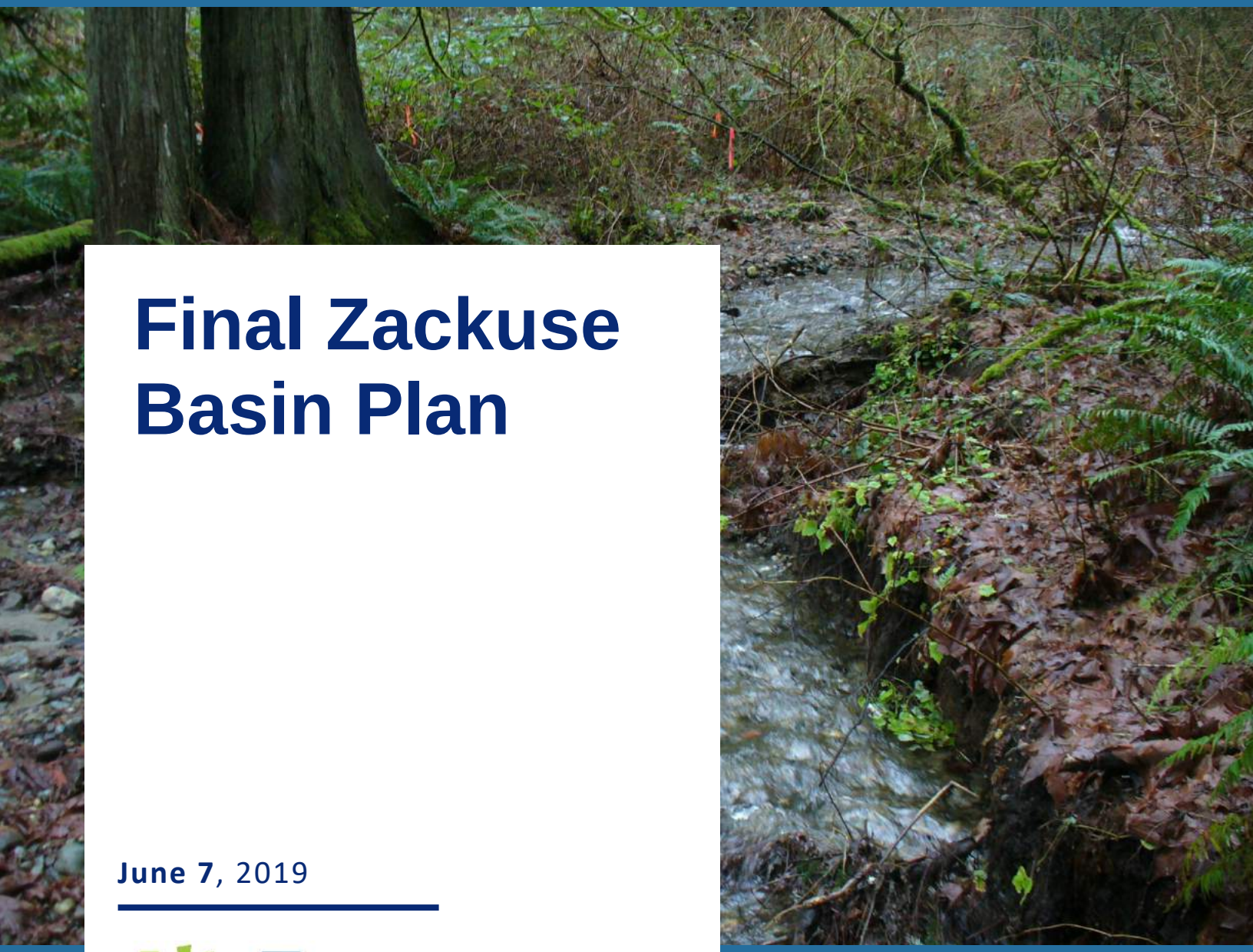

Final Zackuse Basin Plan

June 7, 2019

AltaTerra

OSBORN CONSULTING INCORPORATED

THE WATERSHED COMPANY

City of Sammamish Washington

Executive Summary

The Zackuse Basin Plan is a comprehensive document that describes natural and built conditions in the basin, with a focus on surface and stormwater issues and potential solutions. This plan implements the City's 2016 *Storm and Surface Water Comprehensive Management Plan* Goal 2, which is to "Use drainage basin planning to allocate limited resources to address priority problems and opportunities."

The Zackuse Basin is one of the smallest basins in Sammamish, but it is rich in natural resources. Zackuse Creek flows from its headwaters near 212th Ave SE on the plateau to its mouth in Lake Sammamish, covering just under a mile in length. The lower reaches have historically supported kokanee spawning. The habitat and accessibility for kokanee in this area just got a boost from three culvert replacement projects and channel restoration completed in the fall of 2018. One of the primary goals of this basin plan was to identify projects and strategies to support ongoing success of these projects following construction. One capital project (Zack-CIP-1) was identified to provide additional flow control and reduce erosion and sediment mobilization from the Zackuse Creek south tributary. Implementation of this project will indirectly benefit the channel restoration project by reducing erosion and sediment transport.

Other capital projects include actions to improve drainage on Louis Thompson Road NE (Zack-CIP-2 and Zack-CIP-3) and E Lake Sammamish Parkway (Zack-CIP-4). The Louis Thompson Road NE projects involve construction of a berm at the intersection of 210th Ave NE and Louis Thompson Road to reduce flooding and converting the ditch and culvert system on Louis Thompson Road NE to a pipe system. Zack-CIP-4 will resolve groundwater seepage issues on E Lake Sammamish Parkway, resulting in safety improvements.

The total planning level cost estimate for the four capital projects is between $ 8,300,000 to $11,700,000 depending on options chosen, with over 90% of the estimate being for two of the projects (Zack-CIP-1 and Zack-CIP-3).

Programmatic actions include habitat, operational, policy and water quality projects that address issues and opportunities, including:

- Instream and habitat enhancements near the mouth and upstream of the recent restoration project (Zack-Hab-1 and Zack-Hab-2)
- Continuing or new operational needs, such as uncovering catch basins (Zack-Oper-1), cleaning ditches and culverts (Zack-Oper-2), or cleaning pipes and conducting closed-circuit television (CCTV) in the Montage neighborhood (Zack-Oper-3)
- Long-term strategies such as property acquisition and stream corridor enhancement (Zack-Pol-1)
- Water quality improvements and strategies, such as removing trash from Zackuse Creek (Zack-WQ-1), implementing water quality monitoring (Zack-WQ-2) and identifying strategies for using water quality data (Zack-WQ-3)

List of Acronyms

CCTV	closed-circuit television
cfs	cubic feet per second
City	City of Sammamish
CDA	Critical Drainage Area
CIP	capital improvement project
CMP	corrugated metal pipe
CWA	Clean Water Act
DNR	Washington State Department of Natural Resources
DNS	Determination of Nonsignificance
DO	dissolved oxygen
DS	Determination of Significance
Ecology	Washington State Department of Ecology
ECA	Environmentally Critical Areas
EPA	US Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GMA	Growth Management Act
HDPE	high-density polyethylene
HPA	Hydraulic Project Approval
ID	identification
KWG	Lake Sammamish Kokanee Work Group
LDA	Landslide Drainage Area
LiDAR	light detection and ranging
LID	Low Impact Development
MDNS	Mitigated Determination of Nonsignificance
MS4	Municipal Separate Storm Sewer System

NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
OHWM	ordinary high water mark
PC	personal computer
PHS	Priority Habitats and Species
RCW	Revised Code of Washington
RSI	remote stream incubator
SEPA	State Environmental Policy Act
SMA	Shoreline Management Act
SMC	Sammamish Municipal Code
SWMM	Stormwater Management Model
TMDL	total maximum daily load
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WWHM	Western Washington Hydrology Model

Glossary

Avulsion	The sudden change in course of a river or stream (outside of its normal banks).
Critical Drainage Area	"Critical drainage area" means an area that requires more restrictive regulation than City standards afford in order to mitigate severe flooding, drainage, erosion, or sedimentation problems that result from the cumulative impacts of development and urbanization. Critical drainage areas include areas that drain to Pine Lake and Beaver Lake and all landslide hazard drainage areas.
Dogleg	A sharp bend in a route, such as a creek that turns at a sharp angle.
Fry-of-the-year	First year salmon or cutthroat trout that have hatched and are still quite small.
Gabion	Wire container filled with rock used for energy dissipation and retaining walls.
Glide	A part of the stream where the water is smooth and continuous.
Landslide Drainage Area	Landslide hazard drainage area" means a critical drainage area applied to sites where overland flows pose a significant threat to health and safety because of their close proximity to a landslide hazard area as defined by SMC 21A.15.680.
Low Impact Development	"Low impact development" (LID) is a storm water and land use management strategy that strives to mimic predisturbance hydrological processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed storm water management practices that are integrated into a project design.
Ordinary High Water Mark	"Ordinary high water mark" means the mark found by examining the bed and banks of a stream, lake, or tidal water and ascertaining where the presence and action of waters are so common and long maintained in ordinary years as to mark upon the soil a vegetative character distinct from that of the abutting upland. In any area where the ordinary high water mark cannot be found, the line of mean high water shall substitute. In any area where neither can be found, the top of the channel bank shall substitute. In braided channels and alluvial fans, the ordinary high water mark or line of mean high water shall be measured so as to include the entire stream feature.
Pool	A smaller portion of the stream where the water is still and deeper.

Riffle	A rocky or shallow part of the stream where the water is rougher and more turbulent.
Ripen	The process of salmon reaching maturity before laying or fertilizing eggs.
Scarp	A steep bank or slope produced by erosion (or landslides).
Tightline	A pipe that conveys liquid (e.g., surface water) from one point to another, usually over a steep slope.
Total Maximum Daily Load	A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a plan for restoring impaired waters that identifies the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Table of Contents

List of Tables

List of Photos

List of Figures

1 Introduction

Basin planning is a tool used by the City of Sammamish (City) to assess physical and biological conditions in the City's watersheds and develop capital and programmatic solutions to identified issues. The City Council identified it as a priority action item in the 2016 *Storm and Surface Water Management Comprehensive Plan* (City of Sammamish 2016). Beginning in 1994, King County developed the first basin plan in the area, which covered portions of what is now the City of Sammamish but was then unincorporated King County. King County's *East Lake Sammamish Basin and Nonpoint Action Plan* (King County 1994) included the Zackuse Basin (identified as part of the Monohon Basin in the 1994 report). Following the *East Lake Sammamish Basin and Nonpoint Action Plan*, the City completed two additional basin plans in 2011: the *Inglewood Sub-basin Plan* (George Davis Creek) (City of Sammamish 2011a) and the *Thompson Sub-basin Plan* (Ebright Creek) (City of Sammamish 2011b). Additional basin plans are scheduled for future implementation to achieve Goal 2 of the City's adopted 2016 *Storm and Surface Water Comprehensive Management Plan*. Goal 2 includes using drainage basin planning to allocate limited resources to address priority problems and opportunities.

What is a drainage basin?

Also known as a watershed, a drainage basin is an area of land where water collects and drains to a common outlet such as a river or lake.

The Zackuse Basin is located on the western edge of the City, draining approximately 245 acres from the Sammamish Plateau to Lake Sammamish near Louis Thompson Road. The basin is mostly residential and consists of established neighborhoods with private and public roads and informal and formal stormwater infrastructure, varying by neighborhood. Figure 1-1 shows the basin vicinity.

Streams in the basin include Zackuse Creek, sometimes referred to as the Zackuse Creek mainstem, and the Zackuse Creek south tributary. Additionally, another drainage has formed in what is referred to in this plan as the Tamarack ravine.

Quick Zackuse Basin facts:

- *Basin is 245 acres in size*
- *2018 culvert replacement projects opened over 1,000 feet of Kokanee spawning habitat in basin*
- *Basin is entirely residential*
- *Public and private roads serve residents in basin*

Zackuse Creek is one of several streams on the east side of Lake Sammamish that historically supported kokanee salmon spawning. A 2009 joint project between the King Conservation District and a private property lakefront homeowner daylighted Zackuse Creek from its mouth and Lake Sammamish to East Lake Sammamish Shore Lane. Three culvert replacement projects (East Lake Sammamish Shore Lane, East Lake Sammamish Trail, and the East Lake Sammamish Parkway) and over 400 linear ft of stream restoration were completed in fall 2018. These projects opened more than 1,000 linear feet of spawning habitat for kokanee on Zackuse Creek. One of the goals of this basin plan is to identify basin processes that could affect these restoration efforts in the lower reaches.

The purpose of the Zackuse Basin Plan is to characterize the current physical, biological, and water quality conditions in the basin and develop priority strategies, projects, and actions to improve the overall health of the ecosystem and reduce drainage and flooding problems for the benefit of City residents, infrastructure, and aquatic resources. The Plan is a product of collective efforts between City

residents, stakeholders, the consultant team (Altaterra Consulting LLC, Osborn Consulting Inc., and The Watershed Company) and City staff.

Specific goals and objectives for the Zackuse Basin Plan include:

- Provide a comprehensive and detailed framework to obtain citizen, Council and stakeholder input regarding the needs and priorities for the basin.
- Delineate the Zackuse Creek basin to most accurately characterize flow and water quality conditions.
- Characterize current and predicted future conditions in the basin in the context of surface and stormwater management.
- Identify and rank capital, maintenance, and operational projects and programs that address current and future basin problems such as flooding and erosion.
- Develop planning-level concepts and cost estimates for capital project actions.
- Identify partnership opportunities to improve the health and function of the storm and surface water features in the basin.

AltaTerra

Figure 1-1.
Zackuse Basin Vicinity Map

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

2 Methodology

In the development of this plan, the consultant team used existing information and documents for historical context and reference, verified field conditions in the landscape, evaluated and analyzed a variety of data sources, solicited input from basin residents, and worked with the City to develop workable management strategies and feasible projects for managing stormwater and solving ongoing drainage-related issues in the basin.

2.1 Data Sources and Information

A variety of data and information sources provided context for an analysis of basin conditions and the development of possible solutions to observed problems. Table 2-1 lists the resources consulted and their relevance to this plan.

Table 2-1. Resources Consulted

Resource Document	Author(s)	Date	Relevance
Geographic information system (GIS) data	City of Sammamish/King County	Various dates	GIS data were used in many of the analyses described in Section 3.
Washington interactive geologic map documents	Washington State Department of Natural Resources, Division of Geology and Earth Resources, Geologic Information Portal including 1:24,000 geologic map (Washington Geological Survey. 2017)	2017	Site-specific geologic information is summarized in Section 5.
East Lake Sammamish Basin and Nonpoint Action Plan	King County (1994)	1994	Relevant information is presented in Section 5.
Storm and Surface Water Management Comprehensive Plan	City of Sammamish (2016)	2016	Relevant information is discussed in Section 3.

2.2 Field Methodology

Physical and biological conditions in the basin were evaluated during stream walks and field visits conducted from January through March 2018. Evaluations included a qualitative assessment of 1) erosion and sedimentation of the stream channel and adjacent hill slopes, 2) wetland types and functionality, and 3) stream habitat conditions.

2.2.1 Geomorphic Conditions

Basic stream channel parameters, including the width and depth at approximate bankfull conditions (e.g., the elevation at which flow is fully contained within the stream channel banks), slope, and approximate size of stream bed material (i.e., sand, gravel, and cobbles) were noted during the stream walks. Additionally, areas of excessive sedimentation and or erosion were also observed and assessed. Hill slope conditions, including locations of landslides and approximate dimensions of observable scarps, were also noted during the stream walks.

2.2.2 Wetlands

An inventory-level analysis of wetlands was conducted for this plan. During the fieldwork, previously mapped wetlands were visited, and unmapped wetland areas were sketched onto aerial maps and then transferred to a GIS layer. No formal delineations were conducted; all information generated regarding the wetlands is suitable for landscape- or region-level planning but is not a substitute for formal wetland delineation. Specific development proposals should rely on this information only as a guide. At project sites where wetlands are present, formal delineations of wetland boundaries and determinations of wetland classifications would be necessary to support individual clearing, grading, and building applications.

2.2.3 Stream and Aquatic Habitat Conditions

Stream and aquatic habitat conditions in Zackuse Creek were qualitatively assessed during the stream walks. A qualitative assessment was made regarding the suitability and accessibility of instream habitat for fish, based on observations of the complexity and range of habitat types (i.e., pools, riffles, glides), and vegetative cover.

2.3 Modeling

Limited hydrologic and hydraulic modeling was conducted using existing models developed for other projects and studies. Modeling was performed using the Western Washington Hydrology Model (WWHM) version 4.2.15 and US Environmental Protection Agency (EPA) Stormwater Management Model (SWMM) version 7.0.2340 through personal computer (PC) SWMM platforms to characterize the Louis Thompson Road NE ditch and culvert system. Additionally, hydrologic and hydraulic models were used to conduct preliminary sizing calculations for capital improvement projects (CIPs).

2.4 Data Synthesis

Data synthesis occurred throughout the planning process as information was obtained by means of public input, during site visits, and through document review. A brainstorming session was then held to integrate the data, formulate a well-defined and complete suite of basin issues, and develop potential solutions.

2.5 Strategy Development

Strategies to resolve identified issues were preliminarily developed by the City and consultant team in the brainstorming session and then refined in the development of individual CIP conceptual designs and programmatic project summaries. The public also had an opportunity to comment on the strategies and shape the final product.

3 Regulatory Framework

The City governs land use, stormwater, and the use of natural resources through codes and ordinances that are specific to the City or dictated by overarching state and federal regulations. The City also must comply with a variety of federal, state, and municipal laws and regulations in the management of surface water and stormwater, and many of the City's codes and municipal requirements are the result of state and federal conditions for compliance with broader state and federal laws. These regulations, along with the goals outlined in the City's *Comprehensive Plan* (City of Sammamish 2015) and *Storm and Surface Water Management Comprehensive Plan* (City of Sammamish 2016), were considered in the development of solutions to address stormwater management issues in the basin.

3.1 Federal, State and Local Regulations

There are several regulations related to stormwater runoff (e.g., rain that falls onto impervious surfaces) and natural resources that are relevant to Zackuse Creek and stormwater infrastructure in the basin. A thorough review and description of regulations and their relationship to the City can be found in the City's *Storm and Surface Water Management Comprehensive Plan* (City of Sammamish 2016). Regulations that relate directly to the Zackuse Basin are discussed below.

Surface water quality standards (i.e., Ecology 303(d) list for non-compliance with water quality standards), and the National Pollutant Discharge Elimination System (NPDES) Phase II Permit (i.e., City's Phase II Municipal Separate Storm Sewer [MS4] Permit) are regulatory programs that fall under the Federal Clean Water Act but are administered by the Washington State Department of Ecology. Stormwater discharges in the Zackuse Basin are regulated by the City's NPDES Phase II Permit, including requirements for water quality and flow control facilities. Stormwater requirements have changed over time, and the stormwater facilities present in the Zackuse Basin reflect those changes, as will be discussed in Sections 5.1 and 5.6. Zackuse Creek water quality will be compared to established surface water quality standards to determine compliance, when water quality data is available, as described in Section 5.8.

In-water construction projects, such as the culvert replacements on Zackuse Creek at East Lake Sammamish Shore Lane, the E Lake Sammamish Trail, and E Lake Sammamish Parkway require United States Army Corps of Engineers Section 401 and 404 permits, that also fall under the Federal Clean Water Act. Any future projects with in-water work, would also require Section 401 and 404 permits. Native American Tribes are party to development proposal review of projects within historic tribal expanses, such as Zackuse Creek.

City and State regulations that guide development in the Zackuse Basin include the State Environmental Policy Act (SEPA) that identifies and requires mitigation for environmental impacts. Additionally, the City's Critical Areas Regulations and Surface Water Drainage Code include provisions to protect the built and natural environment from impacts within landslide hazard and landslide hazard drainage areas.

3.2 City Plans

The City's *Comprehensive Plan* (City of Sammamish 2015) prioritized sustainability and health as its overriding goals. Several elements, goals, and policies that were included in the plan relate to stormwater and surface water management. It was stated therein that: "The overall goals of the City's stormwater program is to be in alignment with overall City goals, comply with state and federal regulations, and be responsive to citizen concerns."

The goals from the *Comprehensive Plan* (City of Sammamish 2015) that relate to stormwater and surface water management are listed below:

Environmental Conservation (EC) goals:

- **Goal EC.2 –** Protect people, property, and the environment in areas of natural hazards.
- **Goal EC.3 –** Protect wetlands (including bogs) and other water resources from encroachment and degradation and encourage restoration of such resources.
- **Goal EC.5 –** Maintain and protect surface water and groundwater resources that serve the community and enhance the quality of life.

Utility (UT) goal:

- **Goal UT.6 –** Encourage conservation of water and protect water quality.

Capital Facilities (CF) goal:

- **Goal CF.4 –** Design and locate capital facilities with features and characteristics that support the environment, energy efficiency, aesthetics, technological innovation, cost effectiveness, and sustainability.

In the subsequent *Storm and Surface Water Management Comprehensive Plan* (City of Sammamish 2016), stormwater-related goals and policies were expanded and elaborated upon. It was the intent of this plan, as well as the City's overall stormwater management program, to be consistent with goals and policies outlined in the *Comprehensive Plan* (City of Sammamish 2015).

Storm and surface water goals as identified in the *Storm and Surface Water Management Comprehensive Plan* (City of Sammamish 2016) are listed below. In the plan, these goals are described in more detail and accompanied by key objectives and recommended actions. Working toward achieving these goals will help make progress towards accomplishment of the City's vision, goals, and outcomes as described in the 2015 *Comprehensive Plan* (City of Sammamish 2015), as well as meeting the NPDES permit requirements.

- **Goal 1 (G.1) –** Comprehensively evaluate and address problems related to the existing stormwater system and manage storm and surface water systems to ensure longevity of assets.
- **Goal 2 (G.2) –** Use drainage basin planning to allocate limited resources to address priority problems and opportunities.
- **Goal 3 (G.3) –** Promote surface and stormwater education and outreach.

- **Goal 4 (G.4) –** Promote the recovery of Lake Sammamish kokanee and other threatened or endangered salmonids.
  Goal 5 (G.5) – Prepare a multiyear list of Capital Improvement Projects that address the City's storm and surface water priorities.
- **Goal 6 (G.6) –** Promote City-wide compliance with storm and surface water regulations.
- **Goal 7 (G.7) –** Coordinate surface and stormwater management services with neighboring jurisdictions.
- **Goal 8 (G.8) –** Develop storm and surface water rates and charges based on present and future revenue needs.

This plan incorporates the goals and principles as developed by both the City's *Comprehensive Plan* and *Storm and Surface Water Management Comprehensive Plan* and then goes further to develop a basin-specific program that applies and works toward achieving those goals and principles through the development of capital improvement and programmatic projects. Projects and strategies presented in this plan are recommended in the context of the City's overall vision as well as the goals listed above. Of note is Goal 2 (G.2), which states: "Use drainage basin planning to allocate limited resources to address priority problems and opportunities." This plan is a direct outcome and application of that goal.

4 Stakeholder Involvement and Community Outreach

The Zackuse Basin is composed entirely of residential development that consists of five primary development clusters: Montage (including Cameron Woods and Arbor Heights) near the headwaters of Zackuse Creek on the south/southwest side of Louis Thompson Road NE; Broadmoor Acres/Cedarwood Estates, near the headwaters east of Louis Thompson Road NE; the Tamarack and Tlinget neighborhoods on the north side of Louis Thompson Road NE; the Eden neighborhoods (including Eden Glen, Eden View and Eden Creek Estates), near NE 3rd Street south of Louis Thompson Road NE; and lakefront properties on Lake Sammamish located on Shore Lane, west of E Lake Sammamish Parkway. Figure 4-1 shows approximate locations of these neighborhoods.

Three public meetings and a survey were conducted to engage the community in the basin planning process. Additionally, the ideas and advice of City staff departments (i.e., operations and maintenance, parks, and planning) were requested by the plan team for aspects of the plan specific to their expertise Event summaries and survey results are provided in Appendix A.

A draft of this plan was posted on-line for citizen review and comment. Comments received on the draft plan are provided in Appendix A.

4.1 Community Outreach Meetings

Public outreach at a glance….

- *Three public meetings (over 30 people).*
- *One basin-specific survey (31 responses).*

Three public meetings (two at city hall and one at a homeowner association meeting) were held at different phases of the basin planning project to provide updates on progress and gather input and feedback. Community members provided useful information and comments to the basin planning team at the public meetings during the question and answer and break-out sessions that followed the formal presentations. Attendees provided descriptions of their concerns around stormwater maintenance, landslides, development-related problems (i.e., detrimental effects of development and inability to develop property due to lack of stormwater infrastructure), groundwater seepage, and drainage issues. They also provided details on specific problems and offered to send photos and follow-up information to City staff. Descriptions of surface water and stormwater issues identified by the public are provided in Section 6 and in the event summaries in Appendix A.

Zackuse

Tlinget

Lakefront
(Shore Lane)

Eden
Neighborhoods

Tamarack

Zackuse

Montage
(Including
Cameron Woods
and Arbor Heights

Broadmoor
Acres and
Cedarwood
Estates

Lake
Sammamish

EAST LAKE SAMMAMISH PKWY NE

EAST LAKE SAMMAMISH PKWY SE

LOUIS THOMPSON RD NE

LOUIS THOMPSON RD SE

NE INGLEWOOD HILL RD

SE 4TH ST

212TH AVE SE

218TH AVE SE

Zackuse Creek

Zackuse Creek

Legend

- Subbasin boundaries
- Parcel boundary
- Stream

Streets

- Private
- Public

AltaTerra

N W E S

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

Figure 4-1. Zackuse Basin Neighborhoods

4.2 Zackuse Basin Survey

In addition to community meetings, an online survey was conducted. The link address was provided in the mailer that was sent to property owners and residents to advertise the first public meeting and paper copies of the survey were also made available. The purpose of the survey was to identify basin issues and gain an understanding of surface water and stormwater priorities of basin property owners and residents. Thirty-one people responded to the survey (eighteen responded electronically, and the remainder filled out paper copies). All respondents were property owners; only one was not a basin resident. The survey and detailed results are provided in Appendix A.

Survey questions were developed to obtain community opinions about the following general topics:

- Use of City resources to protect and preserve Lake Sammamish kokanee salmon
- Priorities for City surface water management functions
- Criteria for ranking surface water capital projects

Additionally, the survey provided respondents with an opportunity to communicate details about community-identified surface water or drainage issues to the City and the consultant team. The results of the survey were used to inform ranking criteria developed for Zackuse Basin and City-wide surface water CIPs. Ranking criteria are discussed in Section 7.1.

4.2.1 Survey Results

There is strong support for the protection and preservation of Lake Sammamish kokanee salmon in the Zackuse Basin community. Ninety-three percent of survey respondents agreed with the statement that "Lake Sammamish kokanee are a valued resource that the City should prioritize for protection and preservation." However, over half of those respondents believe that other priorities should be met first.

The order of priorities for City surface water functions based on the average ranking is as follows:

1. Fix local drainage issues in neighborhoods
2. Reduce risk of landslides
3. Reduce flooding on arterial roads (Louis Thompson Road NE and E Lake Sammamish Parkway)
4. Improve water quality in Lake Sammamish
5. Improve water quality in local streams and wetlands
6. Improve stream habitat for fish and wildlife

This ranking confirms the responses to prioritize the protection and preservation of Lake Sammamish kokanee *after* other priorities have been met, since improving stream habitat for fish and wildlife had the lowest average ranking.

Survey respondents were asked to rank four factors according to what they thought should be the most important criteria considered by the City in the construction of stormwater CIPs. The ranking based on averaged survey results is as follows:

1. Safety
2. Time-sensitive opportunities (i.e., availability of resources or partnerships that would make projects more economical or efficient)
3. Environmental benefit
4. Cost

5 Basin Characteristics

Physical, biological, and built environment conditions influence surface water and stormwater runoff in the basin, which in turn result in drainage and natural resource issues, challenges, and potential opportunities to develop strategies for improvement. This section describes the characteristics of the basin, drawing upon information gained through a review of existing documents, public input, direct field observation, and data analysis.

5.1 Built landscape

The basin is entirely residential. All tax parcels within the basin are zoned residential R-1 (1 dwelling unit per acre), R-4 (4 dwelling units per acre), or R-6 (6 dwelling units per acre); and the basin experienced most of its build-out in the 1970s through early 2000s. Figures 5-1 and 5-2 show the decades during which homes currently on developed parcels were constructed in the basin. Figure 5-3 shows the current zoning.

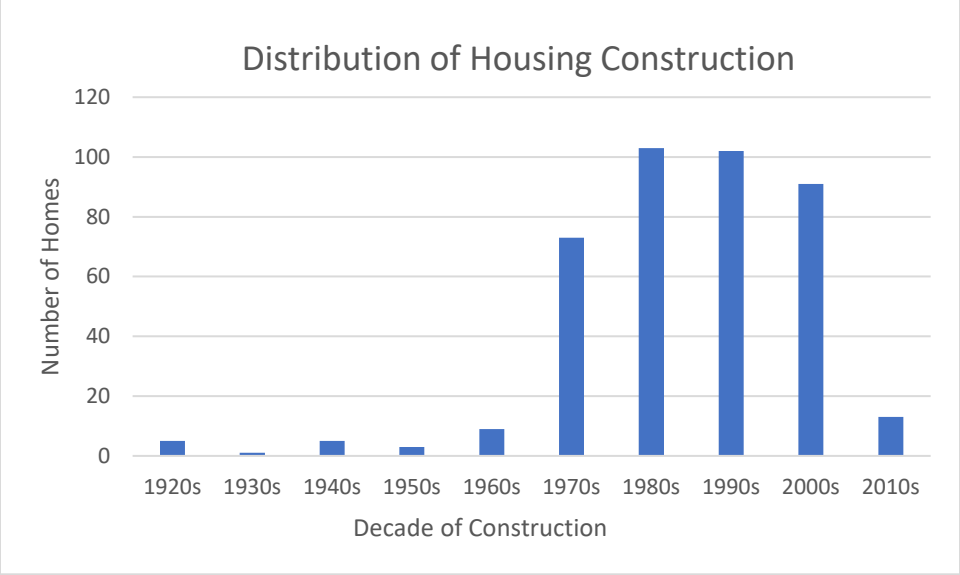

Figure 5-1. Distribution of Housing Construction in Zackuse Creek Basin

Analysis of the age of construction is useful from a stormwater management perspective because it offers a clue to the type and size of stormwater treatment, if any, that was implemented in conjunction with the development. This is particularly important in the absence of documentation that describes design parameters and goals for stormwater treatment. Stormwater infrastructure in the basin is described in Section 5.6; the general ages of development for larger sub-divisions in the basin and the general stormwater requirements at the time of development are shown in Table 5-1.

Legend

Subbasin boundaries

Date constructed

- 1920s
- 1930s
- 1940s
- 1950s
- 1960s
- 1970s
- 1980s
- 1990s
- 2000s
- 2010s
- Tax parcels

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N
W E
S

Figure 5-2. Zackuse Basin Age of Current Development

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
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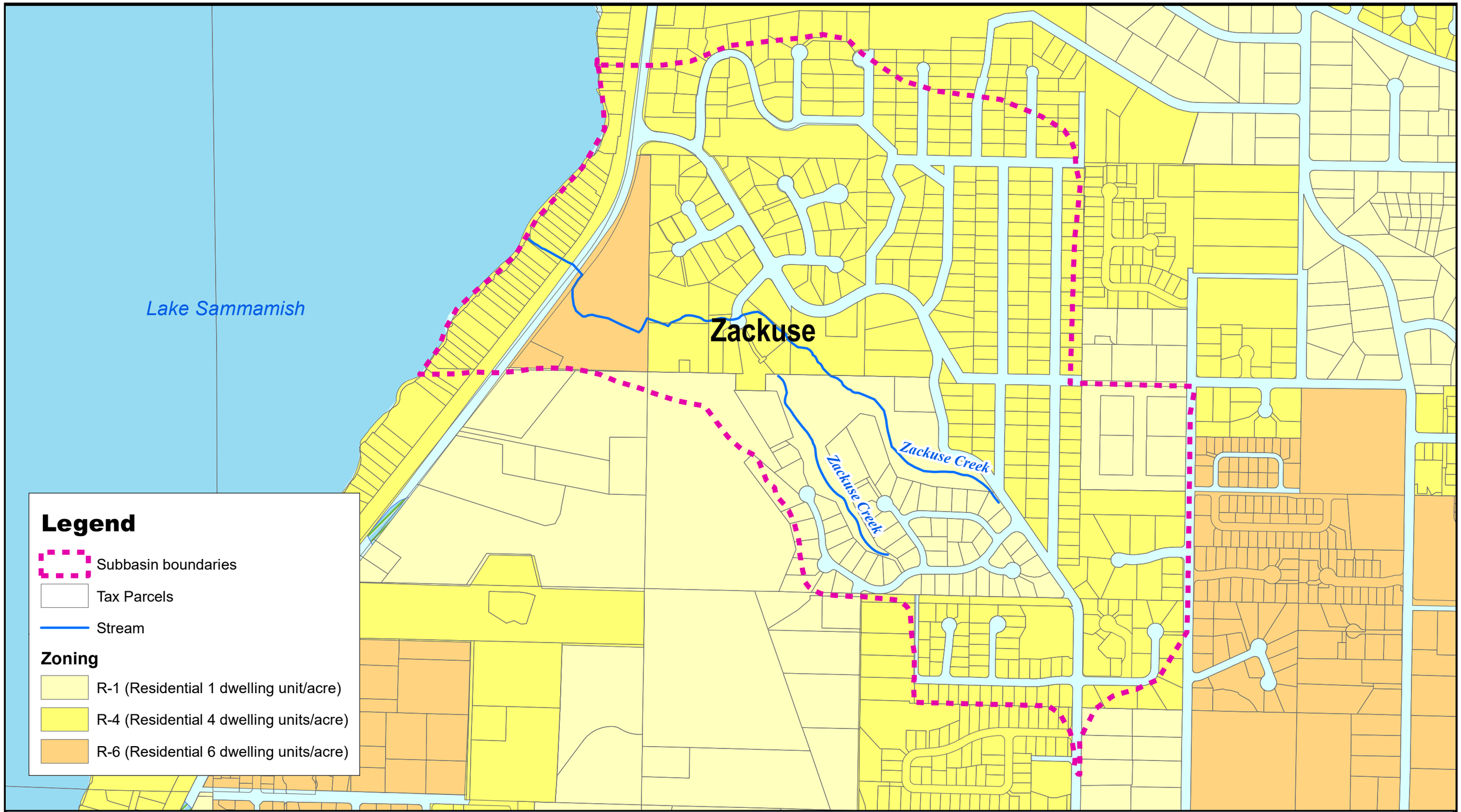


AltaTerra

Figure 5-3. Zackuse Basin Zoning Map

Table 5-1. Ages of Original Developments and Assumed Stormwater Requirements

Development	Decade of Construction	General Stormwater Requirements at time of Construction[a]
Cedarwood Estates	1980s	Prior to 1992, no stormwater flow control was required.
Tamarack and Tlinget	1970s and 1980s	Prior to 1992, no stormwater flow control was required.
Eden View, Eden Creek, and Eden Glen	1970s and 1980s	Prior to 1992, no stormwater flow control was required.
Montage	1990s	In 1992, flow control was required to match peak flows for events of a certain size (Ecology 1992).
Arbors at Pine Lake	2000s	In 2001, flow control was required to match durations and peak flows for events of a certain size, resulting in larger stormwater facilities (Ecology 2001); water quality treatment was also required.
Cameron Woods	2000s	In 2001, flow control was required to match durations and peak flows for events of a certain size, resulting in larger stormwater facilities (Ecology 2001); water quality treatment was also required.

[a] For simplicity, Ecology stormwater requirements at the time of construction are shown. The City was incorporated in 1999 and adopted the King County Stormwater Management Manual (King County 1998) requirements, which are generally consistent with the Ecology manual requirements.

Based on the ages of most of the residential housing and large developments for which stormwater facilities were constructed in the basin, the types and sizes of stormwater facilities are not sized to adequately detain or treat runoff from development in the basin according to current standards, that emphasize stormwater management to prevent flooding, erosion in small streams, and water quality degradation. This will change over time as homeowners remodel or redevelop since they will need to meet newer, more stringent stormwater requirements.

5.2 Topography

The Zackuse Basin drops in elevation from 500 feet at its high point in the northeast corner in the Tamarack neighborhood to 40 feet on the shore of Lake Sammamish. The basin slopes toward the west and is steepest in the middle portion where Zackuse Creek and its south tributary lose most of their elevation and cut through steep-sided ravines before reaching the flat alluvial plain bordering Lake Sammamish. Figure 5-4 presents LiDAR (light detection and ranging) imagery that shows the topographic characteristics of the basin.

The basin topography influences stream channel slope, which in turn affects flow velocity and sediment erosion and depositional processes. These factors can also impact the ability of some fish species to swim upstream. Streams that are too steep can be impassable to fish. The slope characteristics of Zackuse Creek in the context of fish passage are

What is LiDAR?

Light detection and ranging (LiDAR) is a remote-sensing method used to generate precise three-dimensional information about the shape of the Earth and surface characteristics. LiDAR images are useful, combined with field data, to identify landforms and potential issues on a basin-scale.

described in Section 5.7.

Lake Sammamish

Zackuse Creek

Ebright Creek

Zackuse Creek

Legend

- Subbasin boundaries
- Tax parcels
- Stream

AltaTerra

N W E S

Figure 5-4. Zackuse Basin LiDAR Imagery

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

5.3 Geology

The surface geology of the basin is the result of continental glaciation that covered the Puget Sound Lowlands, including the Sammamish Plateau, around 15,000 years ago. The Fraser Glaciation is the most recent glacial episode responsible for the landforms most commonly visible today. However, glaciation in the Puget Sound Area that occurred over the last several million years and has been marked by intervals of warmer nonglacial periods. The Vashon Stade of the Fraser Glacial episode was the maximum extent of the last glaciation in the Puget Sound Lowlands. Geologic deposits associated with this glacial period are:

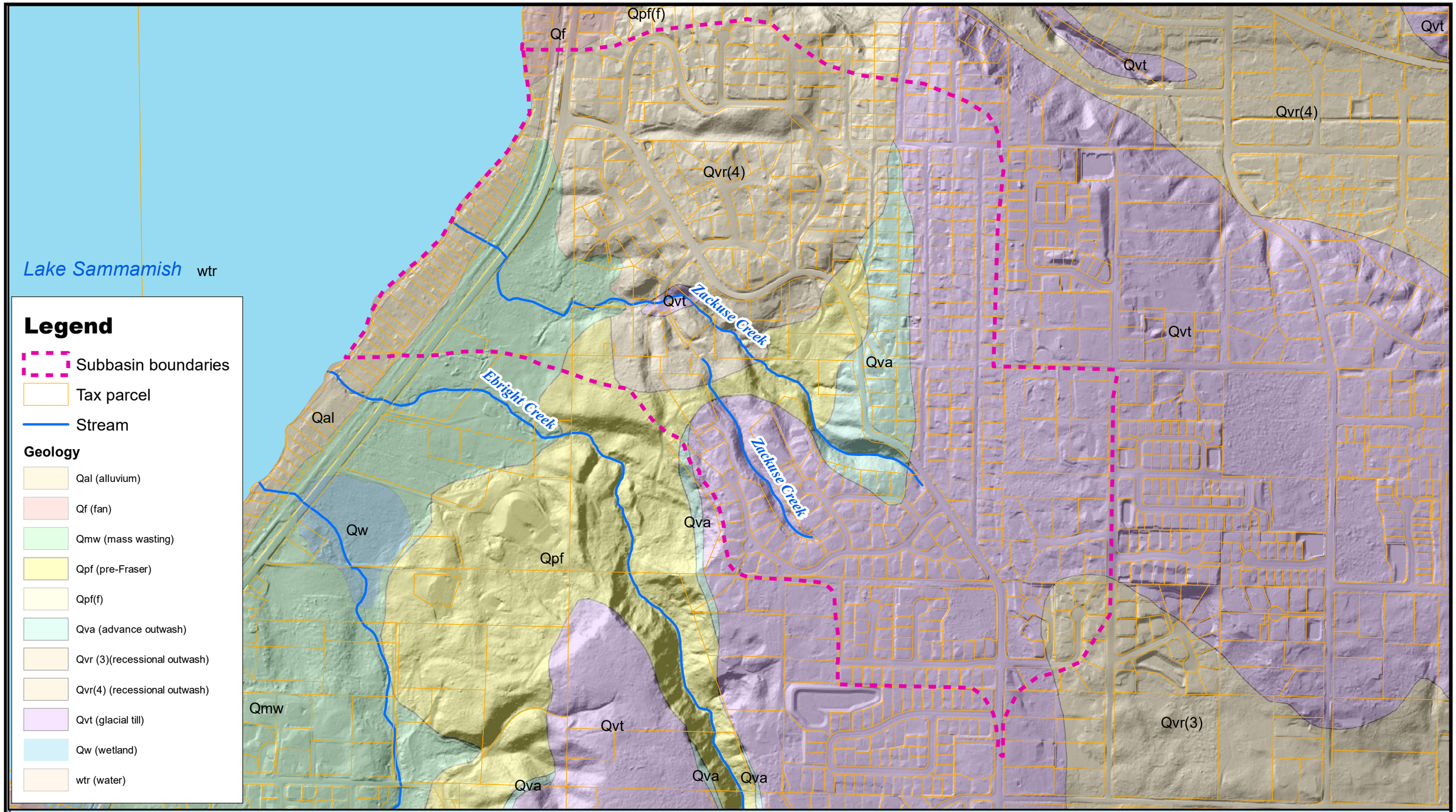
- **Vashon advance outwash (Qva) –** Melt-water deposits formed in front of the advancing glacier on the outwash plain. Advance outwash is generally well-stratified and uniformly deposited sand, gravel, or cobbles and is very permeable.
- **Vashon till (Qvt) –** Very compacted, poorly sorted mix of fine-grained material with angular clasts of rock and some boulders (erratics) that has been transported and deposited by glaciers and compacted from the weight of the ice. Till is generally less permeable because of its dense characteristics.
- **Vashon recessional outwash (Qvr) –** Melt-water deposits formed in outwash plains, valleys and channels on top of glacial till deposits. Recessional outwash consists of stratified sand and gravel that is moderate to well-sorted.

How does geology influence surface water?

The ability of geologic units to infiltrate water has a big impact on surface and groundwater processes in Zackuse Basin. Surface water will runoff (on the surface) geologic units that have poor infiltration (such as glacial till) and may infiltrate easily in geologic units with good infiltration (such as glacial outwash) until the unit becomes saturated, at which point, groundwater seeps may emerge.

Figure 5-5 shows the surface geology in the basin. The surface geology of the upper part of the basin on the top of the plateau is mapped as glacial till. Lower in elevation and beneath the till, advance outwash is mapped in the Zackuse Creek stream channel and between 210th Pl NE and 210th Avenue NE in the Tamarack neighborhood. The advance outwash is susceptible to erosion and infiltrates very well. The geologic unit mapped below the advance outwash is pre-Fraser deposits (Qpf). The pre-Fraser deposits are fine-grained silt and clay that were deposited before the Fraser glaciation. These deposits do not infiltrate well. The contact between pre-Fraser silt and clay and overlying advance or recessional outwash is often the elevation near where groundwater seeps are observed in hill slopes.

A large part of the surface geology on the north and northwest part of the basin is mapped as recessional outwash. The recessional outwash deposited here is part of the large outwash channel that formed in what is now George Davis Creek, north of Zackuse Creek. This channel's outlet was glacial Lake Sammamish in prehistoric times. The other mapped deposits in the basin are nonglacial in origin. Mass-wasting deposits (Qmw) are mapped in the flat plain where Zackuse Creek has lost most of its elevation from the headwaters. Material brought down from hill slope failures upstream in the basin (i.e., advance and recessional outwash) are deposited here in the flat plain where the stream channel does not have enough energy to move the material efficiently. Similarly, alluvium (Qal) is mapped on the shore of Lake Washington. These are sediments deposited from alluvial (i.e., stream) processes.



AltaTerra

N
W E
S

Figure 5-5. Zackuse Basin Surface Geology

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

The longitudinal cross section of the Zackuse Creek stream channel and surface geology in Figure 5-6 illustrates the stratigraphic relationship of the geologic units. A discussion of how the surface geology influences stream channel and hill slope processes is discussed in Section 5.4.

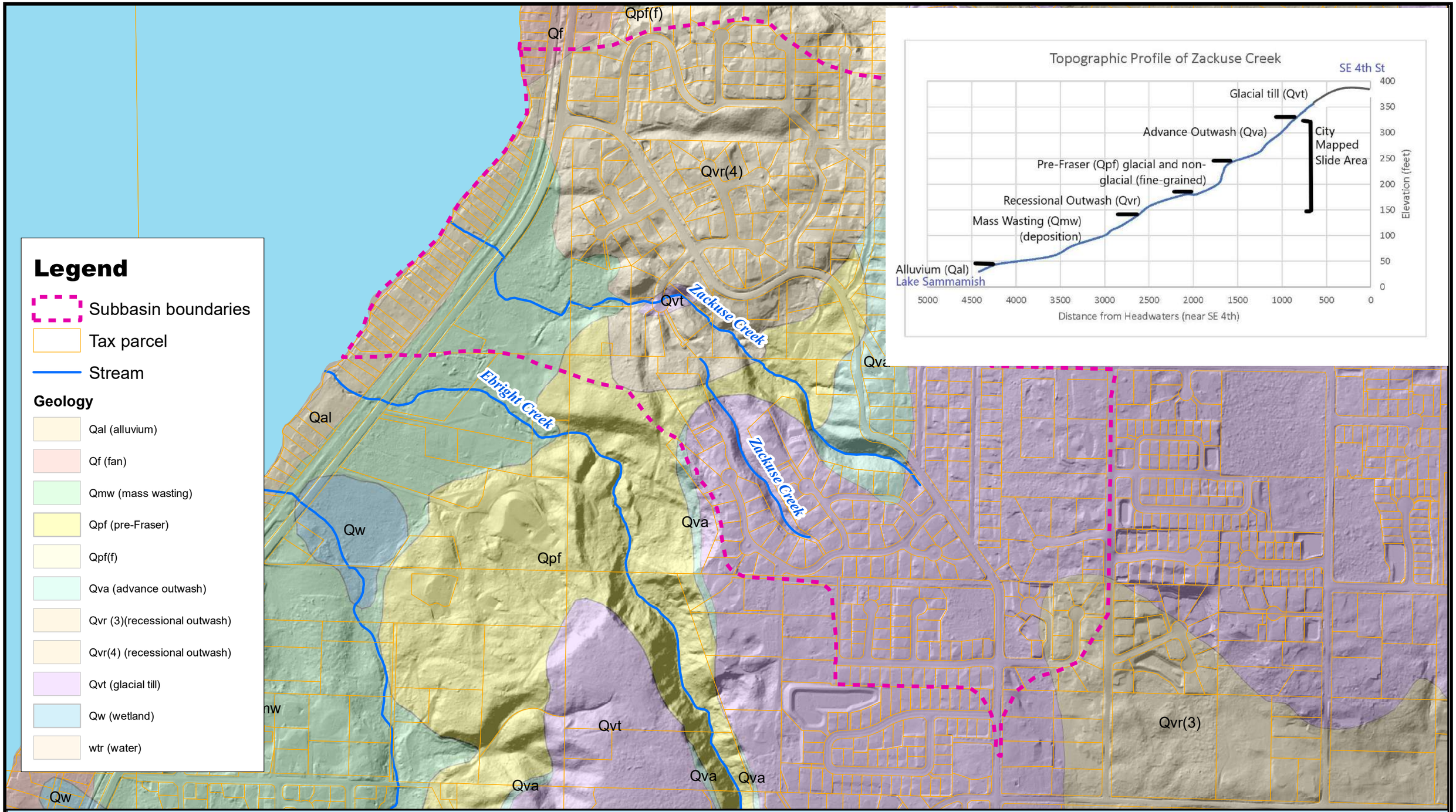
5.4 Geomorphology

Zackuse Basin geomorphology is described below based on observations from stream walks in January and March 2018, data from previous site visits in 2007, and a review of documentation associated with the Zackuse Creek culvert replacement project. A photo log documenting the stream walk conditions is provided in Appendix B. Figure 5-7 provides a map of the general geomorphic characteristics in each reach.

5.4.1 Zackuse Creek Mainstem

The mainstem of Zackuse Creek was walked in January 2018. The Zackuse mainstem originates in a pipe (Photo 5-1) that conveys stormwater runoff from Louis Thompson Road NE and water from headwater wetlands on 212th Avenue SE and the Cedarwood Estates development (Figure 4-1). The stream channels and adjacent hillslopes are not stable in the upper reach. The channel in the upper reach is highly confined to a narrow channel, approximately 3 feet wide, with steep-sided banks and has an average slope of about 10 to 15%. The bed consists of large boulders and cobbles. A landslide occurred in November 2015, on the right bank of the stream, adjacent to Louis Thompson Road NE and at the base of an existing soldier pile wall as a result of drainage discharges. A capital project was completed in winter 2018 to repair the slide and improve the drainage between 210th Pl SE and 211th Pl SE, including installation of a new outfall in Zackuse Creek that conveys stormwater runoff from 210th Pl NE (Photo Z-42a in Appendix B). An outfall (Outfall No. 04) that discharges stormwater from Louis Thompson Road NE to the hill slope above Zackuse Creek has caused additional erosion, just west of the slide location (Photo Z-35 in Appendix B). Large rocks and wood have been placed on the hill slope to stabilize the slope and prevent additional erosion. These efforts have only been marginally successful, as evidence in the field showed that the large material is being undermined. The capital project completed in winter 2018, rerouted most of the runoff that previously went to this outfall to a new outfall at the start of the stream channel.

Photo 5-1. Headwaters of Zackuse Creek. Creek flow originates in 18-inch-diamter pipe, as shown above. Photo taken looking north on January 12, 2018.



AltaTerra

Figure 5-6. Zackuse Basin Longitudinal Profile

Lake Reach
Channelized, low to moderate gradient

Lower Reach
Low gradient, deposition and erosion

Lake Sammamish Outfall

Tamarack Ravine
Channelized Flow from Stormwater Runoff

Lower Middle Reach
Moderate gradient, erosion, landslides, transport

Perched culvert, incised side channel

Outfall 1

Outfall 2

Upper Middle Reach
Low gradient, wetlands, deposition

Outfall 3

Deeply incised ravine downslope of outfall

Outfall 4

Outfall 5

S. Trib. Lower Reach
Low gradient, deposition

S. Trib Headwaters
Steep, erosion, transport

Headwater Reach
Steep, erosion, landslides, transport

Legend

- Outfall
- Subbasin boundaries
- Stream
- Tax parcel
- streets

Geology

- Qal (alluvium)
- Qf (fan)
- Qmw (mass wasting)
- Qpf (pre-Fraser)
- Qpf(f)
- Qva (advance outwash)
- Qvr (3)(recessional outwash)
- Qvr(4) (recessional outwash)
- Qvt (glacial till)
- Qw (wetland)
- wtr (water)

AltaTerra

N W E S

Figure 5-7. Zackuse Basin Geomorphology

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

Photo 5-2. Zackuse Creek downcutting through advance outwash deposits. January 12, 2018.

