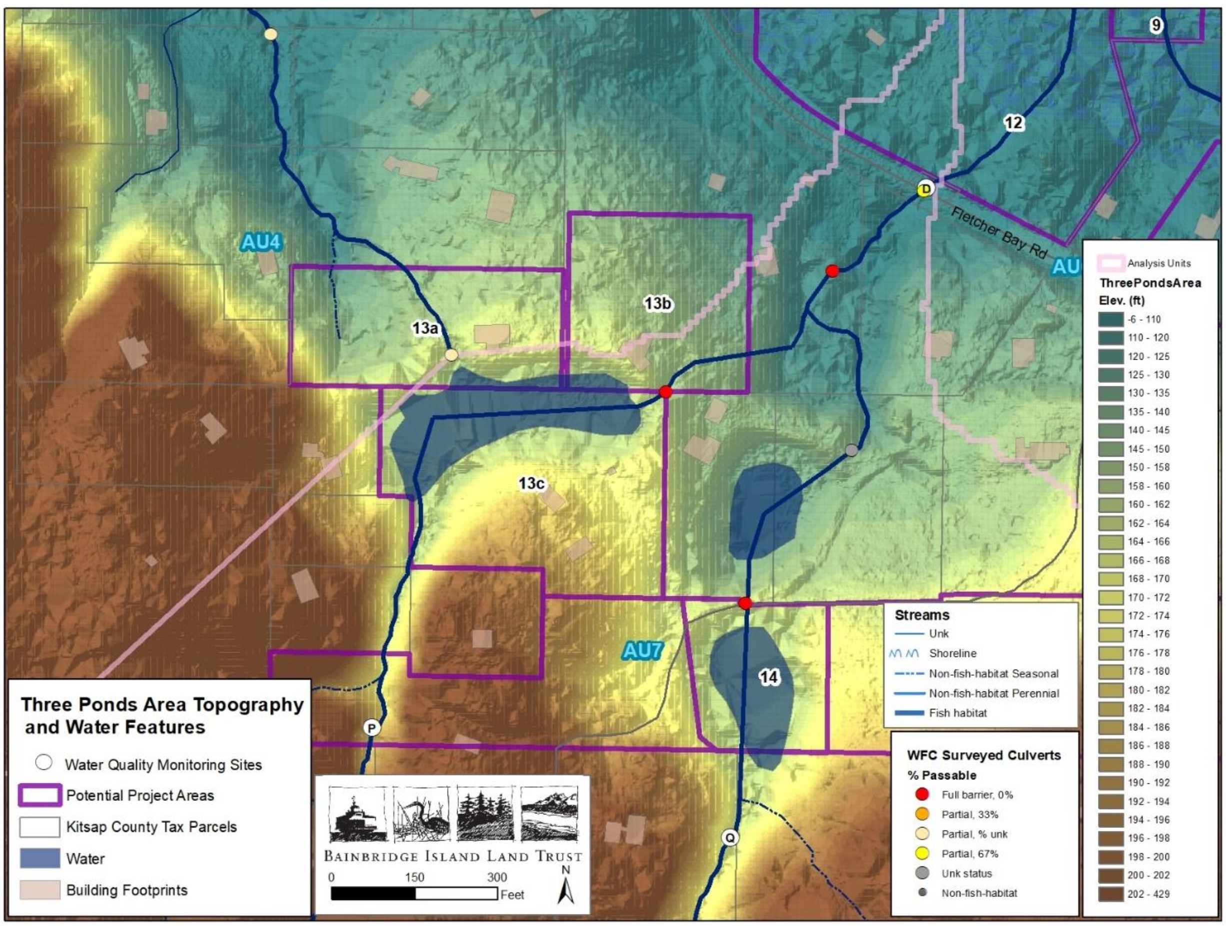


Figure 42. Three Pond area topography, water quality monitoring stations, streams, and water bodies.

Figure 43. Johnson Farm pond.

6.1.7 Project 13a,b,c,d Interbasin Pond Replumbing and Riparian Restoration - AU7/AU4:

One factor that complicated drawing the boundaries between AUs 4 and 7 was the alteration of hydrology that occurred when a pond was built straddling a natural division between subwatersheds. A Springbrook tributary that once flowed directly north from Water Quality Monitoring Site P to continue northwest from the present-day pond is now captured and diverted to flow out of the pond eastward (Figure 42, Potential Project Areas 13a, 13b, and 13c). Thus, although the historic channels would have supported an analysis unit split down the middle of the pond, now a split to include the upper reach with the streams to the east better reflects how water flows.