Downcutting (i.e., channel erosion) is also prevalent in some locations in the upper reach. Sand and gravel in the channel banks are exposed by the stream channel actively cutting its way through this material, which is lowering the bed (Photo 5-2).

Downstream of this upper headwater reach (approximately near 209th Avenue NE), the stream channel enters a relatively short section with a much different characteristic. The gradient is gentler (around 1%), and the channel is not confined by steep slopes. The bed material is much smaller, consisting of large gravel and cobbles (average size around 2 inches in diameter). In fact, there are wetland conditions on both sides of the channel and hillside seeps farther away from the channel. Vegetation in this reach was much thicker and consisted of species such as devils club, salmonberry, piggy-back plant, alders, and cedar trees. Wetlands are described in Section 5.7.5. This section of the channel corresponds with the pre-Fraser silt and clay deposits shown in the surface geology map (Figure 5-5). Because this geologic unit does not infiltrate well, water accumulates on the surface (in wetlands) and subsurface (as groundwater) on top of this material.

Once out of the fine-grained pre-Fraser geologic material, in the downstream direction, the channel once again cuts through sand and gravel deposits (mapped as recessional outwash). The channel is steeper and confined by steep hill slopes. Two slope failures are present on the right bank just upstream of 206th Avenue NE. The larger and more recent landslide occurred in March 2017 and is immediately upstream of 206th Avenue NE. It is approximately 60 feet wide at its base by about 50 feet high. The slide deposited material in Zackuse Creek when the slope originally failed. The creek subsequently cut through the material leaving a bench of sediment on both sides of the channel.

Photo 5-3. Landslide upstream of 206th Avenue NE. Slide deposited material in the stream channel, which subsequently cut a path through, leaving a bench on the left bank (shown on the right side of the photo). January 12, 2018.

Photo 5-3 shows this landslide. The smaller slope failure was observed to have several small trees that were uprooted from slope movement. Additionally, other large fir trees in this area were observed to be leaning in the downslope direction, which is an indication of slope movement. Bed material in this area is cobbles and boulders with gravel. The average bed material size was approximately 3 inches in diameter.

There are very few road crossings on Zackuse Creek; 206th Avenue NE is the only crossing between E Lake Sammamish Parkway and the headwaters, and this road is the sole access for three properties. The stream crosses through two, 24-inch-diameter corrugated metal culverts under 206th Avenue NE. Immediately downstream of the culvert crossing, the channel is armored with large rip-rap to dissipate flows and prevent erosion (Photo 5-4). There is no physical evidence that the culverts are unable to convey flows under 206th Ave NE or that the road has flooded. The channel drops sharply in elevation from the culvert crossing and transitions to

Photo 5-4. Channel downstream of 206th Avenue NE. Road crossing is at guardrail shown at the top of the photo. Large rip-rap in channel prevents erosion downstream of culvert crossing. January 12, 2018.

a lower gradient downstream. The south tributary enters the Zackuse Creek mainstem at this location through a pipe and birdcage outfall structure on the left bank. Notched logs were installed in this reach for grade control at some point in the past (Photo 5-5).

Photo 5- 5. Log grade control structure in channel downstream of confluence with south tributary. Pipe shown on the left of photo is water intake for salmon incubation boxes. January 12, 2018.

The lower reach of Zackuse Creek (between 206th Avenue NE and E Lake Sammamish Parkway) is less confined and primarily lower gradient (<4% slope). It is mostly a depositional reach, except for occasional downcutting and erosion through previously deposited sediment. The channel widens to an average width of 7 or 8 feet and is shallower (1 to 2 feet at bankfull depth), and the grain size is finer (Photo 5-6). Bed material consists of large gravel (1 to 2 inches in diameter) with some cobbles and sand. The channel is this reach is very active, and there is evidence of channel movement back and forth across the floodplain area over the past many decades. Earlier maps show the Zackuse Creek (formerly Eden Creek on some documents) channel to be located to the north of its current location. A dry channel bed was observed to the north of Zackuse Creek during the site visit. Additionally, the channel has some unnatural characteristics in this reach, which indicate that it is in a temporary condition and will change over time. The channel makes two 90-degree turns, creating a dogleg appearance in plan-view (shown in Figure 5-7, lower reach). Stream channels do not naturally turn at right angles unless there is something in the way that blocks movement. In this case, thick sediment may be temporarily shifting the channel direction. However, large storm events that result in bigger flows in the stream and create more energy may change this condition.

Photo 5- 6. Typical channel characteristics in lower reach. Channel is wider and shallower, and grain size distribution in bed is smaller. January 12, 2018.

A comparison of photo evidence from previous documentation in 2012 and 2018 shows that the channel has downcut at least 3 feet to form a new channel just upstream of the dogleg (Photos 5-7a and 5-7b).

Photo 5-7a (left) and 5-7b (right). Photo on left shows Zackuse Creek in 2012 (notice shallow, dispersed flow). Photo on the right is in the same location in January 2018. Channel has incised several feet. Red circle shows clump of trees for reference in each photo.

The culvert crossings at E Lake Sammamish Shore Lane, E Lake Sammamish Parkway and the E Lake Sammamish Trail were replaced after the stream walks had been conducted for this plan. Additionally, the stream was realigned in the summer of 2018 as part of the E Lake Sammamish Parkway culvert replacement between E Lake Sammamish Parkway and the Zackuse Creek dogleg. Because channel conditions have changed in this area, conditions observed during the stream walk are not discussed.

Photo 5- 8. Typical channel section downstream of E Lake Sammamish Parkway. Photo is looking downstream. January 12, 2018.

Downstream of the culvert replacements, between the trail and the mouth at Lake Sammamish, the channel is confined to a narrow, relatively straight, and uniform path that is armored to contain flow within its banks and prevent movement to adjacent properties (Photo 5-8). This section of Zackuse Creek was piped prior to 2009. In 2009, a project by the King Conservation District, in conjunction with a private property owner, removed the pipe and daylighted this section of the Creek.

5.4.2 Zackuse Creek South Tributary

The south tributary of Zackuse Creek was walked in March 2018. The south tributary originates in the Montage neighborhood from a pipe that discharges in a birdcage structure (Photo 5-9) within a depression at the head of a ravine. Two rows of gabion baskets filled with cobbles are located downstream of the birdcage; these provide energy dissipation during high flows.

The stream channel in the ravine gets progressively deeper and wider as it moves in the downstream direction. Bed material also coarsens in the downstream direction, transitioning from sand and gravel at the headwaters to cobbles and boulders where additional flow enters the channel in a high-density polyethylene (HDPE) pipe and outlet structure on the left bank. The channel coarsening is likely the result of finer material being eroded away, rather than larger material being deposited. This flow is conveyed from the West Montage neighborhood stormwater vault (described in Section 5.6). Significant erosion was observed around and adjacent to the outlet structure (Photo 5-10).

Photo 5- 9. South tributary headwaters, looking upstream from first row of gabions. Orange scum on water surface is the result of oxidation. March 8, 2018.

Photo 5-10. Outfall structure from West Montage vault on south tributary. Looking upstream. Erosion has occurred around outlet structure and within the channel. March 8, 2018.

Approximately 50 feet downstream of the outlet structure, the stream gradient flattens, and sediment has been deposited across the ravine bottom (Photo 5-11), with the stream channel cutting a new narrow, deep path through the thick sediment (Photo 5-12). The remaining open channel of the south tributary is incised. The stream enters a birdcage structure upstream of 206th Avenue NE (Photo 5-13) and is conveyed in an 18-inch pipe from the birdcage to another birdcage outlet structure downstream of the 206th Avenue NE culverts on the left bank of the Zackuse mainstem. Figure 5-8 shows a schematic diagram of the stormwater facility at the time of construction at the location where the stream enters the birdcage (Photo 5-13). Sediment has deposited in and around this structure in what was originally a pond. The pipe that originally conveyed flow to the structure has been buried by sediment, and the stream is now discharging over the top of the structure rather than at the bottom as designed.

Photo 5- 11. Depositional area approximately 50 feet downstream of Photo 5-10. Looking downstream. March 8, 2018.

Photo 5-12. Channel incision approximately 100 feet downstream of Photo 5-10. Channel gradient increases and stream has started to incise in sediment shown above in Photo 5-11. Looking upstream. March 8, 2018.

Photo 5- 11. 206th Avenue birdcage structure at the south tributary open channel terminus. 18-inch pipe is buried (see Figure 5-8 for diagram of facility at time of construction). Photo looking to the northwest. March 8, 2018.

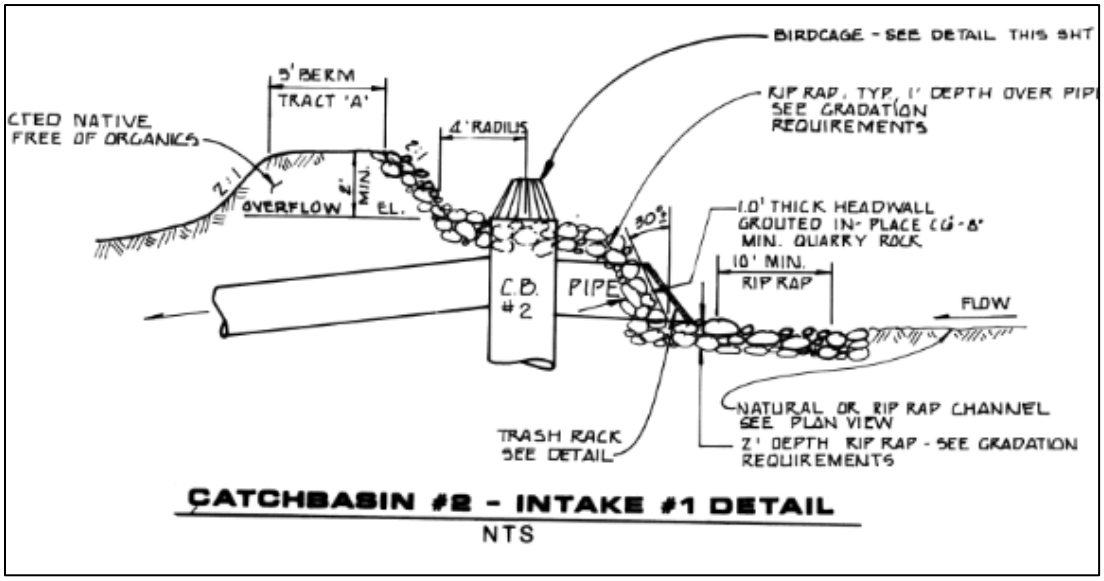


Figure 5-8. Diagram of Stormwater Facility at the Time of Construction (GeoDimensions 1991)

5.4.3 Tamarack Ravine

A channel has formed in the ravine between 208th Ave NE and 205th Ave NE in the Tamarack neighborhood. A stormwater outfall at the head of the ravine (Photo 5-14) discharges water from the upstream neighborhood to this location. As a result, the channel conveys stormwater through this area (Photo 5-15).

Photo 5-12. Tamarack outlet structure at top of Tamarack Ravine. January 12, 2018.

Photo 5-13. Channel forming in Tamarack Ravine. Photo looking east. January 12, 2018.

5.4.4 Other Geomorphic Conditions

Hill slopes in the vicinity of outfalls and side channels were also observed during site visits in January and March 2018. A deeply incised ravine, approximately 15 feet deep by 10 feet wide at its maximum, was noted downstream of Outfall No. 03 on the south side of Louis Thompson Road NE (Figure 5-7). This ravine is clearly visible in LiDAR imagery, which is depicted under the surface geology on Figure 5-7. Additionally, a perched driveway culvert (Photo 5-16) is located on a side channel to the Zackuse mainstem, downstream of Outfall No. 01. This side channel which carries flow from Louis Thompson Road and the Tamarack neighborhood to the Zackuse Creek mainstem is incised downstream of the culvert (Figure 5-7).

Photo 5-14. Perched culvert on private driveway south of Louis Thompson Road NE, near 210th Avenue NE. Looking upstream toward the north. March 8, 2018.

5.5 Climate and Hydrology

The climate in the City and the basin is typical of the Puget Sound region, characterized by wet winters and dry summers, with the wettest months generally occurring between October and March. Average rainfall in the City is around 62 inches per year based on data reported in the weather atlas for Sammamish (Weather Atlas 2018). Rainfall and stormwater runoff are the primary sources of flow in Zackuse Creek; groundwater is a secondary source, supplying water to the stream that has infiltrated into the ground from rainfall or runoff and emerged as seepage. Snow melt also contributes flow to Zackuse Creek on those occasions when temperatures drop below freezing and precipitation turns to snow. Understanding the pattern of rainfall and stormwater runoff conditions is important in the evaluation of basin issues and potential solutions. This section describes existing flow conditions and hydrologic and hydraulic modeling results.

5.5.1 Flow Conditions

Existing hydrologic and hydraulic models and data were reviewed to evaluate flow conditions in Zackuse Creek. A hydraulic analysis was conducted in support of the Zackuse Creek culvert replacement and associated stream restoration project at E Lake Sammamish Parkway. Modeling results indicated that the 2-year flow in Zackuse Creek in the vicinity of E Lake Sammamish Parkway is approximately 12 cubic feet per second (cfs).

5.5.2 Modeling and Results

Existing hydrologic and hydraulic models were used to the extent practical to characterize existing conditions on the Louis Thompson Road NE storm drainage system and to develop conceptual CIPs, as described in Section 7.3.

A new WWHM model was developed in May 2018 for the Louis Thompson Road NE system to characterize the ditch and culvert system on the north side of Louis Thompson Road NE and evaluate flow characteristics of outfalls that discharge to Zackuse Creek from Louis Thompson Road NE. In December 2018, the City completed a capital project near the headwaters of Zackuse Creek that constructed a new soldier pile wall, new bird cage inlets at 210th Ave NE and 211th Place, and rerouted the stormwater conveyance in this area, modifying the conditions that were modeled in May 2018. Modeling results indicated that several culverts and ditches are over capacity at the 25-year or 100-year flow events and that flooding is predicted at a number of nodes. The modeling results represent a reasonable assessment of the existing hydrologic and hydraulic conditions of the project. However, as with all hydrologic and hydraulic models, there are limitations of the model. The model should be used as a planning tool and results should be evaluated against field observations and interpreted accordingly. Refer to Appendix C for more detail on the model limitations and challenges. Figure 5-9 shows the locations of predicted flooding and surcharging based on modeling results. Additionally, the modeling showed that velocities of flow that discharge to Zackuse Creek via outfalls on hill slopes south of Louis Thompson Road NE are over 5 feet per second for the 25-year and 100-year flows. Flow velocities in this range can cause erosion, as has been observed in the field. Table 5-2 lists the outfalls and modeled flows and velocities for the 25-year and 100-year events. Outfall locations are shown in Figure 5-9. Modeling results are presented in Appendix C.

Lake Sammamish Outfall

Lake Sammamish

25-yr Flooding (upstream junction)
100-yr Flooding (1 culvert)

100-yr Flooding (1 culvert)

Outfall 01

Outfall 02

Outfall 03

Outfall 04

Outfall 05

25-yr Flooding (1 culvert)
100-yr Flooding (2 culverts)

25-yr Flooding (2 culverts)
100-yr Flooding (2 culverts)

25-yr Flooding (1 culvert)
100-yr Flooding (1 culvert)

25-yr Flooding (1 culvert)
100-yr Flooding (1 culvert)

Zackuse Creek

Ebright Creek

LOUIS THOMPSON RD NE

LOUIS THOMPSON RD SE

MAIN ST

MAIN DR

NE 6TH PL

NE 6TH ST

NE 5TH PL

NE 4TH ST

NE 3RD ST

NE 2ND ST

NE 1ST ST

SE 1ST ST

SE 1ST PL

SE 2ND

SE 3RD ST

SE 3RD PL

SE 4TH ST

SE 4TH PL

SE 5TH PL

SE 7TH ST

SE 8TH ST

205TH AVE NE

207TH AVE NE

208TH AVE NE

209TH AVE NE

210TH AVE NE

211TH AVE NE

212TH AVE NE

216TH AVE NE

217TH AVE NE

218TH AVE NE

219TH AVE NE

220TH AVE NE

205TH CT NE

206TH AVE NE

210TH PL NE

211TH PL NE

214TH AVE NE

209TH PL SE

210TH PL SE

211TH PL SE

213TH PL SE

214TH AVE SE

215TH PL SE

215TH CT SE

218TH AVE SE

208TH AVE SE

212TH AVE SE

EAST LAKE SAMMAMISH PKWY NE

Legend

- Outfall
- Model Nodes

Channel Type in Model Area

- Culvert
- Ditch
- Pipe
- Subbasin boundaries
- Stream
- Tax parcel
- streets

Pictometry International Corp.

AltaTerra

N
W E
S

Figure 5-9. Zackuse Basin Modeling Results

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

Table 5-2. Summary of Zackuse Basin Modeled Outfall Flows and Velocities

Outfall Location	Pipe Identification	Type	Size	Slope (percent)	25-Year Event		100-Year Event	
					Flow (cfs)	Velocity (ft/s)	Flow (cfs)	Velocity (ft/s)
Lake Sammamish	None available in GIS	Ditch	3 feet wide by 4 feet deep (3:1 horizontal to vertical sideslopes)	2.3	13.3	3.5	19.0	3.9
Outfall No. 01	#29139	Concrete pipe	1.5-ft diameter	3.1	2.6	6.3	3.4	6.6
Outfall No. 02	#74900	Concrete pipe	1.5-ft diameter	8.0	0.9	7.2	1.2	7.6
Outfall No. 03	#24959	Concrete pipe	1.5-ft diameter	6.1	0.7	6.0	0.9	6.4
Outfall No. 04	None available in GIS	Concrete pipe	1.5-ft diameter	5.5	3.5	8.3	4.6	8.7
Outfall No. 05	#29136	Aluminum pipe	1.5-ft diameter	13.7	6.0	7.5	7.0	7.7

5.6 Stormwater Infrastructure

Stormwater infrastructure in the basin consists of City-owned and privately-owned pipes, culverts, and ditches that convey stormwater runoff from public and private roads to Zackuse Creek and Lake Sammamish, and stormwater treatment facilities (i.e., vaults, detention ponds, bioswales) that detain and control flow or provide water quality treatment. This section describes the types and functions of infrastructure in the basin.

> ***What is stormwater treatment?***
>
> *Stormwater treatment refers to methods used to improve stormwater runoff to remove pollutants and mimic natural hydrologic conditions. It includes facilities that function primarily for water quality treatment and for flow control/detention.*

5.6.1 Stormwater Treatment Facilities

Few stormwater treatment facilities were designed to detain stormwater runoff from some of the larger developments in the basin. These facilities were sized according to design criteria and stormwater regulations in place at the time of permitting. Table 5-3 lists the stormwater facilities, including their facility identification (ID) numbers, components, functions, and approximate years of construction. Figure 5-10 shows the facility locations.

Table 5-3. Stormwater Treatment Facilities, Approximate Year Built, Components, and Functions

Facility ID	Name	Approximate Year Built	Components	Function and Area Treated (in parentheses)
D98083	Eden View	1976	Detention pond with restrictor manhole	Detention and flow control (Eden View neighborhood and Louis Thompson Road NE)
D90392	Eden Glen (SLT)	1979	48-inch-diameter detention pipe, flow restrictor, outfall pipe, and rock-lined energy dissipation channel to Zackuse Creek[a]	Detention and flow control (Eden Glen neighborhood)
D90391	Eden Glen (NLT)	1979	48-inch-diameter detention pipe, flow restrictor, and outfall	Detention and flow control (Eden Glen neighborhood)
D92124	Broadmoor Acres	1980	Detention pond (approximately 25 ft by 75 ft by 3 ft)	Detention and flow control
D91053	Tlingit Addition	1983	72-inch-diameter detention pipe	Detention and flow control, some backyard infiltration galleries (Tlingit development, lower Tamarack)
D91136	Cedarwood Lane (PB)	1985	Detention pond (3,880 cubic feet of detention provided)	Detention and flow control (Cedarwood Estates [SE 5th Street and 212th Avenue SE])
D91856/ DRC059	Montage	1991	East Montage vault (20 ft by 80 ft by 8.7 ft) and HDPE pipe and gabion energy dissipation	Detention and flow control (Montage)
D91857/ DRC060	Montage	1991	West Montage vault (50 ft by 20 ft by 7.7 ft), HDPE pipe and outfall discharge, intake, and birdcage overflow near 206th Avenue NE	Detention and flow control (Montage)
DRC076	Montage Center Outfall	1991	Birdcage overflow and gabion energy dissipators	Outfall structure at headwaters of south tributary (Montage)
D92731	Arbors at Pine Lake (west)	2003	Sand filter and detention vault	Water quality and flow control (Arbors at Pine Lake)

Facility ID	Name	Approximate Year Built	Components	Function and Area Treated (in parentheses)
D98932	Cameron Woods	2003	Detention vault, bioswale, and stormfilter vault	Water quality and flow control (Cameron Woods)
DS0073	Dedo Estates Short Plan	2016	Storm vault, sensitive lake treatment storm filter, and cartridge storm filter at catch basin	Water quality and flow control

[a] At the time of construction, Zackuse Creek was located on the north side of floodplain, adjacent to the outfall pipe. The current location of Zackuse Creek is approximately 200 feet south of the outfall.

All the stormwater facilities were constructed in conjunction with residential developments in the basin. The only facilities that provide water quality treatment are facilities constructed after 2000; all of these are located near the headwaters of the basin and include stormwater facilities associated with the Cameron Woods and Arbors at Pine Lake developments that discharge to the south tributary and Dedo Estates Short Plat that discharge to the Zackuse mainstem.

What areas don't have stormwater treatment?

As described in Section 5.1, stormwater facilities are generally constructed at the time of larger scale developments according to the stormwater requirements in place at the time. As a result, older neighborhoods lack stormwater treatment (i.e., Tamarack) or sufficiently sized facilities to protect resources (i.e., Montage).

Facilities constructed in the 1970s, 1980s, and 1990s were all designed to provide some stormwater detention prior to discharge at outfalls on hill slopes or to Zackuse Creek but not water quality treatment. These facilities were also designed to different standards and if designed today, would be much larger and detain greater volumes of water prior to discharge. The Montage development and Eden Glen neighborhood are where most of these facilities are located.

During the field assessment, the general condition of above-ground stormwater facilities was observed. On the south tributary, erosion was observed around the West Montage vault outfall (Photo 5-10), and the pipe and birdcage overflow structure downstream of the outfall was filled in with sediment (Photo 5-13). The gabion energy dissipation structure downstream of the East Montage vault appears to be functioning well, minimizing erosion from this outfall.

The Eden View detention pond, near the intersection of Louis Thompson Road NE and NE 3rd Street, was dry at the time of the site visits in January and March 2018, and there was no evidence of stormwater water in the facility during recent site visits. City staff also have noted that this facility is rarely, if ever, filled with water.

City maintenance staff described the conditions of the two underground vaults located in the Montage development (i.e., the East Montage vault and the West Montage vault). According to City staff, both vaults experience sedimentation, but the East Montage vault is prone to excessive sedimentation, which has resulted in the vault orifice becoming clogged, water backing up into the connecting catch basin, and overflows occurring. To alleviate this problem, City maintenance staff installed a high flow bypass in

a catch basin in the fall of 2017 to allow high flows to bypass the vault. Since this modification was made, there have been no overflows; however, high flows pass downstream un-detained.

The Arbors at Pine Lake and Cameron Woods stormwater facilities were visited with City maintenance staff in April 2018. Both facilities are privately maintained; however, flows from both systems discharge to the Montage overflow birdcage at the headwaters of the south tributary. City maintenance staff expressed concern about the possibility of power failures and how that would impact the sump pump at Cameron Woods, which is necessary to convey stormwater to the development's vault.

Lake Sammamish

Lake Sammamish Outfall

Outfall 01

Outfall 02

Outfall 03

Outfall 04

Outfall 05

D91053

D93083

D90391

D90392

DRC060

D91857

DRC059

D91856

DRC076

D98932

D92731

D92124

DS0061

DS0073

D91136

Zackuse Creek

Zackuse Creek

Ebright Creek

George Davis Creek

0145

EAST LAKE SAMMAMISH LN NE

EAST LAKE SAMMAMISH PKWY NE

EAST LAKE SAMMAMISH SHORE LN NE

NE 7TH CT

NE 5TH PL

NE 3RD ST

NE 2ND CT

NE 2ND ST

NE 1ST PL

NE 6TH PL

NE 6TH ST

NE INGLEWOOD HILL RD

NE 4TH ST

NE 3RD PL

NE 1ST ST

E MAIN DR

SE 1ST ST

SE 1ST PL

SE 2ND ST

SE 2ND PL

SE 3RD ST

SE 3RD PL

SE 4TH ST

SE 4TH PL

SE 5TH PL

SE 6TH ST

SE 6TH PL

SE 7TH PL

SE 8TH ST

SE 8TH PL

SE 3RD WAY

MAIN ST

LOUIS THOMPSON RD NE

LOUIS THOMPSON RD SE

205TH AVE NE

205TH CT NE

206TH AVE NE

207TH AVE NE

208TH AVE NE

209TH AVE NE

210TH AVE NE

211TH AVE NE

212TH AVE NE

213TH PL NE

216TH AVE NE

217TH AVE NE

218TH AVE NE

218TH PL NE

219TH AVE NE

221ST AVE NE

222ND AVE NE

222ND PL NE

210TH PL NE

211TH PL NE

212TH PL NE

214TH AVE NE

206TH AVE SE

208TH AVE SE

209TH PL SE

210TH PL SE

211TH PL SE

212TH AVE SE

213TH PL SE

214TH AVE SE

214TH PL SE

215TH PL SE

218TH AVE SE

218TH PL SE

220TH AVE SE

222ND PL SE

197TH AVE SE

198TH PL SE

SE 8TH CT

200TH AVE SE

Legend

- Outfall
- **Streets**
- Private
- Public
- Zackuse Basin Boundary
- Stream
- Pipes
- Stormwater Facility (ID shown)

Pictometry International Corp.

AltaTerra

N W E S

Figure 5-10. Zackuse Basin Stormwater Treatment Facilities

0 0.0275 0.055 0.11 0.165 0.22 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

5.6.2 Conveyance System

The conveyance system in the basin is a mix of formal and informal infrastructure, depending on the neighborhood. Neighborhoods that were developed all at once as part of a large development or short plat generally have formal conveyance systems with curbs, gutters, catch basins, and pipes. The City owns and maintains conveyance infrastructure in the entire basin, except for the Tamarack neighborhood, which features an informal drainage system of ditches, culverts, and a few pipes and catch basins associated with private roads. Additionally, Louis Thompson Road NE also has an informal ditch and culvert conveyance system. Figure 5-11 shows the locations of ditches, culverts, pipes, and stormwater structures in the basin, as well as public and private roads.

There are approximately 2.4 miles of ditches and 4.6 miles of pipe in the basin. Figure 5-12 shows the distribution of pipe sizes; the majority are 12 inches in diameter. The larger pipes (greater than 48 inches in diameter) are detention pipes that serve as stormwater facilities (as listed in Table 5-3). Figure 5-13 shows the distribution of the pipe ages. The numbers of pipes installed in 1991 and 2000 directly correspond with the development of Montage (1991) and Arbors at Pine Lake (2000), as well as the storm drainage work on Louis Thompson Road NE performed in conjunction with each of these developments.

Lake Sammamish Outfall

Lake Sammamish

Outfall 01

Outfall 02

Outfall 03

Outfall 04

Outfall 05

Zackuse Creek

Ebright Creek

Legend

- Structures
- Outfall
- Ditches
- Pipes
- Zackuse Basin Boundary
- Stream

Streets

- Private
- Public
- Stormwater Facility

N

W E

S

Pictometry International Corp.

Figure 5-11. Zackuse Basin Stormwater Conveyance Infrastructure

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

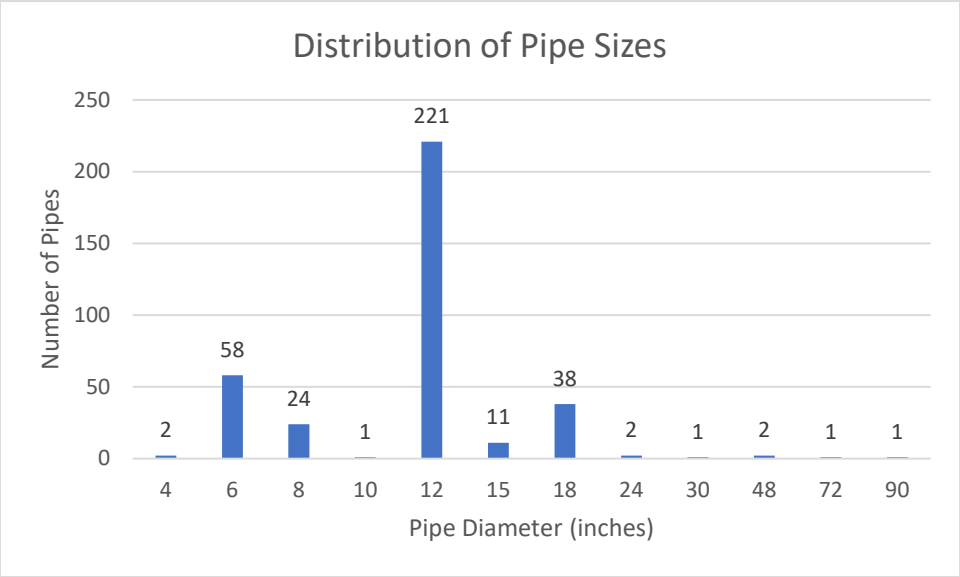


Figure 5-12. Distribution of Pipe Sizes in Basin

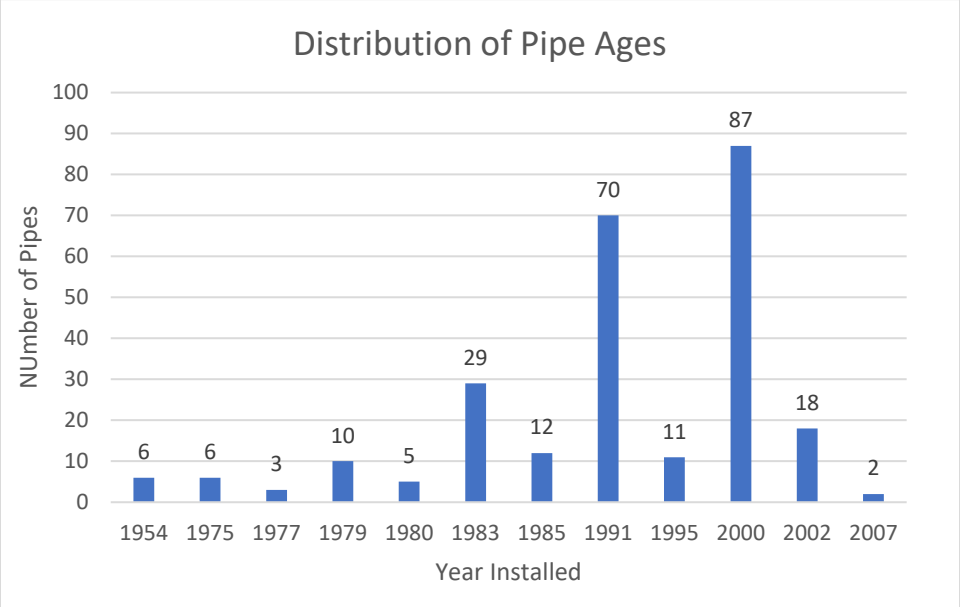


Figure 5-13. Distribution of Pipe Ages in Basin

5.7 Biological Conditions

Biological conditions of Zackuse Creek, associated wetlands, and the adjacent riparian areas were qualitatively assessed during stream walks in January and March 2018. A description of biological conditions in the context of fish use and habitat, hydrologic functions, and water quality benefits in the basin are provided below.

5.7.1 Fish Use and Life Histories

Zackuse Creek is one of several streams on the east side of Lake Sammamish that has historically supported kokanee spawning (Figure 5-14). Additionally, cutthroat trout are known to be in the basin, and coho salmon are thought to be in the basin. This section describes the life histories of these species in the context of habitat conditions in the basin.

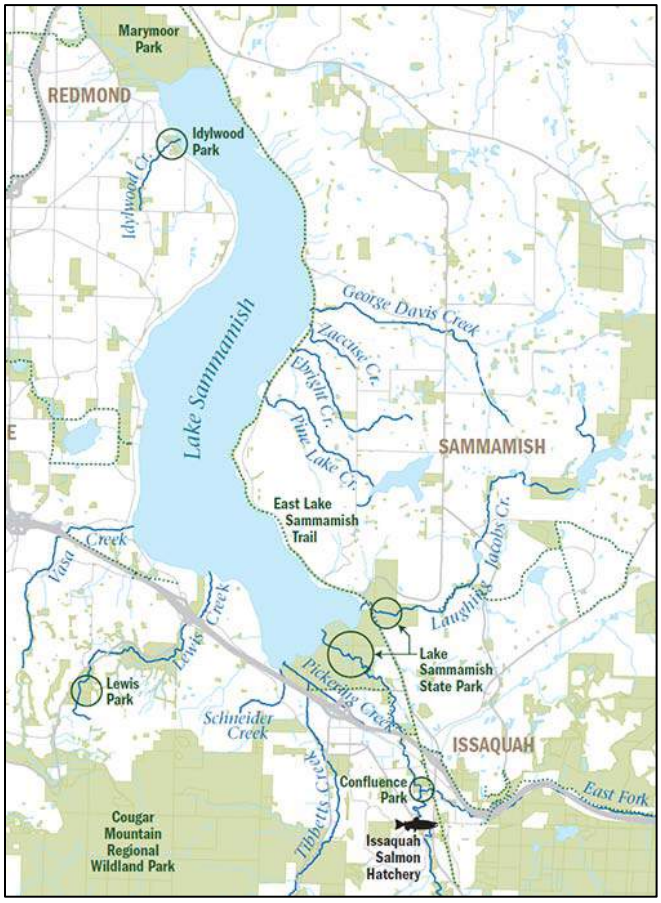


Figure 5-14. Lake Washington Kokanee Streams (King County 2018a)

> ***What fish are expected to be found in Zackuse Creek?***
>
> *Kokanee salmon are expected to spawn in the lower reaches of Zackuse Creek, especially now that new spawning habitat is available after the 2018 culvert replacement projects. Additionally, cutthroat trout are expected to be found throughout Zackuse Creek, and habitat is suitable for coho salmon but below 206th Ave NE.*

5.7.1.1 Lake Sammamish Kokanee

Unlike their larger relative sockeye salmon, kokanee (both *Oncorhynchus nerka*) spend their entire life cycle in fresh water. They migrate to Lake Sammamish as inch-long fry and spend 3 to 4 years in Lake Sammamish before spawning in the late fall and early winter in their natal streams. In recent decades, their numbers have plummeted, and their distribution has been reduced from a large portion of the Lake Washington watershed to only Lake Sammamish and several of its tributary streams (Lake Sammamish Kokanee Work Group [KWG] 2014). A description of the KWG and its efforts to aid in the recovery of kokanee salmon in Zackuse Creek is described in Section 5.7.3.

The life history of kokanee differs from that of cutthroat trout and coho salmon, in that kokanee do not rear as juveniles in streams. Adults arrive in the late fall, November and December, but may need to ripen up in deeper pools, preferably with wood for protection, until they are ready to spawn. When the fry hatch and emerge from the gravel in the spring, they head straight for the lake, possibly on the same night. They do not rear in the creek and are not present in the creek at any life history stage during the

summer. In Zackuse Creek, kokanee spawning is not expected to take place upstream of the 206th Avenue NE crossing to any significant degree – even if passage conditions are improved there – primarily due to the increasing stream gradient going upstream.

5.7.1.2 Coho Salmon

Coho salmon present in the E Lake Sammamish subbasin are part of the Lake Washington/Sammamish Tributaries coho population (WDFW 2005). Adults begin migrating into fresh water and through Lake Washington in the late summer and early fall to eventually reach tributaries such as Zackuse Creek. Adult coho spawners enter Lake Sammamish tributaries and spawn in the late fall, primarily during November and December. Juvenile coho emerge in the spring and rear in fresh water for an additional year before migrating to the ocean.

WDFW's Priority Habitats and Species (PHS) online database (WDFW 2018a), which was accessed on January 25, 2018, indicated that coho salmon are present in Zackuse Creek up to near the 206th Avenue NE crossing, which the WDFW SalmonScape website (WDFW 2018b) identifies as a partial migration barrier. This location is approximately 0.3 mile upstream from the mouth. Since coho typically spend a full year rearing in fresh water before migrating to sea, they can be present as rearing juveniles in suitable habitat at any time of year.

5.7.1.3 Cutthroat Trout

Of the three species, cutthroat trout are the most versatile, and so their life history the most variable. They are pervasive in local streams where access and habitat is suitable. The PHS online database (WDFW 2018a), which was accessed on January 25, 2018, indicated a potential cutthroat trout presence in Zackuse Creek extending from the mouth and into headwater areas. In addition to migrating to lakes and saltwater to rear and grow, cutthroat can also exist as non-migratory or resident forms. As such, they can sometimes remain to complete their entire life history upstream of migration barriers, as long as there are some stream sections with perennial flow above such barriers. Unlike kokanee or coho, cutthroat spawn in the late winter or early spring. Like coho but unlike kokanee, they can be present in Zackuse Creek at any time of year.

5.7.2 Fish Passage Barriers

The SalmonScape website (WDFW 2018b) identifies road and trail crossings of Zackuse Creek and (in most cases) evaluates the level of fish passage barrier imposed by each. These are shown on Figure 5-15.

Note: The alignment of the lower-most creek section was not mapped correctly; the creek passes through culverts at 920253-257. [Source: WDFW 2018b.]

Figure 5-15. Barriers along Zackuse Creek as identified and evaluated on the WDFW SalmonScape website (WDFW 2018b)

The two lower-most potential barriers are on private property and are shown on the SalmonScape website (WDFW 2018b) as unknown blockages. These consist of 6-foot-diameter corrugated metal half-pipe (CMP) culverts, one of which is shown in Photo 5-14. Based on evaluations included as part of this plan, these may be considered hindrances to fish movement but not barriers.

Photo 5-14. One of two 6-foot-diameter culverts along Zackuse Creek approaching the mouth. Lake Sammamish is in the background. This culvert and the other culvert (not shown) may be hindrances to fish movement but are not significant barriers. January 12, 2018.

Proceeding upstream, partial barriers are identified at E Lake Sammamish Shore Lane, E Lake Sammamish Trail, and E Lake Sammamish Parkway. King County corrected the lower two of these barriers as part of its E Lake Sammamish Trail project in fall 2018. Additionally, the City replaced the culvert under E Lake Sammamish Parkway and so corrected the barrier, during the summer fish window of 2018.

The remaining partial (but substantial) man-made barrier along Zackuse Creek occurs at the 206th Avenue NE crossing. This crossing is shown in Photo 5-15.

Photo 5-15. Twin 24-inch-diameter CMP culverts at 206th Avenue NE are considered a partial fish passage barrier. Photo is looking upstream toward the east. January 12, 2018.

No man-made fish migration barriers occur proceeding upstream to the Louis Thompson Road NE inlet pipe to Zackuse Creek, which is considered the headwaters. At that location, the likelihood of fish use is diminished, and flow is considered to transition from stream flow within a confined ravine to stormwater flow along roadside swales and ditches. However, there are boulders and logs situated prior to reaching Louis Thompson Road NE that may be considered partial barriers, and two larger log and debris jams may constitute full barriers. Representative cascades are shown in Photos 5-16 and 5-17, and one of the two larger log and debris jams is shown in Photo 5-18.

Photo 5-16. Cascade in upper Zackuse Creek reach. January 12, 2018.

Photo 5-16. Low falls in Upper Zackuse Creek reach in steep ravine. January 12, 2018.

Photo 5-15. High debris jam in the Upper Zackuse Creek reach in the steep ravine. January 12, 2018.

5.7.3 Role of Zackuse Creek in Kokanee Recovery

The KWG prepared a Draft Blueprint for the Restoration and Enhancement of Lake Sammamish Kokanee Tributaries in 2013 (KWG 2013) and an updated edition in 2014 (KWG 2014). The KWG is an "ad hoc" collaborative group formed in 2007 to identify the causes for the decline of native kokanee in Lake Sammamish and the key actions to turn around that decline, and then foster implementation of those actions. The goals of the KWG encompass returning the kokanee population to robust health and ultimately re-establishing a fishery for kokanee on the lake. The KWG membership includes watershed residents, each of the five local jurisdictions in the Lake Sammamish watershed, the US Fish and Wildlife Service, the Washington Department of Fish and Wildlife, Washington State Parks, the Snoqualmie Tribe, Trout Unlimited, Friends of Issaquah Salmon Hatchery, Save Lake Sammamish, Friends of Pine Lake, and additional stakeholders" (King County 2018a).

Over the past several years, the KWG and its members have assembled the best science available, conducted assessments, implemented a short-term population supplementation program, supported a series of restoration projects, and reached out to the larger community to educate others on kokanee needs in the watershed.

In the blueprint (KWG 2014), Zackuse Creek is identified as a Class 3 kokanee stream. These are "Small secondary streams that have potential for kokanee spawning." However, their presence goes beyond just "potential," since kokanee were observed in Zackuse Creek during the 2012-2013 spawning season (about 60 fish) and have likely been present in other years as well.

Through project implementation and reintroduction (planting newly hatched kokanee fry), the KWG intends to promote the establishment of a self-sustaining population of kokanee in Zackuse Creek. Projects have been conceived and designed to expand and improve natural ecological processes to the benefit of the long-term existence of kokanee in Zackuse Creek. Specifically, in addition to reintroduction, the following Zackuse Creek projects were recommended in the blueprint (KWG 2014):

- Culvert replacement at E Lake Sammamish Shore Lane
- Culvert replacement at E Lake Sammamish Trail
- Culvert replacement at E Lake Sammamish Parkway
- Channel restoration through forested wetland

> *The path to kokanee recovery…..*
>
> *Four projects recommended in the Draft Blueprint for the Restoration and Enhancement of Lake Sammamish Kokanee Tributaries (KWG 2014) were completed in the Zackuse Basin in 2018.*

In anticipation of these habitat restoration and barrier removal projects being constructed in 2018, Trout Unlimited installed a new remote stream incubator (RSI) system on Zackuse Creek in Fall 2016 (Trout Unlimited 2016). The RSI was designed to provide a "safe space" for salmon to hatch, rear, and eventually migrate to Lake Sammamish. It is located just downstream of the 206th Avenue NE crossing. Fish returning to Zackuse Creek after being hatched in this RSI will find improved passage and habitat conditions due to the improvement projects described below.

5.7.3.1 Culvert Replacement and Habitat Improvement

The encouraging news is that all four of the projects identified in the blueprint (KWG 2014) are complete at the time of this plan (November 2018). The first and second, both culvert replacements, were part of King County's E Lake Sammamish Trail project. The City constructed the third and fourth projects as a

combined project that included culvert replacement at E Lake Sammamish Parkway and stream channel restoration extending upstream. Together, the culvert replacement projects will remove migration barriers and open access to spawning habitat for kokanee and other salmonid fish along Zackuse Creek. In addition, the included channel restoration project extending upstream from the parkway will increase the amount and improve the quality of that habitat. However, these projects do not represent the culmination of restoration for the creek. Further habitat improvements for kokanee and for salmonid fish overall will provide further benefits and increase the likelihood of kokanee recovery.

5.7.3.2 Data from Fish Relocation Work

For the City's combined E Lake Sammamish Parkway and stream channel restoration project, fish were captured from the affected stream section and safely relocated to unaffected stream sections either upstream or downstream of the project area. The numbers and types of fish caught and relocated confirmed that Zackuse Creek is well-used by salmonid fish.

Fish capture and relocation efforts were conducted on August 1 through August 3, 2018, by fisheries biologists from The Watershed Company. The stream section from which fish were removed extended from about 30 feet downstream of E Lake Sammamish Parkway to about 600 feet above the parkway. Approximately 475 fish were captured from that section over five electrofishing passes. Fewer fish were caught on each successive pass. This overall density approaches one fish per lineal foot.

Fish by the numbers……

- *475 fish were captured during fish removal and relocation efforts for the E Lake Sammamish Parkway culvert replacement project*
- *All were cutthroat trout*
- *Largest fish was approximately 12 inches in length*

The most striking finding of this effort, though, was that only a single species of fish was found: all fish captured and relocated were cutthroat trout. The cutthroat ranged in size from very small fry-of-the-year upwards to approximately 12 inches in length with the somewhat larger fish, 8 inches or more, accounting for about 10% of the total. In addition, three Northwestern salamanders were captured and relocated along with the trout. No juvenile coho salmon were captured along this stream section; this supports the likelihood that the replaced culverts were indeed barriers to upstream-bound adult coho and other migrating salmonids. Coho are obligated to a migratory life history. Adults spawn and juveniles rear for about a year in small streams, then juveniles normally migrate to sea to grow to maturity before returning. If no adult coho have been able to pass upstream of E Lake Sammamish Parkway to spawn in Zackuse Creek, then it would stand to reason that juvenile coho would not be present above the parkway either. If over the coming years, coho use above the parkway is observed, then this would be an indication that fish passage conditions have improved due to the culvert upgrades. In contrast, the life history of the encountered cutthroat trout allows them to live in streams as resident fish. As residents, they are less affected by passage conditions at culverts and other potential barriers because they can reproduce and carry out their entire life history without needing to leave and return to the creek and having to cross potential barriers in the process.

Kokanee were not expected to be found during this fish capture and relocation effort regardless of their use of the stream because their life history dictates that they would have left the stream to occupy only the lake during the summer months. However, the improved passage conditions are targeted primarily or largely toward increasing the use of the stream by kokanee, so observations of kokanee above the

parkway going forward will be of high interest as an indication of improved fish passage similar to that of coho.

The electrofishing team noted that base flows in Zackuse Creek were quite high given the unusually dry late summer season and the small size of the basin (245 acres). In addition, water temperatures were cold, even on hot days. These are indications that Zackuse Creek may serve as a summertime refuge for salmonid fish seeking the cool, oxygenated water that they need during the summer when other streams in the area may be warmer and when Lake Sammamish is most certainly warmer and lower in oxygen.

5.7.4 Streams

As noted in Section 1, streams in the basin include Zackuse Creek, sometimes referred to as the Zackuse Creek mainstem, and the Zackuse Creek south tributary. Additionally, another drainage has formed in what is referred to in this plan as the Tamarack ravine. Habitat conditions detailed in the subsections that follow are described in the context of their suitability for the fish that are present.

5.7.4.1 Zackuse Creek Mainstem

The Zackuse Creek mainstem is one of several small streams that enter the east side of Lake Sammamish from the Sammamish Plateau. From its mouth in Lake Sammamish to near its source at Louis Thompson Road NE, the creek is approximately 4,000 feet long and has an average slope of about 8%. This is somewhat steep in terms of fish habitat, but the steeper sections are in the upper reaches approaching the headwaters; the lower reaches of the creek, near the mouth, are less steep. As described above, Zackuse Creek is known to be used by kokanee and cutthroat trout and is presumed to be used by coho salmon as well.

For the purpose of this plan, Zackuse Creek has been divided into five primary reaches, which are detailed below, beginning at the mouth of the creek.

Mouth to E Lake Sammamish Trail

The lowermost reach of Zackuse Creek is narrow and lacking in pools and woody cover and has very narrow buffers with limited vegetation as it passes between lakeside residences (see Photo 5-14). The sides of the creek have been armored with angular rock. Fish passage to habitat upstream is adequate but could be improved.

E Lake Sammamish Trail and Road Crossings

Upstream of the lakeside residences, a short stream section was previously dominated by three culvert crossings with little open channel in between. These were at E Lake Sammamish Shore Lane, E Lake Sammamish Trail, and E Lake Sammamish Parkway. These culverts were all replaced in late summer and fall of 2018 with fish-passable culverts by King County and the City. For this reason, they are not addressed in detail as part of this plan.

E Lake Sammamish Parkway to End of Planned Channel Enhancements

The area extending upstream from E Lake Sammamish Parkway is an extensive wetland area. Water gathered against the east side of E Lake Sammamish Parkway and then flowed northward in a ditch-like channel (Photo 5-19) to the former culvert crossing. Channel relocation and enhancements associated with the culvert replacement during late summer 2018 moved this flow away from the roadway and routed it through extensive shrubby wetland areas instead.

Photo 5-17. Zackuse Creek flowing in ditch along E Lake Sammamish Parkway prior to late summer 2018, when the creek was realigned away from the road. Photo is looking to the south. January 12, 2018.

Between Channel Enhancements and the 206th Avenue NE Crossing

Upstream from the E Lake Sammamish Parkway channel enhancements, the Zackuse Creek channel steepens slightly and flows through a mixed forest area. Trees present in this area include western redcedar, red alder, and bigleaf maple. Native shrubs and groundcover include vine maple, salmonberry, sword fern, pig-a-back, and nettle. Non-native, invasive species include Himalayan blackberry and English holly.

Evidence of past debris flow or landslide activity is present along the lower portion. This evidence includes apparent channel movement; snags of cedar trees, which may have been killed by deposition around them; and channel downcutting through what appeared to be landslide or debris flow sediment (Photo 5-20).

Photo 5-18. Channel downcutting through what appears to be landslide deposits in lower reach. January 12, 2018.

Within the basin but outside of other habitat project areas, this stream segment has the most to offer in terms of habitat function and potential. This value is due to the segment's accessibility as the result of recently completed culvert replacements located a relatively short distance upstream from Lake Sammamish, moderate channel gradient (less than 6%), beneficial spawning-grade gravels, and forested riparian condition. This segment has the potential to be well-used by all three salmonid fish species in the basin: cutthroat, coho, and kokanee. As described and documented above, it is already well-used by

cutthroat. Photos 5-21, 5-22, and 5-23 show typical channel and riparian conditions upstream of the channel enhancement area recently constructed.

Photo 5-20. Lower reach includes several moderate plunges that could hinder coho or cutthroat passage and may be problematic for kokanee.

Photo 5-19. Channel incision lessens upstream of Photo 5-21, toward 206th Avenue NE. January 12, 2018.

Photo 5-21. Zackuse Creek channel near the dogleg, upstream of channel restoration area. Note overall forested condition, incised channel, and non-native English ivy on the trees in the background. January 12, 2018.

206th Avenue NE Crossing to Louis Thompson Road NE Crossing

Upstream of 206th Avenue NE, Zackuse Creek flows within a deeper, forested ravine that roughly parallels Louis Thompson Road NE. The channel becomes steeper, averaging a gradient of about 13% compared with 8% for the overall stream length. Trees present include western redcedar, Douglas-fir, western hemlock, red alder, and bigleaf maple. Native shrubs and groundcover include vine maple, salmonberry, devil's club, sword fern, pig-a-back, and nettle. Non-native, invasive species include Himalayan blackberry and nightshade.

Several instances of ravine side slope instability were described in Section 5.4. More wood is present in the channel than farther downstream (Photo 5-23); however, pools are not well formed due to the

steeper slope and larger substrate materials. Along with the steeper channel, the substrate becomes dominated by rounded cobbles and also includes rounded boulders (Photo 5-24). This stream section includes moderate plunges (See Photos 5-16 and 5-17) and a few large, blocking debris jams (Photo 5-25). This stream section is anticipated to be used by cutthroat trout, more than coho or kokanee because cutthroat trout can spend their entire lives in the stream and do not have to pass through the culvert at 206th Avenue NE to access this part of the stream.