The owner of the parcel 13a mentioned that long-time Island residents told her they would often go to fish in the old stream there before it was bermed and ponded. Area landowners also reported that this pond was built by Clarence Johnson for (then-larger) Johnson Farms in 1962, with the large downslope berm built from material excavated from the pond area. Vegetation in the steep draw on Potential Project Parcel 13a is intact woodlands with understories of thick shrubs and ferns. The channel just below the pond berm now tends to be dry, although there is a pond overflow chute to carry water in this direction when the level is very high. There are many seeps and springs in this draw, and water accumulates as you move downstream before joining wetlands about 0.2 miles to the north (on Potential Project Parcel 13d, Figure 32). This is far more natural stream habitat than that created downstream of the eastern outlet of the pond on parcels

13b and 13c, above, and some consideration should be given to reestablishment of water flow to the north through parcel 13a. Any planning effort would need to first establish the range of changes that could be acceptable to the affected landowners, particularly the owners of parcels 13a, b, and c. Should any increased flow to the north be planned, related efforts would include further protection and enhancement of riparian wetlands within the 13d parcel and addressing the partial barrier culverts below 13a (Figure 42). However, careful analysis of the implications of the decreased flow to the northeast would be needed, as this feeds into the wetlands southeast of High School Road x Fletcher Bay Road NE.

6.1.8 Projects 15, 16, and 17 Northeast Tributary Riparian Protection and Restoration - AU5:

In 2017 we obtained permission from several landowners to conduct the survey work necessary to increase our understanding of a previously unmapped northeast tributary of Springbrook Creek running from north of New Brooklyn Road down into the confluence of multiple tributaries just north of the Fletcher Bay Road NE by High School Road intersection. AU5 is the area that this tributary drains. Thanks to this additional survey work, we were able to document 0.87 miles of seasonal stream typed as fish-habitat based on physical criteria, but with multiple fish passage barriers (Figure 44). As further discussed and pictured under the Fletcher Bay Road NE X High School Road culvert complex Conceptual Design, where this tributary meets Fletcher Bay Road NE, a portion of the flow passes directly under the road through a 67% passable barrier and is forced to turn into the now-cleared ditch west of the road and into the “Winter Stream”, while an unknown proportion continues south down the ditch east of the road to join the Winter Stream where it flows through a full-passage-barrier culvert under Fletcher Bay Road NE.