Photo 5-224. Large wood in channel in steep ravine upstream of 206th Avenue NE. January 12, 2018.

Photo 5-23. Typical channel section showing cobbles and cascade in ravine upstream of 206th Avenue NE. January 12, 2018.

5.7.4.2 Zackuse Creek South Tributary

The south tributary originates near SE 3rd Way in the Montage development and flows through a wooded ravine to join the Zackuse mainstem just downstream of 206th Avenue NE. The lower section of this tributary is piped. Forest vegetation along the ravine is largely native and includes sword fern,

osoberry, salmonberry, devil's club, red alder, bigleaf maple, Douglas-fir, and western redcedar. Flows are affected by various stormwater discharges, and the stream channel shows signs of erosion and incision along its course, as described in Section 5.4.2. Fish use of the tributary is not expected due to its small size, steep gradient, potentially intermittent flows, and lower piped section, which is likely a migration barrier.

5.7.4.3 Tamarack Ravine

Tamarack Ravine is the name given to a drainage channel that was observed in the long shallow ravine that originates in the Tamarack neighborhood in the vicinity of 208th Avenue NE and NE 4th Street (Photo 5-26). This ravine is thought to not have carried historical surface flow and so did not have a defined channel. In fact, observations from 2007 indicate that no defined channel existed at that time. However, stormwater discharges to the ravine in recent times appear to have caused seasonal or episodic surface flows to occur and a defined channel to develop or be developing in places. Whether this newly-formed channel constitutes a stream for regulatory purposes is yet to be determined. Flow along this pathway does not make a clear connection to Zackuse Creek, though it has been included for consideration in this plan. It is not used by fish and is not potential fish habitat.

Photo 5-246. Recently forming channel in Tamarack Ravine. Note tree roots crossing the channel that would not likely have grown there had the channel been active when they grew (indicating recent channel development). January 12, 2018.

5.7.5 Wetlands

There are three main wetland types and areas in the basin: depressional headwater wetlands, a mid-basin headwater/slope wetland, and a lower-basin riparian wetland. Additionally, there are numerous small, hillside and ravine sideslope seeps that contribute baseflow to the main channel and tributaries. The larger wetlands are shown on Figure 5-16. For the purpose of this plan, these wetlands are labeled Zack-1 through Zack-5. Most of the hillside seep wetlands are too small to map at the scale relevant to this plan.

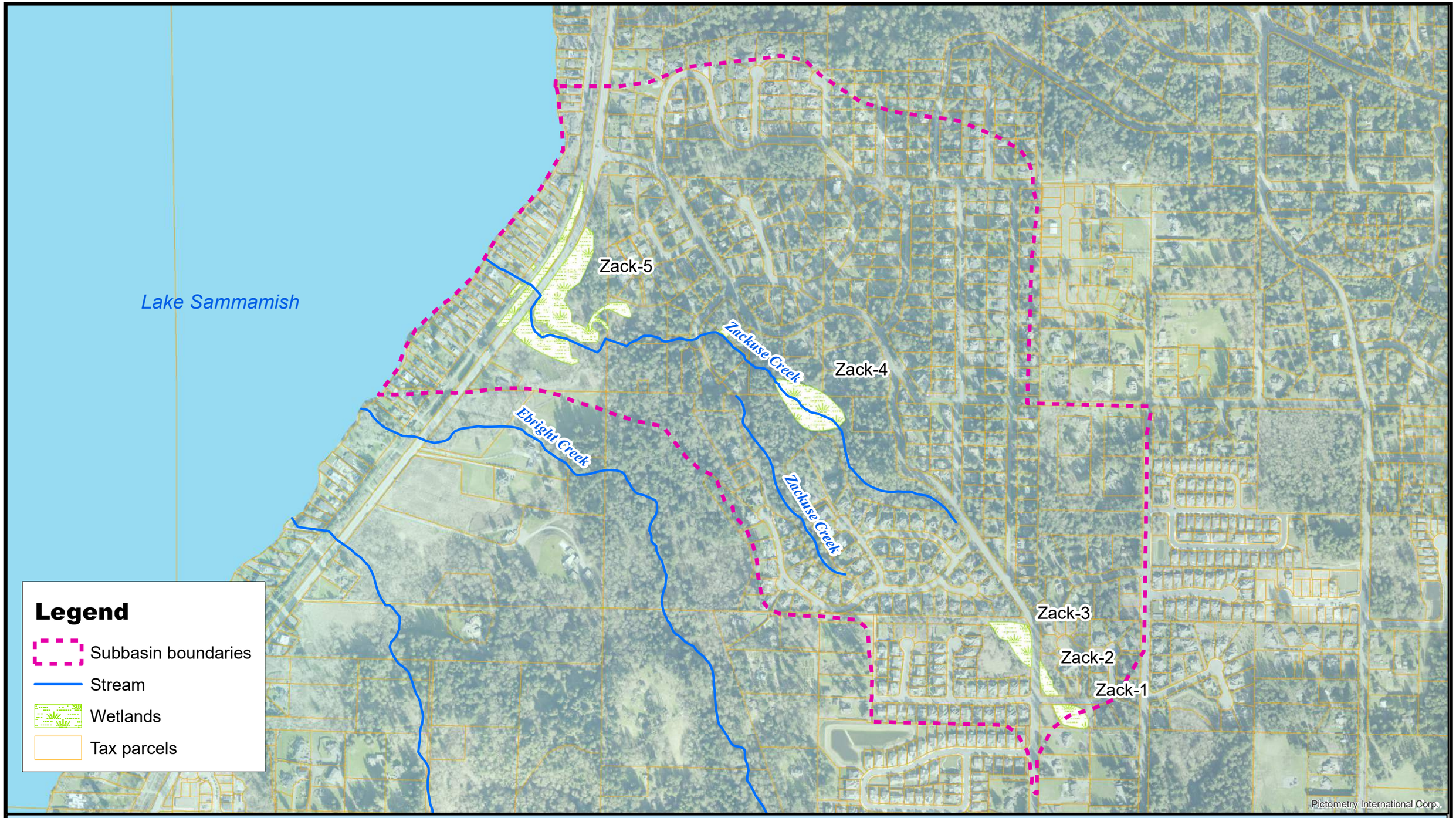
Three depressional headwater wetlands are located near the intersection of 212th Avenue SE and SE 5th Street (Zack-1, Zack-2, and Zack-3). It is likely this was a single wetland prior to the development of the

roads. The wetlands are mostly forested areas surrounded by residential developments. From a hydrologic function perspective, these wetlands serve to store and release stormwater to the beginning of the main, defined Zackuse Creek channel just north of SE 3rd Way. Water quality improvement is also provided but, due to the proximity and density of residential development and roadways and lack of complete buffers on all sides, affords only moderate wildlife functions.

The mid-basin wetland is a depressional feature that is also supported by groundwater seeps emerging from the valley walls (Zack-4). This wetland is forested with a dense shrub understory component. While the complexity of the wetland adjacent to the stream increases roughness, hydrologic functions are limited to baseflow support from the groundwater inputs, as opposed to flood storage. Water quality functions are somewhat limited by the short residence time of stream flow along stream banks. Wildlife habitat functions are well supported due to significant, native-forest buffers; connectivity to the mostly forested length of the channel, both up-and downstream; and complexity of the wetland.

The lower-basin wetland is a riparian system with diffuse, braided flow from the stream (Zack-5). This area slows storm flows due to roughness and channel complexity. The proposed stream channel re-alignment project may reduce this roughness in the short term, following its construction. However, based on the landscape position at the base of steeper grades, complexity is likely to return within a relatively short time period. Due to diffuse flow, water quality functions are moderate, though lower than those in the depressional wetlands in headwater areas. As with the mid-basin wetland, wildlife habitat functions are good due to large, native-forest buffers; complexity of the braided channel; and connectivity to upstream forested channel areas.

Historically, it appears that this lower-basin wetland likely extended to or near the lakeshore. The construction of the former rail line (now the E Lake Sammamish Trail) and the E Lake Sammamish Parkway severed this connection. The interception and concentration of flow in roadside and railroad ditches potentially eliminated wetland areas that once reached the Lake Sammamish shoreline. Currently, wetlands persist between the roadway and the trail in broad, ditched and sloped wetland areas with almost no functioning buffers.



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Note: Features depicted were derived from a variety of sources and are believed to be generally reliable for this study and for general or regional planning purposes. Mapped feature locations and boundaries, including critical areas, are approximate only and are not intended to be used for project- or parcel-specific planning or permitting.

Figure 5-16. Zackuse Basin Wetlands and Streams

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

5.8 Water Quality

The Water Quality Standards for Surface Waters of the State of Washington (Washington Administrative Code [WAC] Chapter 173 201-A designates Lake Sammamish and its tributaries for the following uses:

- **Aquatic life use:** Core summer salmonid habitat
- **Recreation use:** Extraordinary primary contact recreation
- **Water supply uses:** Domestic, industrial, agricultural, stock, wildlife habitat
- **Miscellaneous uses:** Harvesting, commerce and navigation, boating, aesthetics

The water quality criteria associated with these designated uses are:

- **Temperature:** 16 degrees C (60.8 degrees F)
- **Supplemental spawning:** None
- **Dissolved oxygen (DO):** 9.5 mg/L
- **pH:** pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.2 unit.
- **Turbidity:** Turbidity must not be more than 5 nephelometric turbidity units (NTUs) over background when the background is 50 NTUs or less; or a 10% increase in turbidity when the turbidity is more than 50 NTUs.
- **Bacteria:** Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10% of all samples (or any single sample when fewer than 10 samples points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

The water quality status of Lake Sammamish at the mouth of Zackuse Creek is listed as a Category 1, which means that the pollutants that were tested for during monitoring met water quality standards; however, other pollutants that were not tested for may still be present. There are no data for Zackuse Creek in Ecology's water quality assessment (Ecology 2018). Additionally, the City has not yet started monitoring water quality in Zackuse Creek; however, a plan has been developed and adopted (King County 2018b), and water quality monitoring is anticipated to begin in 2019.

> ***What is the quality of water is Zackuse Creek?***
>
> *Water quality in Zackuse Creek has not been tested, and therefore is not known. However, the City will begin monitoring Zackuse Creek water quality as part of its new stream water quality monitoring program.*

Community members expressed concern about possible pollution entering Zackuse Creek through: 1) failed septic systems, and 2) road runoff. Both these mechanisms for pollutant delivery are possible inasmuch as there are still many homes that rely on septic systems for their sanitary sewage treatment, and stormwater runoff from roads in the Zackuse Basin is mostly untreated. Figure 5-17 shows a map of the homes in the basin that are currently connected to the Sammamish Water and Sewer District sanitary sewer system (green lines); all others are assumed to be on individual septic systems. Sewer mains are planned for the entire basin (denoted by red lines on Figure 5-17), and most homes will have an opportunity to connect in the future. It is not possible to know whether septic systems are contributing pollutants to Zackuse Creek

without having specific knowledge (through monitoring) of problem septic systems that could directly relate to high fecal coliform levels in the stream. Even with monitoring, source tracing might be necessary to pinpoint the cause of high fecal bacteria because there are so many possible sources (e.g., wildlife, dogs, birds, and humans).

As described in Section 5.6.1, very few of the stormwater facilities in the basin provide water quality treatment. Most were designed to detain stormwater by slowing its release to the conveyance network or stream channel. Stormwater runoff from roads does carry pollutants such as metals (i.e., copper and zinc), which are especially detrimental to salmon. Water quality treatment should be a component of any future basin surface water project that manages runoff from pollution-generating surfaces, such as roads.

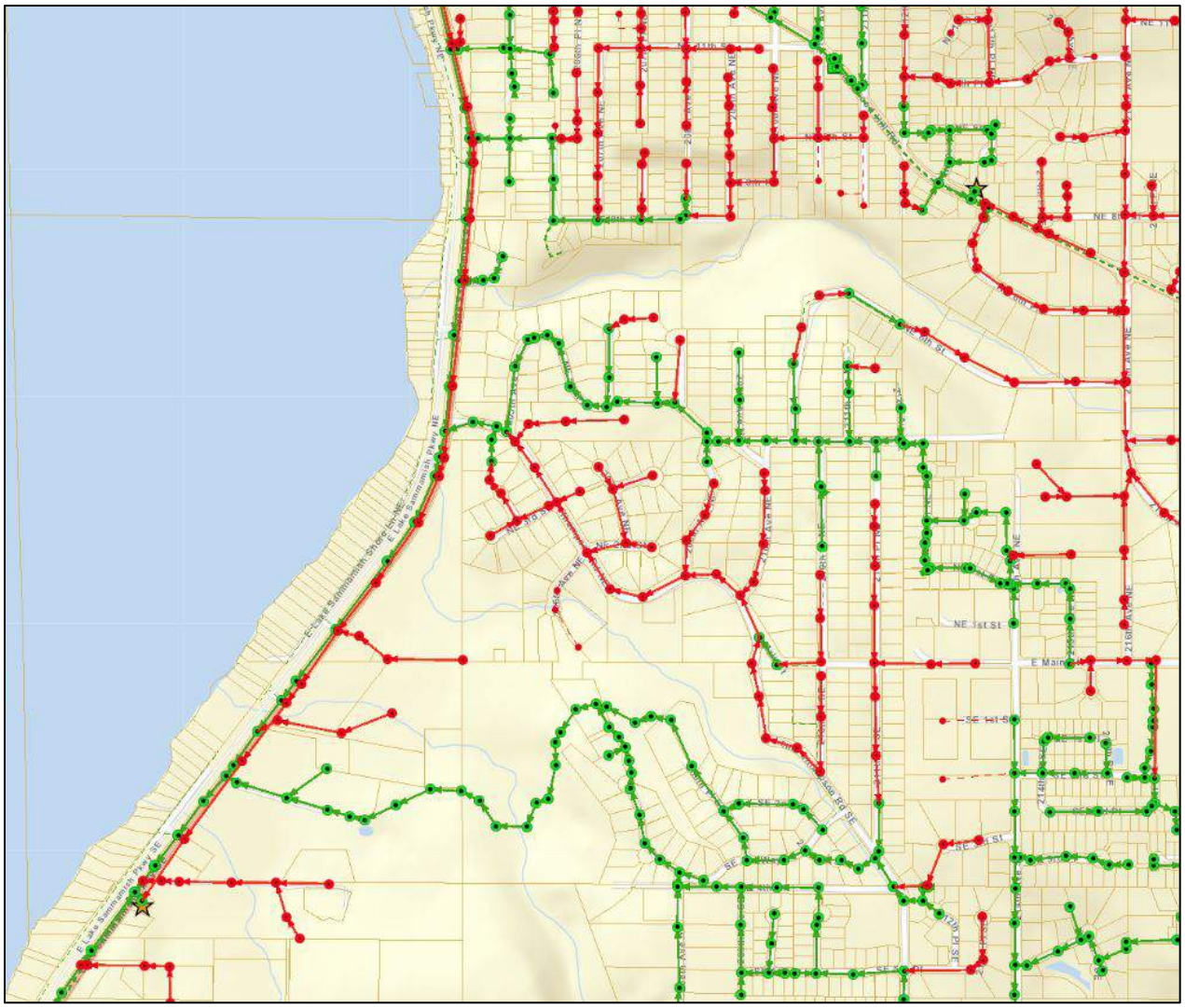

Figure 5-17. Sewer Map in Vicinity of Zackuse Basin Showing Current Sewer LInes (green lines) and Potential Future Sewer LInes (red lines) (Map provided by Sammamish Plateau Water and Sewer District 2019)

6 Surface Water Issues

Surface water issues in the Zackuse Basin were identified in the following ways:

- Community input during public meetings, surveys, and direct contact with City staff
- Observations made during stream walks and site visits
- Input from City maintenance staff

Corroborating evidence of surface water issues was obtained from hydrologic and hydraulic modeling (i.e., predictions of flood locations) and through a review of historical documentation, including photographs and design plans, and comparison of that information to current conditions. This section summarizes the types and locations of issues in the basin. Figure 6-1 shows the types and locations issues in the basin.

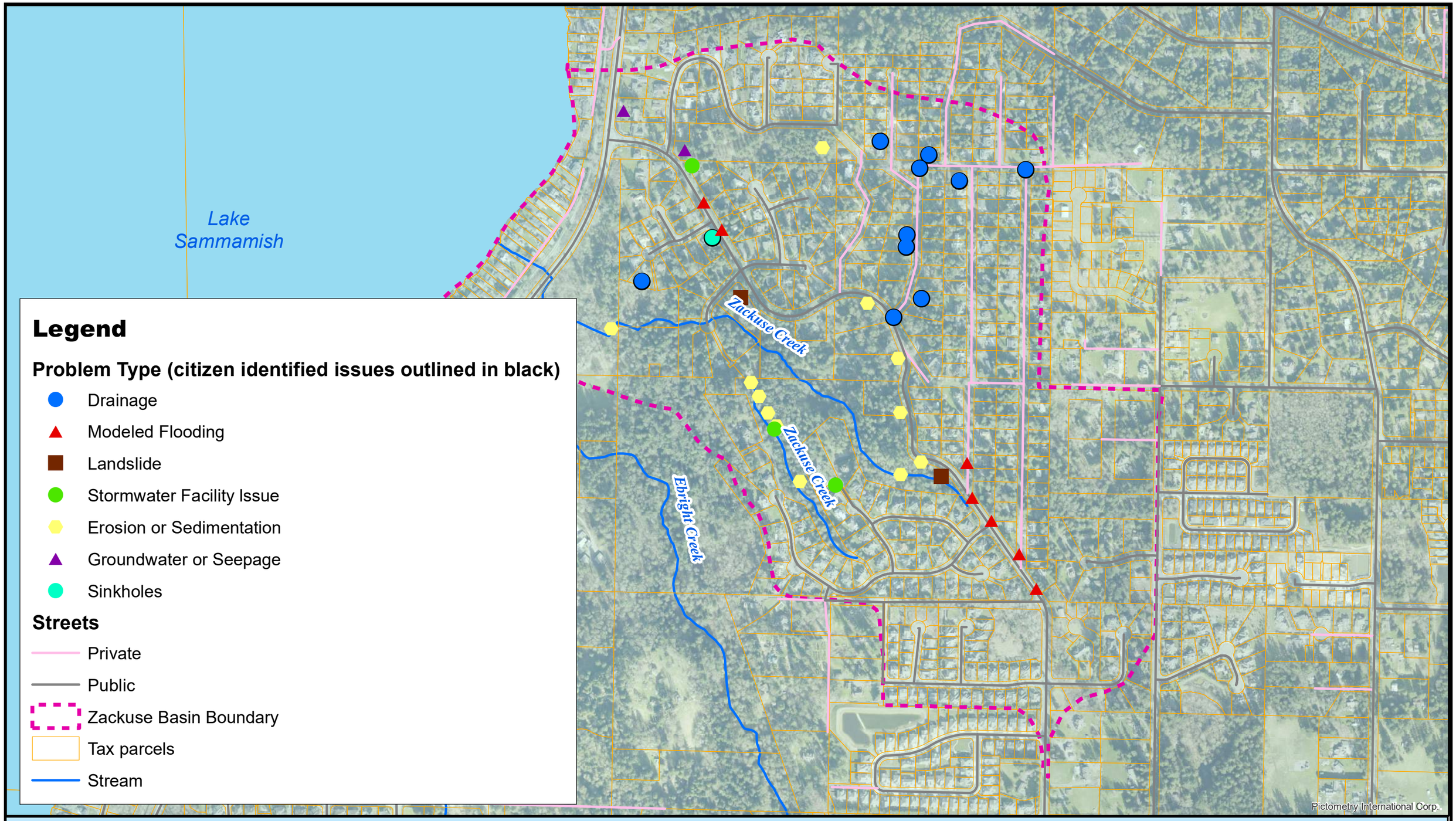

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Figure 6-1. Zackuse Basin Reported and Field-identified Problems

0 0.025 0.05 0.1 0.15 0.2
Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

6.1 Drainage and Flooding

Drainage and flooding issues were identified primarily from citizen and City input, as well as through predictive modeling, inasmuch as it is difficult to observe these issues first-hand during the limited timeframe allowed by this plan. Drainage issues, for the purpose of this plan, are defined as surface water, or groundwater expressed as surface water (i.e., seepage), that may cause safety problems or property damage by its very presence. Flooding is generally more severe than drainage issues, and for the purpose of this plan, refers to overflow conditions in roadside conveyances.

6.1.1 Tamarack Neighborhood Drainage

Zackuse Basin residents and property owners, through both the online and paper surveys, provided many comments regarding drainage issues experienced in the Tamarack neighborhood, a privately owned and maintained neighborhood in the Zackuse Basin. Example comments included:

- "Flooding and erosion in ditches conveying stormwater from up the hill (NE 4th). Debris on road from eroded ditch, water on road freezes during winter, and water that proceeds downhill continues eroding unhardened features in its path."
- "House and driveway has flooded causing extensive damage as a result of water running down 210th Ave. NE."
- "Flooding at 210th Ave NE and Louis Thompson Rd."
- "Seepage (NE 4th and 211th)"

Evidence of Tamarack drainage problems was observed in the form of ditch erosion on NE 4th Street, which is a very steep, private road sloping to the west that makes a sharp left turn onto 209th Avenue NE mid-slope. Numerous complaints have been received by City staff about this condition. Conveyance infrastructure on NE 4th Street consists of ditches and driveway culverts. The ditches are lined with large rocks that, according to homeowners, are replaced regularly because of erosion during high flows. Although the natural slope gradient is to the west, the road and ditch infrastructure turns south at 209th Avenue NE. During high flows, it is difficult for the water to be contained in the ditch when gravitational forces are pushing it to the west along a steeper and straighter path.

6.1.2 Groundwater Seepage and Sinkholes

Zackuse Basin residents reported that groundwater seepage was a concern in several locations in the Tamarack neighborhood. Residents reported wet backyards and year-round flow in ditches. Field observations of surface flow in Tamarack neighborhood ditches during periods of dry weather corroborated the assertion that groundwater seepage does contribute to surface flow in ditches. Additionally, groundwater seepage was observed to be prevalent on hill slopes adjacent to Zackuse Creek during stream walks in both January and March 2018. The locations and elevations of groundwater seeps will vary depending on how much rain falls and infiltrates into the ground and at what time the ground becomes so saturated that water "seeps" out.

Groundwater seepage can be problematic for City infrastructure on roads where water flows year-round and can cause slick and unsafe conditions for drivers or pedestrians due to the presence of vegetation (e.g., algae) during warmer weather or ice when temperatures drop. One such location on E Lake Sammamish Parkway, north of the intersection with Louis Thompson Road NE, was identified by City staff and a resident.

Subsurface groundwater flow can cause voids, which can result in sinkholes or depressions at the ground surface as the ground caves in. A resident in the Eden Glen neighborhood noted ongoing problems with sinkholes on her property near Louis Thompson Road NE. The resident has repaired the sinkholes and within a few years, they appeared again. This property is located in an area of highly infiltrative geologic material, and it is possible that subsurface flow is causing this condition. The conveyance ditch on Louis Thompson Road NE also reportedly loses flow at approximately the same elevation (i.e., water is in the ditch above this elevation and dry below), indicating that water is infiltrating into the ground.

6.1.3 Louis Thompson Road NE Flooding

The Louis Thompson Road NE hydraulic modeling indicated several locations where flooding is predicted to occur in the ditch and culvert system during the 25- and/or 100-year flood events. As discussed in Section 5.5.2 and shown on Figure 5-9, the ditch and culvert system on Louis Thompson Road NE is predicted to be over capacity at higher flows, leading to flooding. During a landslide repair project completed in December 2018 stormwater improvements were made that may alleviate ditch capacity issues on the upper portion of Louis Thompson Road. Installation of new conveyance and birdcage structures captures and conveys stormwater away from Louis Thompson Road in the vicinity of 210th Pl SE and 211th Pl SE. Additionally, conveyance systems on side streets north of Louis Thompson Road NE, including 210th Place SE and 211th Place SE, are unable to convey higher flows and experience flooding. City staff and Tamarack neighborhood residents have reported flooding at the intersection of 210th Avenue NE and Louis Thompson Road NE on many occasions, and City maintenance staff conduct extra spot checks to ensure the culverts are not clogged at this intersection to allow water to be conveyed safely into the Louis Thompson Road NE drainage system.

6.1.4 East Montage Vault

City maintenance staff described how the East Montage vault orifice used to become clogged with sediment. This situation resulted in the inability of stormwater to be released from the vault. Instead, water would back up into the connected catch basin and discharge from the top of the catch basin, overflowing onto the road, resulting in erosion and causing untreated water to be discharged overland. Flooding at the vault location occurred on at least one or two occasions before maintenance staff installed a new bypass catch basin to bypass high flows around the vault, which means that high flows now bypass the vault undetained and untreated.

6.2 Erosion

The locations and extent of erosion issues discussed here are in the context of basin problems and their association with surface and stormwater runoff. Erosion is a natural process, and some erosion is necessary to maintain sediment supplies in salmon spawning streams, such as Zackuse Creek. The types of erosion that occur in the basin are hill slope erosion (i.e., landslides and hill slope failures); channel erosion, as was observed during stream walks and is described in Section 5.4; and outfall erosion (from stormwater discharged on top of slopes).

Nearly all the issues described below result in sediment that 1) has either been transported and deposited in downstream locations within Zackuse Creek or Lake Sammamish, 2) is currently stored in Zackuse Creek and could be mobilized and transported in the future, or 3) is part of an ongoing process that will continue to supply sediment to Zackuse Creek.

6.2.1 Landslides

Two relatively large landslides are located on the north side of Zackuse Creek, adjacent and downslope of Louis Thompson Road NE. One slide is located near the headwaters of the creek between 211th Pl SE and 210th Pl SE and occurred in November 2015. It was reportedly caused by surface water discharging over the top of the slope after a culvert became clogged. This slide is being repaired in the fall of 2018 through the installation of a new soldier pile wall to stabilize the road embankment, with bioengineered stabilization on the slope between the base of the wall and Zackuse Creek. New drainage facilities are being installed to discharge stormwater upstream of the slide area and to reduce the likelihood of culverts clogging.

The other large slide is located northeast of 206th Avenue NE, between Louis Thompson Road NE and Zackuse Creek. The slide occurred in March 2017 and blocked the stream channel with debris. The stream channel has since cut through the debris, creating a bench of sediment through the slide area. This sediment is temporarily stored in the bench but will likely continue to be mobilized and deposited downstream during high flow events. A detailed assessment of the slope failure was not conducted, however, factors that often result in such slope failure include topographic and geologic conditions (i.e., steep slopes and geologic units prone to erosion and hillslope failures), and saturated soil conditions. The topography in the vicinity of the slide is steep (over 40%) and the mapped surface geology is recessional outwash (gravelly deposits that are infiltrate well and erode) that is likely juxtaposed over less pervious material, such as glacial till or pre-Fraser fine grained deposits. Soil saturation would occur in the recessional outwash deposits following periods of precipitation, where the rate of precipitation exceeds the rate of infiltration in the less pervious unit below. Slope failures tend to occur when the weight of the soil and the water in the saturated material becomes too heavy to maintain its natural position on the slope.

What causes landslides?

Many factors can contribute to landslides, including:

- *Steep slopes*
- *Favorable geologic conditions (loose, erodible soil)*
- *Saturated soil*
- *Earth movement (earthquakes)*
- *Removal of stabilizing Vegetation*

Zackuse Basin landslides likely result from a combination of the one or more of first three bullets.

6.2.2 Channel Erosion

Channel erosion, primarily in the form of downcutting, is occurring at several locations within the Zackuse mainstem and in the south tributary. In the Zackuse mainstem, downcutting was observed near the transition from the steep headwaters to the wetland area in the upper middle reach and in the lower reach upstream of the channel realignment and restoration project associated with E Lake Sammamish culvert replacement. The lower reach downcutting has occurred over a 6-year timeframe through thick deposits of sediment that were likely deposited from upstream landslide sources. Historical documentation of Zackuse Creek in this lower reach, combined with field evidence of former channels indicates that Zackuse Creek routinely migrates back and forth across the floodplain and may at times occupy multiple braided threads concurrently.

Downcutting and subsequent sedimentation is active in the south tributary. Sediment removed from within the channel and deposited downstream in flatter reaches has the potential to be remobilized during high flows and transported further downstream. Currently, the south tributary enters a pipe at

the end of its open channel section through an overflow birdcage near a private residence. This structure was designed with an inlet pipe and trash rack in a depression that has been filled in with sediment from upstream. Now water flows over the structure, rather into the base through a pipe as it was designed (Section 5.4). This structure could fail if it were to become clogged.

As discussed in Section 5.6.1, stormwater treatment (i.e., flow control and/or water quality treatment) in the Zackuse Basin is mostly non-existent or undersized according to today's standards. Stormwater regulations have evolved as research supporting better stormwater management techniques has been completed. Today, stormwater regulations are designed to protect small stream channels, such as Zackuse Creek, from erosion by detaining flows that match pre-development peak flows and durations. When the Montage development was constructed, stormwater facilities were mostly designed to prevent flooding. Undersized flow control facilities (by today's standards) and the lack of flow control facilities for some developments could be the primary reasons why erosion is occurring in the south tributary and Zackuse mainstem.

6.2.3 Outfall Erosion

Erosion that occurs in other locations is directly related to stormwater runoff, inasmuch as it is occurring immediately downslope of outfalls. Severe erosion is occurring at two outfalls (Outfall Nos. 04 and 01) on the downslope (south) side of Louis Thompson Road NE when water is discharged at these locations. At Outfall No. 04, City staff have tried to harden the slope with large rocks, logs, and debris to prevent further erosion from occurring, but this has not been effective. At Outfall No. 01, a very large headcut has formed approximately 100 feet downslope of the road, and a deep chasm has been excavated all the way to Zackuse Creek (see Photos 10 and 11, Appendix B). The chasm is approximately 10 ft wide and 15 ft deep and could get larger as the slopes are over-steepened, cave in, and then water removes the material below. Modeling results indicate that velocities at these outfalls exceed the maximum velocities specified for maintaining slope protection.

Stormwater is discharged into the Tamarack Ravine from an outlet structure, installed in 2007/2008, that bubbles over at the head of the ravine. The stormwater discharged to this location has created a new channel that was not present in 2007. This development shows both the power of water and the need to be thoughtful about discharge locations and the potential consequences.

6.3 Water Quality

There is no quantitative water quality data available for Zackuse Creek; however, water quality samples have been collected at Lake Sammamish near the creek mouth and have not exceeded water quality standards for the parameters that have been analyzed (Ecology 2018). Most urban and suburban streams have degraded water quality due to the input of pollutants from stormwater runoff, modified flow conditions (i.e., higher flows in the winter, lower flows in the summer), and land conversion from forest to residential development. The types of problems that are typical of urban streams are high temperatures, low DO, and excessive fecal coliform. Zackuse Creek has significant groundwater input, which is a benefit for keeping the water cold and flow rates more consistent year-round. As discussed above, there are still many homes in the basin that are on septic systems, and if not functioning properly, these systems could contribute pollutants to the stream. Without water quality monitoring data, it is impossible to accurately assess the actual water quality conditions.

6.4 Habitat Components

Several of the issues described above influence habitat for kokanee and other fish in Zackuse Creek, in both positive and negative ways. Basin issues in this section are described in the context of fish habitat and use.

6.4.1 Fish Access

The 206th Avenue NE road crossing presents a partial or full barrier to fish passage into the upper basins. The lowermost reaches below 206th Avenue NE with comparatively higher flows and lower gradients will be most important for providing and maintaining access to and for fish in Zackuse Creek because this is where most of the fish use will occur. The upper reaches offer less habitat because there are fewer pools, steeper gradients, and higher-velocity flows.

6.4.2 Water Quality and Quantity

The quantity and quality of water in Zackuse Creek is important to the fish species that use the stream during their life histories. Kokanee use the stream only for spawning and egg incubation, from approximately November through May; they do not rear to any extent in stream habitats and are not present in streams over the summer. Clean well-oxygenated water that is relatively free of fine sediment (i.e., silt and sand) is needed during the winter incubation period. Flows also need to be moderated and slopes stabilized to avoid excessive scour or deposition, which would sweep away or bury and suffocate, respectively, incubating eggs. Groundwater inputs in Zackuse Creek contribute to clean, well-oxygenated water. However, sediment input, including fine sediment, could limit the viability of salmon eggs deposited in spawning gravels. Additionally, high peak flows, partially due to stormwater inputs during the winter months, could also result in scour, sweeping away incubating kokanee eggs. Coho and cutthroat spend more time in the stream as fry and adults and therefore are affected by seasonal low-flow issues, although there is no indication that low stream flows are a habitat limiting factor in Zackuse Creek. Flow data has not been collected on Zackuse Creek, however, field evidence suggests that groundwater provides a consistent year-round base flow to the lower reaches of the channel, and extreme winter flows can be destructive to the point of causing channel migration.

6.4.3 Spawning Habitat

Clean gravel of the right gradation (e.g., small-to-medium-sized gravel for the fish species present in Zackuse Creek) is necessary for spawning. Landslides and channel erosion can be beneficial because they supply gravel to the stream channel, which is then transported during high flows and deposited in lower-gradient reaches. This process is important for maintaining spawning gravel quality in Zackuse Creek. However, landslide activity can also have negative impacts on salmon spawning. Landsliding on adjacent Ebright Creek is thought to be responsible for essentially wiping out an entire year class of incubating kokanee due to suffocation by fine sediment.

6.4.4 Pools and Cover

Pools with wood cover are used extensively by rearing coho and cutthroat trout, as well as by spawning adults, for holding (i.e., waiting to spawn) and protection to escape from predators. Pools are formed as a result of roughness from large wood or rocks that create variable velocities and scour deeper sections within a channel cross section. Some areas of Zackuse Creek, such as the middle section of the mainstem have many debris jams and a significant amount of wood; others areas, such as the south

tributary and the upper mainstem reach are almost devoid of wood and/or pools. However, there is opportunity for wood recruitment in the channel from the surrounding riparian forest.

7 Basin Plan Actions

Projects and strategies were developed to address issues identified in the basin; some address multiple issues and/or community concerns, and others focus on a single problem. This section describes the projects and strategies that were identified and the criteria used to rank and determine which projects would be further refined into conceptual designs and planning-level cost estimates for CIPs. Table 7-1 lists the projects and strategies identified. CIPs are listed in order of ranking score; Zack-CIP-1 through Zack-CIP-4 are actions to be advanced to the City's capital improvement program.

Table 7-1. Identified Projects and Strategies

Project Identification (CIPs are listed by ranking score)	Ranked Score (out of 100 points) Only capital projects were ranked	Project	Location	Issues Addressed							
				Drainage	Maintenance	Community Concerns	Future Development	Safety	Habitat	Erosion	Water Quality
Zack-CIP-1	55	Retrofit West Montage Neighborhood	West Montage neighborhood		✓				✓	✓	✓
Zack-CIP-2	40	Reduce sheet flow on Louis Thompson at 210th Ave NE	210th Avenue NE and Louis Thompson Road NE	✓	✓	✓		✓			
Zack-CIP-3	65	Louis Thompson Road tightline	Louis Thompson Road NE	✓	✓		✓	✓		✓	✓
Zack-CIP-4	35	Intercept groundwater seepage on East Lake Sammamish Parkway	Louis Thompson Road NE and E Lake Sammamish Parkway		✓	✓		✓			
Zack-CIP-5	35	Upsize culverts to increase capacity on 210th Place SE and 211th Place SE near intersection with Louis Thompson Road	210th Place SE and 211th Place SE	✓	✓						
Zack-CIP-6	30	Uncover CB (catch basin) under fog line and reset vertical alignment of outfall pipe	Louis Thompson Road NE near top of basin at Outfall 4		✓			✓	✓	✓	
Zack-CIP-7	30	Provide new flow control/water quality facility	Louis Thompson Road NE near 210th Avenue NE						✓	✓	✓
Zack-CIP-8	20	Engineered channel realignment	Zackuse Creek near the dogleg						✓		
Zack-CIP-9	20	Address flooding at Zackuse headwater wetland	212th Avenue SE	✓	✓			✓			

Project Identification (CIPs are listed by ranking score)	Ranked Score (out of 100 points) Only capital projects were ranked	Project	Location	Issues Addressed							
				Drainage	Maintenance	Community Concerns	Future Development	Safety	Habitat	Erosion	Water Quality
Zack-CIP-10	10	206th Ave culvert replacement	206th Avenue NE Neighborhood						✓		
Zack-Hab-1	Not ranked	In-stream and habitat improvements near Zackuse mouth and Shore Lane	Mouth near Shore Lane						✓		
Zack-Hab-2	Not ranked	In-stream and habitat improvements near Zackuse dog-leg in realignment reach	Near channel dogleg						✓		
Zack-Oper-1	Not ranked	Continue periodic culvert and ditch cleaning on Louis Thompson Road NE	Louis Thompson Road NE	✓	✓						
Zack-Oper-2	Not ranked	Uncover buried catch basins at intersection of Louis Thompson Road NE and East Lake Sammamish Parkway	Louis Thompson Road NE and E Lake Sammamish Parkway		✓						
Zack-Oper-3	Not ranked	CCTV and clean pipes in East Montage Neighborhood	East Montage neighborhood		✓					✓	✓
Zack-Pol-1	Not ranked	Include Zackuse corridor in long-term property acquisition plan	206th Avenue NE Neighborhood						✓		
Zack-WQ-1	Not ranked	Remove trash in Zackuse Creek	Zackuse Creek headwaters			✓			✓		✓
Zack-WQ-2	Not ranked	Implement water quality monitoring in Zackuse Basin	Zackuse Creek			✓					✓

Project Identification (CIPs are listed by ranking score)	Ranked Score (out of 100 points) Only capital projects were ranked	Project	Location	Issues Addressed							
				Drainage	Maintenance	Community Concerns	Future Development	Safety	Habitat	Erosion	Water Quality
Zack-WQ-3	Not ranked	Identify strategies for using water quality data to implement Stormwater Comprehensive Plan Action G.5.1.B Stormwater Opportunity Fund and G.1.2.A Stormwater Retrofit Strategy in Zackuse Basin	Zackuse Basin and City			✓					✓
City-Pol-1	Not ranked	Develop stormwater recommendations to address impacts of climate change	City-wide	✓	✓		✓	✓			
City-Prog-1	Not ranked	Improve City maps and public accessibility	City-wide			✓					

7.1 Project Ranking Criteria

Ranking criteria were developed for surface water capital projects in conjunction with the Zackuse Basin Plan but through an independent City process that included approval by the Sammamish City Council by adoption of resolution R2018-804. The purpose of developing ranking criteria and ranking methods was to establish a rational, objective, consistent, and transparent approach for ranking potential stormwater CIPs based on City priorities. The ranking method quantified the benefits of doing a project on a numerical point scale so that the total benefit of a project could be compared with other City projects. The criteria were developed by conducting a review of how other jurisdictions rank stormwater CIPs and using the results of community outreach efforts conducted for this plan and input from the broader Sammamish Community. An online survey of all City residents was conducted to inform the ranking process; over 100 responses were received. The criteria that were determined to be the most important to citizens were weighted more heavily in the ranking method. The criteria were ranked as follows:

1. Environmental benefit (30 points possible)
2. Facilities and maintenance (25 points possible)
3. Safety (25 points possible)
4. Population benefitted (10 points possible)
5. Time-sensitive opportunity (10 points possible)

Each project could earn a total of 100 points. A description of how the criteria were applied to each project is provided below.

7.1.1 Environmental Benefit

The environmental benefit of a project was estimated based on the project's ability to protect, restore, or improve natural watershed function(s). The matrix presented as Figure 7-1 shows how many points were assigned to a project based on its size and the number of watershed functions (i.e., habitat, water quality, hydrology) protected, restored, or improved. A maximum of 30 points were possible.

	Number of Watershed Functions		
	1 Function	**2 Functions**	**3+ Functions**
Large Area *(500 linear feet or greater, or 2,000 square feet or greater)*	**15**	**25**	**30**
Small Area *(Less than 500 linear feet, or less than 2,000 square feet)*	**10**	**20**	**25**

Figure 7-1. Environmental Benefit Points Matrix

7.1.2 Facilities and Maintenance

The facilities and maintenance criterion applied if the project included the building or retrofitting of stormwater facilities *and/or* addressed maintenance needs at existing facilities. The following points were possible for facilities, based on whether the facility would be built or retrofit to address one or more current or projected impacts of growth or climate change, including (1) conveyance, (2) stormwater volume, (3) water quality, (4) erosion, and (5) natural resource protections.

- 15 points if 3 or more impacts were addressed
- 10 points if 2 impacts were addressed
- 5 points if 1 impact was addressed
- No points if no impacts were addressed

Additional or separate points were awarded, if maintenance of existing facilities provided a long-term, cost-saving solution to an ongoing problem, the following points were possible:

- 10 points if the problem was permanently resolved
- 5 points if a minor maintenance issue was resolved
- 5 points if costs were reduced
- 0 points if there was no change

7.1.3 Safety

Safety was an important factor for Sammamish residents. How well a project addressed safety depended on the nature of the problem and how frequent it occurs. Severe safety impacts with very frequent occurrences earned the maximum number of points, whereas minor safety problems that occur infrequently earned no points. Figure 7-2 presents a matrix that shows safety impact vs. frequency and the number of points assigned, based on priority.

SAFETY RISK ASSESSMENT	Safety Impact		
Drainage Issue Frequency	Minor	Moderate	Major
Already Occurring, with Annual Frequency	10	20	25
Has Occurred Periodically in Last 5 Years	5	15	20
Almost Certain to Occur within Next 5 Years	5	10	15
Unlikely to Occur Within the Next 5 Years	0	5	15

Figure 7-2. Safety Impact Points Matrix

7.1.4 Population Benefitted

Projects that benefitted more people received more points than those that benefitted fewer people. However, this criterion was weighted as being less important, and thus only 10 points were possible. Figure 7-3 shows how this criterion was applied based on the number of residents that benefitted from a project.

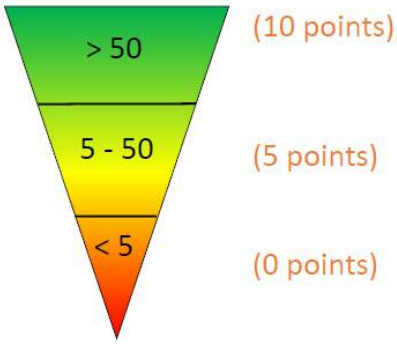

Figure 7-3. Population Benefitted Points Diagram

7.1.5 Time-Sensitive Opportunity

The time-sensitive opportunity criterion was created to give weight to outside factors that might allow projects to leverage resources by taking advantage of opportunities that might otherwise not exist. These are projects that might not happen if not for the opportunity, such as unexpected grant funding or availability of land that could be beneficial to achieving City stormwater management goals. Ten points maximum were available for this criterion, as follows:

- 10 points if the project might not happen without this opportunity
- 5 points if there was an option to leverage a moderate amount of funding or a take advantage of a partnering opportunity
- Zero points if there was no link to other opportunities, and City needed to fund the project entirely

7.2 Public vs. Private Projects

As described in Section 6.1.1, there were several drainage issues reported in the Tamarack neighborhood. Nearly all roads in Tamarack are private; drainage facilities (i.e., ditches and pipes) that convey runoff from the neighborhood and maintenance of the drainage facilities and private roads is the responsibility of the neighborhood. No projects for the Tamarack neighborhood are included in the Zackuse Basin Plan because of the City's potential liability with implementing projects on private property that don't have a clear public nexus. A technical memorandum was prepared that describes a potential project that could be implemented in the Tamarack neighborhood as a solution to ongoing drainage issues. The technical memorandum is provided in Appendix D.

7.3 Ranked Capital Improvement Projects

Four of the ten CIPs listed in Table 7-1 are actions for inclusion in the City's capital improvement program. These projects represent the four projects that ranked the highest when scored according to the ranking methodology described in Section 7.1. The project ranking spreadsheet for the entire list of CIPs is provided in Appendix E. The four ranked projects represent an assortment of large and small

projects that address existing drainage problems and community safety concerns and will support improvements in water quality and habitat in Zackuse Creek. The solutions developed to address existing drainage problems focused on techniques that would not exacerbate or potentially cause additional problems. For instance, low impact development (LID) infiltrative stormwater retrofit alternatives are not proposed to address drainage problems because of known basin issues with groundwater seepage and landslides. Infiltrative techniques could cause additional slope problems with the addition of more water into the ground. Projects are also designed so that they can be implemented independent of one another in no defined order. Details of these CIPs are provided in Appendix F and include descriptions of the projects, conceptual schematic diagrams, and planning-level cost estimates. Table 7-2 presents the projects and planning-level cost estimates.

How were CIP solutions selected?

For many of the drainage issues identified, there is more than one solution to the problem. In general, the least intrusive, cost effective solution was put forward in this plan. For instance, a capital project was originally identified for the East Montage Vault, but a maintenance project (Zack-Oper-3) was put forward instead because maintenance might solve the problem. For other issues, the capital improvement project identified in the plan may change during design if an alternative that provides equivalent function is determined to be a better choice (i.e., vaults could become detention ponds or other flow control/water quality facilities, if appropriate).

Table 7-2. Capital Improvement Projects and Planning-Level Cost Estimates

Identification Number	Project	Planning-Level Cost Estimate (rounded to nearest $10K)
Zack-CIP-1	West Montage stormwater retrofit	$3.9M
Zack-CIP-2	Sheet flow on Louis Thompson at 210th Ave NE	$80K
Zack-CIP-3	Louis Thompson Road NE tightline	$4.2M – $7.6M
Zack-CIP-4	Intercept groundwater seepage on East Lake Sammamish Parkway	$120K
	TOTAL	$8.3M - $11.7M

7.3.1 West Montage Stormwater Retrofit (Zack-CIP-1)

The purpose of this project is to provide additional flow control in the Montage neighborhood to reduce erosion in the south tributary. The project involves the construction of a new flow control vault and a flow splitter to divert flows from the headwaters to the new vault. During project development, it was determined that maintenance personnel have difficulty accessing the birdcage structure at the headwaters of this south tributary, so improved maintenance access was added to the project. Maintenance activities would not reduce flows and erosive forces on the stream channel in the south tributary, therefore, maintenance was not considered as an option for resolving flow control problems. This project indirectly supports kokanee restoration efforts in the lower reach by addressing high flows that result in erosion and excessive sediment supply and transport. Water quality treatment could be added to this project, in addition to the sediment reduction component.

7.3.2 Drainage Improvements at Louis Thompson Road and 210th Ave NE (Zack-CIP-2)

Roadway runoff from 210th Avenue NE sheet flows down the steep hill and overtops Louis Thompson Road NE, instead of being properly conveyed in the existing ditch and culvert system along 210th Avenue NE. This situation results in a safety concern due to water flowing over the roadway, especially in freezing temperatures, and causes erosion on the downstream side of the road.

This project involves the construction of a berm across 210th Ave NE within the Louis Thompson Road NE right of way to capture sheet flow runoff and convey it to the Louis Thompson Road NE ditch and culvert system. Additionally, two new catch basins and a storm drainage pipe are included at the intersection of Louis Thompson Road NE. The project is designed to capture the sheet flow and convey it to the Louis Thompson Road NE, improving safety at the intersection of these two roads and reducing maintenance on Louis Thompson Road NE. Continuing maintenance on Louis Thompson Road NE is an alternative to constructing this project. The project summary sheet provides an estimate of maintenance costs.

7.3.3 Louis Thompson Road NE Tightline (Zack-CIP-3)

The Louis Thompson Road NE tightline project proposes to upgrade the existing ditch and culvert system on Louis Thompson Road NE to a tightline system that includes an 18-inch storm sewer pipe on Louis Thompson Road with stub-outs to collect stormwater from side streets. This project would address 25- and 100-year modeled flooding on Louis Thompson Road, reduce high velocities and erosion from

outfalls to Zackuse Creek, reduce flooding in the Tamarack neighborhood, and mitigate stormwater impacts from future in-fill development. Water quality treatment will be part of the project design. Additionally, estimated costs for non-motorized improvements such as sidewalks, and curbs and gutters are provided. Two different project alternatives were evaluated; a short option that extends from 210th Avenue NE to the infiltration facility east of East Lake Sammamish Parkway near the intersection of 205th Ave NE and Louis Thompson Road NE, and a long option that extends from 210th Place SE to the infiltration facility.

7.3.4 Address Groundwater Seepage at E Lake Sammamish Parkway (Zack-CIP-4)

A catch basin collection and conveyance system is proposed on the east side of E Lake Sammamish Parkway to intercept groundwater seepage from an adjacent retaining wall. The conveyance system will direct the flow to the south to an outfall that crosses under E Lake Sammamish Parkway at Louis Thompson Road NE. This project will improve road safety by directing flow away from the road and driving surface, however, it will not stop the ongoing groundwater seepage. It will also reduce potential mobilization of roadway pollutants by minimizing contact with water.

7.4 Programmatic Projects and Strategies

In addition to CIPs, several other types of programmatic projects and strategies were identified to improve drainage, water quality, or habitat in the Zackuse Basin or improve the City stormwater management program to address community concerns or future needs. These were organized into several categories: operational projects, habitat projects, water quality projects, policy projects, and City-wide projects. Each is briefly summarized below; detailed summary sheets are provided in Appendix F. The locations of the capital and programmatic projects are shown in Figure 7-4.

7.4.1 Habitat Projects

Two in-stream and habitat improvement projects are included in this plan: Zack-Hab-1 and Zack-Hab-2. Zack-Hab-1 will enhance stream conditions between the mouth of the Zackuse Creek and E Lake Sammamish Shore Lane, and Zack-Hab-2 will enhance conditions near the dogleg, upstream of the channel realignment and restoration project just completed. The stream channel flows between residential properties between the mouth of the creek and Shore Lane and is confined to a relatively straight, narrow corridor that lacks diversity in riparian vegetation and stream channel roughness. There is room for habitat improvement in this reach, which will benefit kokanee salmon and other salmonids. Zack-Hab-1 improvements could include vegetation enhancements, in-channel modifications, or shorter culvert sections, with the active participation and involvement of property owners. Improvements associated with Zack-Hab-2 could include adding large woody debris to provide structure; removing invasive vegetation; and adding extensive plantings of native, woody shrubs such as willows. The purpose of this project is to extend creek improvements upstream from the recently completed stream channel realignment and restoration project and to preempt potential channel migration, that could move the stream away from the newly restored area.

7.4.2 Operational Projects

Three operational projects are included in this plan: Zack-Oper-1, Zack-Oper-2, and Zack-Oper-3. Zack-Oper-1 and Zack-Oper-2 focus on achieving improved functionality from the existing drainage system on Louis Thompson Road NE, and Zack-Oper-3 focuses on improvements in the East Montage stormwater vault. Zack-Oper-1 involves continuing periodic maintenance of the ditches and culverts on Louis Thompson Road NE to ensure they are free and clear of debris and sediment in order to convey water

efficiently. Zack-Oper-2 involves uncovering catch basins that were inadvertently paved over on Louis Thompson Road NE near E Lake Sammamish Parkway, rendering them inaccessible for inspection and cleaning.

The East Montage vault was an ongoing maintenance issue for City staff and prompted the City to retrofit a bypass catch basin in the fall of 2017 at the vault to bypass high flows around the vault. Prior to the retrofit, sediment routinely clogged the vault orifice, resulting in overflows. Since the catch basin modification was implemented, overflows have been avoided, but high flows are bypassing the vault undetained, essentially reducing the functionality of the vault.

Operational project Zack-Oper-3 is designed to be conducted in phases to 1) determine the source of sediment that was responsible for clogging the orifice of the vault, 2) take action to minimize sediment delivery to the vault based on the results of sediment source tracing, and 3) restored vault functionality to detain high flows.

The drainage system upstream of the East Montage vault consists of curbs, gutters, and pipes. There are no open ditches and, therefore, no obvious sources of sediment to be eroded and deposited in the vault. The road network is paved, and residential lots in the neighborhood are landscaped with well-kept lawns and vegetation and no bare ground. Without an obvious surface source of sediment, a possible source could be broken stormwater pipes and subsurface erosion. This project proposes to use closed circuit television (CCTV) cameras to evaluate the buried pipes to determine their condition and whether there are breaks or sources of sediment entering from underground. If failures are identified, those pipes should be repaired or replaced. If pipes are in good condition, maintenance strategies should be modified to include one of the following:

- Installation of Type II catch basins to replace existing Type I catch basins, so that more sediment can be collected upstream in deeper sumps associated with the Type II catch basins
- Increased frequency of maintenance at the vault

This project will address the sedimentation issue through maintenance actions and ultimately return the vault to its original function.

7.4.3 Policy Projects

One policy project is included in this plan: Zack-Pol-1. This project involves taking a forward-looking approach toward comprehensive property acquisition, restoration, and management of resources in the basin, with a focus on the 206th Avenue NE corridor. The City recently completed a stream channel restoration project and culvert replacement on Zackuse Creek at E Lake Sammamish Parkway. The only other partial fish barrier on the stream is 206th Avenue NE. The remaining stream corridor on the Zackuse mainstem and the south tributary is set aside as tract land that will not be developed. A long-term approach to this corridor could include property acquisition and the potential daylighting of the south tributary in the location where it is currently piped. Upstream capital projects, such as Zack-CIP-1, that provide greater flow control would be key to the long-term success of a better functioning corridor for fish and wildlife.

7.4.4 Water Quality Projects

Three water quality projects are included in this plan: Zack-WQ-1, Zack-WQ-2, and Zack-WQ-3. Zack-WQ-1 involves the removal of trash and debris from the stream channel near the headwaters of Zackuse

Creek. This project will entail hiring contractors or using City staff and equipment because the scope of the trash removal is beyond that which could be accomplished by volunteer crews. The location of the stream channel next to Louis Thompson Road NE has made the channel an easy "dumping ground" over the past many decades, and the debris accumulated in the channel consists of large car parts, equipment, and potentially hazardous materials. It is also located at the base of a very steep embankment.

Zack-WQ-2 involves implementing the City's water quality monitoring program in the Zackuse Basin to establish baseline water quality conditions, monitor changes, and take action if conditions worsen. This project was approved by City Council in 2018 as part of the Surface Water Quality and Riparian Habitat Monitoring Plan. Zack-WQ-3 involves using the water quality data collected in Zack-WQ-2 to develop targeted water quality strategies, depending on the results of the monitoring. Strategies will include implementation of actions identified in the City's *Storm and Surface Water Management Comprehensive Plan* (City of Sammamish 2016), such as:

- ***Action G.5.1.B Stormwater Opportunity Fund***, provides City projects funds to add water quality treatment where it would otherwise not be required.
- ***Action G.1.2.A Stormwater Retrofit Strategy and Implementation***, provides funds for designing and constructing small retrofit projects.

7.4.5 City-Wide Projects

Two City-wide strategies are identified: City-Pol-1, and City-Prog-1. City-Pol-1 involves the development of stormwater strategies, policies, and codes to address the effects of climate change. King County is developing a new climate change hydrology model. The City should evaluate adoption of the model when it is finalized. Until then, the City should consider temporarily using the 100-year conveyance standard in the interim. City-Prog-1 is a community-focused project that involves improving maps and accessibility for Sammamish residents.

Lake Sammamish

Zack-CIP-4
Zack-Hab-1
Zack-CIP-3
Zack-CIP-7
Zack-CIP-2
Zack-CIP-8
Zack-Pol-1
Zack-Hab-2
Zackuse Creek
Zackuse Creek
Zack-CIP-5
Zack-CIP-6
Zack-Oper-3
Zack-WQ-1
Zack-CIP-1
Ebright Creek
Zack-CIP-9

Legend

- Zackuse Creek Basin Boundary
- CIPs developed in conceptual plans
- All other identified CIPs or location-specific projects

Streets

- Private
- Public
- Tax Parcels
- Stream

AltaTerra

N
W E
S

Figure 7-4. Zackuse Basin Project Locations

0 0.025 0.05 0.1 0.15 0.2 Miles

Coordinate System: Lambert Conformal Conic
Central Meridian: 120°50'0"W
1st Std Parallel: 47°30'0"N
2nd Std Parallel: 48°44'0"N
Latitude of Origin: 47°0'0"N

8 Partnerships and Grant Opportunities

Several of the projects and strategies included in this plan require participation by people outside of the City or would benefit from partnerships with outside organizations. Additionally, grant opportunities may be available to supplement City funding sources. This section describes the general partnerships and/or grants that may be available for projects and strategies.

8.1 Projects with Habitat Components

Two projects (Zack-Hab-1 and Zack-Hab-2) that solely focus on habitat improvements are in and adjacent to Zackuse Creek. The reaches where improvements are located on privately owned property; these projects cannot be completed without approval and/or participation by the individuals that own the land. Additionally, the type of improvement that is ultimately constructed, if any, will depend on the desires of the property owner.

Zack-Pol-1 is a long-range planning and policy project that identifies properties for City acquisition in the Zackuse Creek corridor. The project would connect tracts of land that are undeveloped and create an uninterrupted stream corridor that provides fish passage, open stream channels and restores watershed functions for fish and wildlife. This project would benefit from community and regional partners with common goals and vision for preservation and restoration of watersheds that support kokanee salmon. Downstream landowners have already demonstrated a willingness to participate in restoration efforts by allowing restoration to occur on private property. The KWG has also been supportive of the City's efforts to restore kokanee habitat and improve fish passage. These are obvious partners. Other partners should include private landowners in the vicinity.

Grants and loans are available for habitat and stream projects through King County governmental agencies, depending on how well the goals of the project align with the goals of the funding organization. For instance, the 2018 Zackuse Culvert replacement project at E Lake Sammamish Parkway received grant funding from the following:

- King Conservation District
- King County Flood Reduction District
- King County Sub-Regional Opportunity Fund
- King County Waterworks

These organizations are potential sources of grant funding for habitat related projects, and for projects associated with long-term corridor acquisition and restoration in the vicinity of 206th Ave NE (Project Zack-Pol-1).

8.2 Projects with Water Quality Components

Many of the projects have a water quality component involving source control (Zack-WQ-1), water quality monitoring (Zack-WQ-2), treatment (several CIPs will include water quality treatment), or identification of opportunities to provide water quality (City-WQ-1). The City partnered with King County to develop the water quality monitoring plan and has an interlocal agreement with King County for the County to conduct water quality monitoring. Various grants and loans are available from the Washington State Department of Ecology for water quality related activities, including:

- Centennial Clean Water Program

- Clean Water Section 319 Program
- Stormwater Financial Assistance Program
- Washington State Water Pollution Control Revolving Fund Program

Some of the projects in this plan may be eligible and potentially competitive for Ecology grants depending on how they are represented.

8.3 Stormwater Improvement Projects

The stormwater CIPs in this plan will not likely be good candidates for grant funding without a water quality component, especially since none are LID projects. LID projects tend to be ranked higher than others and are favored by grant funding organizations. All CIP projects should consider water quality treatment for grant eligibility.

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Appendix A

Community Outreach Materials

Event Summaries
January 2018 Public Meetings
Zackuse Basin Plan

Event #1- Open House, January 24, 2018, Sammamish City Hall

Event #2- Neighborhood Event, January 31, 2018, Eden Glen Homeowners Association

Prepared for the City of Sammamish Public Works Department
February 2, 2018

AltaTerra

Table of Contents

Background

The Zackuse Creek Basin is located on the western edge of the City of Sammamish, draining approximately 240 acres from the Sammamish Plateau to Lake Sammamish near Louis Thompson Road. The basin is mostly residential and consists of established neighborhoods with private and public roads and informal and formal stormwater infrastructure, depending on the neighborhood. Zackuse Creek is one of several streams on the east side of Lake Sammamish that historically supported Kokanee spawning. Culvert replacement projects at the East Lake Sammamish Trail and on the East Lake Sammamish Parkway are expected to open spawning habitat for kokanee on Zackuse Creek. The culvert projects are scheduled to be constructed in the summer of 2018.

The purpose of the Zackuse Basin Plan is to characterize current physical, biological, and water quality conditions in the basin, and develop priority strategies, projects and actions to improve the overall health and reduce flooding problems for the benefit of Sammamish residents, city infrastructure, and aquatic resources.

Event #1 Information

Speakers:	Danika Globokar, PE, Associate Stormwater Engineer (City of Sammamish) Erin Nelson, PE, LG, Water Resources Engineer (Altaterra Consulting LLC)
Project/City Representatives:	Tawni Dalziel, PE, Stormwater Manager (City of Sammamish)
Attendees:	21 attendees from the public
Date and Time:	Wednesday, January 24, 2018, 6:00 – 8:00 p.m.
Location:	Sammamish City Hall, Council Chambers

Event #2 Information

Speakers:	Danika Globokar, PE, Associate Stormwater Engineer (City of Sammamish)
Project/City Representatives:	Tawni Dalziel, PE, Stormwater Manager (City of Sammamish)
Attendees:	13 attendees from the public
Date and Time:	Wednesday, January 31, 2018, 6:00 – 8:00 p.m.
Location:	Neighborhood residence

Event Objectives

The objectives of the meetings were to:

- Raise awareness of basin planning, including what it is, and how it is being implemented in Sammamish
- Explain the elements of the Zackuse Basin Plan
- Communicate the project schedule, opportunities for feedback, and anticipated outcomes
- Discuss observations from recent field survey
- Solicit input on problems in the basin and broad stormwater management priorities
- Answer questions and take comments

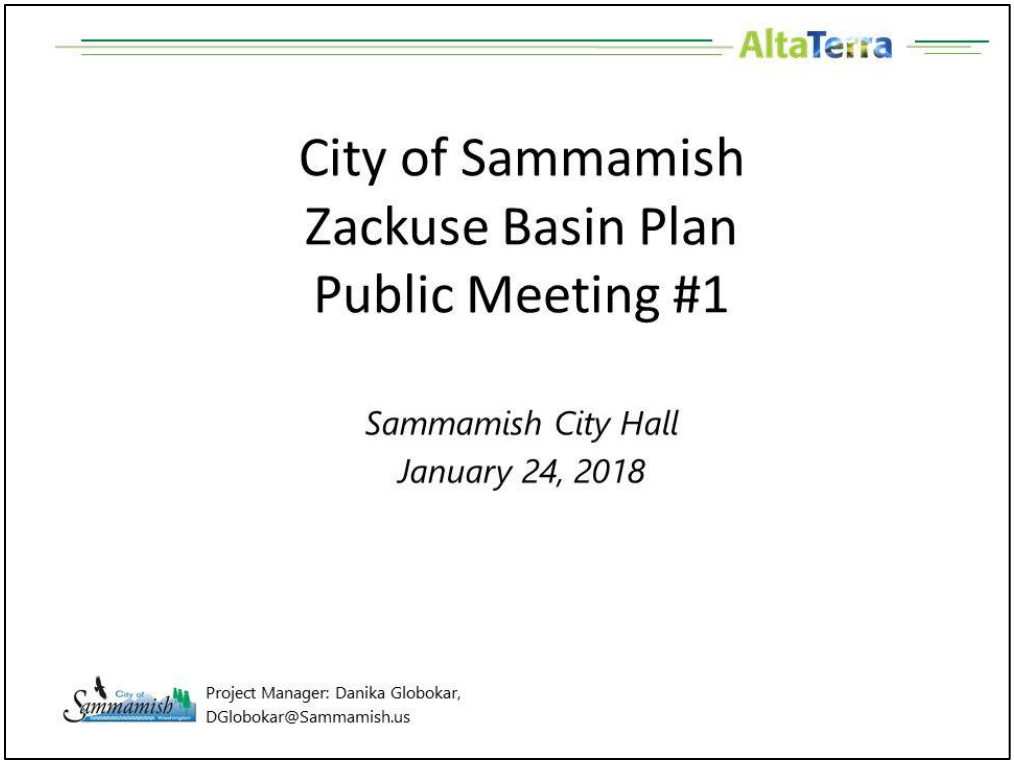
Event Formats

The Event #1 format included a short presentation followed by break-out groups stationed around large aerial maps of the basin to allow attendees to discuss specific issues in a smaller group setting. Event #2 was an informal setting in a residential home. It included a presentation, followed by a discussion.

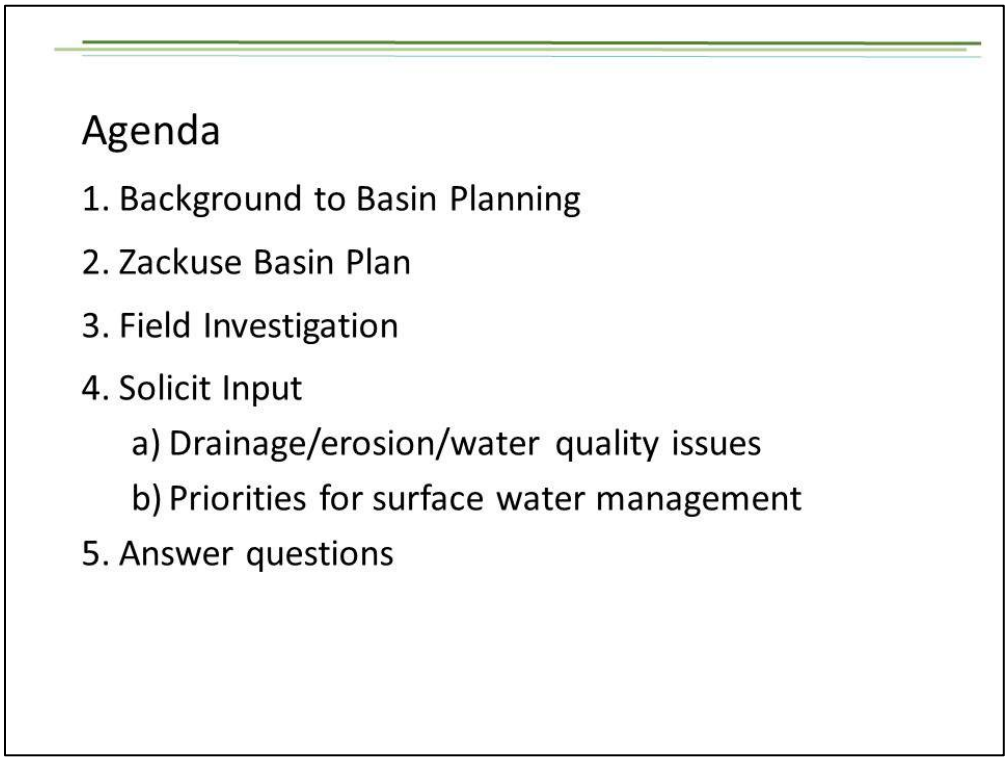
A sign-in sheet was available at both events, as well as summary hand-outs, and paper copies of a survey that was also available electronically on-line (a link to the survey was provided on the postcard that was mailed to property owners/residents in the basin to advertise the public meeting).

Presentation

Danika Globokar presented a PowerPoint presentation at both events with the goal of outlining the objectives for the public meeting and describing the project. Erin Nelson assisted in the presentation at Event #1 in the description of the basin plan tasks and schedule and the field survey. The PowerPoint slides are shown below.



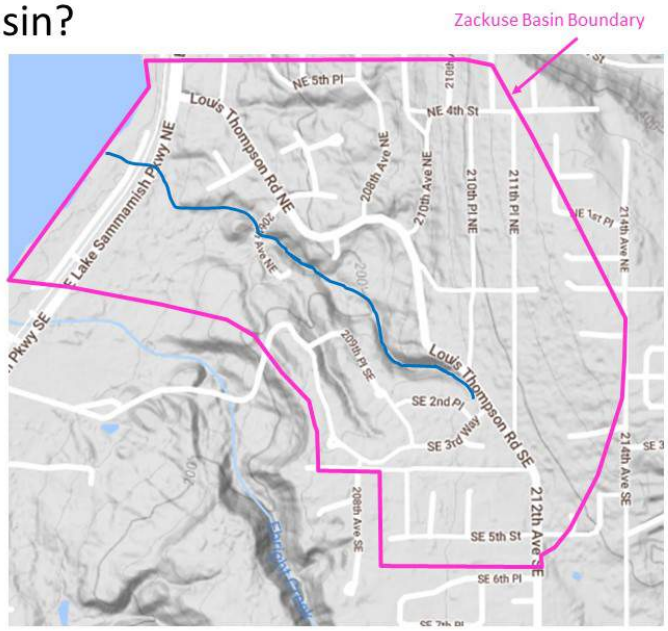
Slide 1



Slide 2

What is a Basin?

- Also known as a watershed.
- An area of land where water collects and drains off into a *common outlet*, such as into a river or lake.
- Multiple basins in Sammamish



Slide 3

Basin Planning Goals

- Characterize basin conditions
  - Existing and future
- Identify problems and develop conceptual solutions for:
  - Flooding
  - Erosion
  - Groundwater seepage
  - Water quality
  - Degraded habitat
- Prioritize Projects – develop priority criteria

Slide 4

Example types of projects

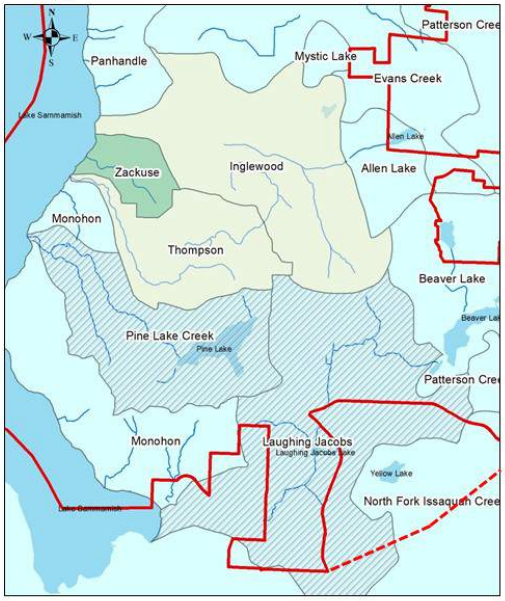
Issue/Opportunity	Capital Improvement Projects		Planning Projects	Operations Projects
	Capital 	Education 	Policies, Studies, and Coordination 	Maintenance 
Habitat or natural area improvements	Heron Creek Culvert Crossing at Springdale Court NW	N/A	N/A	N/A
	N/A	Develop Invasive Vegetation Management Strategy for Aquatic Areas	N/A	N/A

Slide 5

Sammamish Basin Planning

Past

- East Lake Sammamish Basin and Non-Point Action Plan (1994[1])
- Inglewood Basin Plan (2004, 2011[2])
- Thompson Basin Plan (2011)



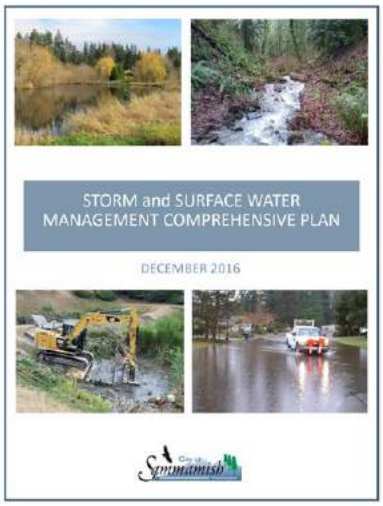
[1] Conducted by King County prior to City Incorporation
[2] Updated in 2011 to include Town Center

Slide 6

Sammamish Basin Planning

Re-Initiated

- 2016 – City adopted a new Storm and Surface Water Management Comprehensive Plan
  - ID'ed basin planning as a priority action item
- Start with Zackuse
  - Template for future basins
  - Establish project priorities
  - Prioritize City resources

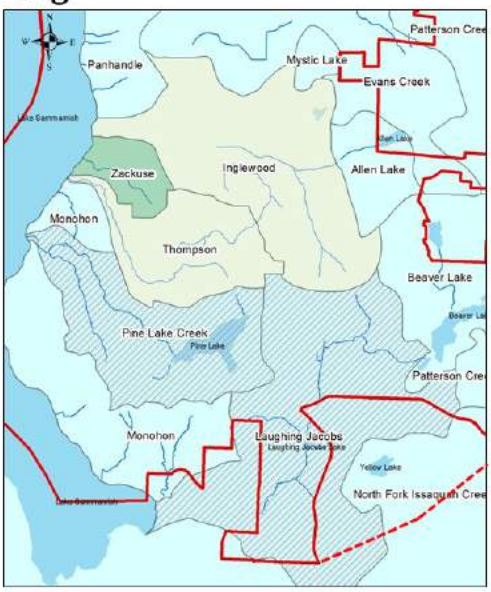


Slide 7

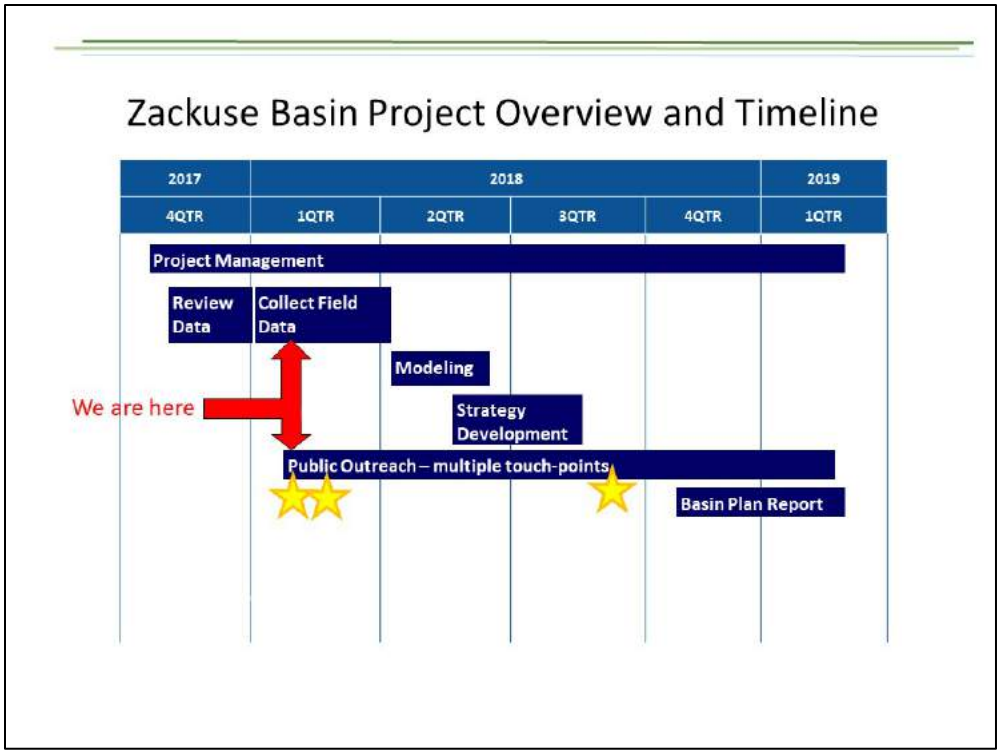
Sammamish Basin Planning

Current and Future

- Zackuse Basin Plan (2017-2019)
- Laughing Jacobs Creek Basin Plan (start 2018)
- Pine Lake Creek Basin Plan (start 2021)
- Future basins TBD



Slide 8



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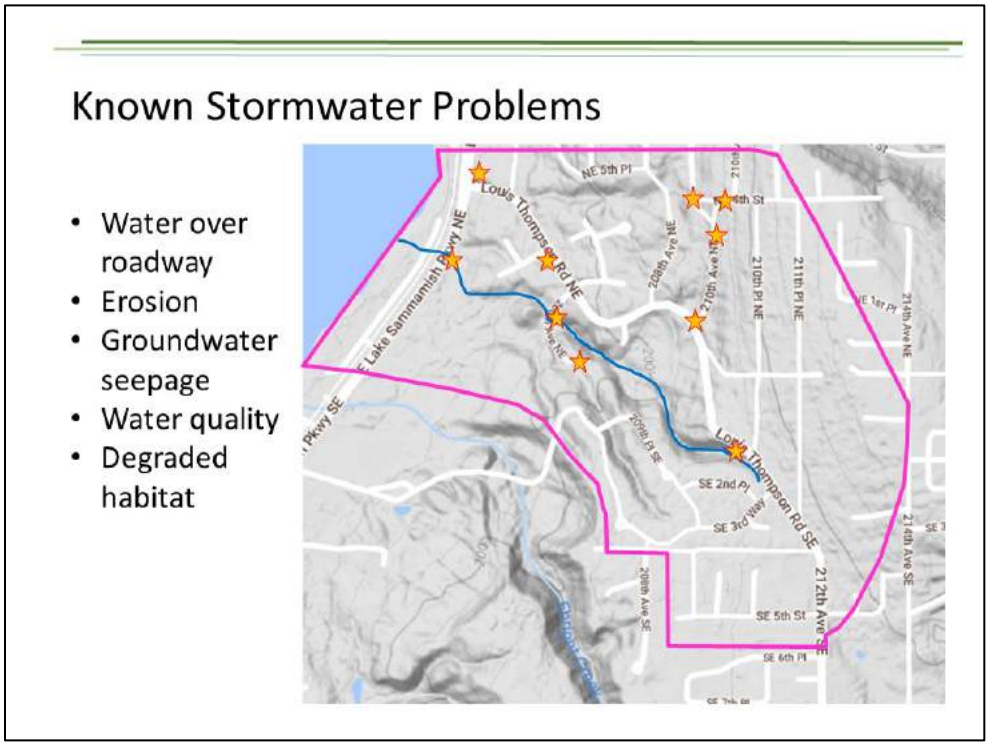

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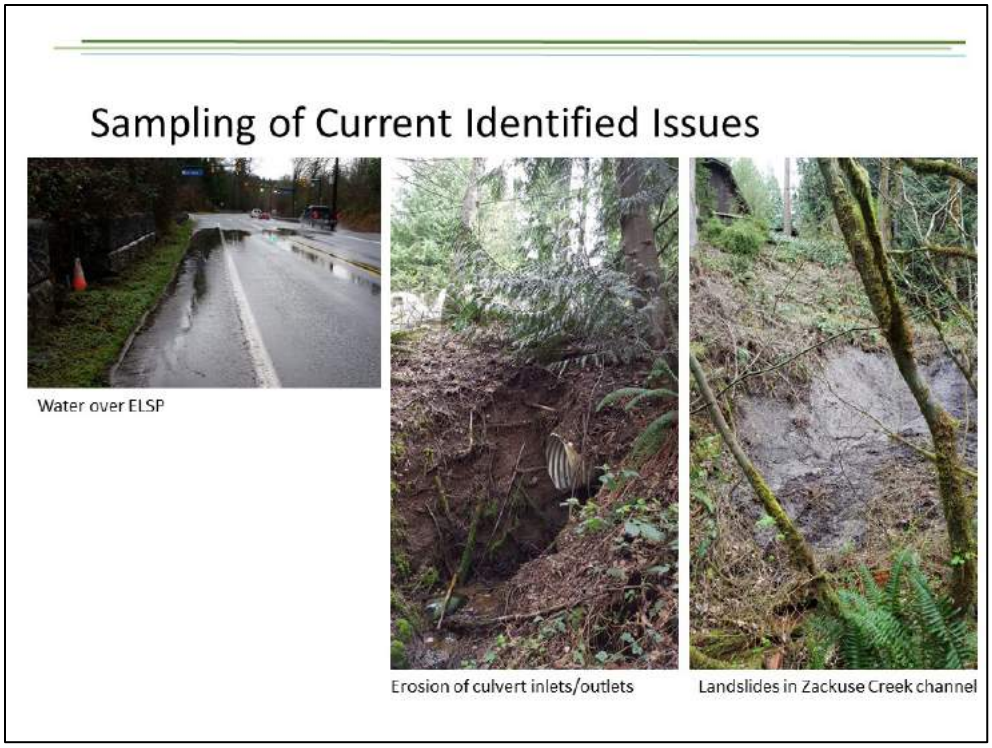

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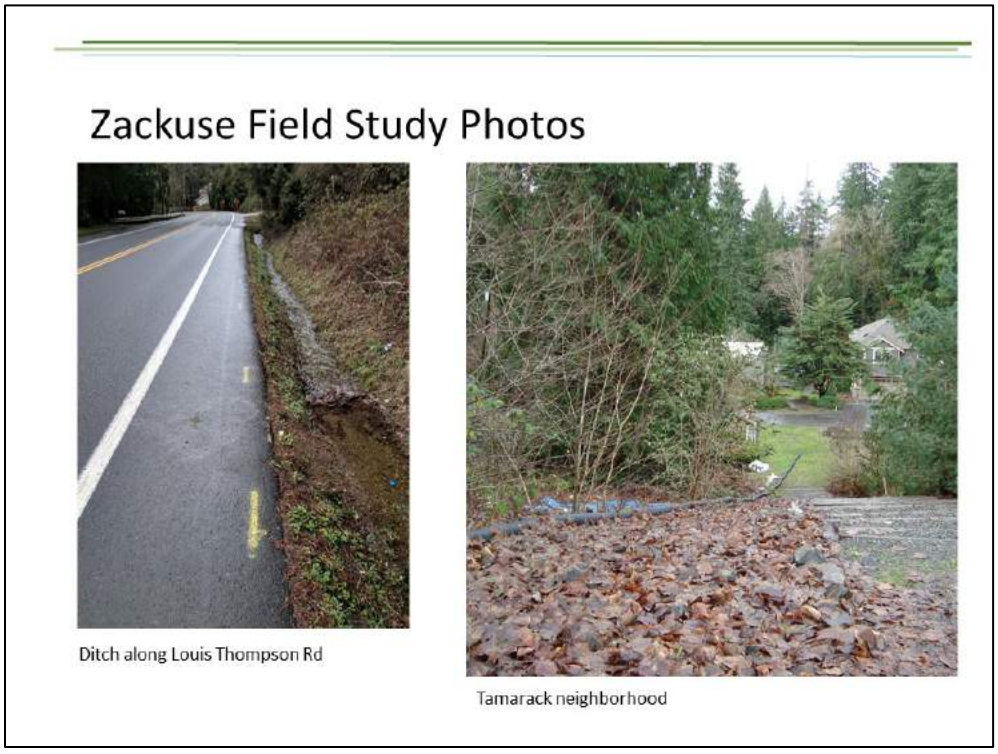


Slide 12

Zackuse Stream Walk Photos

Mouth of Zackuse Creek in Lake Sammamish

Mouth of Zackuse Creek in Lake Sammamish

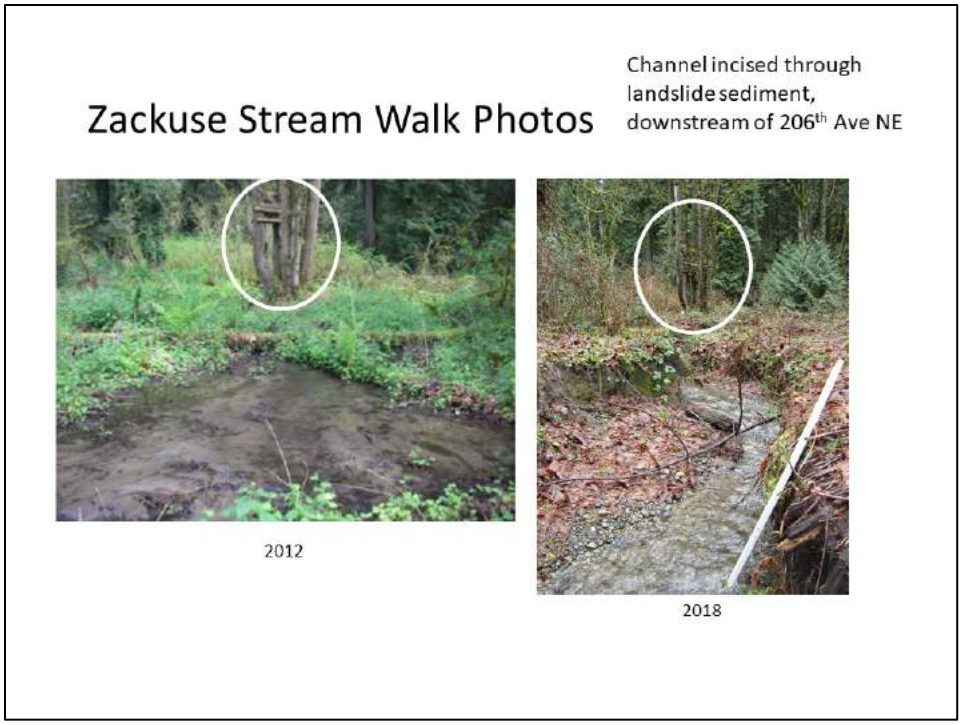
Slide 13

Zackuse Stream Walk Photos

Between mouth and Shore Lane NE

East side of East Lake Sammamish Parkway (ELSP)

Slide 14



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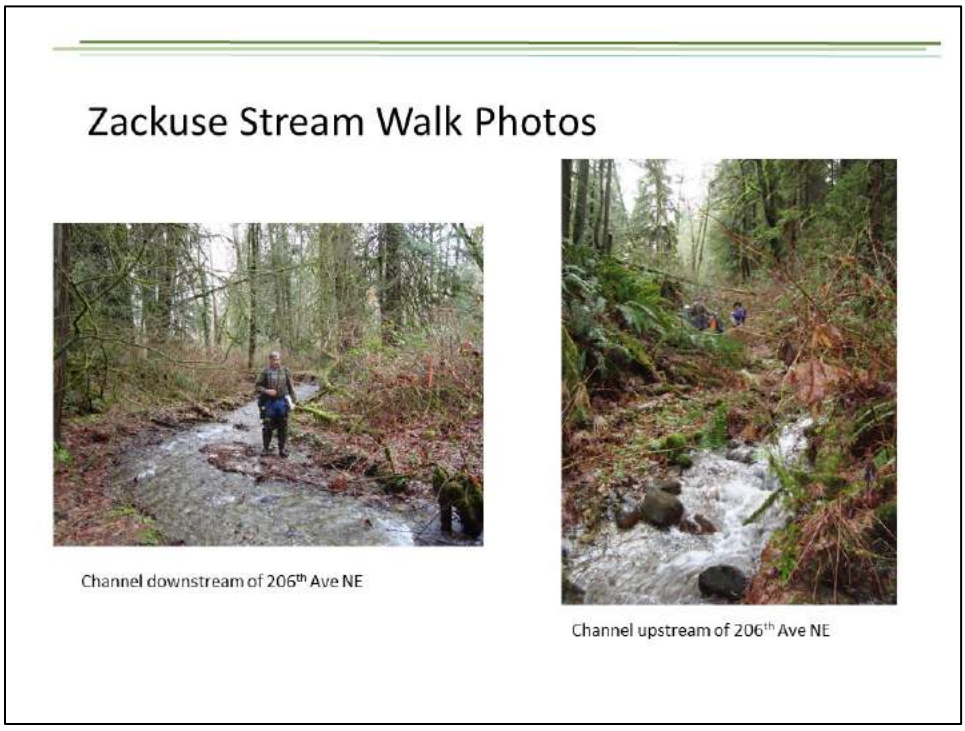

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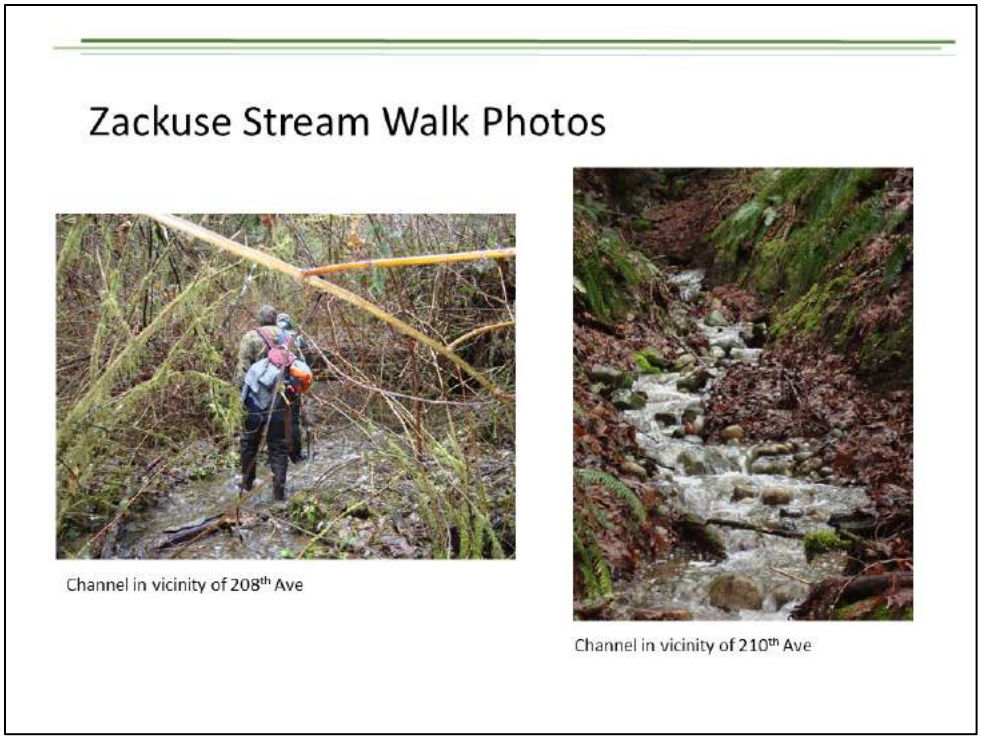

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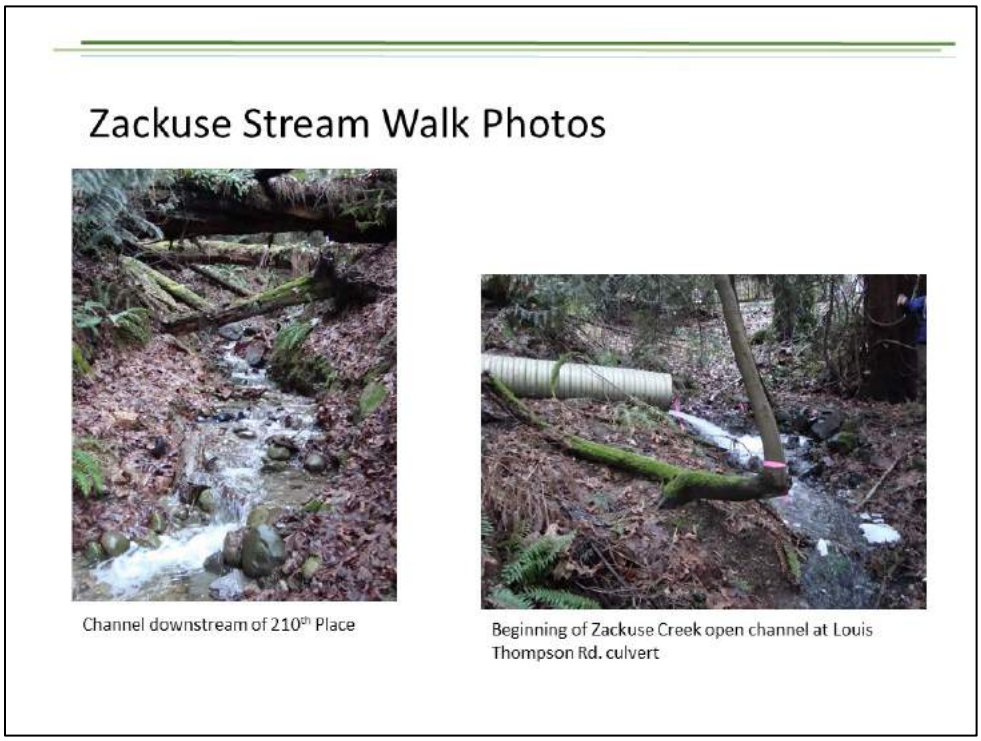

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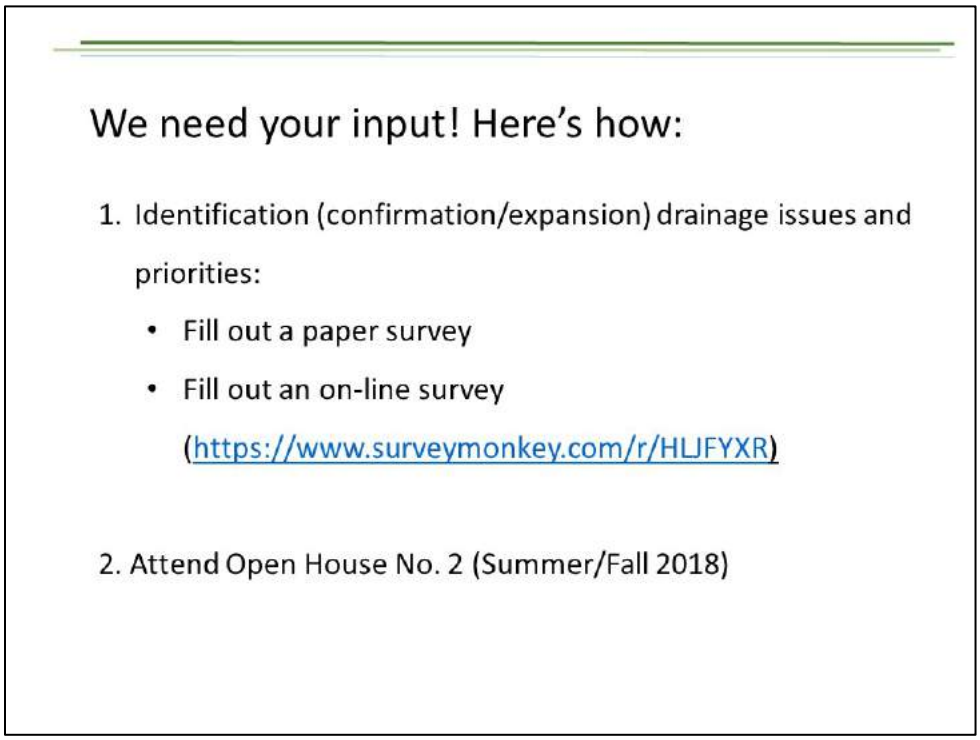


Slide 20

Slide 21

Question and Answer Session

Following the PowerPoint presentation at Event #1, there was a brief question and answer session. Questions raised included the following:

Q. What is the relationship between the Zackuse Basin Plan and the Zackuse Culvert Replacement at East Lake Sammamish Parkway?

A. Information from the culvert replacement project informs the basin plan. The basin plan looks at the whole area and the processes that influence the area in the vicinity of the culvert replacement project. In this way, they are connected.

Q. There were concerns about the stream restoration staying open because of upstream sediment delivery from landslides, and the potential for salmon eggs to be buried.

A. Concern was noted.

Q. Have water samples been taken in the basin? There was a specific reference to old septic systems.

A. The City is working on a water quality monitoring strategy, however, there has been no recent water quality samples taken in the Zackuse basin.

Q. How can the Tamarack neighborhood be managed given that it's private? How is the City viewing Tamarack with its haphazard drainage?

A. The questions surrounding drainage in the Tamarack neighborhood are policy-related and involve decisions at the City Council level.

Q. Timing question about how things are being prioritized? Specifically, in reference to KC projects such as the trail culvert projects.

A. The City coordinates with King County on all projects and conducts review of their proposed projects such as the two culvert projects on the trail.

Breakout Groups

Following the large group presentation and question and answer session, attendees were asked to break into smaller groups to discuss local issues and provide more detail on specific locations, timing, and frequency of issues in their neighborhood. Danika asked for a show of hands of those that live in the Tamarack neighborhood. Approximately 2/3 of the attendees live in Tamarack, therefore, those attendees were asked to go to tables with either Danika or Tawni, so that their specific concerns could be heard. The remaining attendees joined Erin at a separate table.

What we heard…..

Many of the residents and property owners in attendance have lived in Sammamish for several decades, and therefore have a great historical knowledge of events, and changes in the Zackuse Basin. Several offered to provide photos and documents to supplement what the team has gathered for the basin plan. Attendees provided feedback on survey forms, maps, and in discussions with City and consultant staff. Some of the topics of discussion are listed below.

- Maintenance issues and the need to maintain existing stormwater infrastructure to function as originally constructed and intended (birdcage on 206th Ave NE)
- Concern about landslides and debris blocking new stream channel and smothering salmon eggs
- Concern about landslides and safety (property issues)
- Development issues and the inability to develop property without having stormwater infrastructure to accommodate development (Berg property)
- Development issues in Tamarack and ad hoc nature of stormwater infrastructure to accommodate new development and the impact to downstream neighbors
- Older development and inadequate stormwater controls (Montage)
- Groundwater seepage is of concern, particularly in the Eden Glen neighborhood where most residents have experienced issues with high groundwater.

Issues

Table 1 lists the specific problem areas that were identified by residents, including their locations.

Problem Type	Location	Description
Flooding	21007 NE 4th	Flooding and erosion in ditches conveying stormwater from up the hill. Debris on road from eroded ditch, water on road freezes during winter, and water that proceeds downhill continues eroding unhardened features in its path.
Sinkholes	20513 NE 3rd St	Sinkholes continue to form on the north side of the home at this address. It has been a problem since the homeowner moved in. She fixes them, but they reappear in a few years.
Landslides and drainage	114 210th Ave NE	Unable to grow trees on property, worried about landslides and saturated soil.
Flooding	215 210th Ave NE	House and driveway has flooded causing extensive damage as a result of water running down 210th Ave NE.
Drainage	405 210th Ave NE	Groundwater seepage at NE 4th and 210th Ave NE intersection floods roadway. Water in ditch used to infiltrate, now too much water and too little capacity.
Flooding	108 Louis Thompson Rd	Flooding at 210th Ave NE and Louis Thompson Rd

Survey Results

An on-line survey was provided in the mailer that was sent to property owners and residents to advertise the public meeting. Paper copies of the survey were provided at the public meeting for attendees to fill out. The objectives of the survey were to identify issues in the basin, and to gain an understanding of what issues are important to the property owners and residents of the Zackuse Basin from a stormwater management standpoint. The survey questions are shown below.

Survey Questions

2. Within Zackuse Basin, I am a: (check all that apply)

- [ ] Resident
- [ ] Property owner
- [ ] Renter

3. What is your property address? (OPTIONAL)

Address

4. Lake Sammamish Kokanee Salmon are a valued resource that the City should prioritize for protection and preservation. How closely does this statement align with your personal views?

- ○ Absolutely. I completely agree.
- ○ I agree, if there is budget after other priorities are met.
- ○ I do not agree with this statement.

5. In consideration of City surface water management functions, please rank the following in order of your personal priorities (from highest to lowest with 1 being the highest).

- Improve water quality in Lake Sammamish
- Improve water quality in local streams and wetlands
- Reduce flooding on arterial roads (Louis Thompson Rd and East Lake Sammamish Parkway)
- Fix local drainage issues in neighborhoods
- Improve stream habitat for fish and wildlife
- Reduce risk of landslides

6. Please rank the following from highest to lowest (1 being highest) what you think are the most important factors for determining which surface water projects get constructed?

- Cost
- Safety
- Environmental benefit
- Time-sensitive opportunity

7. Please tell us about any surface water or drainage issues in your neighborhood. Provide as much detail as possible, including location, time of year the problem occurs, and frequency of the problem.

8. Would you like to be contacted by City staff to follow up on problems described above?

- [ ] Yes
- [ ] No

9. Please provide contact information if you would like City staff to get in touch with you.

Name	
Email Address	
Phone Number	

Survey Responses

A total of 31 responses were received. Eighteen respondents did so electronically, and the remaining respondents filled out paper surveys. The results were compiled and are presented below.

Q1. The average length of time that respondents have lived or owned property in Sammamish is 21 years.

Q2. 30 out of 31 respondents are residents. 31 out of 31 respondents are property owners. No respondents are renters.

Q3. Addresses are not provided here.

Q4. Regarding the statement that Lake Sammamish Kokanee are a valued resource that the City should prioritize for protection and preservation.

- 11 respondents completely agree
- 18 respondents agree if there is budget after other priorities are met
- 2 respondents did not agree with the statement

Q5. The average ranking (Low numbers being higher priority) based on respondents' priorities for City surface water management functions is shown below:

- Improve water quality in Lake Sammamish: 4.2
- Improve water quality in local streams and wetlands: 4.5
- Reduce flooding on arterial roads (Louis Thompson Road and East Lake Sammamish Parkway): 2.97
- Fix local drainage issues in neighborhoods: 1.84
- Improve stream habitat for fish and wildlife: 4.63
- Reduce risk of landslides: 2.13

Q6. The average ranking (Low numbers being more important factors) based on respondents' thoughts on the most important factors that should be considered by the City in the construction of CIPs:

- Cost: 3.16
- Safety: 1.52
- Environmental Benefit: 2.52
- Time-sensitive opportunity: 2.23

Event Summary
August 1, 2018 Public Meeting
Zackuse Basin Plan

Prepared for the City of Sammamish Public Works Department
August 22, 2018

AltaTerra

Table of Contents

Background

The purpose of the Zackuse Basin Plan is to characterize current physical, biological, and water quality conditions in the basin, and develop priority strategies, projects and actions to improve the overall health and reduce flooding problems for the benefit of Sammamish residents, city infrastructure, and aquatic resources.

Field work was conducted in the first quarter of 2018, and two public meetings were held in January 2018 to describe the basin plan project and solicit input from the community on problems in the Zackuse basin as well as broader stormwater management priorities. A survey was also conducted to solicit input for basin planning priorities as well as site-specific issues.