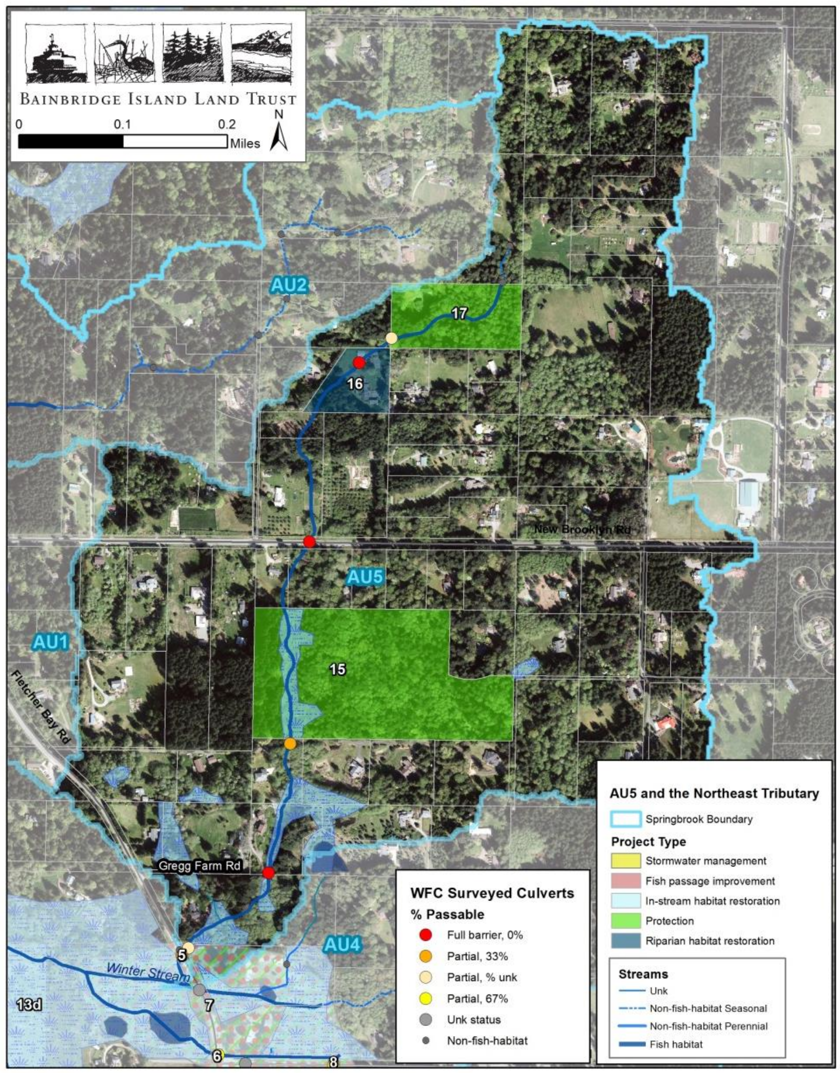


Figure 44. The Northeast Tributary and AU5 2015 aerial.

North of Fletcher Bay Road NE this Northeast Tributary flows through a full-fish-passage-barrier culvert under Greg Farm Lane, 850 feet upstream from the confluence with the Winter Stream (Figure 44). Here intact forest habitat to the south transitions to a straight narrow channel filled with tall grasses, sedges, shrubs and forbs bordered by lawn mowed to the channel edge to the north.

Figure 45. Narrow unmowed streamside vegetation north of full passage barrier culvert, Greg Farm Lane.

Replacing the culvert here would restore access to 0.71 miles of upstream suitable fish habitat, and would be best combined with working with the landowner to learn about the newly mapped stream and regulatory buffer, and understand the benefits of the restoration.

About 730 feet further upstream from Greg Farm Lane, the creek winds through wetlands in a beautiful mature western red cedar and Douglas-fir forest on an undeveloped 17.5-acre parcel (Figure 44 Potential Project #15; Kitsap County Tax Number 212502-3-005-2009), above a 67% passage barrier culvert under Berganio Lane. The landowners are long-time Islanders with a deep appreciation of their lands and a combination of culvert replacement and assisting the landowners in preserving these forest habitats would be a valuable future project. In the context of Bainbridge Island, this is a substantial piece of undeveloped and unprotected forest, and protection through conservation easement or purchase would be highly beneficial to stream health and to maintenance of high-quality forest habitat in the watershed.

Figure 46. Mature forest along the Northeast Tributary, south of New Brooklyn Road.

North of New Brooklyn Road, the stream course between a distinct ravine at the very top of the tributary to the road is difficult to estimate from aerial photographs and was mapped using a combination of modeling from LIDAR followed by on-the-ground verification with landowners. Most of the landowners we communicated with did not consider water flowing through their properties to constitute a stream, nor was it mapped or regulated as a stream by the City of Bainbridge Island. On Tax Parcel Number 212502-2-024-2008 (Figure 44 Potential Project 16), the water (not flowing at the time of our December 2017 visit) comes into the top of the property through a culvert under a driveway. The previous owner had it flowing through a small pipe under a raised garden area, then down a ditch in the lawn into forest below the property. The current owner found flooding to be a recurrent issue, sometimes into their shop/garage building. They regraded and eliminated the pipe and attempted to make the water flow in something closer to the natural low point and no longer have flooding issues. Water now flows down a ditch along their gravel driveway, then down across the driveway in front of the shop/garage, and into the ditch through the lawn. Water flows only in rainy periods, and frequently disappears into the ground before reaching the downstream neighbor. Were fish able to access this reach, the driveway would serves as a full passage barrier.

Figure 47. Northeast Tributary north of New Brooklyn Road.

In contrast, the property immediately upstream (Figure 44 Potential Project 17; Tax Parcel Number 212502-2-015-2009) hosts very high-quality riparian habitat along about 760 feet of typed fish-habitat stream, with ferns under large mature trees in a distinct ravine. Aside from some trails and minor clearing, development impacts are restricted to the benches above the draw. The stream transitions from seasonal fish-habitat to seasonal non-fish-habitat at the northern boundary of the property, and ends about 200 feet further upstream.

Figure 48. Excellent habitat at headwaters of Northeast Tributary, Potential Project #17.

All along this tributary a key action will be informing landowners of the stream and its values as well as regulatory protections. Long-term protection of the forested ravine combined with working with the landowner directly south to restore a healthier channel and riparian vegetation would be quite beneficial to function and downstream water quality in this tributary.

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