Event Information

Speakers:	Danika Globokar, PE, Associate Stormwater Engineer (City of Sammamish) Erin Nelson, PE, LG, Water Resources Engineer (Altaterra Consulting LLC)
Project/City Representatives:	Tawni Dalziel, PE, Stormwater Manager (City of Sammamish) Cheryl Paston, PE, Deputy Public Works Director (City of Sammamish)
Attendees:	15 attendees from the public
Date and Time:	Wednesday, August 1, 2018, 6:00 – 8:00 p.m.
Location:	Sammamish City Hall, Council Chambers

Event Objectives

The objectives of the meeting were to:

- Provide an update on the Zackuse Basin Plan schedule
- Communicate preliminary results from field and modeling efforts, and community input
- Discuss project prioritization criteria and process for ranking projects
- Provide an opportunity to comment on recommended projects
- Answer questions and take comments

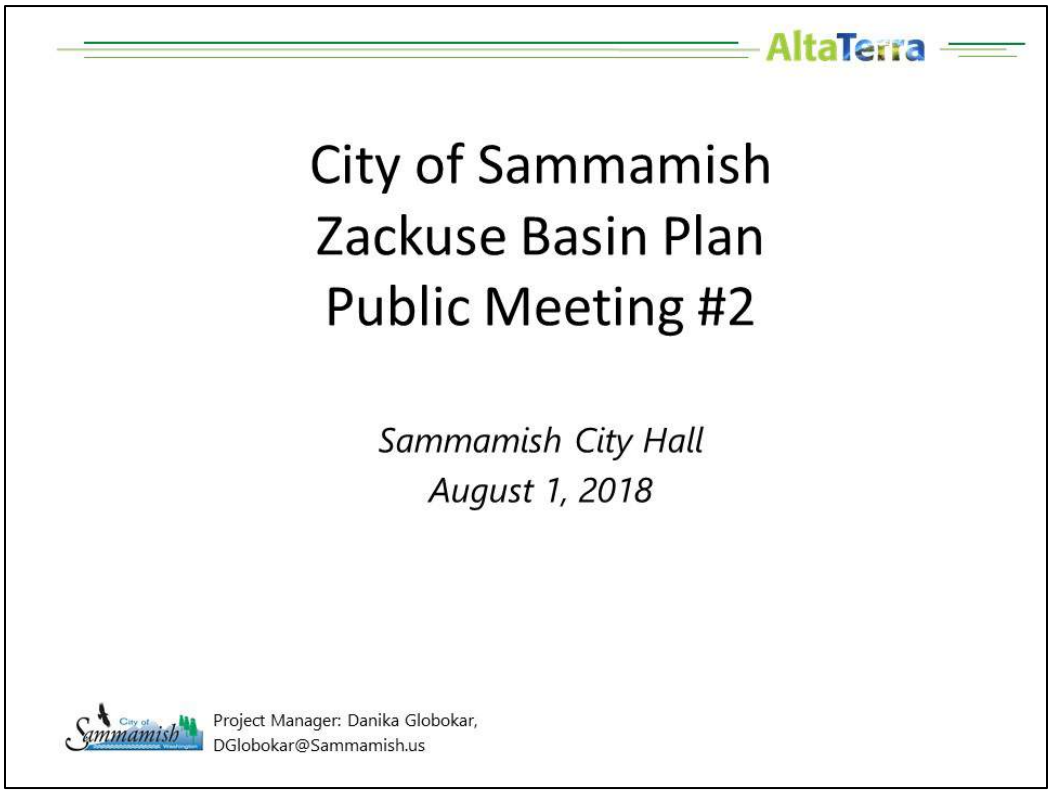
Event Format

The event format included a short presentation followed by break-out groups stationed around large maps of the basin that show locations of recommended projects, coupled with binders of project summaries to allow attendees to provide comments and ask questions in a smaller group setting.

A sign-in sheet was available at the entrance, as well as summary hand-outs.

Presentation

Danika Globokar presented a PowerPoint presentation at the event with the goal of outlining the objectives for the public meeting and describing the project. Erin Nelson assisted in the presentation at Event #1 in the description of the basin plan tasks and schedule and the field survey. The PowerPoint slides are shown below.



Slide 1

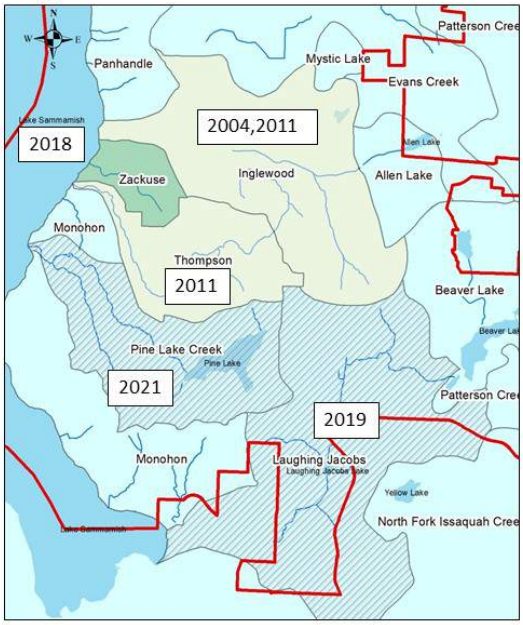
Agenda

1. Basin Planning Refresher
2. Schedule Update
3. Preliminary Results (field, model, open house, survey results)
4. Surface Water Capital Project Prioritization Criteria
5. Recommended Projects
6. Answer questions

Slide 2

Basin Planning – Refresher!

- Basin = watershed.
- An area of land where water collects and drains off into a *common outlet*, such as into a river or lake.
- Multiple basins in Sammamish
- Purpose = ID surface water problems and solutions
- Start with Zackuse!
  - Template for future basins
  - Establish project priorities
  - Prioritize City resources



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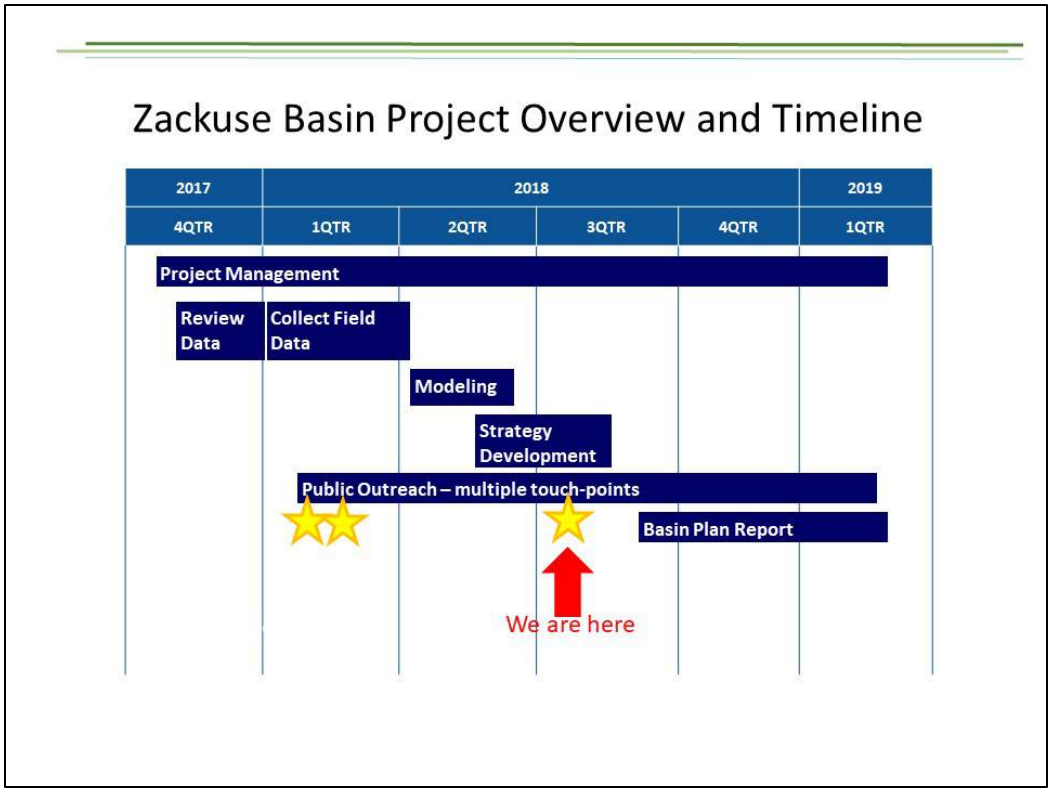

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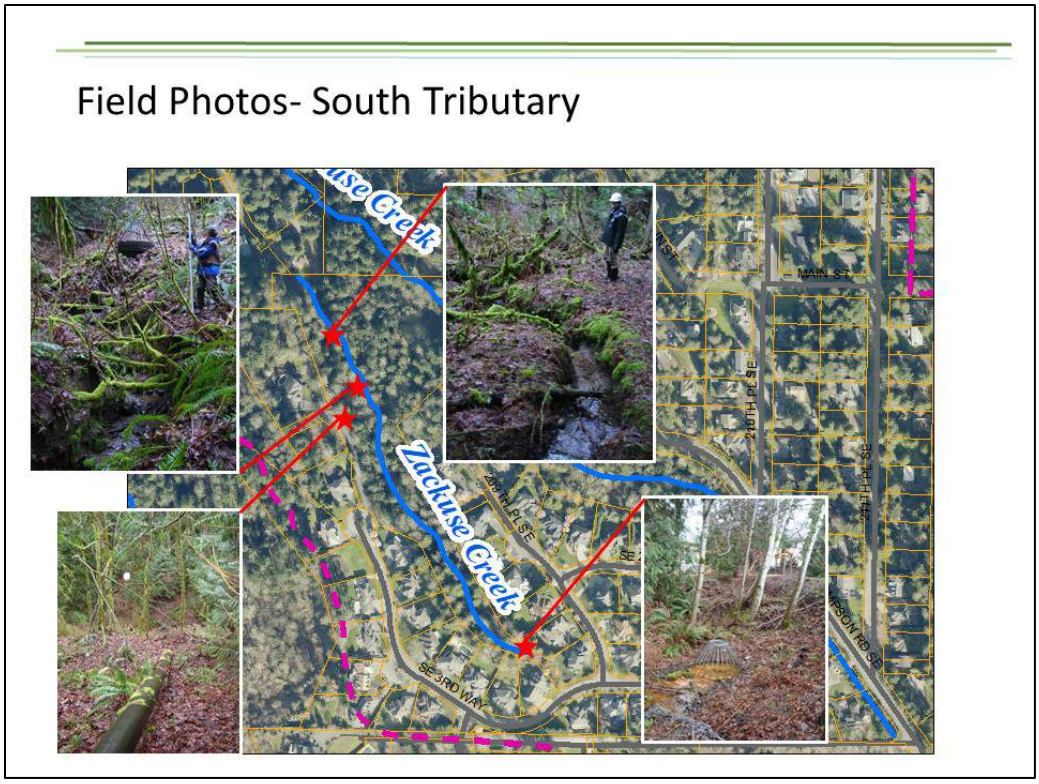

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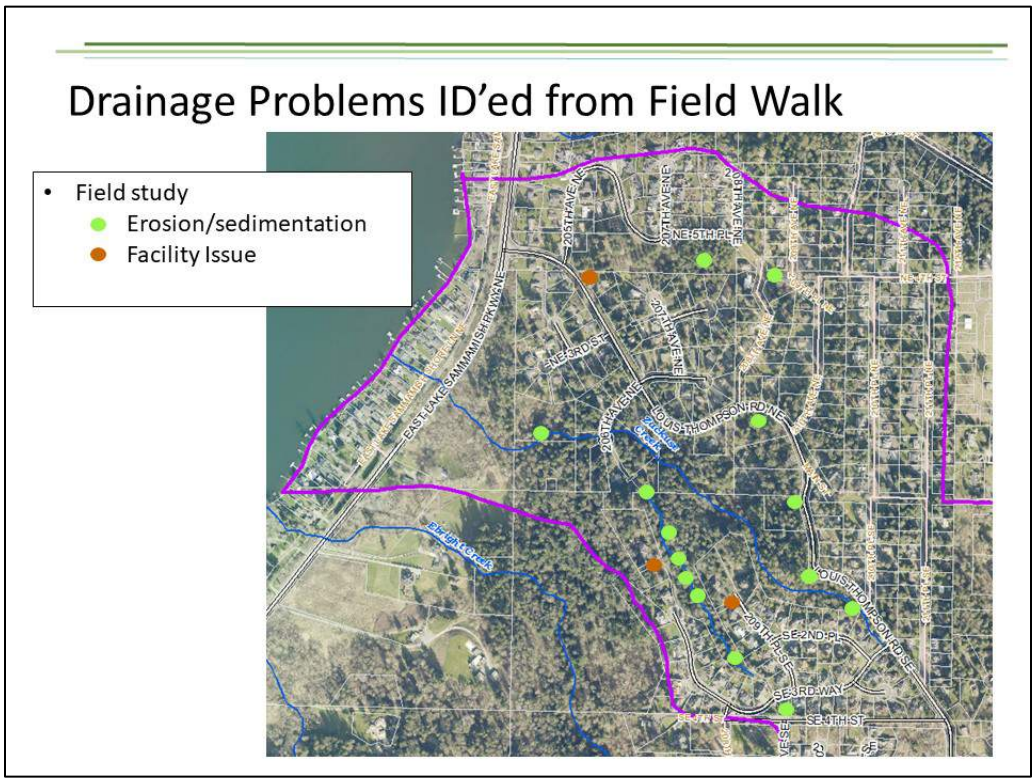

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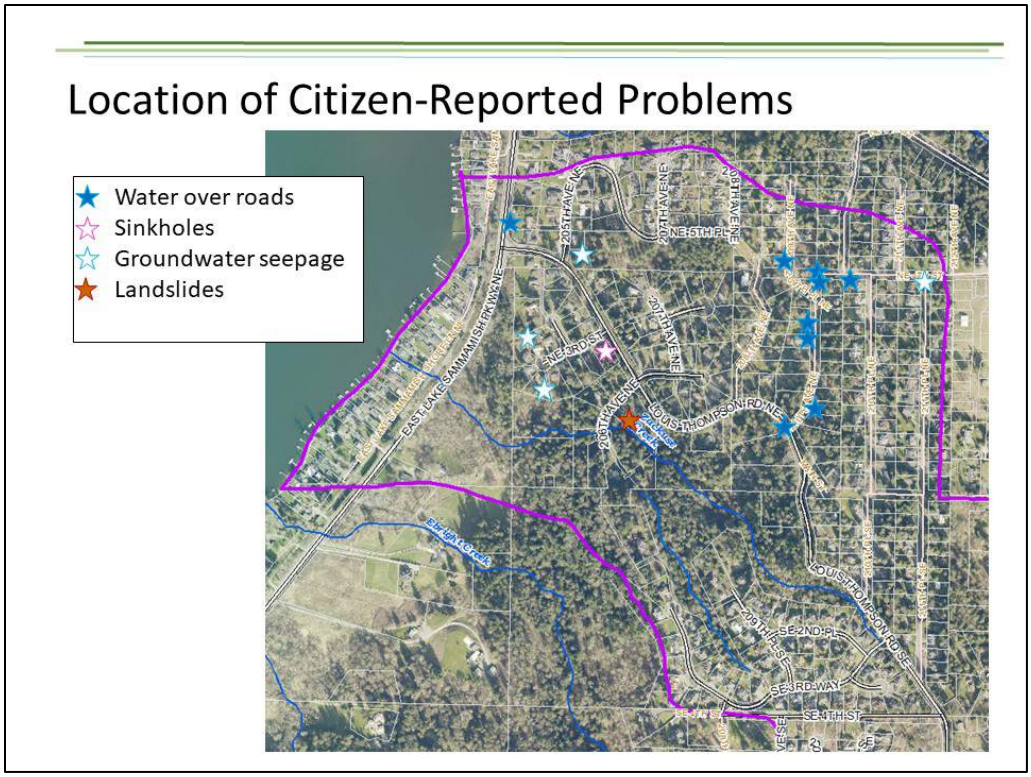

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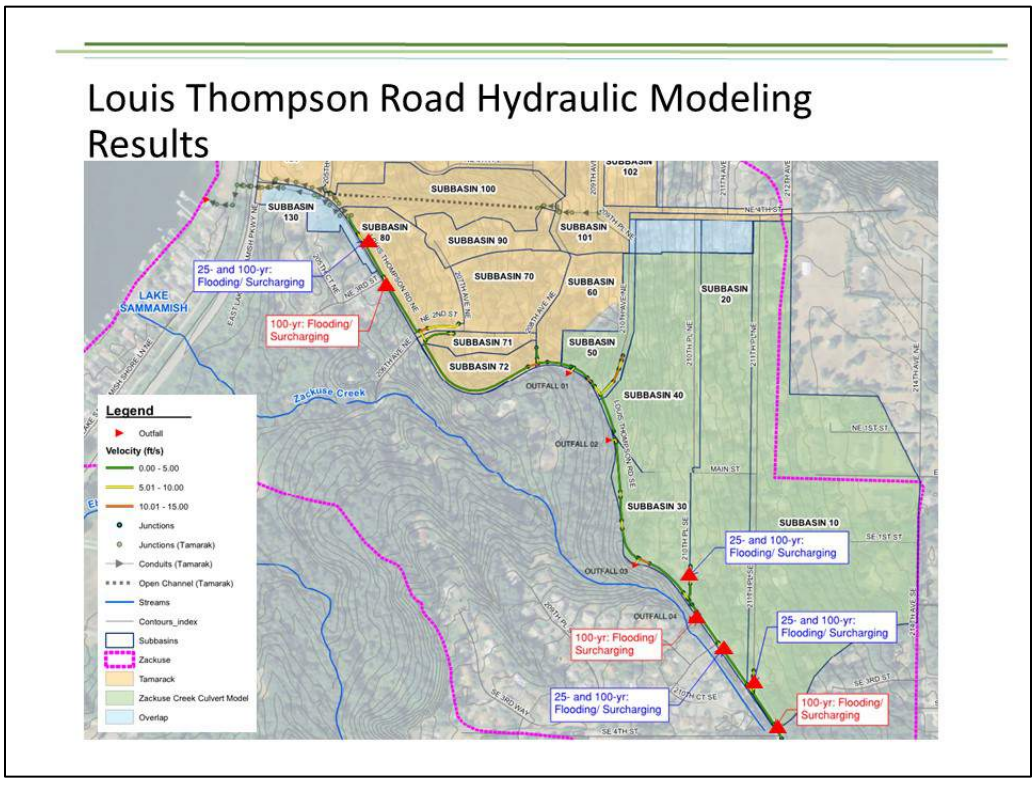

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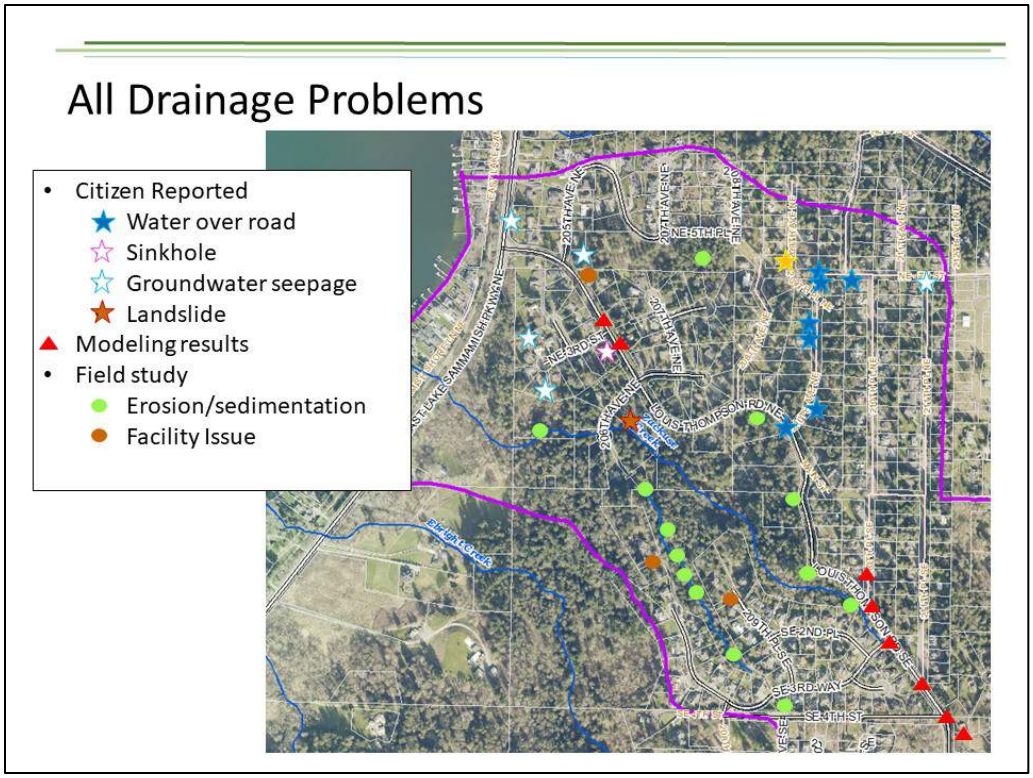

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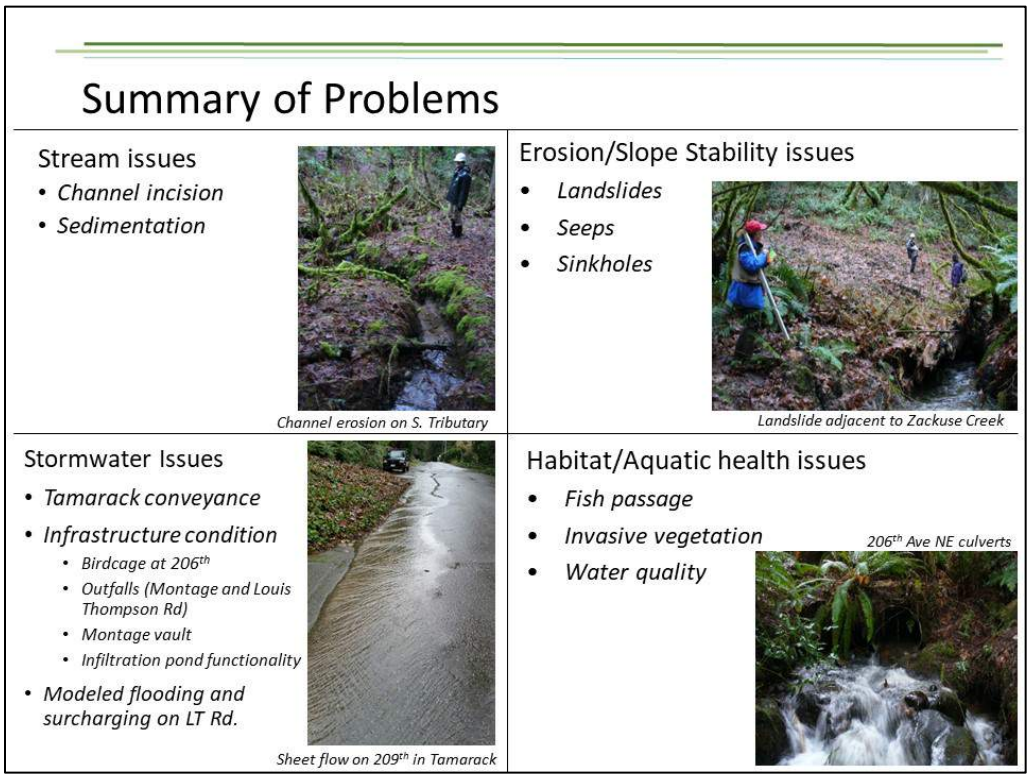
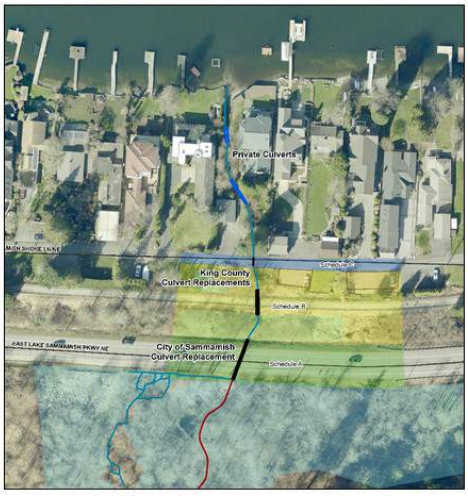


Slide 11

Yes, we can make improvements in the Basin!

1) Strong Community Support for:
- *Natural resources protection and restoration*
- *Drainage improvements*

2) Existing Projects/initiatives that:
- *Improve fish passage and habitat*
- *Acquire property to protect resources*

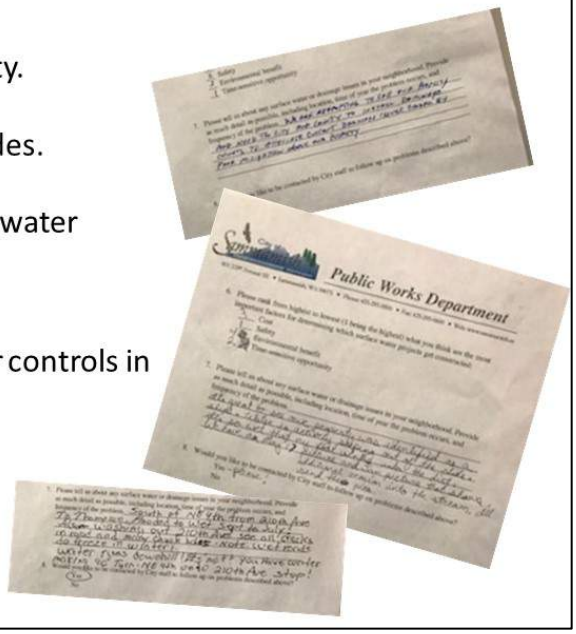


Zackuse Creek culvert replacement project and channel realignment at East Lake Sammamish Parkway

Slide 12

Open House Results- What We Heard…

- Maintenance is a priority.
- Concerns about landslides.
- Ad-hoc nature of stormwater infrastructure.
- Inadequate stormwater controls in older neighborhoods.
- Groundwater seepage.



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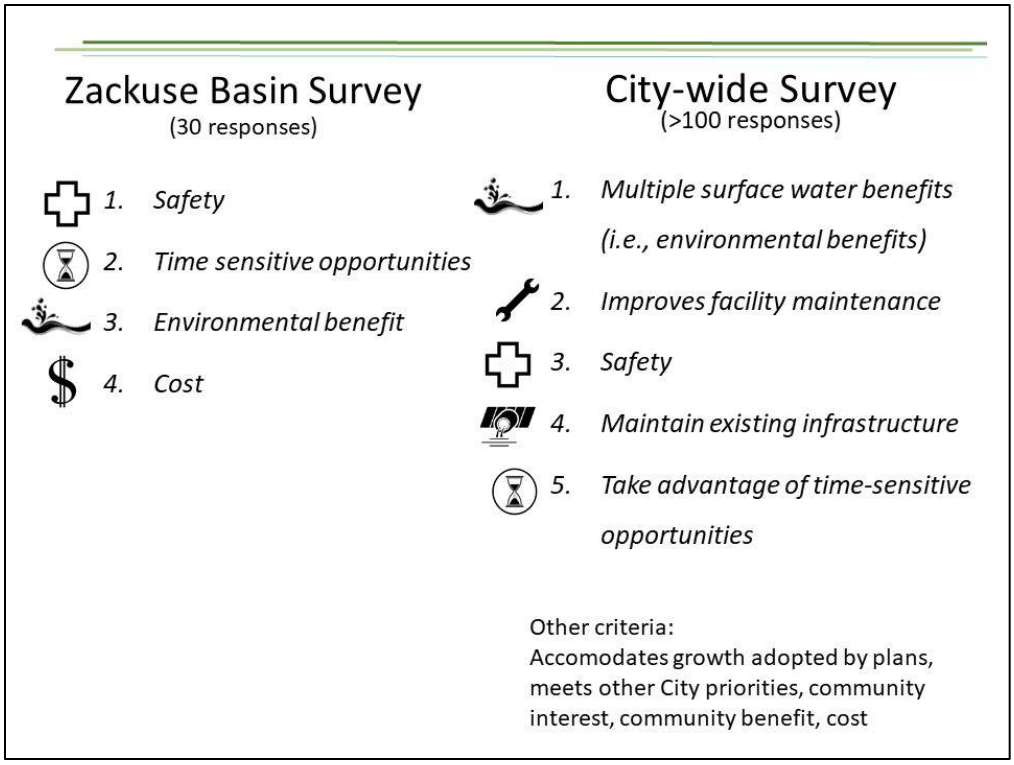

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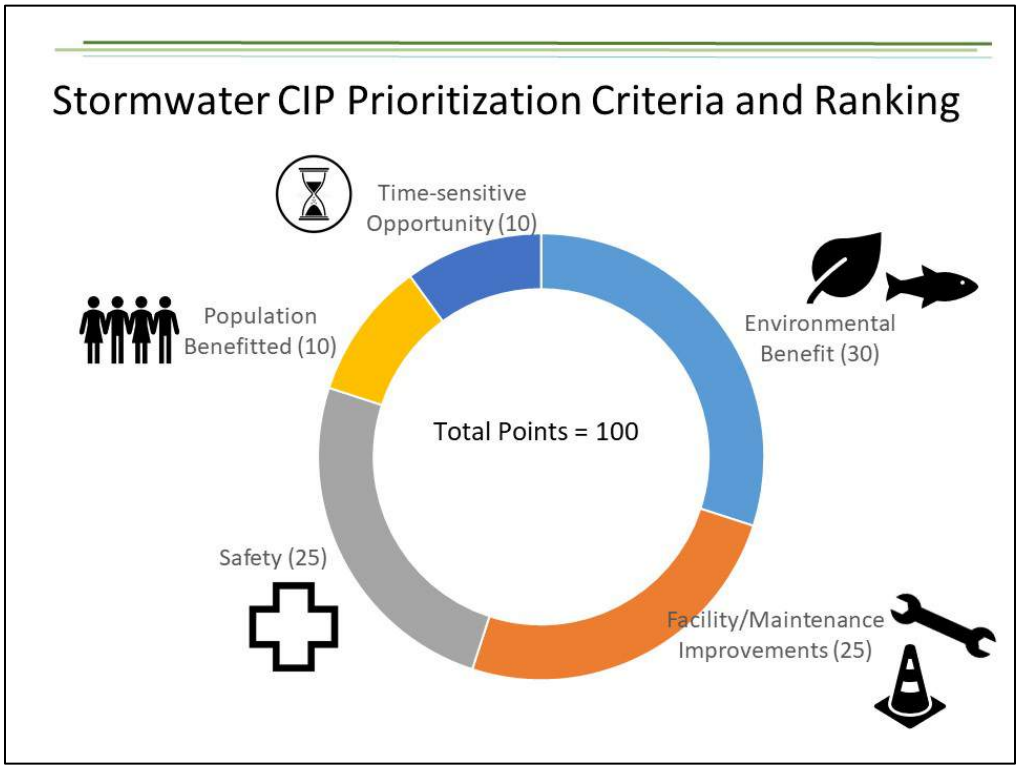


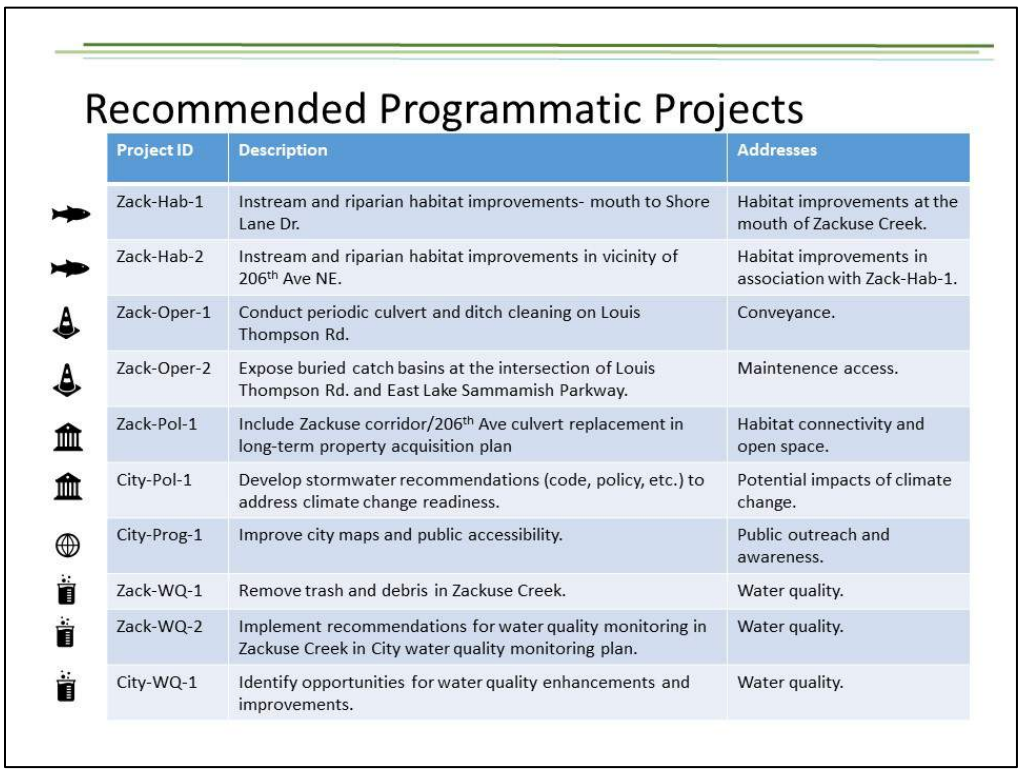
Slide 15

Recommended Capital Projects (in order of priority)

Conceptual Designs Developed

Project ID	Score	Description	Addresses
Zack-CIP-1	65	Tamarack tightline (NE 4th to Louis Thompson Rd)	Drainage issues in Tamarack.
Zack-CIP-2	55	Retrofit West Montage neighborhood	Stream channel erosion and aquatic habitat.
Zack-CIP-3	45	Develop solutions for sheet flow at 210th Ave NE and Louis Thompson Rd.	Drainage, maintenance and safety issues on 210th Ave NE and Louis Thompson Rd.
Zack-CIP-4	45	Retrofit East Montage neighborhood	Maintenance issues in stormwater infrastructure.
Zack-CIP-5	45	Tightline stormwater on Louis Thompson Rd.	Maintenance issues.
Zack-CIP-6	35	Intercept groundwater in ditch adjacent to East Lake Sammamish Parkway north of Louis Thompson Rd.	Safety concern.
Zack-CIP-7	35	Upsize culverts on 210th Pl NE and 211th Pl NE	Surcharging at culverts during high flows.
Zack-CIP-8	30	Fix broken stormwater pipe under Louis Thompson Rd. near 211th Pl. NE.	Infrastructure and potential safety concern.
Zack-CIP-9	30	Flow control/water quality facility near 210th Ave NE and Louis Thompson Rd.	Water quality and conveyance.
Zack-CIP-10	20	Channel stabilization upstream of dog-leg in Zackuse Creek.	Realignment of channel to a more stable form.
Zack-CIP-11	20	Address flooding at Zackuse headwater wetlands	Flooding on 212th Ave NE.

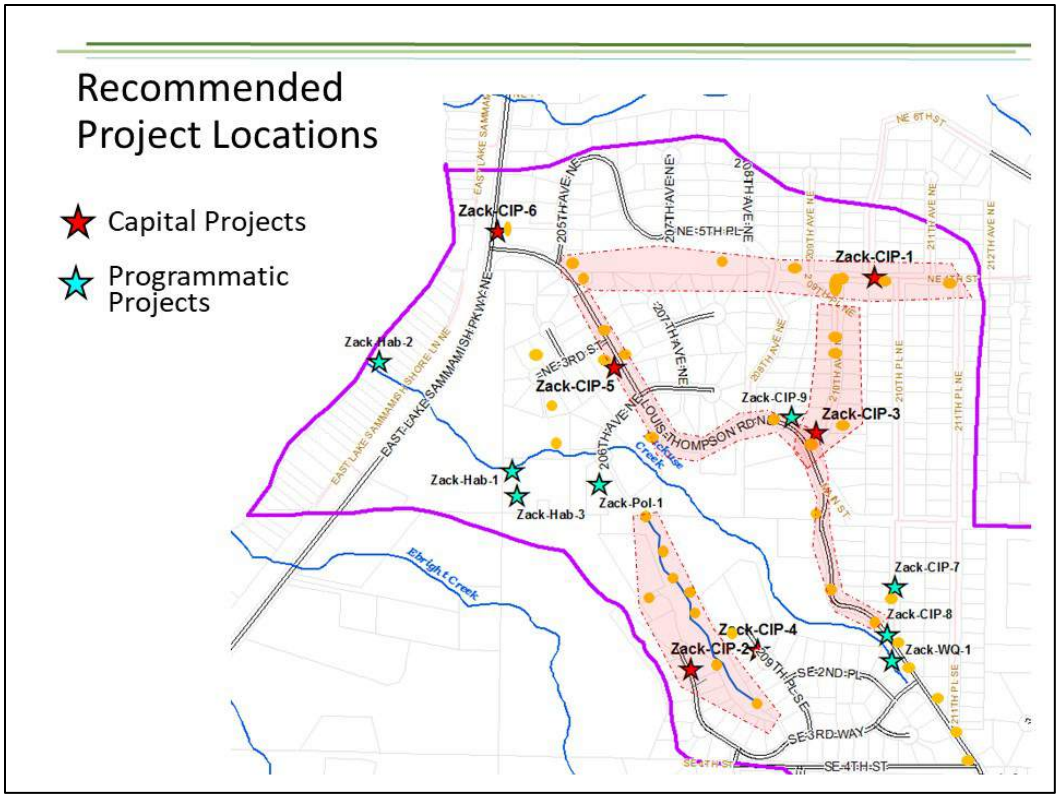
Slide 16



Recommended Programmatic Projects

Project ID	Description	Addresses
Zack-Hab-1	Instream and riparian habitat improvements- mouth to Shore Lane Dr.	Habitat improvements at the mouth of Zackuse Creek.
Zack-Hab-2	Instream and riparian habitat improvements in vicinity of 206th Ave NE.	Habitat improvements in association with Zack-Hab-1.
Zack-Oper-1	Conduct periodic culvert and ditch cleaning on Louis Thompson Rd.	Conveyance.
Zack-Oper-2	Expose buried catch basins at the intersection of Louis Thompson Rd. and East Lake Sammamish Parkway.	Maintenence access.
Zack-Pol-1	Include Zackuse corridor/206th Ave culvert replacement in long-term property acquisition plan	Habitat connectivity and open space.
City-Pol-1	Develop stormwater recommendations (code, policy, etc.) to address climate change readiness.	Potential impacts of climate change.
City-Prog-1	Improve city maps and public accessibility.	Public outreach and awareness.
Zack-WQ-1	Remove trash and debris in Zackuse Creek.	Water quality.
Zack-WQ-2	Implement recommendations for water quality monitoring in Zackuse Creek in City water quality monitoring plan.	Water quality.
City-WQ-1	Identify opportunities for water quality enhancements and improvements.	Water quality.

Slide 17



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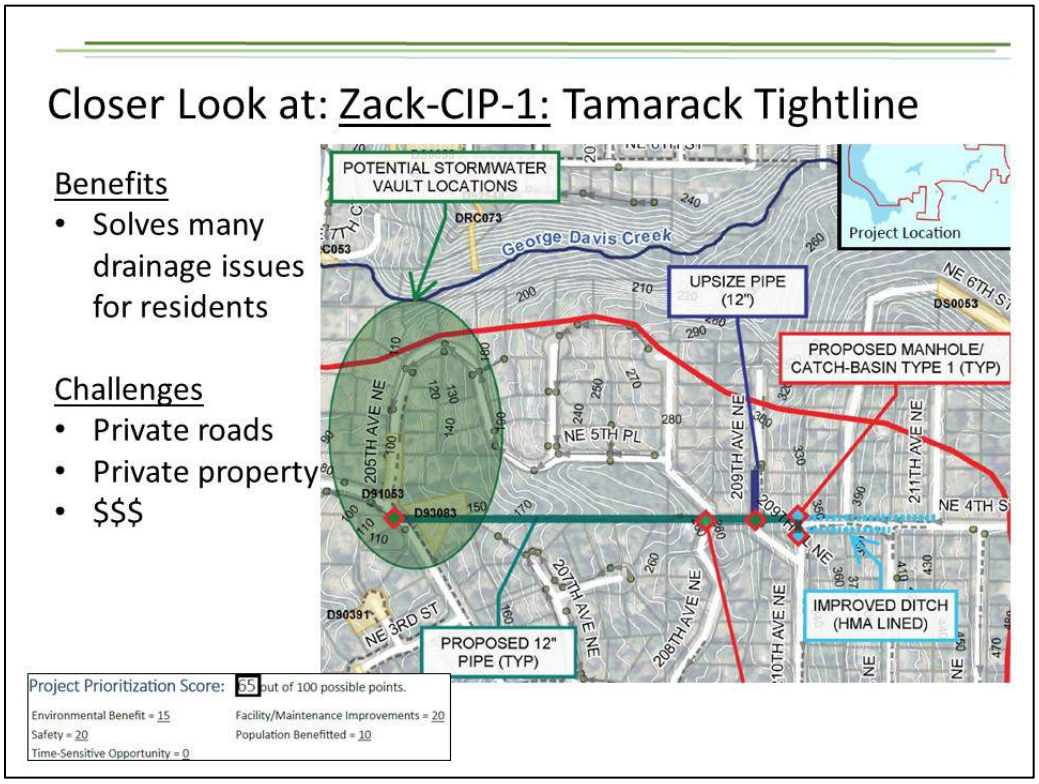


Slide 19

Closer Look at: Zack-CIP-3: 210th Sheet Flow

Benefits

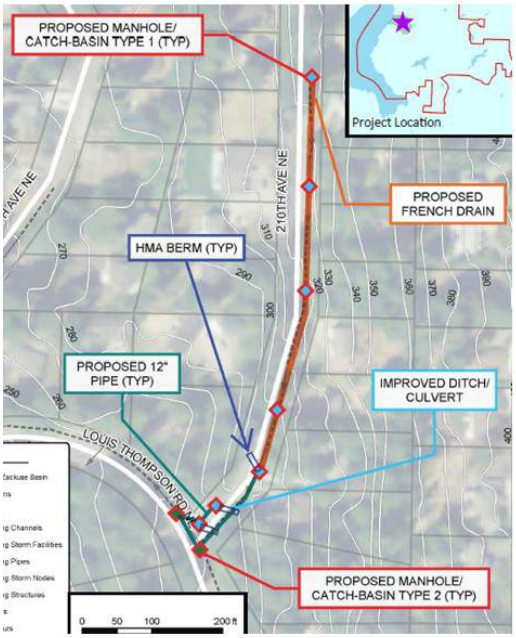
- Improves intersection safety
- Reduces maintenance on LT Rd.

Challenges

- Private roads
- Private property
- Maintenance

Project Prioritization Score: 45 out of 100 possible points.

Environmental Benefit = 0
Facility/Maintenance Improvements = 15
Safety = 20
Population Benefitted = 10
Time-Sensitive Opportunity = 0

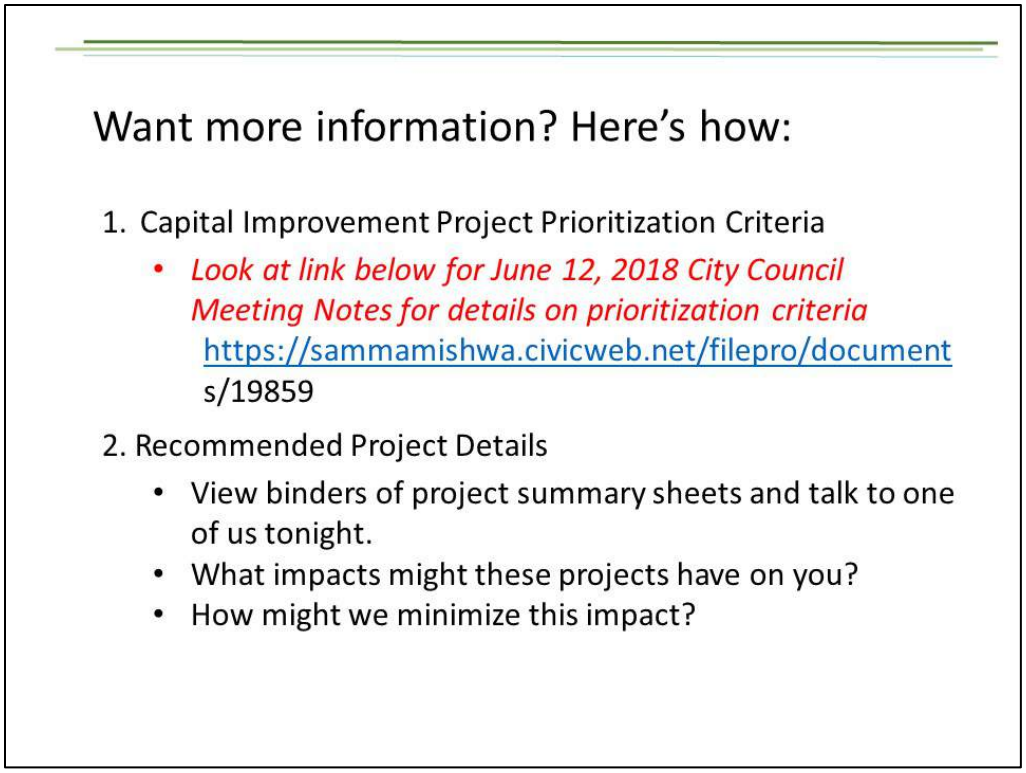


Slide 20

Next Steps

1. Finalize CIPs and Programmatic Projects
2. Complete Draft Basin Plan (Fall 2018)
3. Present findings to Planning Commission and City Council (Late 2018/Early 2019)

Slide 21



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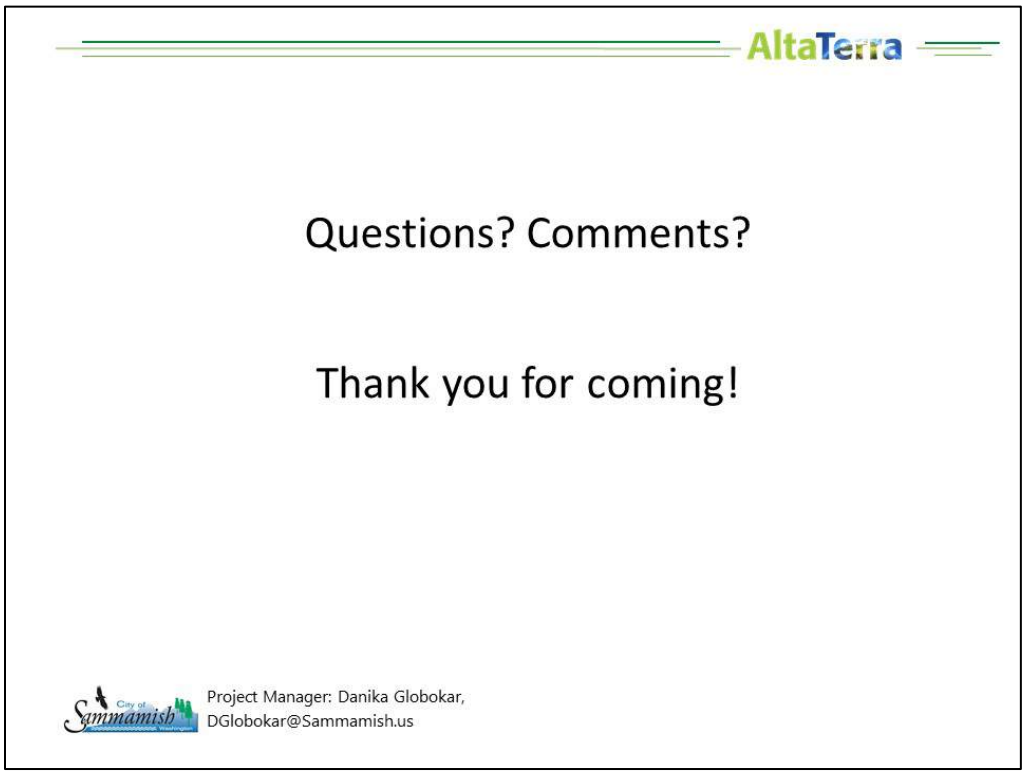

Slide 23

Question and Answer Session

Following the PowerPoint presentation at Event #1, there was a brief question and answer session. Questions raised included the following:

Q. What is the relationship between the Zackuse Basin Plan and the Zackuse Culvert Replacement at East Lake Sammamish Parkway?

A. Information from the culvert replacement project informs the basin plan. The basin plan looks at the whole area and the processes that influence the area in the vicinity of the culvert replacement project. In this way, they are connected.

Q. There were concerns noted about the perceived lack of water quality related projects. Fecal coliform and failed septic tanks were mentioned. There was a recommendation to include a map of septic systems in the basin plan report.

A. Danika provided more information about water quality monitoring, which is a project to be implemented and will be useful in establishing water quality baseline data against state standards. She also described how water quality components are being incorporated into most, if not all, recommended capital projects.

Q. There was a question about City-recommended projects on private property and whether there was any discussion with the affected property owners.

A. Danika and Erin provided described how the recommended projects are not guaranteed and that nothing would proceed without the express permission and cooperation of property owners affected. The specific project that was referenced was a project suggesting stream habitat improvements near the mouth of Zackuse Creek. Habitat improvements would be on private property and would require a willingness on the part of the property owners to participate in any such project. Improvements such as this suggested in the basin plan are provided to show the City where ecological benefits could be significant.

Q. There were questions about the culvert replacement project and transportation detour route on East Lake Sammamish Parkway.

A. Tawni answered questions related to the detour route.

Breakout Groups

Following the large group presentation and question and answer session, attendees gathered around two tables to look through binders of recommended project summary sheets and large maps depicting recommended project locations.

Questions and comments we heard…..

In general, attendees appeared to be in agreement with the recommended projects that were put forward to address stormwater-related problems in the basin. There were many questions about funding and when projects might get constructed. Staff responded that the projects are only

recommended at this point, and that once on the CIP, they will be put in the queue for funding and construction along with other City priorities. There is no guarantee that these projects will be constructed or a timeframe for when they will be constructed. Specific concerns on projects that we heard include the following:

- (Zack-CIP-1)-Tamarack tightline should be extended up the hill in the basin, and pipe size should be confirmed. There were concerns about open, lined ditch (rather than a pipe), and that the pipe is undersized. Response from project team is that final design will include a final analysis of pipe size, type and location to meet the objectives of the project (reduce drainage issues in Tamarack)
- (Zack-CIP-3)- 210th Ave NE drainage improvement. Several attendees expressed support for this project but were concerned about the size/heights of the French drains on the road. They were not concerned about freezing or ice because people generally use other routes during those conditions because the road is steep. A nearby property owner provided input on her personal property issue in the same vicinity. She has erosion on the back side of her property (behind her house) from high groundwater or surface runoff from the uphill neighbors. Another property owner on 210th Ave NE wondered if the project would benefit his parcel such that he wouldn't have to implement LID (Answer: No). He also wondered if the French drain system might intercept contaminated water from failed septic systems and deliver to the stream more quickly. He had concern about failed septic systems in the neighborhood.

Public Comments on Draft Plan

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Comments on Zackuse Creek Draft Basin Plan

March 29, 2019

There is a lot of good work in the draft plan related to identifying storm drainage maintenance issues along with suggested fixes. There is language regarding Zackuse Creek itself as an important stream for Kokanee recovery and habitat into the future.

I have two broad concerns with this draft basin plan. First, despite policy guidance in he adopted Water Quality and Riparian Habitat Monitoring Plan, no actual water quality information was used in developing the plan, the description of challenges facing the basin, or the project lists. Second, storm drainage problems in my neighborhood are downplayed as to their scope and origin nor are they listed for any corrective action.

Concern 1:

In the Council adopted Water Quality and Riparian Habitat Monitoring Plan, adopted in September 2018, there is reference to the newly completed culverts to provide Kokanee better access to key spawning habitat. That plan also discussed water quality monitoring specifically for Zackuse Creek.

> **"Monitoring Zackuse Creek (Figure 4) will provide important data to guide these restoration projects, evaluate their effectiveness, and protect the City's investment in this stream. This report recommends:**
>
> **• Monthly routine stream water quality monitoring**
>
> **• Annual B-IBI sampling**
>
> **• Continuous streamflow and temperature gaging "**
>
> Page 38, City of Sammamish Water Quality and Riparian Habitat Monitoring Plan September, 2018

And yet, in April of this year 2019, the City Council will consider a Draft Basin Plan for the Zackuse Creek Basin absent any actual water quality information. The plan itself is absent recommendations for improving water quality in Zackuse Creek except for some needed landslide prevention and garbage removal efforts.

The authors of the Water Quality and Riparian Habitat Monitoring Plan, in fact addressed water quality in Zackuse Creek at the bottom of page 38

The decision to develop a basin plan and to specifically decide not to test the actual water in the basin is negligent in my opinion. Perhaps the water quality does not suffer from pathogens from old septic systems in the basin or contain heavy metals, known to be harmful to fish and humans, but it is very probable given the testing results from the adjacent streams facing lake Sammamish, including Laughing Jacobs, Pine Lake Creek, Tibbets Creek and George Davis Creek.

The Council adopted City-wide water quality monitoring plan included a statement from the authors in a footnote on page 38 that instead of testing Zackuse Creek

> **"This report assigns a lower priority to monitoring metals concentrations in Zackuse Creek, given the expense. It is expected that metals concentrations in Zackuse Creek would be generally similar to nearby streams (both in Sammamish and the Puget Sound region), which had some concerns with copper, lead, and zinc for salmonid health (see Section 3.1.3). Instead of gathering more data, it would be more useful to improve storm water treatment to reduce metals entering salmonid habitat."**
>
> Footnote, page 38, City of Sammamish Water Quality and Riparian Habitat Monitoring Plan

Despite this warning regarding the likely presence of metal contamination known to impact salmonid health, the Basin Plan has been drafted absent any actual water quality sampling or project locations or projects designed to address this very common urban runoff problem. Developing Basin Plans including project identification should not occur absent water quality information and it is certainly not how we honor our commitment to recovery of our resident Kokanee population.

A remedy to this backwards approach (Basin plan development before water quality testing) to Basin Planning is to include a commitment by the City Council to revisit the Zackuse Basin Plan at such time as the water quality information becomes available.

Concern 2:

My Tamarack neighborhood has had drainage problems dating back to the turn of the century, the year 2000. I participated in the discussion and the funding of preliminary drainage plans in 2006 and 2007 as a City Council member and Mayor. And yet the draft Basin plan does not include anything other than a vague description of the problem and no project is listed.

The idea that private roads means that the City can continue to approve building permits that increase the runoff while suggesting that private residents need to solve the problem is not right. I own part of a private road, but I do not have a right to build, construct or modify any drainage on my neighbor's property that they own. Only the City can act in the public interest to acquire drainage easements and make improvements. With or without a Local Improvement District, this is what needs to happen before more landslides are impacted by houses built under City of Sammamish authorized permits.

The City staff and Council should ask themselves in the final stages of the development and adoption of this plan, how does the plan meet the related Goals and Policies and Master Plans?

RELATED CITY GOALS, POLICIES, AND MASTER PLANS:
Environment and Conservation

- **Goal EC.1 Serve as a leader in environmental stewardship of the natural environment for current and future generations.**
- **Goal EC.2 Protect people, property and the environment in areas of natural hazards**
- **Goal EC.5 Maintain and protect surface water and groundwater resources that serve the community and enhance the quality of life.**

Of all the basins the City of Sammamish could have picked to develop and adopt a basin plans without water quality information, Zackuse is perhaps the worst pick. With all the money, time and funding the City and others have put into Kokanee recovery the very idea of developing a Zackuse Creek basin plan without any information on water quality to inform the process is disappointing and wrong.

Thank you for your consideration of my comments.

Mark
[redacted]

From: John [redacted]
To: Danika Globokar
Subject: Re: City Soliciting Your Input: DRAFT Zackuse Basin Plan Posted Online
Date: Tuesday, March 26, 2019 10:23:42 AM

Danika,

Thanks for your response. I have a vacant parcel ([redacted]) on [redacted]. Are there any proposed development projects in that area to mitigate? Also it looked like my neighbor to the south reported drainage flooding.

I guess I am just trying to figure out if the problems in that area are going to be addressed, and how.

Thanks,

John [redacted]

> On Mar 25, 2019, at 5:24 PM, Danika Globokar <dglobokar@sammamish.us> wrote:
>
> Hi John,
>
> I'm collecting comments via email, directly to me. If you have a particular area of the basin you're concerned about, you can let me know and I can direct you to the specific place in the Basin Plan where you might find that info.
>
> One of the goals of the projects was identifying drainage issues from citizen input, hydraulic modeling, and field investigations. A lot of the 220 pages describes our field work and the current status of the health of the Zackuse Basin, as well as summarizing the drainage issues.
>
> From these issues, my team developed potential projects and actions that the City may implement in the future to improve the health of the basin, and reduce stormwater and drainage issues. **I think that final list of recommended actions is what some people may be most interested in. To get a summary of these, please see Chapter 7 (page 79-91).** Appendix E (page 185) includes a table with all the projects. Appendix F (page 187) contains summary sheets from each project. Note there's no guarantee of

implementation of any of these projects, as they must be compared to the need of implementing projects City-wide.

Thanks for the feedback about the email being a bit too vague, and the document being too daunting. My head's been buried in it too long. I'll be sure to include a brief "go to this page if you're interested in X" in the final email reminder I send out later this week.

Thanks,
Danika

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From: John [redacted]
Sent: Monday, March 25, 2019 3:16 PM
To: Danika Globokar <dglobokar@sammamish.us>
Subject: Re: City Soliciting Your Input: DRAFT Zackuse Basin Plan Posted Online

Danika,

Thanks for the update. I have to admit however I got a bit lost in the several hundred of pages. Was there a place to comment? Candidly, I could have used a better summary of the study.

John [redacted]

On Mar 19, 2019, at 2:19 PM, Danika Globokar <dglobokar@sammamish.us> wrote:

Dear resident,

At some point in the last year, you've either attended an Open House for the Zackuse Basin Plan, or contacted me with concerns about storm and/or surface water in the watershed.

From late 2017 through early 2019, I've been working with a consultant team to investigate drainage issues in the Zackuse Basin. We've also developed possible solutions that the City or others could implement to improve storm infrastructure and surface water resources in the Basin, and we shared those preliminary conceptual plans with citizens in August 2018. I'm now reaching out to citizens who live in the Zackuse Basin to provide input into the City's developed final DRAFT Zackuse Basin Plan. Feel free to share this email and the links with your neighbors.

Do the projects and recommendations we developed capture your understanding of the basin, and are they what the basin needs? Let me know by calling me or emailing me **at** this email address. The comment period will be open from **March 18th through March 29th.** We plan to present an introduction to the Basin Plan to City Council on 16 April.

Link to the project webpage:
https://www.sammamish.us/government/departments/public-works/storm-and-surface-water-management-program/storm-surface-water-projects/zackuse-basin-plan/

Link to the DRAFT Zackuse Basin Plan (also posted at the bottom of the project webpage):
https://www.sammamish.us/attachments/pagecontent/51881/February%202019%20Revised%20Draft%20Basin%20Plan%20Report.pdf

Feel free to contact me with any questions or concerns you may have. I greatly appreciate your feedback!

Thank you,
Danika

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From: Danika Globokar
To: [redacted]
[redacted] Zackuse Basin Plan - Public Comments/Input
Date: Friday, March 29, 2019 2:57:21 PM
Attachments: Zackuse Basin Plan_Feedback from Jacey Harder.pdf
Comments on Draft Zackuse Basin Plan Mark Cross March 29 2019 final .pdf
RE City Soliciting Your Input DRAFT Zackuse Basin Plan Posted Online.msg

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[redacted]

Here is what I received from residents (or their agents) in the basin. Two are attached as PDFs. One is attached as an email item. Two are copied and pasted below. I expect [redacted] to arrive tonight (she requested a slight extension).

FROM GARY [redacted]

Danika,

Wow - I'm so pleased to see that the "Retrofit West Montage Neighborhood - Zack-CIP-1" received a prioritization score of 55!! That is absolutely wonderful!

Mary [redacted] and I have had the concern for years that the West Montage system needed a redesign or at least serious maintenance! It will be such a relief to see improvements made to that area.

I was hopeful that some work could also be directed to the slide area just north of our 206th Ave culverts. You list land slides as a high risk item that seriously contributes to downstream sedimentation. Any work to reduce that area's slide potential would truly be a good investment in the protection of Zackuse Creek restoration. That stated - I also certainly understand the many demands placed on your limited funds/time.

We thank you and Tawni for all that you have accomplished!!

Hope to see you both next Tuesday to meet with David to discuss the 206th culvert replacement project!
Gary and Mary [redacted]

FROM FRED [redacted]
Hi Danika,
Per our conversation late Monday (Thankyou for working late!), I am sending you a note regarding the culvert replacement and upsizing needed under the new trail located at East Lake Sammamish Parkway and Thompson Hill Road. The existing culvert does not look to be long enough for the new trail being constructed and while it should be extended in length, it would be good to increase the size (diameter) of the culvert so that any future need would not require excavation of the trail to install a new culvert. Thanks for your attention to this with

King County in the next day.

Please let me know if I can be of assistance. Let's address this now instead of later.

Thank You!

Fred [redacted]

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Response to Revised Draft Zackuse Basin Plan, dated Feb 4, 2019

Written by Jacey [redacted] property owner at [redacted], Sammamish

Introduction / Background

- Thank you for the education and such comprehensive work of area water issues.
- This response is driven by concern for salmon habitat, including downstream from the 206th Ave culvert replacement and stability of our hillside.
- It seems there hasn't been as many visitors specifically to our property as with other parts of the creek. My perception is there is are multiple organizations and individuals who are passionate about this creek. I'm surprised there isn't more discussion about future landslides, and I suspect lack of awareness is the reason for not targeting the landslide on our property for future fixes. I'm at a loss for how to spread the word or how to navigate these organizations. Hopefully this response helps to share information for action.
- We had a landslide in spring 2017. The area continues to erode, saturation is heavier this spring compared with last spring, and since the landslide water now constantly flows from the area.
- References can be found by looking for the associated *blue dot* in this presentation. The experts won't need most of these references, but they're here just in case.

- The tone of my "assertions" is not meant to be authoritative. I'm doing the best I can to piece together the information and summarize for awareness and, hopefully, action. Your expertise is always solicited and not meant to be questioned.
- Experts are eagerly welcome on our property to survey the landslide.

Assertions / Information / Questions

- **Another landslide into Zackuse Creek is highly likely.**
  - A geo survey of this area says there is concentrated groundwater seepage in the area of the 2017 slide, and there is of ground failure and landslide that could introduce a high sediment load into the stream, or temporarily block the stream. (Ref C).
  - "…sediment [in our landslide] is temporarily stored in the bench but will likely continue to be mobilized and deposited downstream during high flow events…factors that often result in such slope failure [are found in the vicinity of the slide, such as the 40% slope and] … gravelly deposits that infiltrate well and erode…juxtaposed over less pervious material… Slope failures tend to occur when the weight of the soil and the water in the saturated material becomes too heavy to maintain its natural position on the slope." (Ref F for property location, Ref D / Pg 18 of Report for similar wording as above, Ref J for above excerpt)
  - The next side would occur in an area with even steeper slopes than the spring 2017 slide. This will continue to be the case as the slope is area is moving uphill (Ref C) towards Louis Thompson Rd. Check two videos of the property today. Links are at Ref B, Videos 2 and 3. A pictures we've taken to show slide progression since summer of 2017 (Ref's N-P).
- **This area is either viable salmonoid habitat or an area that directly impacts viable habitat.**
  - Trout and peamouth chub were both found in our part of the creek within the past year (Ref's A &B). Is this life an indicator of an environment fit for salmonoid? Or close to fit for salmonoid with small habitat improvements?
  - The area immediately below the 206th crossing is deemed viable (Ref H, Pg 49 of Report), and the 206th road crossing culvert is being replaced to allow fish to pass. The culvert will lead the fish onto our section of the stream. Why would the culvert be replaced if the section above the culvert (aka: our landslide area) doesn't support fish? This is really a question, not rhetorical.
  - The larger section of the stream above 206th is deemed too steep for salmonoid (Ref G, Pg 42 of Report) but what about the small section between the landslide on our property and 206th? The **slope** seems (I really don't know) to be the same as the area below the 206th crossing which support salmonoid. (Ref B, Video 1)
  - The video (Ref B, Video 1) shows how close the slide is (**proximity**) to this fish area below 206th. WDFD says **coho salmon are present in Zackuse Creek up to near the 206th Avenue NE crossing** and seem to not go further because of the 206th road "barrier" (Ref G) (which is being fixed), not because the actual stream changes on the upper side of 206th.
  - Is the stream viable with our avg 3" stream bed material size? (Ref F) Compared with the small to medium sized gravel needed for salmonoid? (Ref K)

Assertions / Information / Questions Continued…

- **Failure to prevent future slides could harm spawning salmonoid.**
  - "Kokanee use the stream only for spawning and egg incubation, from approximately November through May…water that is relatively free of fine sediment … is needed during the winter incubation period. Flows also need to be moderated and slopes stabilized to avoid excessive scour or deposition, which would sweep away or bury and suffocate, respectively, incubating eggs…" (Ref K)
  - **"…**landslide activity can also have negative impacts on salmon spawning. Landsliding on adjacent Ebright Creek is thought to be responsible for essentially wiping out an entire year class of incubating kokanee due to suffocation by fine sediment." (Ref K)

- **Why didn't this landslide make it to the list of possible capitol improvement projects? Even if "not ranked".**
  - "Reduce risk of landslides" was the 2nd priority from the resident survey. (Ref D, Pg 11 of Report) This same survey where ranking criteria for capitol improvement projects was also derived. (Ref D & L)
  - This landslide was on the priority list of a prior version of priorities; displayed during a meeting at City Hall.
  - *The City of Sammamish Comprehensive Plan* (2015), Environmental Conservation (EC) goals apply to this situation, "Protect people, property, and the environment in areas of natural hazards." (Ref D, Pg 7 of Report, Goal EC.2)
  - The cost to fix this landslide issue might be relatively small considering other expenditures. An estimate to comply with geo-tech mitigation recommendations was $38K. (Ref M)

The following pages are for Reference only.

From: Danika Globokar
To: [redacted]
Subject: FW: Input for Revised Draft Zackuse Basin Plan due 3/29/2019
Date: Monday, April 1, 2019 5:32:15 AM
Attachments: Input after Review of Revised Draft Plan Zackuse Basin.doc

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[redacted]

[redacted]

[redacted]

From: Mary [redacted]
Sent: Friday, March 29, 2019 9:37 PM
To: Danika Globokar <dglobokar@sammamish.us>
Subject: Input for Revised Draft Zackuse Basin Plan due 3/29/2019

Dear Danika,

a1) Aug2018: **CIP-1 was 65pts Tamarack Tightline (NE 4th ST to Louis Thompson Rd NE) and should NOT be relegated off the list**
+see pgs 116-**117** of 220 online 65pts outranks 55pts for Zack-CIP-1 Montage.
+ pg **111** of 220 see Q4 and A5 survey results on public input for projects/priorities
and then pg **176** of 220:
-if the public benefit is greater in scope than the public cost... public funds have been invested to evaluate issues, and develop potential actions in support of determinations of whether further public funds would result in a clear public benefit

There are public benefits for managing stormwater, controlling overflows for safety, dealing with groundwater seepage, reducing landslides and erosion that also takes sediment and pollutions down stream (to Zackuse) and impacts high peak flows, protect groundwater, avoid contamination of septics, meet NPDES requirements, provide what the GMA requires, reduce maintenance and time staff and council spend on unresolved issues and respond to/address complaints, etc. The City has stated requirement for public drainage easements to do work in private areas, and impacted Tamarack owners have understood this. Working with agreeable parties has great value vs not taking this opportunity. There is also great value to getting and having easements for public facilities/drainage and use. The City is doing other work on private property and buying land too. Basin planning is to reduce flooding, erosion, protect property too.

a2) The Zackuse Basin plan ignores the northern portion of the basin. Please see my MS Word .doc file attached regarding Tlingit, Tamarack, ELSTrail etc
-Lake Sammamish Water Quality is not great, and Category 2 and 5 for several things--this is missing entirely from the Basin Plan draft

-NPDES and 2016 KCSWDM clarified requirements for untreated stormwater infiltration within 1/4 mile of sensitive lakes/Lake Sammamish
-Groundwater, aquifers, public wells, and private wells should all receive protection and this too is missing entirely from the Basin Plan draft
-Septics should be maintained by owners, protected against stormwater intrusion by the City and Codes/regs, protecting water quality
-Groundwater seepage is the result of stormwater NOT being managed enough nor comprehensively and causes further problems in LHA and septic areas
-Where growth has occurred without adequate stormwater facilities by the time of occupancy, there are problems/issues, and hazards must be protected until problems are alleviated
-infiltrative soils can be saturated by too much flow, too fast, too long a duration and this must be dealt with through comprehensive management of stormwater

b) ZACK-CIP-2 Sheet flow on Louis Thompson at 210th AVE NE should be combined with Tamarack Project 2 (pg 182-184 of 220) and funded publically
+Add extension of drainage to the North side of NE 4th ST to pickup excessive development related runoff caused by Growth in Tamarack without tightline
+This would help address flooding, help with erosion and silt/sediment, and solve cross-subbasin overflows on 210th AVE NE present since 2013
+private roads do not need to be assumed by the city, but public drainage easements can like and should be obtained for project and future maintenance
+consider extending tightline along south side of NE 4th ST to 210th PL NE (with stubs) where the Landslide Hazard area begins, and pipe is needed
+there is groundwater seepage is worrisome in landslide hazard areas, LID techniques/french drains/checkdams, are not feasible/suitable given the soils

c) ZACK-CIP-3 Louis Thompson Road tightline (liken to CIP for "historic" Inglewood neighborhood on Inglewood Hill Road--SW, H2O, sewer, sidewalk(s))
+Modify modeling to include FULL BUILDOUT conditions in Zackuse Basin, as tightline (and sewer) will allow growth, remodeling, redevelopment
+pg **160** of 220 does not seem to include "side streets" or enough of them. Water flows downhill and takes the easiest path. Tamarack flows west/south!
+Detention is not address and will be needed for Flow Control, and 18-inch pipes may not be large enough for full-buildout of basin to Louis-T.
-Eden View stormpond is too small and not well-sited for large use
+Tlingit condition report and actual capacity in use would be very good to know, plus potentially using a flow meter for this next year to get data
+Tlingit detention pipe within 205th AVE NE is truly worth looking into (existing condition/capacity), retrofit as a shared facility for drainage
+Add water quality for area just below/west of Louis Thompson Rd NE at East Lake Samammish Parkway.
+King County ELST has a Walkway planned to connect the Trail and the Parkway... NOW IS THE TIME TO work with and do City projects with the ELST
+Ensure KC drainage existing and planned will be sufficient for existing, CIPs planned, and all future growth/development in Zackuse Basin

d) ZACK-CIP-4 Intercept groundwater on ELSParkway just north of Louis-T traffic signal
-City of Sammamish has major road/arterial that does NOT have roadside drainage... this must be fixed!
+Couple this CIP with #3 Louis-T tightline, and add Water Quality treatment under the KC ELST Walkway for road pollutants and all SW directed here
+Find any catch basins that got covered up when paving was done in 2013 on Louis Thompson, ensure that CCTV was done to identify all existing drainage

e) I think ZACK-CIP-5 was done (??) with the Slide Repair on Louis-T Road in 2018 at 210th PL SE and 211th PL SE

f) I think ZACK-CIP-6 might be required by NPDES for asset management and maintenance of drainage systems (must find the CB)

g) ZACK-CIP-7 WQ and flow control can be done lower down at 205th AVE NE/Tlingit and by KC ELST Walkway
-consider roadside WQ like was done for Inglewood CIP project

h) ZACK-WQ-2 any water quality monitoring should start sooner than later as it takes time to get baselines and evaluate
+rain gauge(s) is/are needed too in the area of either Zackuse headwaters and/or Ebridge Creek to develop rainfall-to-runoff ratios
+budget for 3 precipitation gauges for uploading via telemetry was available in the past, and the City plans for 1 rain gauge (at the Commons?)
+SPW has shared their rainfall data publically online via KC Hydrology website, and KC will host data for free making it available generally for anyone
++Three days of rain >=1.0 inches is statistically significant for landslides... and matches events that have occurred in Zackuse Basin and our City

i) City-Pol-1 Climate change is real, and using whatever King County might do is a good idea and to implement

j) City-Prog-1 Maps are needed, and public accessibility and access to information is vital and essential
+Sammamish Property Tool lacks streams layer
+Steep Slopes mapping is missing though mapped in the 2015 Comp Plan generally, and specifically in Inglewood & Tamarack Emergency Ordinances

h) Flow control is best handled via detention in Zackuse Basin due to steep slopes, landslide hazards and soils.
+Detention costs are some of the biggest numbers
+Water Quality costs will increase $ too, but really increase the chance for getting grants
+Best chance to get grants now/sooner as later everyone will want $ for WQ or it will just flat be required

i) Tawni Dalziel informed me that NPDES requirements upcoming this June 2019 will REQUIRE Basin planning.

k) If Zackuse Basin plan is really to be the template, format, process, procedure for doing future basin plans, then there are pieces missing identified within my inputs with this email (flooding, erosion, groundwater seepage, water quality, degrading of not only habitat but important trees and vegetation for stability, and septic factors with education for best maintenance, understand fix/replace costs, protections for SW to NOT compromise systems--working or reserve drainfields, identify and reduce fecal coliform in basin, NPDES/KCSWDM requirements, and surely pedestrian and vehicle safety due to water over roads etc.)

l) Ensure **Stormwater Code Amendments** truly take into account protection of Landslide Hazard areas, drains to, steep slopes, setbacks/buffers, and avoidance of land disturbance... and certainly NOT putting water/stormwater into soils and slopes which causes safety issues, slides, and other downstream detrimental, deleterious impacts

m) Ensure **Interim/Permanent Development regulations** protect critical areas, define clearing limits BEFORE any work begins, limits grading, etc.

I appreciate the amount of work being done in support of basin planning and stormwater projects. Thank you for this opportunity to provide input earlier.

Best regards, Mary [redacted]

Attachment 4-page .doc

Detailed Input/review of Revised Draft Zackuse Basin Plan 3/29/2019 M. [redacted]

Tlingit Plat was recorded 1984, & please also fix misspelling "Tlinget" throughout.
Tlingit is pronounced "TLIN-git" or "KLIN-kit."
English pronunciation of their native word *Lingit*, which means "people."
http://www.bigorrin.org/tlingit_kids.htm Wikipedia: "People of the Tides" (also spelled Tlinkit.)

Tlingit has public roads and stormwater system serving 23 of 28 Lots in the 1984 Plat. There are 5 lots (1,2,4,5&6) with individual infiltration systems—plus unplatted adjacent. **Per NPDES regulations, 2016 KCSWDM clarified requirements for infiltrating within ¼ mile of a "sensitive" lake, Lake Sammamish. This is totally ignored.**

Tlingit has flow control via the 205th AVE NE in-road detention pipe 160 lin. ft, 72" diam. (Myron Anderson see especially page 2 of 4 in the Engineering AS-BUILT dated 1983)
https://maps.sammamishwa.gov/arcgis/rest/services/EngrVault/EngrVault/MapServer/dynamicLayer/154/attachments/328?layer=%7B%22source%22%3A%7B%22type%22%3A%22mapLayer%22%2C%22mapLayerId%22%3A0%7D%7D

This public stormwater system in public roads is mostly Corrugated Metal Pipe (CMP) which has a 30-year (with maybe 40 years) life expectancy. 2019-1983 = **36 years old**
Verbal info from former Public Works Director, Steve Leniszewski

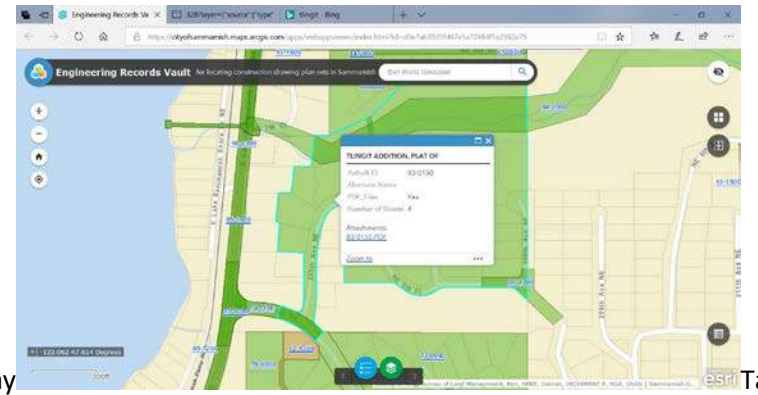
The City/consultants have never clarified if/suspects additional capacity in this system?
Tlingit roads (public) were slated for asphalt pavement overlay in 2015, but not done yet "Tlingit neighborhood was a potential site to be repaved this year but we pulled it from the list because PSE is replacing some of their gas mains in the area" per 5/1/2015 email cpaston@sammamish.us

The City needs detention in this area of the Zackuse Basin for existing/future dev.

ENTIRELY MISSING is the FACT that East Lake Sammamish Trail (ELST) is in 90% Plans from King County, permitting via the City of Sammamish, for public walkway at/below the intersection and traffic signal at Louis Thompson Road NE and ELSPrkwy.

Tlingit/205th Ave has public road/land for detention and stormwater retrofit for City uses!!

Water Quality should be done, and if planned/constructed UNDER the KC WALKWAY would be able address WQ issues and improve WQ just before it goes to Lake Samm.



KC ELST 90% - Walkway Tamarack 1964

M. [redacted]

In five (5) Emergency Surface Water Management Ordinances 2014-2016 the City of Sammamish defined "historic" plats as <1977. Tamarack 2-pg survey/Plat was directly recorded by the King County tax Assessor in 1964. Homes build piecemeal, roads have ditches that run alongside each street/avenue with culverts under roads and driveways. Thus, ditches & culverts do provide drainage as a conveyance system for stormwater.

King County first made drainage recommendations/guidelines in 1969-1971, but did not have drainage requirements until 1977, and flow control was first required in May 1979. [Consultant use of Ecology "1992" on page 15 (28/220 online) is interesting, but rather misleading to use for the Zackuse Basin which was constructed/built in King County.] Use King County dates instead in Table's 3rd column- as K.C. regs applied in this area. [Could keep 1992 info for Ecology as Footnote Ecology requirements is good info.] *Also, strongly suggest table rows be re-sorted from OLDEST to NEWEST. Break out Tamarack 1964 from Tlingit 1983 as they are separate neighborhoods, not combined.*

There are numerous complaints and truly important issues and concerns in "historic" neighborhood, <1977 per City, Tamarack (1964 Plat) that lies just above/east of Tlingit. The City of Sammamish has many studies since 2007 due to # of drainage issues here. **Tamarack-West flow Option B** could connect to Tlingit public stormwater system, and detention is needed as City consultant Osborn studied 2011-2013+recently in Nov 2016. **Tamarack-West flow Option C** could use/connect via "the ravine" to Eden View Plat (1977) Stormwater Pond #D98038. All impacted owners signed Rights Of Entry (ROEs) for surveys and work done in 2016 for Downstream Analysis of NE 4th ST tightline. City has indicated requirement for "public drainage easements" needed to build the project. All residents/owners impacted understood this requirement and seemed agreeable.
Drainage/easements have a "value" & public benefits, which were emailed to City Manager Lyman Howard & Finance Committee.

Tamarack was 60% developed when City of Sammamish incorporated (8/31/1999). There are 210 lots in the Plat, and *growth occurs by "in-fill" development as existing recorded single-family-home R-4 size Lot adds a new home in a "piecemeal" way.* Through City permitting/review/& approvals… 40+ new homes were built 2000-2016. Tamarack is now 80% developed and still has 40 Lots (R-4 size) left as Vacant to build.

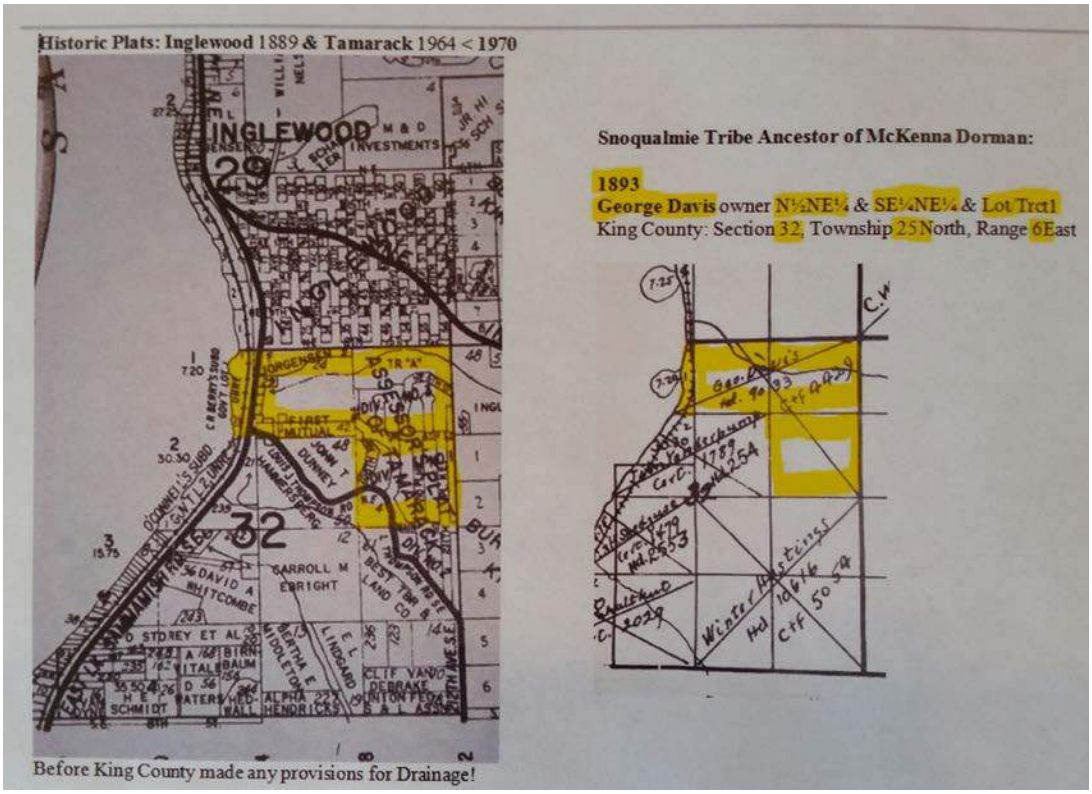
Adopted SMC 24.20.010 **East Lake Samammish Basin Plan** (1994) p.iii (5/145 online) says in steep drainages (N. Monohon=Zackuse Basin) "*pipe down the west slope*" also mentioning retention/detention and water-quality treatment. Yet no tightline pipe exists! https://your.kingcounty.gov/dnrp/library/1994/kcr910-01.pdf

The City of Sammamish used old regulations (1998) until forced to adopt 2016 code. Landslide Hazard Drainage Areas as "drains to" Landslide Hazard Areas was added (mapped) above Tamarack's belly-band of LHA in December 2016 effective 1-1-2017. [The soils in the Revised Draft Zackuse Basin plan are described and well-illustrated.] Stormwater from development *saturates the soils* causing flooding, erosion, & crosses a subbasin boundary in Tamarack on 210th AVE NE; large volumes to Zackuse Creek.

Cross-subbasin flow must be dealt with and a tightline added in Landslide hazard areas.

Tamarack Plat lies directly adjacent on the south to the 1889 "historic" Inglewood Plat. Tamarack 1964 lies E/above Tlingit 1984 Plat. Surface/Stormwater flow from Tamarack North to George Davis Creek (is NOT in Zackuse Basin); Westward where a tightline pipe for drainage is truly needed, and Southward to Zackuse Creek… not to be ignored!

McKenna Sweet Dorman spoke at City Council on 10-11-2016 and BLM/GLC traces her *Snoqualmie Tribe Ancestory* to "George Davis" who owned 2/3 of Tamarack in the 1880s + all lands westward (Tlingit, etc.) all the way to the shores of Lake Samammish.



Revised Draft Zackuse Basin Plan uses the wording "Tamarack Ravine" and lumps *Tamarack, the parcels below it, and Tlingit all combined into one neglected item.* Plus, there is NO RAVINE within Tamarack. Use instead "the ravine below Tamarack".

Windward Environmental LLC in 2011 did a field visit while studying Tamarack and the area. Two key things were noted: In Tamarack, on 210th AVE NE just south of NE 4th ST the roadside *"ditch ends"* (flows going cross subbasin started about 2013); Windward walked "the ravine" parcel below Tamarack noting, *"no evidence of any surface water flow"* in 8/8/2011. In 2012 a private tightline for drainage was permitted by the City and approved using only an 8in diameter pipe to outfall just below Tamarack—the volumes of stormwater runoff, speed, and duration have created the stream/channel p52 65/220 photographed by the City/consultant for the Revised Draft of the Zackuse Basin Plan. The info in the Draft report states 2007 & is in error; flows not present until 2012 and the flow channel has become defined since that time—too much flow, not able to infiltrate.

M. [redacted]

I have provided City, Council, and Staff information and photo records of the flow channel (noted by AltaTerra) running like a "stream" to and through the bottom of "the ravine" below Tamarack. There has been such extensive runoff, and for months at a time, that a private well shed is flooded and runoff has flowed all the way to the Louis Thompson Road NE north-side ditch! This is untreated stormwater runoff that infiltrates within ¼ mile of sensitive Lake Sammamish, and may also be affecting groundwater. Due to the soils, history of that particular area, and septics being present, it seems very likely that flooding on Eastlake Sammamish Parkway is related to these saturated soils.

Additionally, there is a stormwater pond from 1977 built for Eden View which is just above this old private well (circa <1950) and this area being flooded often by extensive development-related runoff outflowing westward from Tamarack. Thus, while this well-head area should have a standard 100-foot sanitary setback, it is considered *"poorly protected"*. In fact, groundwater contamination is likely if not already be occurring! [Link from Peter Isaksen, Environ. Health. Srvcs/KC Dept of Health email 2/23/2018] https://www.kingcounty.gov/depts/health/environmental-health/piping/drinking-water/shallow-wells.aspx

Eden View stormwater pond was transferred from KC to the City in 2000, and was a "forgotten" stormwater facility until 2009 when City MOS unburied it from blackberries. Built in 1977, before KC May 1979 flow control requirements, holds just a small amount of surface/stormwater runoff & only during very high rain/runoff periods (p.35 48/220.)

Tlingit in-road detention pipe (& Eden View stormpond?) are important to look at for K.C. ELST Walkway for pedestrian & vehicle safety… plus all basin growth. Tamarack drainage improvements have been studied because a solution is truly needed which involves a tightline pipe for safety in the landslide hazard area, and detention as flows in Zackuse Basin run from 500ft in elevation to 40ft at Lake.

Ignoring the north half of the Zackuse Basin in the draft report is just not warranted. There are public stormwater facilities the City owns and needs to be aware of and care for. Also, these resources can be used and linked together to provide solutions to drainage problems for both existing development and future growth.

Couple Tlinigit, Eden View resources and Tamarack drainage issues together with both *Zack-CIP-3 Louis Thompson Road tightline*, and with solution(s) for Zack-CIP-4 flooding of *Eastlake Sammamish Parkway* just north of Louis Thompson Road NE intersection / traffic signal. Add Water Quality treatment where ELST Segment 2B puts a Walkway!

Tamarack – draft does not fully show problems reported on various/all draft maps.
Omission:
Pg **175** of 220, On 7-Apr-2015 $271,000 was allocated for Phase 1 tightline NE 4th ST

Error:
Pg **176** of 220, paragraph after bullet, in 2nd line & 6th line fix "209th" to be "210th" Ave.
This flooding occurs often with steady flows, long after rains, as crossbasin overflows to Zackuse Creek.

Appendix B

Stream Survey Photo Log

Photo Log

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are organized into three sections; mainstem Zackuse Creek, South Tributary Zackuse Creek, and Upland Areas. For the stream survey, photos are shown in the order that the stream survey was conducted, from the most downstream point to the most upstream point. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Zackuse Creek are identified as Z-X, with X being the number of the photograph. Upland photos are denoted with Up-X, with X being the number of the photograph.

Mainstem Zackuse Creek

Photographs taken on the mainstem Zackuse Creek are shown in Figure 1. Photo location (i.e., approximate distance from start of the stream survey), number, and description are provided below each photo. Mainstem photos were taken on January 12, 2018, except for Photo Z-42a which was taken after installation of the new outfall in the fall of 2018.

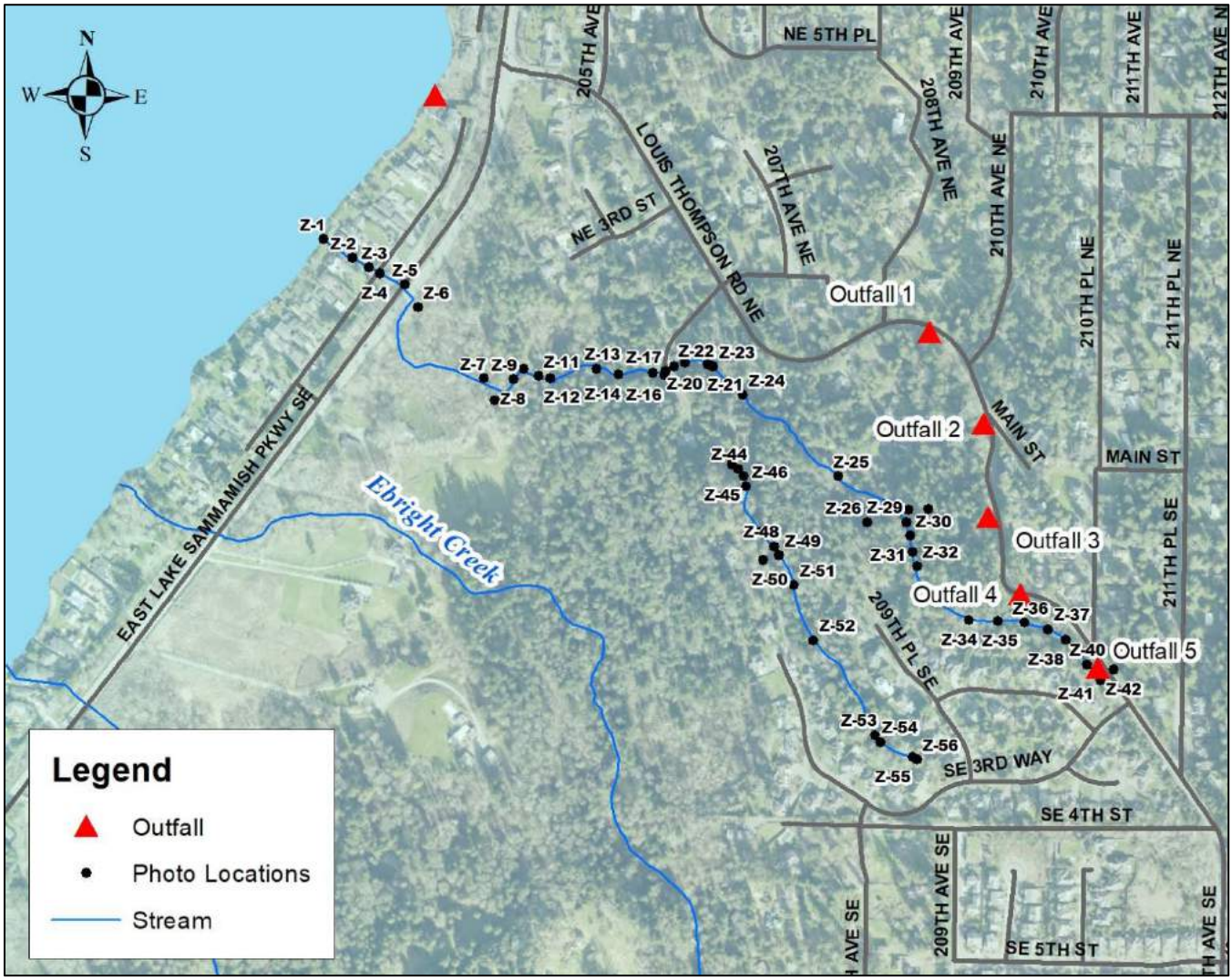


Figure 1. Zackuse Creek Mainstem Photo Location Points

Site location: Mouth of Zackuse Creek at Lake Sammamish
Photo number: Z-1
Description: Looking North

Site location: ~10' upstream of mouth
Photo number: Z-2
Description: Looking upstream from mouth to the east

Site location: 100' upstream of mouth

Photo number: Z-3

Description: Looking upstream at second culvert from mouth (photo taken from first culvert)

Site location: 200' upstream of mouth

Photo number: Z-4

Description: Looking downstream from Shore Lane at second culvert (from mouth)

Site location:	400’ upstream of mouth
Photo number:	Z-5
Description:	Looking downstream (west) from East Lake Sammamish Parkway at trail culvert

Site location:	450’ upstream of mouth
Photo number:	Z-6
Description:	Upstream side of East Lake Sammamish Parkway, looking south. Stream is flowing north in ditch adjacent to the Parkway (Parkway is on right side of photo)

Site location: ~1,100' upstream of mouth
Photo number: Z-7
Description: Looking upstream (east), near upstream end of future restoration project.

Site location: ~1,200' upstream of mouth
Photo number: Z-8
Description: Looking south at ditch entering channel.

Site location:	~1,300' upstream of mouth in alignment with ditch
Photo number:	Z-9
Description:	Looking upstream to the north, in approximate alignment with ditch in photo Z-8. Channel is incised approximately 3 feet, and flow direction turns 90 degrees to the west immediately downstream of this location, and 90 degrees to the east approximately 100' upstream of this location. This is location of dogleg. Sediment deposition appears to block flow, causing shift in channel direction.

Site location:	~1,350' upstream of mouth.
Photo number:	Z-10
Description:	Looking downstream to the southwest at location of dogleg. Channel is incised through thick sediment deposits.

Site location: ~1450' upstream of mouth

Photo number: Z-11

Description: Looking upstream to the east. Channel is incised approximately 3 feet, and flow direction turns 90 degrees to the south immediately downstream of this location.

Site location: ~1450' upstream of mouth

Photo number Z-12

Description: Close-up of streambanks, composed of unsorted loosely deposited sediment.

Site location: ~350' downstream of 206th Avenue NE
Photo number: Z-13
Description: Looking downstream where incision in channel is starting.

Site location: ~300' downstream of 206th Avenue NE
Photo number: Z-14
Description: Relatively stable, wider stream section.

Site location: ~100' downstream of 206th Avenue NE

Photo number: Z-15

Description: Looking upstream (east) at log weir installed by King County (c. late 1990s)

Site location: 206th Avenue NE

Photo number: Z-16

Description: Birdcage structure and energy dissipation for stormwater outfall, conveying discharge from Montage neighborhood

Site location: 206th Avenue NE
Photo number: Z-17
Description: Looking upstream at twin 24-inch-diameter culverts on downstream side of 206th Avenue NE

Site location: 206th Avenue NE
Photo number: Z-18
Description: Looking downstream at twin 24-inch-diameter culverts on upstream side of 206th Avenue NE

Site location: ~50' upstream of 206th Avenue NE
Photo number: Z-19
Description: Looking upstream. Right bank (left side of photo) is very wet (groundwater seepage).

Site location: ~150' upstream of 206th Avenue NE
Photo number: Z-20
Description: Looking upstream at right bank hillslope failure (left side of photo) and debris in channel.

Site location:	Same location as Z-18, looking downstream
Photo number:	Z-21
Description:	Right bank hillslope failure (right side of photo).

Site location:	~200' upstream of 206th Avenue NE
Photo number:	Z-22
Description:	Looking downstream at hillslope debris (both sides of photo- stream has cut through this material)

Site location: Same location as Photo Z-20
Photo number: Z-23
Description: Looking downstream direction (toward northwest), at hillslope scarp.

Site location: ~300' upstream of 206th Avenue NE
Photo number: Z-24
Description: Looking upstream at cascade.

Site location: ~900' upstream of 206th Avenue NE

Photo number: Z-25

Description: Looking upstream at flatter gradient channel through wetland area. Groundwater seepage extensive in this reach.

Site location: ~1,100' upstream of 206th Avenue NE

Photo number: Z-26

Description: Looking southeast at stormwater tightline from Montage neighborhood

Site location: ~1,200' upstream of 206th Avenue NE
Photo number: Z-27
Description: Looking north at right bank gully. Very wet conditions.

Site location: ~100' upstream of gully mouth with Zackuse Creek
Photo number: Z-28
Description: Looking east at exposed sidewall of gully incised approximately 6 - 10 feet into hillslope.

Site location: ~1,200' upstream of 206th Avenue NE

Photo number: Z-29

Description: Looking upstream at cut timber in the channel.

Site location: ~1,275' upstream of 206th Avenue NE

Photo number: Z-30

Description: Looking upstream at debris jam in channel. Lots of downed trees and narrow channel through this reach.

Site location: ~1,350' upstream of 206th Avenue NE
Photo number: Z-31
Description: Looking upstream, geology is more competent in this location.

Site location: ~1,400' upstream of 206th Avenue NE
Photo number: Z-32
Description: Looking upstream at boulder cascade.

Site location: ~1,500' upstream of 206th Avenue NE
Photo number: Z-33
Description: Looking upstream at channel. Short lower gradient reach between steeper sections.

Site location: ~1,600' upstream of 206th Avenue NE
Photo number: Z-34
Description: Looking upstream.

Site location: ~1,750' upstream of 206th Avenue NE

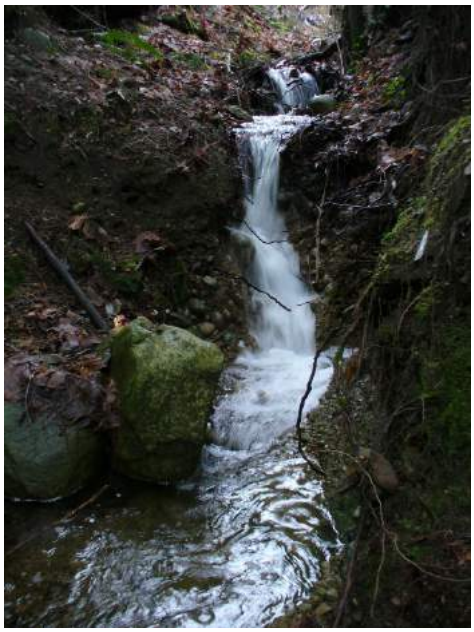
Photo number: Z-35

Description: Looking north up at Louis Thompson Rd. NE at Outfall 4 at the top of photo.

Site location: ~1,800' upstream of 206th Avenue NE

Photo number: Z-36

Description: Looking upstream on the downstream side of right bank slide (top of photo, slide is covered with black plastic) adjacent to Louis Thompson Rd.



Site location: ~2,000' upstream of 206th Avenue NE
Photo number: Z-37
Description: Looking upstream near right bank slide area, downstream of photo Z-38.

Site location: ~2,000' upstream of 206th Avenue NE
Photo number: Z-38
Description: Slide shown on left side of photo.

Site location: ~2,000' upstream of 206th Avenue NE

Photo number: Z-39

Description: Looking upstream at debris in channel (near slide).

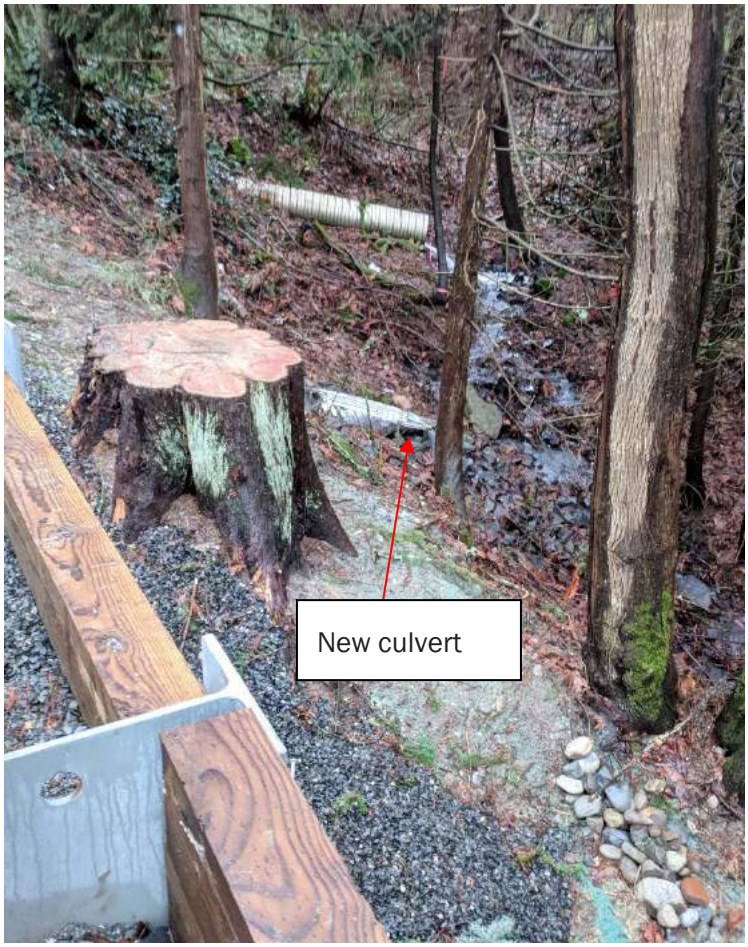
Site location: ~2,100' upstream of 206th Avenue NE

Photo number: Z-40

Description: Looking upstream at culvert (Outfall 5) discharging water to form the headwaters of Zackuse Creek.

Site location: ~2,100' upstream of 206th Avenue NE
Photo number: Z-41
Description: Close-up of culvert (Outfall 5) discharging water to Zackuse Creek (headwaters).

Site location: ~2,100' upstream of 206th Avenue NE
Photo number: Z-42
Description: Looking downstream at culvert discharging water to Zackuse Creek.



Site location: ~2,100' upstream of 206th Avenue NE

Photo number: Z-42a

Description: New culvert (installed in 2018) conveying stormwater from 210th Pl NE.

South Tributary Zackuse Creek (206th Ave NE to SE 3rd Street)

South Tributary Zackuse Creek photo locations are shown in Figure 2. South Tributary Zackuse Creek photos were taken on March 8, 2018.

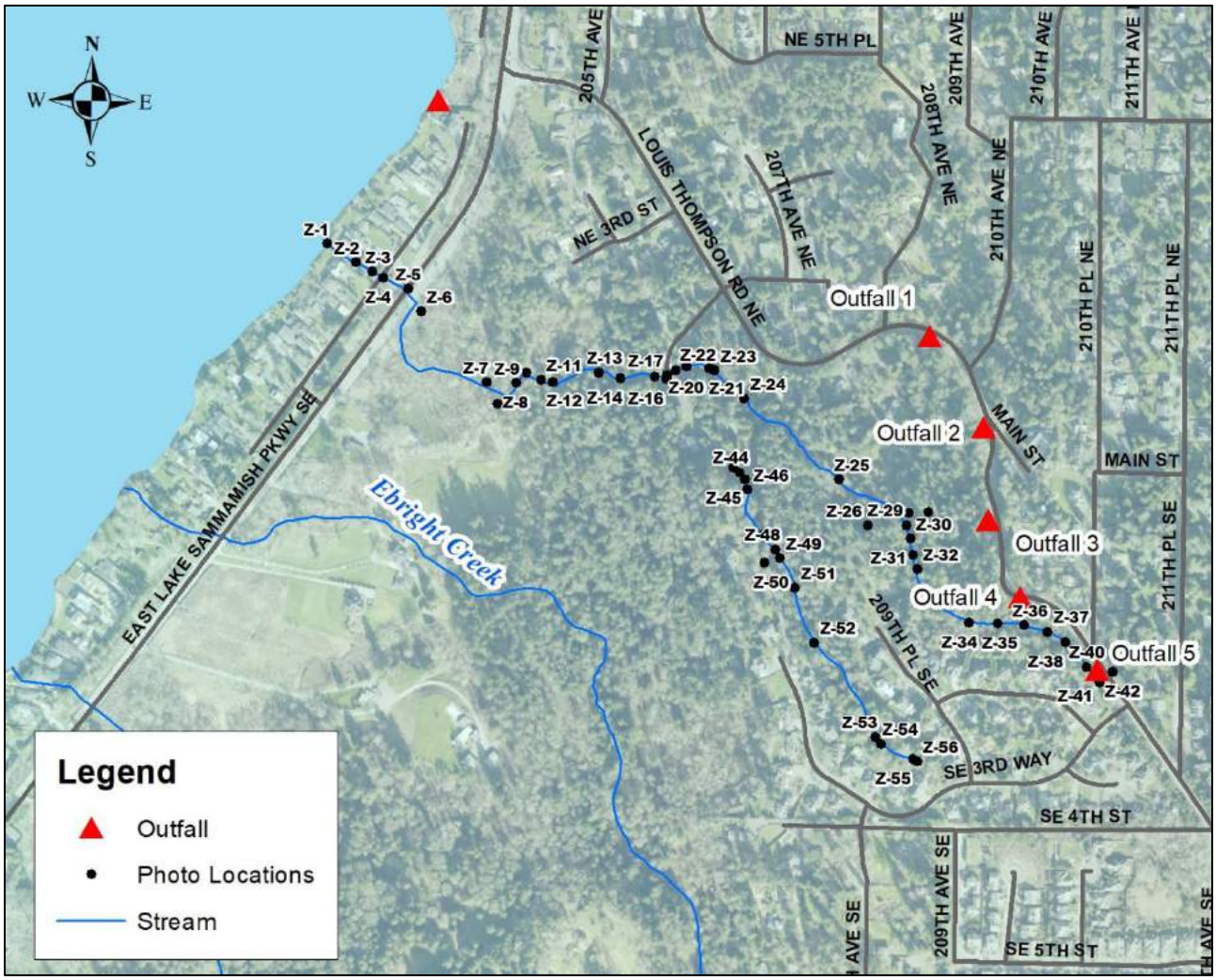


Figure 2. Zackuse Creek South Tributary Photo Location Points

Site location:	East of 206th Avenue NE
Photo number:	Z-43
Description:	Looking southeast at birdcage structure at terminus of open channel portion of S. Tributary Zackuse Creek

Site location:	Same location as Photo Z-43
Photo number:	Z-44
Description:	Looking northwest at birdcage structure. Foreground of photo has been filled in with sediment. Eighteen inch-diameter pipe is buried beneath the sediment.

Site location: 100' upstream of birdcage near 206th Ave NE
Photo number: Z-45
Description: Incised channel through deposited sediment.

Site location: 150' upstream of birdcage east of 206th Ave NE
Photo number: Z-46
Description: Deeper incision in the upstream direction.

Site location:	350' upstream of birdcage east of 206th Ave NE
Photo number:	Z-47
Description:	Looking upstream at incised channel and outlet structure on left bank (middle of photo) from west Montage neighborhood.

Site location:	400' upstream of birdcage east of 206th Ave NE
Photo number:	Z-48
Description:	Upstream side of outlet structure looking to the northeast.

Site location:	400' upstream of birdcage east of 206th Ave NE
Photo number:	Z-49
Description:	Looking west at outlet structure. HDPE pipe from Montage neighborhood and West Montage vault is to the left of the structure covered with leaves.

Site location:	400' upstream of birdcage east of 206th Ave NE
Photo number:	Z-50
Description:	Looking north along HDPE pipe down to stream channel and outlet structure near the top of the photo.

Site location:	450' upstream of birdcage east of 206th Ave NE
Photo number:	Z-51
Description:	Looking upstream at incised channel.

Site location:	~750' upstream of birdcage east of 206th Ave NE
Photo number:	Z-52
Description:	Looking downstream to the west. Channel is slightly incised.

Site location: ~1000' upstream of birdcage east of 206th Ave NE
Photo number: Z-53
Description: Looking downstream at channel where incision is beginning.

Site location: ~1000' upstream of birdcage east of 206th Ave NE
Photo number: Z-54
Description: Same location as photo Z-53, showing incision.

Site location:	~1100' upstream of birdcage east of 206th Ave NE
Photo number:	Z-55
Description:	Looking downstream (west) at birdcage outfall and gabion structures behind it. Location is near SE 3rd Street. Headwaters of S. Tributary.

Site location:	~1100' upstream of birdcage east of 206th Ave NE
Photo number:	Z-56
Description:	Closer view of same location as Photo Z-55.

Upland Areas

Upland photo locations are shown in Figure 3. Upland photos 1-3 were taken on January 12, 2018. The remainder were taken on March 8, 2018.

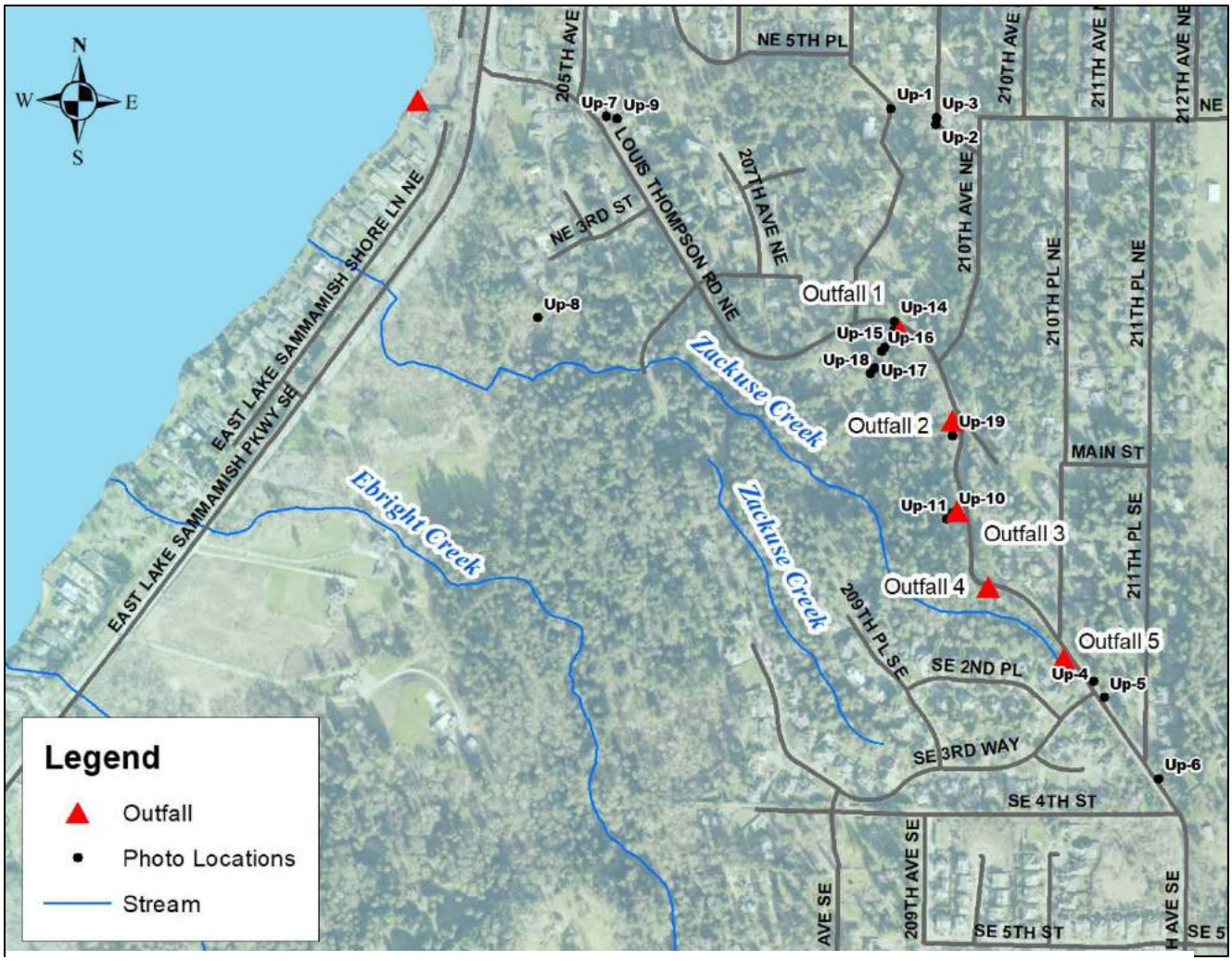


Figure 3. Zackuse Basin Upland Photo Location Points

Site location:	Temporary drainage pipe on slope from 209th Ave NE to 208th Ave NE, in alignment with NE 4th Street in Tamarack
Photo number:	Up-1
Description:	Looking East

Site location:	209th Ave NE catch basin and berm that conveys water from private homes on 209th Ave NE. Road runoff is conveyed in temporary storm water pipe.
Photo number:	Up-2
Description:	Looking at catch basin from the north

Site location:	Location of catch basin and berm shown in photo Up-2.
Photo number:	Up-3
Description:	Looking north. Berm separates flow from south 209th Ave NE road runoff from private home drainage that flows to catch basin on other side of berm.

Site location:	Louis Thompson Road upstream of Zackuse Creek headwaters
Photo number:	Up-4
Description:	Looking northwest at east side of road (water in ditch) that flows to Zackuse Creek

Site location:	430’ upstream of mouth
Photo number:	Up-5
Description:	Upstream side of East Lake Sammamish Parkway, looking south. Stream is flowing north in ditch adjacent to the Parkway (Parkway is on right side of photo)

Site location:	~1,100’ upstream of mouth
Photo number:	Up-6
Description:	Looking upstream (east), near upstream end of future restoration project.

Site location:	Infiltration facility (D93083) on corner of Louis Thompson Rd. and 205th Ave NE
Photo number:	Up-7
Description:	Looking north from Louis Thompson Rd. Pond is dry and shows no evidence of water.

Site location:	South of Eden Glen neighborhood near stormwater outfall (D90392)
Photo number:	Up-8
Description:	Looking north in approximate location of stormwater tightline outfall from Eden Glen neighborhood.

Site location:	Ditch on north side of Louis Thompson Rd. near NE 3rd St and infiltration facility
Photo number:	Up-9
Description:	Roadside ditch is dry between NE 3rd and infiltration facility.

Site location:	Culvert (Outfall 3) on south side of Louis Thompson Rd.
Photo number:	Up-10
Description:	Looking north up at culvert and half-pipe.

Site location:	Same location as Photo Up-10
Photo number:	Up-11
Description:	Looking up at culvert (Outfall 3) on downslope side of Louis Thompson Rd. Location approximately 150 feet below this point is deeply incised and eroded.

Site location:	Depression on south side of Louis Thompson Road to the west of 210th Ave NE
Photo number:	Up-12
Description:	Looking south from Louis Thompson Road

Site location: Culvert on north side of Louis Thompson Road west of 210th Ave NE
Photo number: Up-13
Description: Looking south at culvert

Site location: Looking north (upstream at same culvert in Photo Up-13- Outfall 1)
Photo number: Up-14
Description: Looking North

Site location:	Private driveway culvert crossing (downstream side) downstream of Photo Up-14
Photo number:	Up-15
Description:	Culvert is perched approximately 3 feet above the channel bed.

Site location:	Same location as Up-15
Photo number:	Up-16
Description:	Scaled back view looking north

Site location: Downstream of perched driveway culvert
Photo number: Up-17
Description: Channel is incised.

Site location: Same location as Up-17
Photo number: Up-18
Description: Looking south

Site location:	Outfall 2 on south side of Louis Thompson Road
Photo number:	Up-19
Description:	Looking to the southwest from Louis Thompson Road.

Appendix C

Hydrologic Modeling Memorandum

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DATE NOVEMBER 09, 2018

TO ERIN NELSON, PE, ALTATERRA

CC DANIKA GLOBOKAR, PE, ASSOCIATE STORMWATER ENGINEER, CITY OF SAMMAMISH

FROM LAURA RUPPERT, PE, VICE PRESIDENT, OSBORN CONSULTING, INC.
SHANNON GRAY, EIT, PROJECT ENGINEER, OSBORN CONSULTING, INC.

SUBJECT ZACKUSE CREEK BASIN PLAN – MODELING MEMORANDUM

INTRODUCTION

The Zackuse Creek Basin is located on the western edge of the City of Sammamish. The entire basin is approximately 240 acres and drains from the Sammamish Plateau to Lake Sammamish. Stormwater runoff from the northern portion of the Zackuse Creek Basin flows south and into the ditch and culvert system along Louis Thompson Road NE. This area is the focus of the modeling effort, and is referred to as the "Louis Thompson Road NE Basin" in this report. The remaining runoff from the Zackuse Creek Basin, not included in the Louis Thompson Road NE Basin, contributes flow to Zackuse Creek and its tributaries. The areas that do not drain to the Louis Thompson Road NE stormwater system were not studied as part of this report.

The Louis Thompson Road NE Basin contributes flow to Zackuse Creek through five (5) culverts that outfall on the southern side of the road, and to Lake Sammamish through a culvert at the intersection of East Lake Sammamish Parkway and Louis Thompson Road NE that is connected with an open channel to the lake. The Louis Thompson Road NE Basin is approximately 115 acres in size. Properties in the basin are zoned as R-1 and R-4 residential, and land cover consists primarily of single-family residential houses. Topography ranges in elevation from approximately 40 feet to 500 feet with slopes up to approximately 30% in the steepest areas.

The Louis Thompson Road NE Basin includes a system of drainage pipes, culverts, and ditches. Drainage pipes are typically buried pipes used to convey stormwater runoff to a mainline or receiving water body, which are connected in-series by catch basins. A culvert is a buried pipe that is used to convey surface water under roads and driveways. Due to the function of the drainage pipes in the Louis Thompson Road NE Basin (i.e., conveying flow under roadways and driveways, and lack of a stormwater mainline system) the majority of drainage pipes are referred to as culverts for the remainder of this memorandum.

The goal of this study is to use hydrologic and hydraulic modeling to characterize the existing ditch and culvert flow along the north side of Louis Thompson Road NE in order to identify locations of anticipated flooding. Understanding the ditch hydrology and hydraulics is important because stormwater has overtopped the road and resulted in landslides in the past. Modeling was performed using the Western Washington Hydrology Model (WWHM) and the EPA Storm Water Management Model (SWMM) through the PCSWMM platform.

EXISTING MODELS

Existing hydrologic and hydraulic models have been developed for portions of the Zackuse Creek Basin in support of other projects. These models have been utilized to the extent practical to support the characterization of the Louis Thompson Road NE Basin. The existing models include:

- WWHM and HEC-RAS models used as part of the Zackuse Creek Culvert project to assess existing conditions in the Zackuse Creek Basin with an emphasis on flow conditions contributing to the lower Zackuse Creek.
- WWHM and PCSWMM models used as part of the Tamarack Drainage Improvement project to assess the existing flows reaching Lake Sammamish (through the culvert at the intersection of East Lake Sammamish Parkway and Louis Thompson Road NE), and potential changes in peak flows due to future development.

Table 1 presents an overview of the models that were reviewed.

Table 1 | Previous Hydrologic and Hydraulic Models Developed in the Sackuse Creek Basin

Zackuse_RoutedFINAL (WWHM [Western Washington Hydrologic Model])	Otak Inc., 4/28/2017	The purpose of this model was to assess the existing basin conditions contributing to flow conditions in lower Zackuse Creek. Model included 15 subbasins that drain to the point of compliance at the E Lake Sammamish Parkway culvert (176.8 acres). An additional point of compliance was included in the model at the 206th Avenue NE culvert.
Zackuse_ProposedCon (HEC-RAS [Hydraulic Engineering Center-River Analysis System])	Otak Inc., 8/4/2017	This model was built to evaluate sediment mobility between 206th Avenue NE and E Lake Sammamish Parkway. The point of compliance was at E Lake Sammamish Parkway, and the model compared conditions of the existing channel through this reach with the proposed conditions through the reach for the future realigned and restored stream channel associated with the E Lake Sammamish culvert replacement.
Tamarack-Durations Existing (WWHM)	OCI, 11/17,2016	The purpose of this model was to assess existing conditions in the Tamarack neighborhood in order to evaluate possible drainage solutions. Eight subbasins were modeled for a total drainage area of 52.14 acres; existing conditions included a storage tank and detention pond. Each subbasin had its own point of compliance.
Tamarack-Durations (WWHM)	OCI, 11/17/2016	This model assessed future, fully developed conditions in the Tamarack neighborhood using the same subbasins as the existing conditions model.
Tamarack_Ex (SWMM)	OCI, 11/17/2016	The purpose of this model was to assess existing conditions in the lower portion of Zackuse Creek

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		Basin, including peak flows and velocities at the downstream end of the system.
Tamarack_Prop (SWMM)	OCI, 11/16/2017	This model assessed proposed conditions in the lower portion of the basin but used different inflow inputs to represent proposed conditions.

SUBBASIN DELINEATION

The Louis Thompson Road NE Basin was divided into 17 subbasins to perform modeling calculations. Subbasin boundaries were delineated using data from the existing models (as discussed above); and King County and City of Sammamish GIS data, including elevation contours, streams, drainage pipes, culverts, manholes, and catch basins. Subbasins were further subdivided by choosing specific points in the stormwater conveyance system (i.e., contributing side streets) and separating out the land area that contributes flow to each point in the models.

Site visits were performed to verify subbasin boundaries. Subbasin boundaries were confirmed by locating high points at the edge of subbasins and by visually locating pipes or culverts that redirected flow to create a basin boundary. The subbasin delineations used for the Louis Thompson Road NE Basin can be seen in **Figure 1**. Note that this figure does not show the full extent of the existing models, but rather shows only the basins that contribute flows to Louis Thompson Road NE. **Table 1** provides an overview of the subbasin parameters that were used for modeling purposes and includes percent impervious area, slope, and soil type.

The basin areas of the existing models have overlapping areas in Subbasins 20, 40, and 130. As a conservative approach, the areas were not adjusted for the Louis Thompson Road NE Basin, and small portions of the subbasins are double counted (i.e., both models assume contributing flows from the overlapping area). **Figure 1** shows the areas of overlap. One of the subbasins from the existing Tamarack Drainage Improvement project was divided into 5 (five) subbasins (Subbasins 60, 70, 71, 72, and 80) for the Louis Thompson Road NE Basin model. This breakdown better reflects the location of the contributing flows from the various side streets that discharge to Louis Thompson Road NE. All other subbasins remained consistent with the existing model data.

WWHM MODEL

A new WWHM model was created to compute runoff from existing conditions in Subbasins 10 through 80. The results from the existing Tamarack Drainage Improvement WWHM model were used for Subbasins 90 through 130. Input data required for WWHM includes impervious and pervious cover, slopes, and soil types. This input data was primarily pulled from the existing models. The subbasin delineation, as described above, was the only modification to the existing model input data. The existing model input parameters were confirmed by visual approximation as described below. **Table 2** provides detailed information on the input parameters used for each subbasin.

Table 2 | Summary of WWHM Parameters

Subbasin	Total Area (AC)	Existing Percent Impervious	Slope Percent			Soil Percent	
			Flat	Moderate	Steep	Outwash	Till
10	30.35	16%	18%	44%	39%	0%	100%
20	13.76	18%	5%	35%	60%	0%	100%

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Table 2 | Summary of WWHM Parameters							
Subbasin	Total Area (AC)	Existing Percent Impervious	Slope Percent			Soil Percent	
			Flat	Moderate	Steep	Outwash	Till
30	4.59	30%	11%	45%	43%	0%	100%
40	11.06	14%	2%	14%	83%	4%	96%
50	2.61	12%	6%	23%	71%	95%	5%
60	3.58	34%	16%	84%	0%	100%	0%
70	4.70	34%	16%	84%	0%	100%	0%
71	1.22	34%	16%	84%	0%	100%	0%
72	2.08	34%	16%	84%	0%	100%	0%
80	4.66	34%	16%	84%	0%	100%	0%
90	2.70	48%	20%	0%	80%	100%	0%
100	5.82	2%	0%	100%	0%	100%	0%
101	7.57	40%	11%	0%	89%	51%	49%
102	2.33	38%	26%	0%	74%	41%	59%
110	14.07	49%	23%	0%	77%	100%	0%
120	2.15	38%	15%	85%	0%	29%	71%
130	1.61	33%	5%	95%	0%	62%	38%

Subbasin Impervious Cover

The City of Sammamish 2012 Impervious Area GIS data was used to confirm impervious areas. The data was brought into GIS and visually checked for each subbasin. All impervious area percentages remained the same as in the existing models. Impervious area for the subbasins ranged from 2 to 49 percent, with an average impervious area of 30 percent.

Subbasin Soils

Soil information was taken from the Natural Resources Conservation Service (NRCS) Web Soil Survey, which compiles soil survey data from various sources. The NRCS Web Soil survey was used to visually confirm the existing model soils. The NRCS soils data was brought into GIS and checked against each subbasin to verify the predominant soil type. Soils in the upper Louis Thompson Road NE Basin consist primarily of glacial till, and soils in the lower portion of the basin primarily consist of glacial outwash soils. A small area of glacial till is present at the lowest elevations in the basin. The basin consists of 63 percent till soils, and 37 percent outwash soils. WWHM requires soils to be categorized as Type A/B, Type C, or saturated soils. Soil categories were assigned using the Stormwater Management Manual for Western Washington, which classifies the outwash soils in the basin as Type A/B and the till soils as Type C. Soils information is provided in **Figure 2**.

Subbasin Slopes

City of Sammamish 2012 2-foot Contour GIS data was used to confirm slopes. All slopes data remained the same as in the existing models. The Louis Thompson Road NE Basin is categorized as 48 percent steep slopes (greater than 15 percent slope), 39 percent moderate slopes (5-15 percent slopes), and 13 percent flat (less than 5 percent slope).

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SWMM MODEL

SWMM was used to model flow from WWHM through the ditch and culvert system in the Louis Thompson Road NE Basin. The drainage system for the model was constructed using survey data, record drawings, City of Sammamish GIS, and field measurements/observations. The conveyance network extends from the base of Louis Thompson Road NE, at East Lake Sammamish Parkway, to the upper limits of the Zackuse Creek basin. Flows for the SWMM model were taken from WWHM results for the 25- and 100-year peak runoff. Flow from each subbasin was applied as a constant flow at the appropriate model node.

The model is primarily intended to simulate the existing ditch and culvert conveyance along Louis Thompson Road NE to identify locations of anticipated flooding. Because of the model's intended use, the full drainage system through the Louis Thompson Road NE Basin was not included in the model. The network extends up at least two nodes along side streets to simulate the associated ditch or culvert at those locations, but does not include the full drainage system along the side streets. The existing Tamarack Drainage Improvement SWMM model was used as a starting point and expanded upon. For more detail on this section of the model, refer to the Tamarack Drainage Improvements Project – Modeling Memorandum (OCI, 2016). Refer to **Figure 3** for the SWMM model set-up.

The diameter and material of the culverts modeled in this study were predominately based on GIS data. One additional outfall was observed in the field and added to the SWMM model. Ditch areas were observed in the field to determine the bottom width, approximate side slope, and estimated channel roughness. The slopes of all conveyance systems were based on GIS contours (2-feet intervals). There were a combination of six (6) culverts and ditches that were entered into SWMM as having a flat (0%) slope. The flat slope is based on GIS contours and may not reflect the as-built conditions. SWMM automatically used the minimum elevation drop for those conduit sections. One pipe, one culvert, and one ditch were added to the existing GIS data to reflect field observations.

MODELING RESULTS

The peak flow results predicted by WWHM are provided in **Table 3**. Peak flows for subbasins 90 through 130 were taken from the existing Tamarack Drainage Improvements Project WWHM model and were not rerun for this project. Hydrologic and hydraulic modeling results associated with the Louis Thompson Road NE conveyance system have been provided separately

Table 3 | WWMH Modeled Existing Peak Flows

Subbasin	Flows by Subbasin (CFS)		
	2-yr	25-yr	100-yr
10	3.13	6.40	8.38
20	1.72	3.51	4.60
30	0.82	1.62	2.09
40	1.12	2.30	2.99
50	0.16	0.30	0.38
60	0.54	1.02	1.31
70	0.71	1.33	1.72
71	0.18	0.35	0.45
72	0.32	0.59	0.76
80	0.70	1.32	1.70
90	0.50	0.82	1.00
100*	0.12	1.31	3.47

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Table 3 | WWMH Modeled Existing Peak Flows			
Subbasin	**Flows by Subbasin (CFS)**		
	2-yr	**25-yr**	**100-yr**
101*			
102*			
110	2.38	5.18	6.81
120	0.42	0.83	1.09
130	0.27	0.54	0.71

**For existing conditions, Subbasin 101 and 102 were modeled as lateral basins with total flow measured at the outlet of Subbasin 100.*

The peak flows and velocities predicted by SWMM for the outfalls are listed in **Table 4**.

Table 4 | SWMM Modeled Peak Flows and Velocities							
Location	**Outfall**			**25-yr**		**100-yr**	
	Type	**Size**	**Slope**	**Flow (CFS)**	**Velocity (ft/s)**	**Flow (CFS)**	**Velocity (ft/s)**
Lake Sammamish Outfall	Ditch	3-foot bottom width 4-foot depth 3:1 (H:V) side slopes	2.3%	13.3	3.5	19.0	3.9
Outfall 01	Concrete Pipe	1.5 – foot diameter	3.1%	2.6	6.3	3.4	6.6
Outfall 02	Concrete Pipe	1.5 – foot diameter	8.0%	0.9	7.2	1.2	7.6
Outfall 03	Concrete Pipe	1.5 – foot diameter	6.1%	0.7	6.0	0.9	6.4
Outfall 04	Concrete Pipe	1.5 – foot diameter	5.5%	3.5	8.3	4.6	8.7
Outfall 05	Aluminum Pipe	1.5 – foot diameter	13.7%	6.0	7.5	7.0	7.7

The number of nodes that are predicted by SWMM to flood and the number of ditches or culverts that are over capacity are listed in **Table 5**. The locations where the conveyance system floods can be seen in **Figure 4**. This figure also depicts the velocities for the conveyance system.

Table 5 | SWMM Modeled Capacity Summary		
	Number of Nodes Flooded / Surcharged	**Number of Culverts / Ditches Over Capacity**
25-yr	9	5
100-yr	14	8
Total nodes / conduit	92	91

Velocities at the outfalls along Louis Thompson Road NE are over 5 feet per second. The high velocities are caused by steep slopes in the roadside conveyance system and culvert crossings. The velocities at the outfalls are corroborated by the location of erosion and sedimentation issues at the culvert outfalls. Per the 2016 King County Surface Water Design Manual (KCSWDM), riprap is required at all outfall locations with velocities between 5 and 10 feet per second.

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Along Louis Thompson Road NE the ditches generally consist of cobbles along the bottom with grass/vegetated sides. The manning's roughness value for these ditches was determined to be 0.04 based on field observations. Results from the SWMM model indicate that velocities for these ditches do not exceed 5 feet per second. In Figure 4, the portions of the conveyance system along Louis Thompson Road NE where velocities exceed 5 feet per second are located at culverts, however, those culverts discharge to the ditches. It is recommended that the outlets of these culverts include rip-rap protection. Per the KCSWDM, vegetation-lined ditches are appropriate where the bottom slope is 6-percent or less and velocities are under 5 feet per second. Rock-lined ditches are recommended in areas where these values are exceeded. The ditches that flow to Outfalls 01, 02, 03, and the Lake Sammamish Outfall all have slopes greater than 6-percent, however, velocities remain under 5 feet per second. The modeled velocities appear to match observed conditions with limited erosion visible along these ditches.

Many of the side streets that discharge to Louis Thompson Road NE have velocities that exceed 5 feet per second, and slopes in exceedance of 6-percent. This includes the ditches along 210th Ave NE, 208th Ave NE (exceedances in slope but not velocity), and NE 2nd Street. The modeled results for 210th Ave NE and NE 2nd Street match field conditions, where there appears to be roadway overtopping and sediment buildup. Field observations for 208th Ave NE did not indicate erosive velocities.

Refer to **Appendix B** for the KCSWDM tables with the required minimum design requirements for outfall protection (Table 4.2.2.A Rock Protection at Outfalls) and channel protection (Table 4.4.1.A Channel Protection).

MODELING LIMITATIONS AND CHALLENGES

As with all hydrologic and hydraulic modeling, there are limitations to how much a model represents real world conditions. Oftentimes, these limitations are associated with constraints of time and availability of input data. The modeling results included in this memorandum represent a reasonable assessment of the existing hydrologic and hydraulic conditions associated with the project. The model should be used as a planning tool and for understanding locations where flooding is more likely. Output results should be evaluated against field observations, and interpreted accordingly. Below is a brief list of some modeling limitations:

- Input parameters (e.g. soil type, slope, contributing basin area, percent impervious, culvert/ditch material, and culvert/ditch geometries) are predominately based on GIS and field observations. Any future design or modeling efforts should be based on detailed survey data.
- Infiltration along the ditches is not accounted for in the model, therefore, locations of flooding in the model may be overestimated in areas where infiltration occurs in real world conditions.
- The model does not account for accumulation of sediment and debris which can increase the likelihood of flooding in portions of the system that are not well maintained.
- The model does not account for groundwater seepage into the conveyance system.
- The models assumed all pervious and impervious areas drain to the conveyance system within the subbasin. This may overestimate flows at an outfall in areas where runoff does not actually reach the conveyance system.
- The model is not calibrated to gage data (gage data was not available when the model was developed).

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WWHM Vault Sizing for CIP 1

Hydrologic analysis was performed using WWHM to size the flow control facility for Capital Improvement Project (CIP) 1. Input data required for WWHM includes impervious and pervious cover, slopes, and soil types. The basin inputs used for this model were based on the Zackuse Creek Culvert model data for the existing conditions within the basin. Fully developed conditions were not analyzed for this basin. The pre-developed condition for the basin assumed forested land cover. The existing basin characteristics are listed in **Table 6**.

Table 6 | Summary of WWHM Parameters for CIP 1

Total Area (AC)	Existing Percent Impervious	Slope Percent			Soil Percent	
		Flat	Moderate	Steep	Outwash	Till
6.66	32%	29%	51%	20%	0%	100%

A flow control facility was designed to provide a storage volume that would match the duration of the pre-developed peak flows from 50% of the 2-year up to the full 50-year storm flow. A presettling volume equal to 0.25 times the basic water quality treatment volume (0.2 ac-ft) was included in the detention vault size to address sediment issues. The volume needed to match those peak flow conditions and presettling is approximately 65,000 cubic feet of storage. **Table 7** shows the modeled pre-development and mitigated conditions. WWHM's Auto Vault function was used to size the detention vault. Modeling results associated with CIP 1 have been provided separately.

Table 7 | CIP 1 Modeled Peak Flows

Flow Frequency	Pre-Developed Conditions (CFS)	Mitigated Conditions* (CFS)
2-yr	0.216	0.132
25-yr	0.536	0.408
50-yr	0.605	0.515
100-yr	0.670	0.642

**Mitigated conditions include existing basin conditions, and a proposed flow control vault.*

CIP 1 includes a flow splitter that would divert flows from the existing Cameron Woods neighborhood discharges and send them to the proposed flow control facility. The Cameron Woods neighborhood has an existing flow control facility, and this basin was not included in sizing the CIP 1 vault. Final design of the CIP 1 detention vault should account for the Cameron Woods basin and flow control structure. Refer to **Figure 5** for a schematic drawing of CIP 1.

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Appendix D

Drainage Issues in Tamarack Neighborhood Technical Memorandum

Technical Memorandum

Subject:	Drainage Issues in Tamarack Neighborhood
To:	Danika Globokar, PE, City of Sammamish
From:	Erin Nelson, PE, LG, Altaterra Consulting LLC
Date:	April 2, 2019

NOTICE: The Tamarack Neighborhood (Tamarack) is a private neighborhood within the City of Sammamish, with private roadways and private stormwater and drainage systems that are maintained by the homeowners within the neighborhood. The City of Sammamish does not own or maintain the private roadways, stormwater and drainage systems within the Tamarack Neighborhood.

The City Council of the City of Sammamish directed staff to review drainage within the Zackuse basin, which drains approximately 240 acres in the west portion of the City of Sammamish. The Tamarack neighborhood is located within the Zackuse basin, and non-attenuated flows from Tamarack and other basin neighborhoods may contribute to elevated peak flows in Zackuse Creek. This Technical Memorandum seeks to identify the drainage issues within the Tamarack neighborhood that contribute to storm and surface water concerns within the Zackuse basin but recognizes that remediating these issues are not the responsibility of the City of Sammamish.

The City of Sammamish does not accept responsibility for the issues identified herein and expressly disclaims any and all liability pertaining to the issues within the Tamarack neighborhood discussed herein. Any remediation proposals included herein are provided for informational purposes only and do not represent a commitment by the City of Sammamish to undertake the same.

1.0 Background and Timeline

A background and timeline of plat and housing development in the Tamarack neighborhood, and drainage evaluations completed in the last ten years, is presented to provide context for the discussion of drainage issues in the Zackuse basin that occur in the Tamarack neighborhood and could be remedied by private property owners in Tamarack. A schematic timeline in Figure 1 shows the history of development and drainage concerns through the present day.

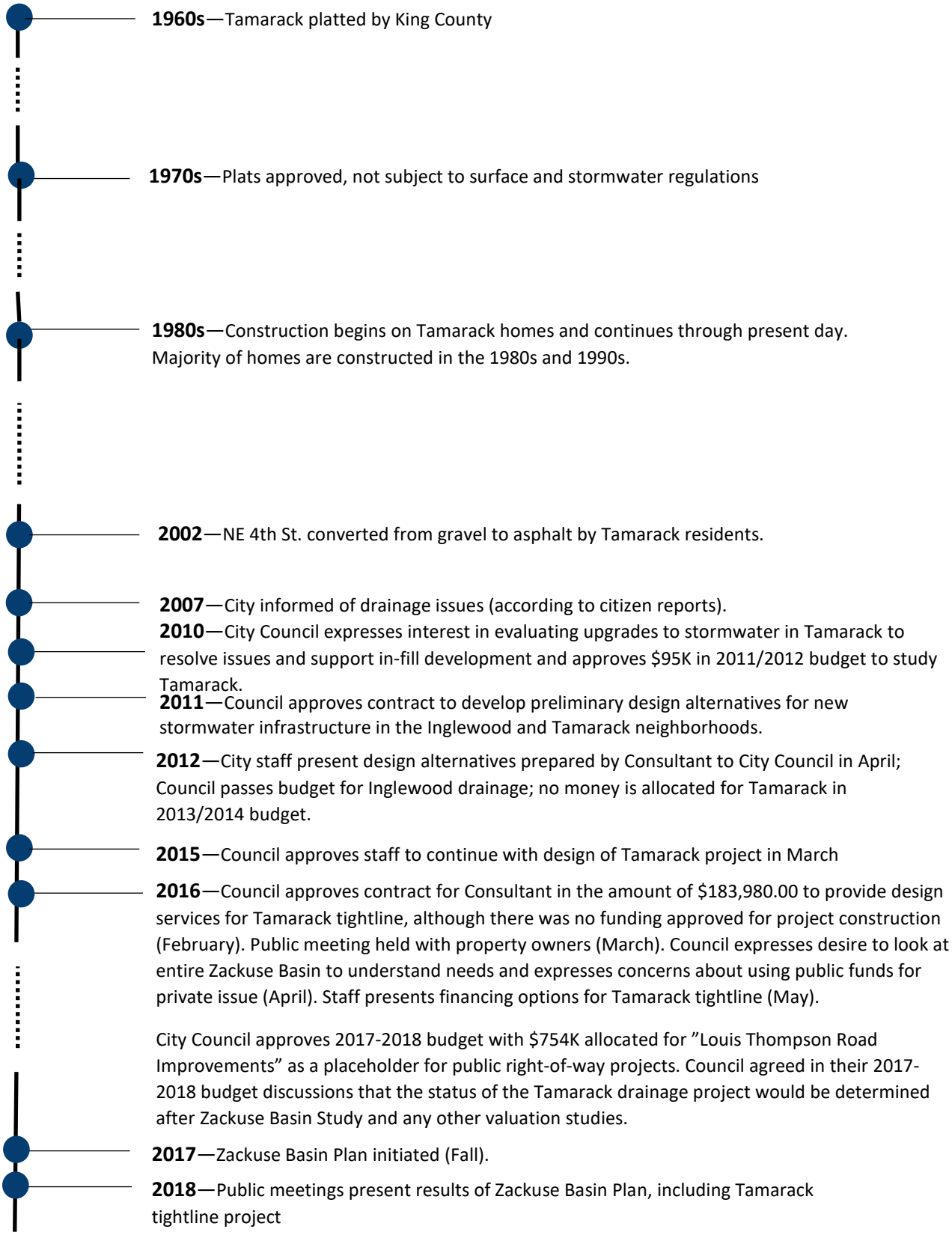


Figure 1. History of Tamarack development and drainage evaluations (1960s to present)

Throughout the evaluation and discussions of drainage issues and remedies in the Tamarack neighborhood, including the Tamarack tightline project, the issue of private road and stormwater drainage ownership and associated maintenance responsibilities were at the forefront. According to Sammamish Municipal Code (SMC 13.20.090, Ordinance 02017-432), the City may assume maintenance of privately maintained drainage facilities only if the public benefit is greater in scope than the public cost, among other requirements. It is the opinion of Staff that the public benefit from this project is not greater in scope than the anticipated cost of the project.

No commitments were made by Staff or Council to ultimately construct a project in Tamarack, however, public funds have been invested to evaluate issues, and develop potential actions in support of determinations of whether further public funds would result in a clear public benefit.

2.0 Current Drainage Characteristics

Current drainage conditions in the Tamarack neighborhood were assessed through public comment and field evaluation. Rights of entry were received by property owners prior to conducting the field evaluation on private property.

Many of the comments received during the Zackuse basin planning public outreach were regarding drainage issues experienced in the Tamarack neighborhood. Example comments included:

- "Flooding and erosion in ditches conveying stormwater from up the hill (NE 4th). Debris on road from eroded ditch, water on road freezes during winter, and water that proceeds downhill continues eroding unhardened features in its path."
- "House and driveway has flooded causing extensive damage as a result of water running down 210th Ave. NE."
- "Seepage (NE 4th and 211th)"

Evidence of Tamarack drainage problems was observed in the form of ditch erosion on NE 4th Street, which is a very steep, private road sloping to the west that makes a sharp left turn onto 210th Avenue NE mid-slope. Numerous complaints have also been received by City staff about this condition. Conveyance infrastructure on NE 4th Street consists of ditches and driveway culverts. The ditches are lined with large rocks that are replaced regularly because of erosion during high flows. Although the natural slope gradient is to the west, the road and ditch infrastructure turns south at 209th Avenue NE, another private road. During high flows, the water is not always contained in the ditch. Gravitational forces pull it to the west along a straighter path, resulting in water sheet flowing across the road at multiple locations.

Additionally, roadway runoff from 210th Avenue NE sheet flows down the steep hill and overtops Louis Thompson Road NE, instead of being properly conveyed in the existing ditch and culvert system along 210th Avenue NE. This situation results in a safety concern due to water flowing over the roadway, especially in freezing temperatures, and causes erosion on the downstream side of the road.

Channel erosion was also observed in the Tamarack ravine, between 208th Avenue NE and 205th Avenue NE. The ravine is downstream of a private stormwater outfall that discharges drainage from the upstream neighborhood.

3.0 Potential Tamarack Drainage Actions

There are potential actions that could be taken by the private property owners in Tamarack to address citizen drainage concerns. Tamarack Drainage Project #1 is a tightline project that would contain drainage to minimize erosion in the ditches on NE 4th. Previous studies have evaluated options to manage Tamarack drainage. In 2013, the recommended option was to install drainage improvements on NE 4th and connect and improve stormwater pipes on 205th Ave NE to convey stormwater through the Tlinget neighborhood. This option did not include flow control and was selected because it connected to City right-of-way and did not involve easement acquisition. Tamarack Drainage Project #1 is a tightline that was another option considered during the 2013 options analysis. This option includes a flow control vault and is routed in a more direct flow path that would require easements on private property. The flow control component increases the planning level cost estimate compared to the Tlinget option, however, without flow control the costs are similar. The project summary sheet for Tamarack Drainage Project #1 is provided in Attachment 1.

Tamarack Drainage Project #2 is a project that involves construction of improved drainage a French drain, berms, and an improved ditch and culvert system, as well as the installation of new catch basins on 210th Avenue NE. Additionally, new catch basins and a storm drainage pipe are included on the west side of 210th Avenue NE. The project summary sheet for Tamarack Drainage Project #2 is provided in Attachment 1.

ATTACHMENT 1

PROJECT SUMMARY SHEETS

Project ID:	Tamarack Project #1
Tamarack Tightline (NE 4th St to Louis Thompson Rd)	
Preliminary Cost: $3,179,400	

Ravine erosion (left photo)

Ad-hoc stormwater drainage and failed slope (right photo)

Project Description:

The Tamarack neighborhood was developed with an ad-hoc, informal drainage network that has resulted in an inadequate drainage system that contributes to drainage issues on NE 4th St, 209th Ave NE, and through a ravine that drains towards Louis Thompson Road. The proposed CIP is to construct a tightline conveyance system starting at the intersection of NE 4th St and 210th Ave NE, and continuing west through the ravine towards Louis Thompson Road NE. The project includes improvements to the ditch / culvert system along NE 4th St, upsized conveyance system along 209th Ave NE, and a proposed flow control vault at the downstream end of the tightline system.

Benefits and Opportunities:

- Formal drainage system, reduce ditch erosion.
- Solve multiple drainage issues.

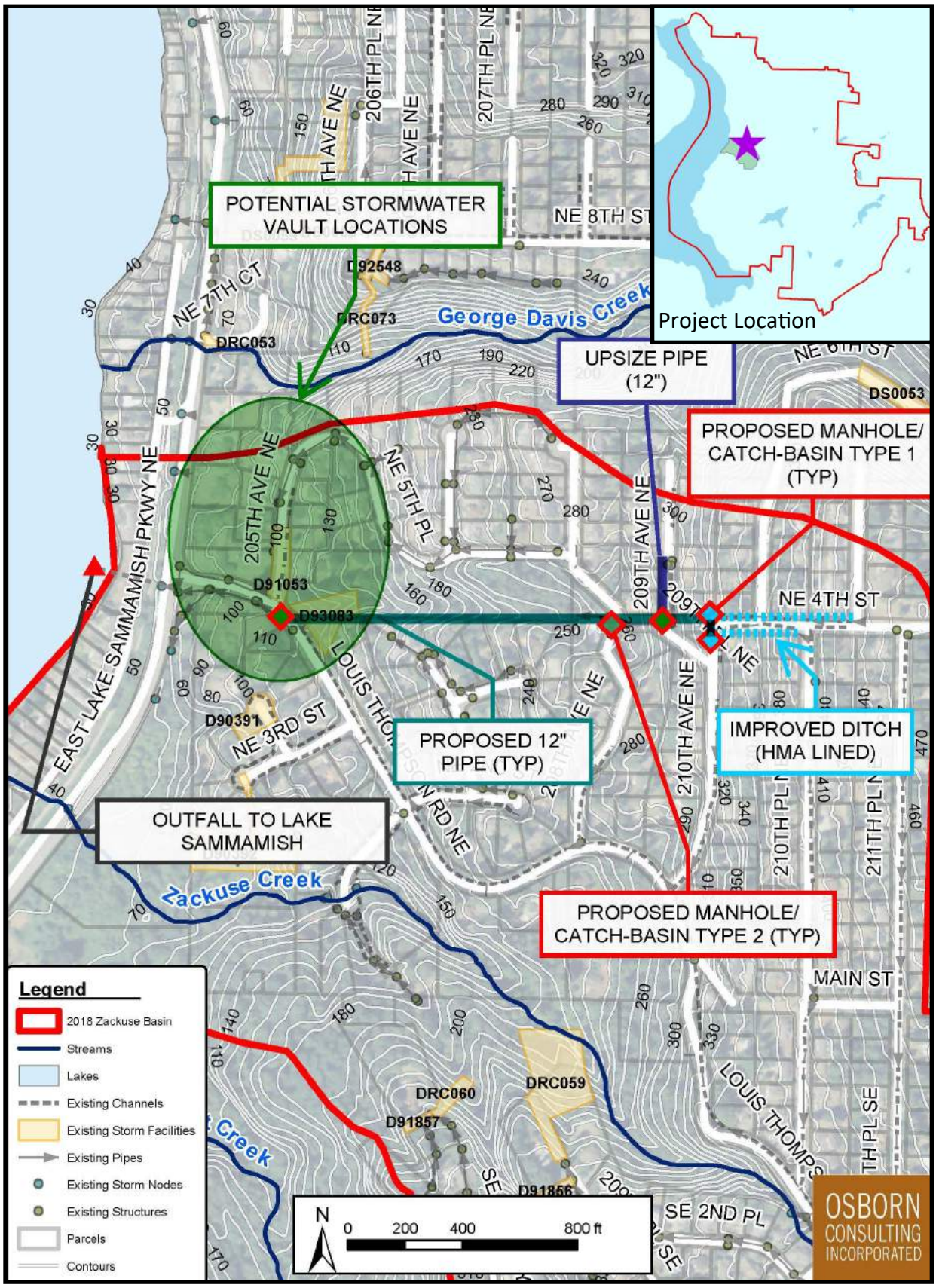
Challenges:

- Private road system. Needs private funding and maintenance.

Assumptions and Considerations:

- Easements and coordination with private property owners is required.
- Although it may be possible to site a flow control vault on existing City-owned property, it may be necessary to acquire easements or a tract for this a flow control facility. Preliminary cost estimate assumes easement or tract acquisition.
- Size of detention vault has been assumed from the existing Tamarack Drainage Improvements Project – Modeling Memorandum (Osborn Consulting, 2016), and no additional sizing was conducted for this CIP.
- Detention vault sizing does not include any infiltration. Geotechnical investigation needed to determine if infiltration is possible.
- Existing wetland near the outfall at Lake Sammamish must be protected according to drainage code requirements. A hydrologic assessment will be required during the design phase to ensure the proposed drainage improvements will match the existing volume and pattern of water stored in the wetland.

Schematic:


POTENTIAL STORMWATER VAULT LOCATIONS
UPSIZE PIPE (12")
PROPOSED MANHOLE/ CATCH-BASIN TYPE 1 (TYP)
PROPOSED 12" PIPE (TYP)
IMPROVED DITCH (HMA LINED)
OUTFALL TO LAKE SAMMAMISH
PROPOSED MANHOLE/ CATCH-BASIN TYPE 2 (TYP)
Project Location
George Davis Creek
Zackuse Creek
NE 8TH ST
NE 4TH ST
MAIN ST
SE 2ND PL
NE 7TH CT
NE 5TH PL
NE 3RD ST
205TH AVE NE
206TH PL NE
207TH PL NE
209TH AVE NE
210TH AVE NE
210TH PL NE
211TH PL NE
EAST LAKE SAMMAMISH PKWY NE
LOUIS THOMPSON RD NE
D92548
DRC073
DRC053
DS0053
D91053
D93083
D90391
DRC060
DRC059
D91857
D91856
Legend
2018 Zackuse Basin
Streams
Lakes
Existing Channels
Existing Storm Facilities
Existing Pipes
Existing Storm Nodes
Existing Structures
Parcels
Contours
N
0 200 400 800 ft
OSBORN CONSULTING INCORPORATED

PROJECT ID: Tamarack Project #1

Planning Level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$110,395.00
Water Pollution/Erosion Control	%	5%	1	$55,197.50
SPCC Plan	LS	$500	1	$500
Traffic Control	%	3%	1	$32,609
Potholing	EA	$1,200	2	$2,400
Clearing & Grubbing	SY	$5	2,750	$13,750
Remove Asphalt Conc. Pavement	SY	$20	150	$3,000
HMA lined V-ditch	LF	$15	750	$11,250
Detention Vault	CF	$25	28,000	$700,000
Catch Basin Type 1	EA	$2,000	2	$4,000
Catch Basin Type 2 48 In. Diam.	EA	$5,000	3	$15,000
Connect to Existing Drainage Structure	EA	$1,500	1	$1,500
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	1,725	$293,250
Pipe Anchors	EA	$3,300	6	$19,800
Roadway Restoration	SY	$150	150	$22,500
Landscape Restoration	SY	$10	1,700	$17,000
Subtotal				$ 1,302,151
Washington State Sales Tax			10%	$ 130,215
Construction Contingency			50%	$ 651,076
Subtotal Construction Costs				$ 2,083,442
Administration and engineering design			20%	$ 416,688
Design Contingency			10%	$ 208,344
Permitting			1%	$ 20,834
Land acquisition and easements	SF	$50	9,000	$ 450,000
Total Project Cost				**$ 3,179,400**

2018 Project ID:	Tamarack Project 2
Sheet flow on Louis Thompson at 210th Ave NE	
Preliminary Cost: $415,400	

210th Ave NE (looking north from Louis Thompson Rd) (left photo)

Intersection of 210th Ave NE and Louis Thompson Rd. (right photo)

Project Description:

Roadway runoff from 210th Ave NE is not properly conveyed to the existing ditch and culvert system, and instead sheet flows down the steep hill and overtops Louis Thompson Road. The sheet flow poses an erosion risk on the downstream side of the road and freezes in the winter causing a safety concern.

The proposed CIP includes providing a French drain, berms, improved ditch and culvert, and new catch basins located along the eastern side of 210th Ave NE. The western side of 210th Ave NE includes proposed catch basins and storm drainage pipes. The project would increase the quantity of roadway runoff that is captured and conveyed to Louis Thompson Road, reducing the sheet flow that crosses Louis Thompson Road.

Benefits and Opportunities:

- Improved safety at intersection.
- Reduced maintenance on Louis Thompson Road (average approximately $10K/year)

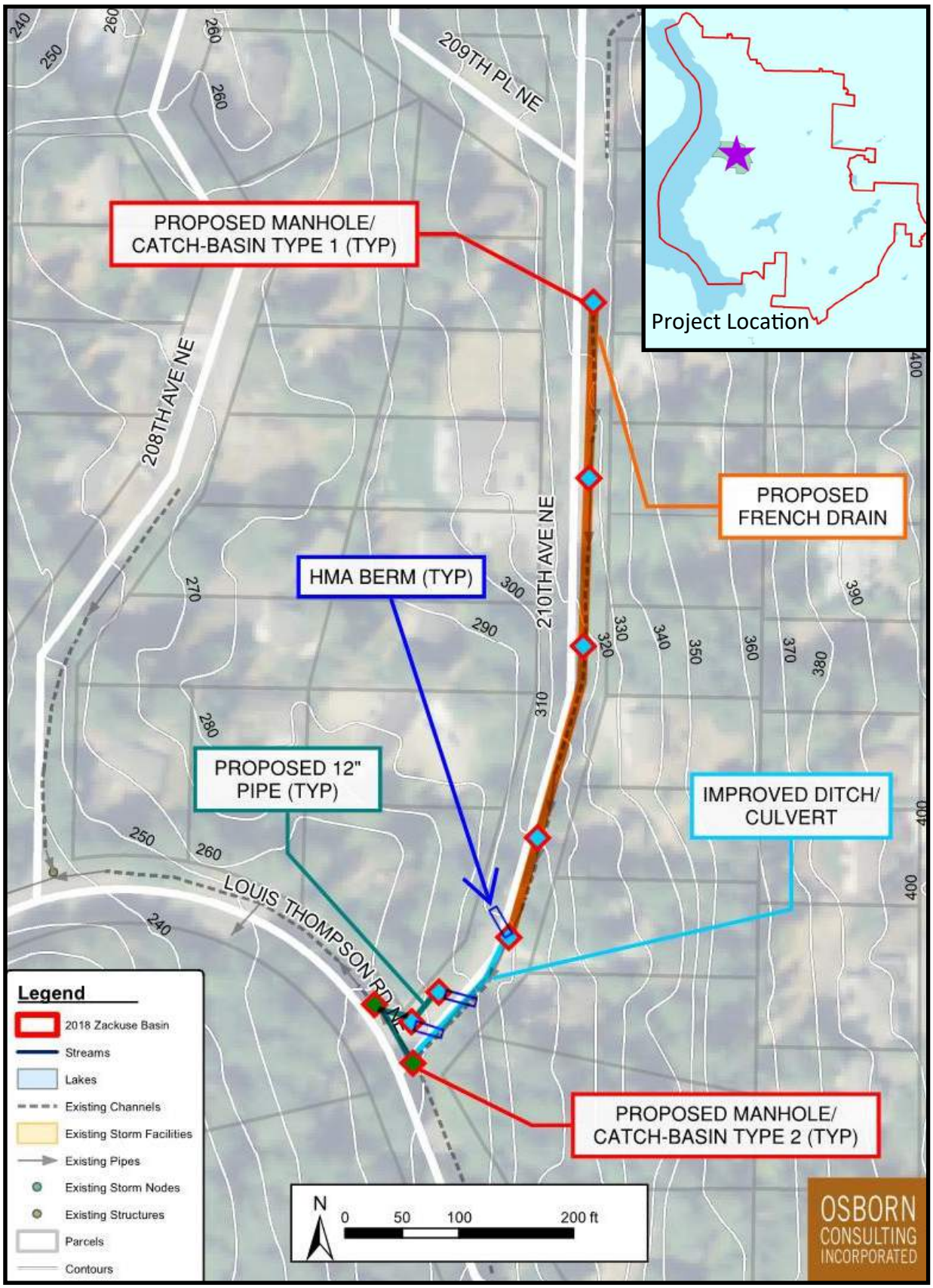
Challenges:

- Private property and private streets.
- Maintenance required to prolong performance.
- Solution is short-term.

Assumptions and Considerations:

- Easements and coordination with private property owners iw required for work on private streets. The private street would need to be brought up to current City standards for the City to take over responsibility for the private street.
- The proposed design performance may degrade over time due to sediment build-up in the French drain system. Regular City maintenance will prolong the system's performance.
- A more robust improved culvert and ditch system was assessed for this CIP but would have require walls and easements. The improved ditch and culvert solution would be less expensive to maintain but would be much more expensive to construct.
- This project does not include costs to increase roadway capacity, or improve nonmotorized access or lighting.

Schematic:


PROPOSED MANHOLE/
CATCH-BASIN TYPE 1 (TYP)
PROPOSED
FRENCH DRAIN
HMA BERM (TYP)
PROPOSED 12"
PIPE (TYP)
IMPROVED DITCH/
CULVERT
PROPOSED MANHOLE/
CATCH-BASIN TYPE 2 (TYP)
Project Location
209TH PL NE
208TH AVE NE
210TH AVE NE
LOUIS THOMPSON RD NE
Legend
2018 Zackuse Basin
Streams
Lakes
Existing Channels
Existing Storm Facilities
Existing Pipes
Existing Storm Nodes
Existing Structures
Parcels
Contours
N
0
50
100
200 ft
OSBORN
CONSULTING
INCORPORATED

Planning Level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$16,255.00
Water Pollution/Erosion Control	%	5%	1	$8,128
SPCC Plan	LS	$500	1	$500
Traffic Control	%	6%	1	$9,753
Potholing	EA	$1,200	5	$6,000
Clearing & Grubbing	SY	$5	390	$1,950
Remove Asphalt Conc. Pavement	SY	$20	70	$1,400
HMA Berm	LF	$15	180	$2,700
Catch Basin Type 1	EA	$2,000	7	$14,000
Catch Basin Type 2 48 In. Diam.	EA	$5,000	2	$10,000
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	150	$25,500
French Drain Pipe 12 In. Diam.	LF	$150	600	$90,000
Roadway Restoration	SY	$150	70	$10,500
Subtotal				$ 196,686
Washington State Sales Tax			10.0%	$ 19,669
Construction Contingency			50%	$ 98,343
Subtotal Construction Costs				$ 314,697
Administration and engineering design			20%	$ 62,939
Design Contingency			10%	$ 31,470
Permitting			2%	$ 6,294
Land acquisition and easements	SF	$5	0	$ -
Total Project Cost				**$ 415,400**

Appendix E

Project Prioritization Ranking Score Sheet

Project Ranking Score Sheet

PROJECT ID	PROJECT	PLANNING-LEVEL COST ESTIMATE (rounded to nearest $10K)	CRITERIA						TOTAL BENEFIT SCORE	COMMENTS
			Environmental Benefit (30)	Facilities (25)		Safety (25)	Population Benefitted (10)	Time-sensitive Opportunity (10)		
				Maintenance (10)	Facility Effectiveness (15)					
CIP-1	Retrofit West Montage Neighborhood	$4,990,000	20	5	15	10	5	0	55	At least two watershed functions improved (hydrology, habitat), facility provides flow control and natural resource protections, safety may be partially improved for neighbors downstream of birdcage near 206th Ave NE, few people directly benefit.
CIP-2	Sheet flow on Louis Thompson at 210th Ave NE	$420,000	0	10	5	15	10	0	40	No environmental benefit, fixes maintenance problem at Louis Thompson Road and 210th Ave NE, provides improved conveyance, addresses safety issue (water over roadway) for multiple user on busy road.
CIP-3	Louis Thompson Road tightline	$5,380,000	15	10	15	15	10	0	65	Water quality improvements (watershed function), maintenance improvements (reduced ditch and culvert cleaning), improved conveyance and natural resources protection, no safety benefits, benefits large population (busy road).
CIP-4	Intercept groundwater seepage on East Lake Sammamish Parkway	$120,000	0	10	0	15	10	0	35	No environmental benefit, fixes maintenance problem at Louis Thompson Road and ELSP, improves conveyance, addresses safety issue (water over roadway) for multiple users on busy road.
CIP-5	Upsize culverts	Not calculated	0	5	10	10	10	0	35	No environmental benefit, minimal maintenance improvement (private roads), improves conveyance, reduces flooding (improving safety), large population benefitted because reduces impacts on busy road (Louis Thompson Road NE)
CIP-6	Fix CB (catch basin) under fog line	Not calculated	0	0	10	10	10	0	30	No environmental benefit, doesn't fix maintenance issue, improves conveyance and safety (because of failure risk) and benefits a large population since the project is on a busy road (Louis Thompson Road NE)
CIP-7	Flow control/water quality facility	Not calculated	15	0	15	0	0	0	30	Water quality and flow control benefits (watershed functions), no maintenance improvements, benefits growth with facility functions, no safety benefits, no immediate population benefitted.
CIP-8	Engineered channel realignment	Not calculated	20	0	0	0	0	0	20	Habitat benefits (watershed functions), no other benefits.
CIP-9	Address flooding at Zackuse headwater wetland	Not calculated	10	0	5	0	5	0	20	Improved water quality or flow control (watershed functions), improved facility effectiveness (conveyance), improved safety (reduce flooding).
CIP-10	206th Ave culvert replacement	Not calculated	10	0	0	0	0	0	10	Partial fish passage barrier will open up limited upstream habitat.
Oper-3	CCTV and clean pipes in East Montage Neighborhood	$40,000	20	5	15	0	5	0	45	At least two watershed functions improved (hydrology, habitat), facility provides flow control and natural resource protections, safety is minimally affected, few people directly benefit.

Appendix F

Project Summary Sheets and Planning Level Cost Estimates

2018 Project ID:	Zack-CIP-1
Retrofit West Montage Neighborhood	
Preliminary Cost: $3,944,700	

Bird cage at headwaters (left photo)

Stream channel erosion (right photo)

Project Description:

Existing bird cage structure at the headwaters of the south tributary is difficult to maintain due to access issues. The existing flow control facility (D91857) has a large amount of sediment buildup that clogs the flow control orifices, and causes the flow control facility to go into overflow. The south tributary is highly eroded downstream of both facilities, indicating need for additional flow control.

The proposed CIP improves maintenance access to the existing headwater structure and constructs new sediment and flow control facility to reduce erosion within the south tributary. The proposed project includes a flow splitter that would divert the Cameron Woods neighborhood discharges to the proposed flow control facility from the headwaters of the south tributary. The proposed flow control vault is proposed upstream of the existing vault (D91857). Water quality treatment, in addition to sediment reduction, could also be added to this project.

Benefits and Opportunities:

- Reduce stream erosion and downstream sedimentation.
- Improve maintenance access.
- Protect investment (Zackuse stream restoration).

Challenges:

- Private property.
- Project is only one element necessary to improve entire stream corridor.

Project Prioritization Score: 55 out of 100 possible points.

Environmental Benefit = 20

Facility/Maintenance Improvements = 20

Safety = 10

Population Benefitted = 5

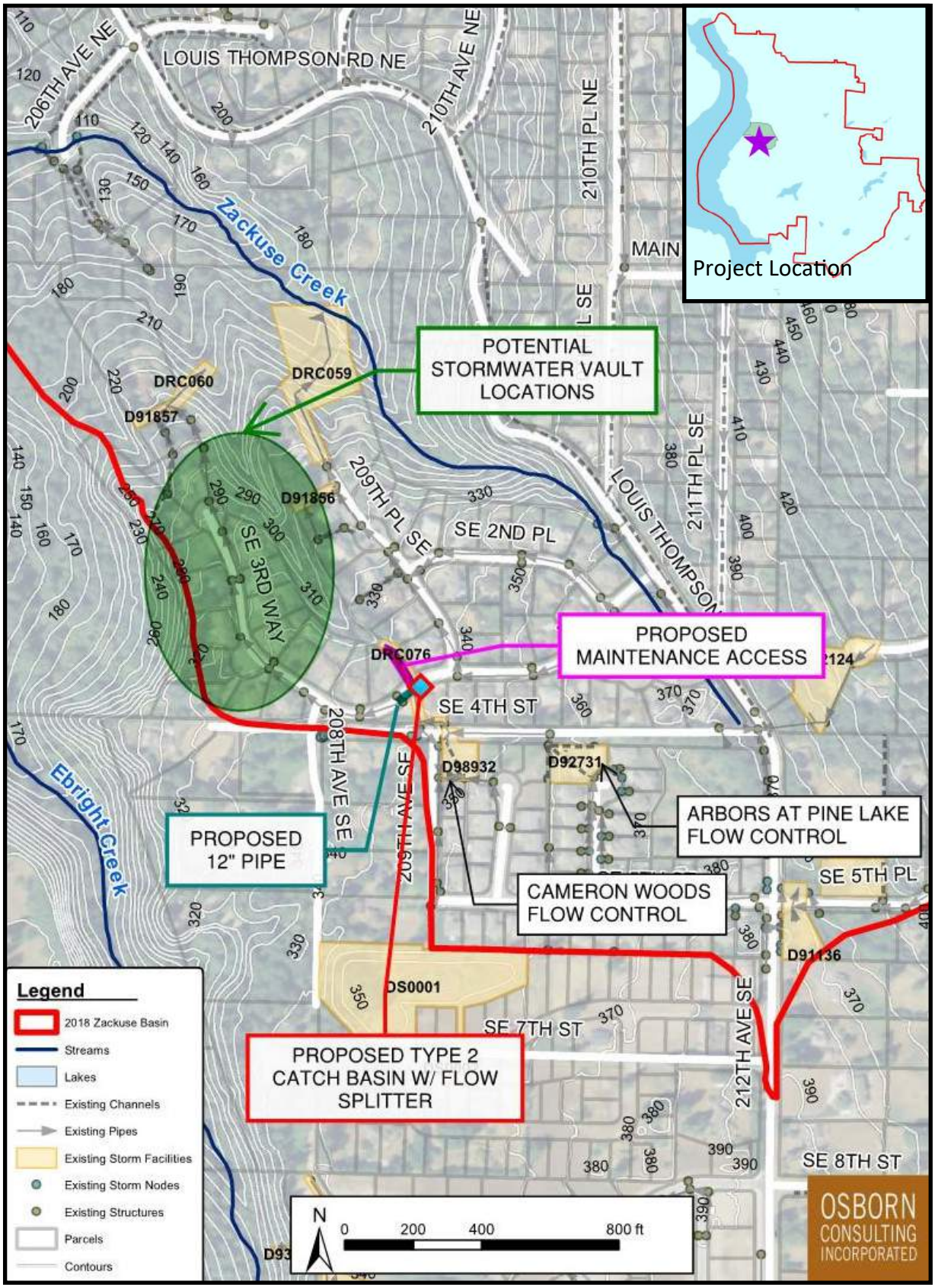
Time-Sensitive Opportunity = 0

Assumptions and Considerations:

- Easements, coordination with property owners, and purchasing of land is required.
- Hydrologic analysis was performed using WWHM to size the sediment and flow control facility for this project, designed to provide a storage volume that would match the duration of the pre-developed peak flows from 50% of the 2-year up to the full 50-year storm flow. A presettling volume equal to 0.25 times the basic water quality treatment volume was included in the vault size to address sediment issues. The detention volume needed for peak flow and sediment conditions is approximately 65,000 cubic feet of storage.
- Hydrologic analysis was performed using the Western Washington Hydrology Model (WWHM) to size the sediment and flow control facility for this project.

2018 PROJECT ID: Zack-CIP-1

Schematic:



Planning Level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$169,418.00
Water Pollution/Erosion Control	%	5%	1	$84,709
SPCC Plan	LS	$500	1	$500
Traffic Control	%	3%	1	$50,825.40
Potholing	EA	$1,200	2	$2,400
Clearing & Grubbing	SY	$5	2,200	$11,000
Remove Asphalt Conc. Pavement	SY	$20	70	$1,400
Detention Vault	CF	$25	65,000	$1,625,000
Catch Basin Type 2 48 In. Diam.	EA	$5,000	1	$5,000
Connect to Existing Drainage Structure	EA	$1,500	3	$4,500
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	90	$15,300
Cement Conc. Driveway 8 In.	SY	$125	20	$2,500
HMA Cl. 1/2 in. PG 64-22 (QTY>50 TON)	TON	$225	60	$13,500
Roadway Restoration	SY	$150	70	$10,500
Crushed Surfacing Base Course	CY	$43	60	$2,580
Subtotal				$ 1,999,132
Washington State Sales Tax			10.0%	N/A
Construction Contingency			30%	$ 599,740
Subtotal Construction Costs				$ 2,598,872
City Staff Time			0%	$ -
Administration and engineering design			20%	$ 519,774
Design Contingency			0%	$ -
Permitting			1%	$ 25,989
Land acquisition and easements	SF	$50	16,000	$ 800,000
Total Project Cost				**$ 3,944,700**

2018 Project ID:	Zack-CIP-2
Sheet flow on Louis Thompson at 210th Ave NE	
Preliminary Cost: $79,600	

210th Ave NE (looking north from Louis Thompson Rd) (left photo)

Intersection of 210th Ave NE and Louis Thompson Rd. (right photo)

Project Description:

Roadway runoff from 210th Ave NE is not properly conveyed to the existing ditch and culvert system, and instead sheet flows down the steep hill and overtops Louis Thompson Road. The sheet flow poses an erosion risk on the downstream side of the road and freezes in the winter causing a safety concern.

The proposed CIP includes constructing a berm in the Louis Thompson Road NE right-of-way on 210th Ave NE and new catch basins and cross culvert to convey sheet flow to the Louis Thompson Road NE ditch and culvert system.

Benefits and Opportunities:

- Improved safety at intersection.
- Reduced maintenance on Louis Thompson Road (average approximately $10K/year)

Challenges:

- Maintenance required to prolong performance.
- Solution is short-term.

Project Prioritization Score: 40 out of 100 possible points.

Environmental Benefit = 0

Safety = 15

Time-Sensitive Opportunity = 0

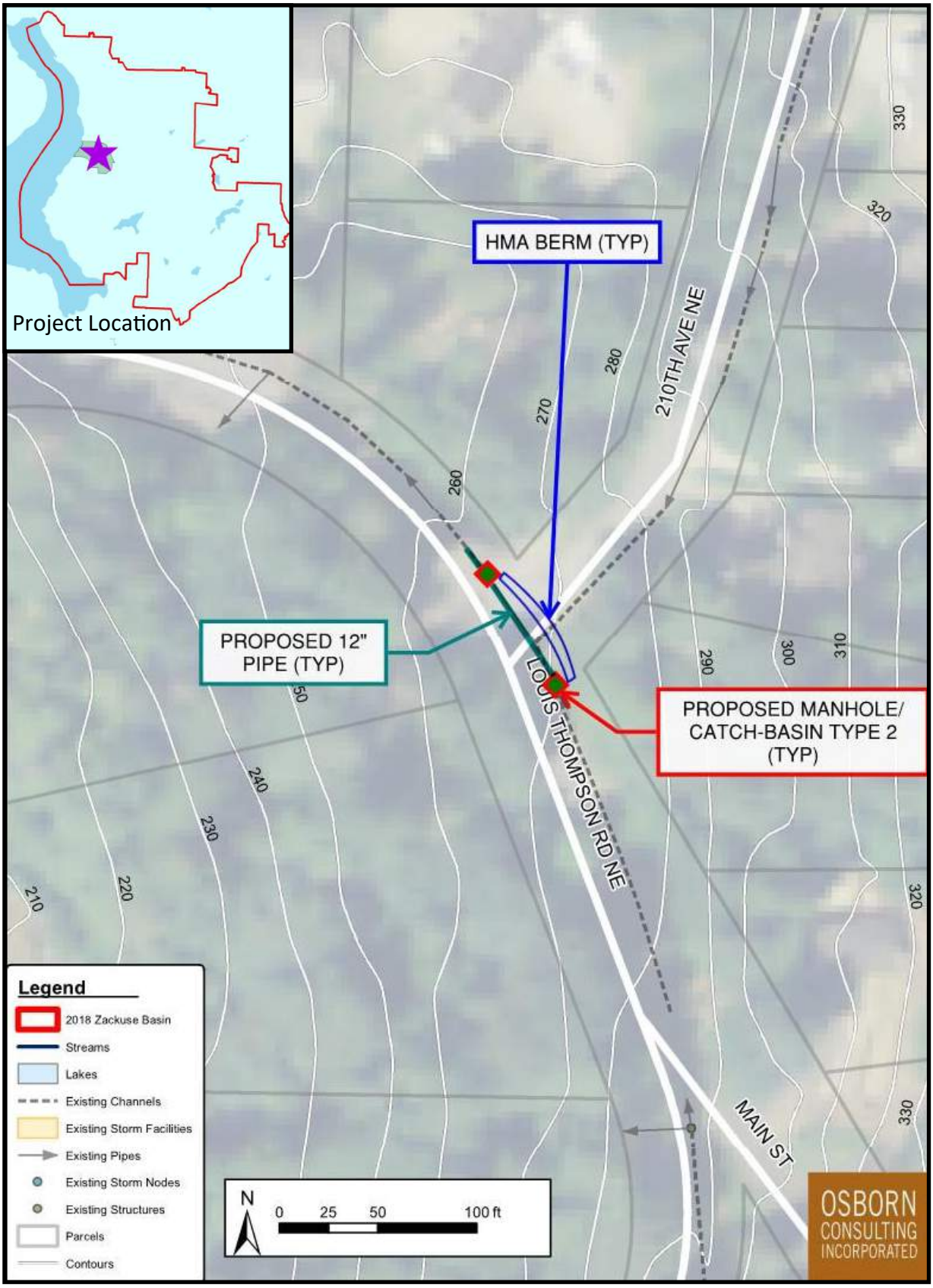
Facility/Maintenance Improvements = 15

Population Benefitted = 10

Assumptions and Considerations:

- This project does not include costs to increase roadway capacity, or improve nonmotorized access or lighting.

Schematic:


Project Location
HMA BERM (TYP)
PROPOSED 12" PIPE (TYP)
PROPOSED MANHOLE/ CATCH-BASIN TYPE 2 (TYP)
210TH AVE NE
LOUIS THOMPSON RD NE
MAIN ST
Legend
2018 Zackuse Basin
Streams
Lakes
Existing Channels
Existing Storm Facilities
Existing Pipes
Existing Storm Nodes
Existing Structures
Parcels
Contours
N
0 25 50 100 ft
OSBORN CONSULTING INCORPORATED

Planning Level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$3,320.50
Water Pollution/Erosion Control	%	5%	1	$1,660.25
SPCC Plan	LS	$500	1	$500
Traffic Control	%	6%	1	$1,992
Potholing	EA	$1,200	2	$2,400
Clearing & Grubbing	SY	$5	16	$80
Remove Asphalt Conc. Pavement	SY	$20	40	$800
HMA Berm	LF	$15	45	$675
Catch Basin Type 1	EA	$2,000	0	$0
Catch Basin Type 2 48 In. Diam.	EA	$5,000	2	$10,000
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	75	$12,750
French Drain Pipe 12 In. Diam.	LF	$150	0	$0
Roadway Restoration	SY	$150	40	$6,000
Subtotal				$ 40,178
Washington State Sales Tax			10.0%	
Construction Contingency			50%	$ 20,089
Subtotal Construction Costs				$ 60,267
City Staff Time			0%	$ -
Administration and engineering design			20%	$ 12,053
Design Contingency			10%	$ 6,027
Permitting			2%	$ 1,205
Land acquisition and easements	SF	$5	0	$ -
Total Project Cost				**$ 79,600**

2018 Project ID:	Zack-CIP-3
Louis Thompson Road NE Tightline	
Preliminary Cost: $4.2M—$7.6M	

Louis Thompson Road typical section (both photos)

Project Description:

The existing conveyance system along Louis Thompson Road NE consists of ditches and culverts. Portions of the drainage system are located within a critical drainage area and/or landslide hazard area. This CIP is designed to accommodate runoff from potential future road improvements and/or development, and provide water quality treatment. There is currently no water quality treatment for runoff on Louis Thompson Road NE. An existing landslide repair project was completed in December 2018 that improved drainage between 211th Pl SE and 210th Pl SE.

The proposed CIP includes upgrading Louis Thompson Road NE (from 210th Pl SE to 205th Ave NE) to consist of a curb and gutter system that includes catch basins and a storm sewer pipe. The base project (Schedule A on schematic) includes a tightline from 210th Ave NE to 205th Ave NE with water quality treatment and conveyance to the existing infiltration facility. Options include an extended tightline between 210th Ave NE and 210th Pl SE (Schedule B on schematic) and non-motorized improvements for the entire length (Schedule C), including curb, gutter and sidewalks. The project includes stub-outs to collect runoff from side streets. The project would alleviate erosion at existing outfalls on south side of Louis Thompson Road NE. The short and long tightline cost options are provided in a table with planning level cost estimates.

Benefits and Opportunities:

- Formal drainage system, reduce ditch erosion.
- Increases storm system capacity.
- Improved water quality.
- Reduce erosion at outfalls.

Challenges:

- Flow control siting could be a challenge and is not included in cost estimate. Existing infiltration facility is too small to retrofit.

Project Prioritization Score: 65 out of 100 possible points.

Environmental Benefit = 15

Safety = 15

Time-Sensitive Opportunity = 0

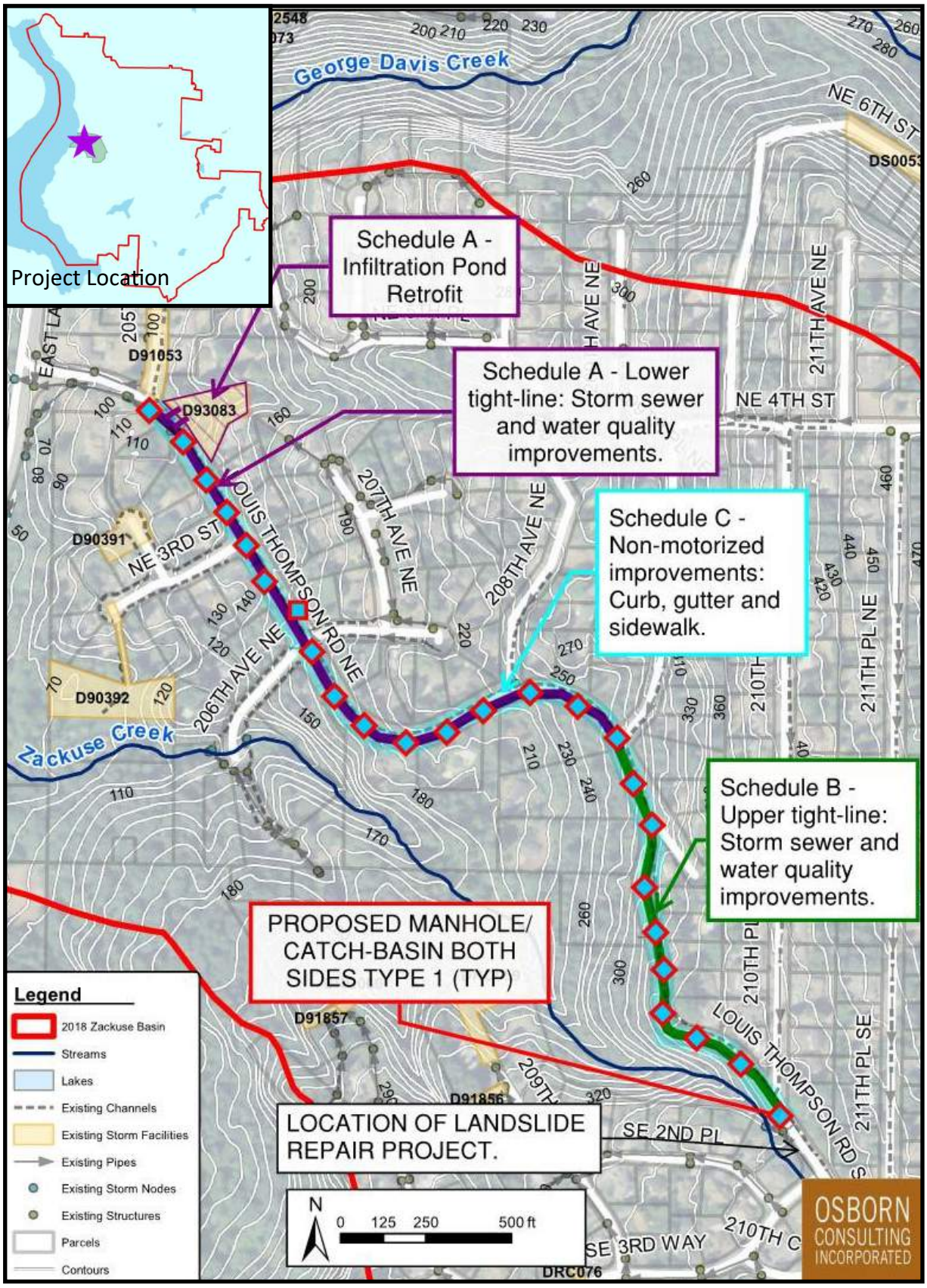
Facility/Maintenance Improvements = 25

Population Benefitted = 10

Assumptions and Considerations:

- An 18-inch storm sewer pipe was assumed to provide adequate conveyance capacity, however, further analysis will be required during the design phase.

Schematic:


Project Location
Schedule A - Infiltration Pond Retrofit
Schedule A - Lower tight-line: Storm sewer and water quality improvements.
Schedule C - Non-motorized improvements: Curb, gutter and sidewalk.
Schedule B - Upper tight-line: Storm sewer and water quality improvements.
PROPOSED MANHOLE/ CATCH-BASIN BOTH SIDES TYPE 1 (TYP)
LOCATION OF LANDSLIDE REPAIR PROJECT.
George Davis Creek
Zackuse Creek
NE 6TH ST
NE 4TH ST
NE 3RD ST
SE 2ND PL
SE 3RD WAY
211TH AVE NE
211TH PL NE
211TH PL SE
210TH PL
210TH C
208TH AVE NE
207TH AVE NE
206TH AVE NE
LOUIS THOMPSON RD NE
LOUIS THOMPSON RD S
EAST LA
D91053
D93083
D90391
D90392
D91857
D91856
DS005
DRC076
Legend
2018 Zackuse Basin
Streams
Lakes
Existing Channels
Existing Storm Facilities
Existing Pipes
Existing Storm Nodes
Existing Structures
Parcels
Contours
N
0 125 250 500 ft
OSBORN CONSULTING INCORPORATED

Option	Description	Cost		
		Tightline +Water Quality	Non-motorized improvements (Schedule C)	Tightline plus non-motorized
Short tightline	210th Ave NE to 205th Ave NE (Schedule A)	$4,205,100	$1,677,000	$5,882,100
Long tightline	210th Pl SE to 205th Ave NE	$5,949,900	$1,677,000	$7,626,900

Planning Level Cost Estimate Schedule A:

Lower tightline– 210th Ave NE to 205th Ave NE

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$138,681
Water Pollution/Erosion Control	%	5%	1	$69,341
SPCC Plan	LS	$500	1	$500
Traffic Control Arterial Streets	%	9%	1	$124,813
Potholing	EA	$1,200	13	$15,600
Remove Asphalt Conc. Pavement	SY	$20	1,620	$32,400
Removal of Structures and Obstructions	EA	$2,000	3	$6,000
Plug and Abandon Existing Pipe	EA	$500	1	$500
Catch Basin Type 1	EA	$2,000	26	$52,000
Modular Wetland System	EA	$19,600	26	$509,600
Connect to Existing Drainage Structure	EA	$1,500	1	$1,500
Polypropylene Culvert Pipe 18 In. Diam.	LF	$225	2,070	$465,750
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	455	$77,350
Cement Conc. Traffic Curb and Gutter	LF	$26	0	$0
HMA Cl. 1/2 in. PG 64-22 (QTY>50 TON)	TON	$150	560	$84,000
Crushed Surfacing Base Course	CY	$43	270	$11,610
Subtotal				$ 1,719,644
Washington State Sales Tax			10.0%	N/A
Construction Contingency			30%	$ 515,893
Subtotal Construction Costs				$ 2,235,538
City Staff Time			0%	$ -
Administration and engineering design			20%	$ 447,107.54
Design Contingency			0%	$ -
Permitting			1%	$ 22,355.38
Land acquisition and easements	SF	$5	0	$ 1,500,000
Total Project Cost				**$ 4,205,100**

Planning Level Cost Estimate Schedule B:

Upper tightline– 210th Ave NE to 210th Pl SE

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$89,449
Water Pollution/Erosion Control	%	5%	1	$44,725
SPCC Plan	LS	$500	1	$500
Traffic Control Arterial Streets	%	9%	1	$80,504
Potholing	EA	$1,200	7	$8,400
Remove Asphalt Conc. Pavement	SY	$20	1,040	$20,800
Removal of Structures and Obstructions	EA	$2,000	1	$2,000
Plug and Abandon Existing Pipe	EA	$500	1	$500
Catch Basin Type 1	EA	$2,000	18	$36,000
Modular Wetland System	EA	$19,600	18	$352,800
Connect to Existing Drainage Structure	EA	$1,500	1	$1,500
Polypropylene Culvert Pipe 18 In. Diam.	LF	$225	800	$180,000
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	825	$140,250
Cement Conc. Traffic Curb and Gutter	LF	$26	0	$0
HMA Cl. 1/2 in. PG 64-22 (QTY>50 TON)	TON	$150	360	$54,000
Crushed Surfacing Base Course	CY	$43	180	$7,740
Subtotal				$ 1,109,168
Washington State Sales Tax			10.0%	N/A
Construction Contingency			30%	$ 332,750
Subtotal Construction Costs				$ 1,441,918
City Staff Time			0%	$ -
Administration and engineering design			20%	$ 288,384
Design Contingency			0%	$ -
Permitting			1%	$ 14,419.18
Land acquisition and easements	SF	$5	0	$ -
Total Project Cost				**$ 1,744,800**

Planning Level Cost Estimate Schedule C:

Non-motorized Project Elements

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$85,976
Water Pollution/Erosion Control	%	5%	1	$42,988
SPCC Plan	LS	$500	0	$0
Traffic Control Arterial Streets	%	9%	1	$77,378
Potholing	EA	$1,200	0	$0
Remove Asphalt Conc. Pavement	SY	$20	0	$0
Removal of Structures and Obstructions	EA	$2,000	0	$0
Plug and Abandon Existing Pipe	EA	$500	0	$0
Catch Basin Type 1	EA	$2,000	0	$0
Modular Wetland System	EA	$19,600	0	$0
Connect to Existing Drainage Structure	EA	$1,500	0	$0
Polypropylene Culvert Pipe 18 In. Diam.	LF	$225	0	$0
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	0	$0
Cement Conc. Traffic Curb and Gutter	LF	$26	7,800	$202,800
Cement Concrete Sidewalk	SY	$104	5,200	$540,800
Cement Concrete Curb Ramp	EA	$2,180	12	$26,160
Subtotal				$ 1,066,102
Washington State Sales Tax			10.0%	N/A
Construction Contingency			50%	$ 533,051
Subtotal Construction Costs				$ 1,599,154
City Staff Time			0%	$ -
Administration and engineering design			20%	$ 319,831
Design Contingency			10%	$ 159,915
Permitting			1%	$ 15,991.54
Land acquisition and easements	SF	$5	0	$ -
Total Project Cost				**$ 2,094,900**

2018 Project ID:	Zack-CIP-4
Intercept groundwater seepage on East Lake Sammamish	
Preliminary Cost: $123,300	

Pooling water on ELSP from seepage emanating from bank on left side of photo

Project Description:

Groundwater seepage from an existing retaining wall sheet flows across East Lake Sammamish Parkway (ELSP) and creates a drainage concern during both wet and dry weather conditions at the intersection of ELSP NE and Louis Thompson Road.

The proposed CIP is to construct a catch basin collection and conveyance system along the east side of ELSP to intercept groundwater seepage from an adjacent retaining wall. The seepage will be direct south and outfall at the culvert that cross under ELSP at Louis Thompson Road.

Benefits and Opportunities:

- Improved road safety.
- Less opportunity for contact with roadway pollutants and mobilization of pollutants into receiving waters.

Challenges:

- Project will not stop the seepage, only redirect it.

Project Prioritization Score: 35 out of 100 possible points.

Environmental Benefit = 0

Safety = 15

Time-Sensitive Opportunity = 0

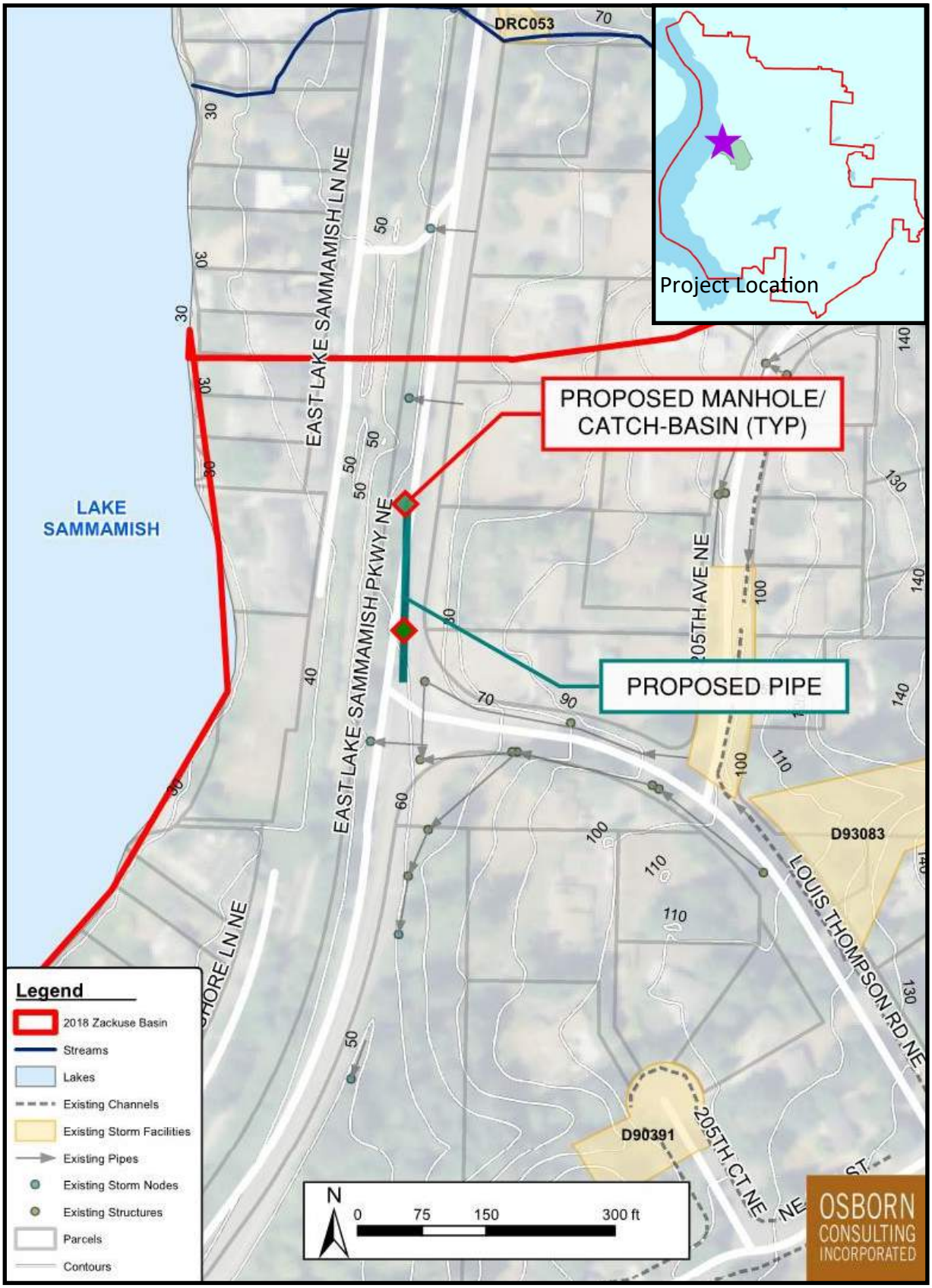
Facility/Maintenance Improvements = 10

Population Benefitted = 10

Assumptions and Considerations:

- The project will directly connect an existing 4-inch drainage pipe to the proposed upstream catch basin and collect general seepage that emerges.

Schematic:


DRC053
Project Location
PROPOSED MANHOLE/
CATCH-BASIN (TYP)
PROPOSED PIPE
LAKE
SAMMAMISH
EAST LAKE SAMMAMISH LN NE
EAST LAKE SAMMAMISH PKWY NE
205TH AVE NE
LOUIS THOMPSON RD NE
205TH CT NE
D93083
D90391
Legend
2018 Zackuse Basin
Streams
Lakes
Existing Channels
Existing Storm Facilities
Existing Pipes
Existing Storm Nodes
Existing Structures
Parcels
Contours
N
0
75
150
300 ft
OSBORN
CONSULTING
INCORPORATED

Planning Level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	1	$6,025.00
Water Pollution/Erosion Control	%	5%	1	$3,013
SPCC Plan	LS	$500	1	$500
Traffic Control	%	9%	1	$5,423
Potholing	EA	$1,200	2	$2,400
Remove Asphalt Conc. Pavement	SY	$20	95	$1,900
Catch Basin Type 1	EA	$2,000	2	$4,000
Connect to Existing Drainage Structure	EA	$1,500	1	$1,500
Polypropylene Storm Sewer Pipe 12 In. Diam.	LF	$170	210	$35,700
Roadway Restoration	SY	$150	95	$14,250
Subtotal				$ 74,710
Washington State Sales Tax			10.0%	N/A
Construction Contingency			25%	$ 18,677.50
Subtotal Construction Costs				$ 93,388
City Staff Time			0%	$ -
Administration and engineering design			20%	$ 18,678
Design Contingency			10%	$ 9,339
Permitting			2%	$ 1,868
Land acquisition and easements	SF	$5	0	$ -
Total Project Cost				**$ 123,300**

2018 Project ID:	Zack-Hab-1
Instream and habitat improvements near Zackuse Creek mouth and Shore Lane	
Potential Cost Range: $10,000 (revegetation) to $135,000 (daylight stream with no culvert replacement)	

Zackuse Creek near mouth, looking upstream (east). January 2018.

Zackuse Creek near Shore Lane, looking downstream (west). January 2018.

Project Description:

Zackuse Creek flows through residential properties between East Lake Sammamish Parkway and Lake Sammamish. Within this residential context, there is room for habitat improvements to benefit Kokanee salmon and other salmonids. Stream banks could be planted more densely with native species, rounded cobble and gravel materials could replace or supplement existing angular rock banks, and wood and rock materials could be added within the active channel to dissipate stream energy and provide hydraulic diversity, thereby improving fish passage. Variable velocities along the length of the reach and across the channel width at any given location would allow fish to seek out microhabitats with slower velocities where they can rest between traversing the remaining shorter, high-velocity sections.

Benefits and Opportunities:

- Improve fish passage at variable flows.
- Improve habitat conditions, including shade and cover.
- Possibly daylight culverted sections.

Challenges:

- Exclusively private property, except at trail crossing. Will require voluntary participation by property owners.
- Limited space for adding wood. May use other structural roughness, such as rounded cobbles and boulders.

Assumptions and Considerations:

- This project could involve a range of improvements from a) only vegetative improvements to b) added in-channel modifications to create hydraulic diversity, to (c) added daylighting of culverted sections. The level of complexity will depend on the willingness of property owners to participate, and availability of funding. Targeted outreach to directly-affected property owners and the local neighborhood would be a key first step to gauge interest.

2018 Project ID:	Zack-Hab-2
Instream and habitat improvements near Zackuse Creek dog-leg in realignment reach	
Potential Cost Range: $46,000 (invasive removal and revegetation) to $156,000 (large woody debris)	

Zackuse Creek near dogleg, looking upstream (north). January 2018.

Zackuse Creek upstream of dogleg, looking downstream (west). Channel incised in several feet of sediment. January 2018.

Project Description:

The Zackuse Creek culvert replacement and stream realignment/restoration project will reconstruct Zackuse Creek from East Lake Sammamish Parkway to a location approximately 400 feet upstream where the new stream channel will connect with the existing channel. Immediately upstream of the restoration project, Zackuse Creek is severely incised through several feet of sediment and the channel makes an abrupt 90 degree turn in the vicinity of the new connection point. Instream and riparian habitat improvements could be made in the reach between the current restoration project and 206th Ave NE to facilitate channel movement that will result in a more stable configuration (not a 90 degree turn) and encourage pool development. Potential improvements include adding large woody debris to provide structure, removing invasive vegetation, and extensively planting with native, woody shrubs, such as willows.

Benefits and Opportunities:

- Extend creek improvements upstream.
- Pre-empt potential channel avulsion that moves stream away from newly restored channel.

Challenges:

- Exclusively private property. Will require voluntary participation by property owners.
- Continued input of upstream sediment (channel erosion and landslides) will result in deposition in this reach, followed by downcutting, and potential channel migration.

Assumptions and Considerations:

- This project could involve a range of improvements from a) only vegetative improvements to b) in channel modifications to create hydraulic diversity. The level of complexity will depend on the willingness of property owners to participate, and availability of funding.

Planning Level Cost Estimate:

Potential Costs	Description	Units	Unit Cost	Total	Comments
Revegetation Only	Revegetate 10,000 square feet or area for invasives to be removed and replanted in vicinity of stream channel. Extensive planting with willow stakes.	10,000	4.6	$ 46,000.00	Assumed less than $4.60/SF estimate for removal of invasives and revegetation provided by TWC.
Add large wood to channel (construction plus permitting)	Assumes $60K for construction, $50K for permitting. No replacement of culvert.	1	$ 110,000.00	$ 110,000.00	Assumes difficult access
			Total	$ 156,000.00	

2018 Project ID:	Zack-Oper-1
Continue periodic culvert and ditch cleaning on Louis Thompson Rd. NE	
Preliminary Cost: $54,700 per cleaning	

Louis Thompson Road culvert. April 2018.

Louis Thompson Road ditch. March 2018.

Project Description:

Culverts and ditches that convey stormwater runoff on Louis Thompson Road become clogged with sediment and vegetative growth resulting in reduced capacity to convey flow.

This project is to conduct periodic culvert and ditch cleaning on Louis Thompson Road to prevent sediment and vegetation build-up and facilitate unobstructed flow conditions. Additionally, rip-rap protection will be added to culvert inlets where flow velocities exceed 5—6 feet per second, contributing to ditch erosion.

Benefits and Opportunities:

- Better stormwater conveyance.
- Reduced sheet flow over roadway.

Challenges:

- None.

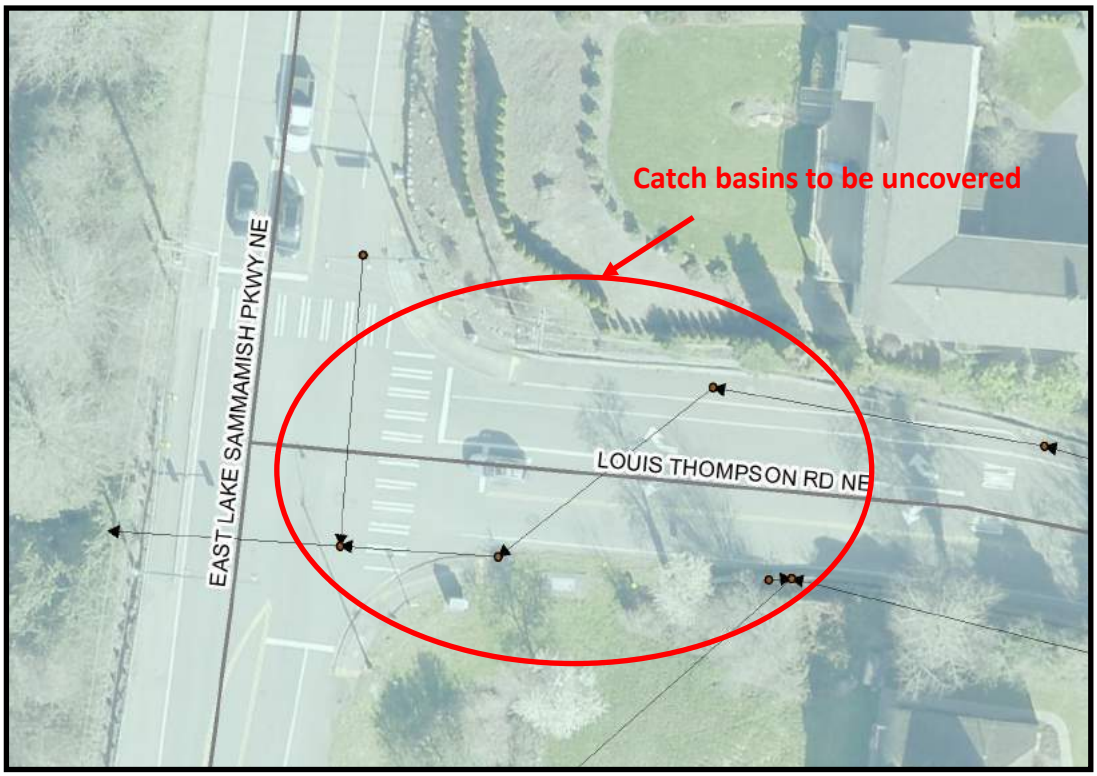
Assumptions and Considerations:

- Culverts and ditches will be cleaned by City or contracted crews during the dry season.

PLANNING LEVEL COST ESTIMATE:

Item	Description	Quantity	Units	Price	Total
1	Traffic Control	1	LS	$ 20,000.00	$ 20,000.00
2	Mobilization	1	LS	$ 15,000.00	$ 15,000.00
3	Culvert protection	11	Each	$ 500.00	$ 5,500.00
4	Culvert cleaning and jetting	500	LF	$ 5.00	$ 2,500.00
5	Ditch maintenance, including haul	311	CY	$ 87.50	$ 27,212.50
6	Vegetated berm removal, including haul	37	CY	$ 100.00	$ 3,700.00
7	2- to 4-inch rock, including haul	77	CY	$ 200.00	$ 15,400.00
8	Hydroseed	16,800	SF	$ 0.35	$ 5,880.00
				Total	$ 54,692.50

2018 Project ID:	Zack-Oper-2
Uncover buried catch basins at intersection of Louis Thompson Rd. and East Lake Sammamish Parkway	
Planning Level of Effort (hours): 48	



Project Description:

During a road paving project, catch basins at the intersection of Louis Thompson Rd and East Lake Sammamish Parkway were inadvertently paved over. This has resulted in lack of access for maintenance, CCTV inspection and cleaning.

This project is to uncover the catch basins and ensure that the system beneath the roadway is functioning properly and can be inspected, cleaned, and accessed as needed.

Benefits and Opportunities:

- Better access for system maintenance.

Challenges:

- None.

Assumptions and Considerations:

- It is assumed that no damage to the catch basin or stormwater pipes occurred during the paving project and no repairs or replacement is required.

Planning Level of Effort:

Task	Description	Level of Effort (hours)
Uncover buried catch basins, install new covers, and repair asphalt pavement.	Assume this will take three people two days (2 workers, 1 truck, 1 flagger)	48
	Total	**48**

2018 Project ID:	Zack-Oper-3
CCTV and Clean Pipes in East Montage Neighborhood	
Preliminary Cost: $36,000	

East Montage vault (under gravel drive) and catch basins (foreground)

Project Description:

Sediment builds up in the existing East Montage flow control vault (D91856) clogging the flow control orifices, leading to overflows. In response to vault overflows, the City retrofitted a bypass catch basin to safely convey higher flows. The overflows and associated flooding have stopped; however high flows bypass the vault undetained.

The proposed CIP will be phased. Phase I will include CCTV and pipe cleaning of the conveyance system upstream of the vault to identify sediment sources. Results of CCTV may indicate need for further study, or identify system failures that require repair or replacement. Depending on outcome of CCTV results, Phase II will include (a) pipe repair and replacement, (b) installation of Type II catch basins or other sediment facility to collect more sediment upstream of vault, and/or (c) increased maintenance frequency.

Benefits and Opportunities:

- Reduce sediment delivery to vault and improve vault functionality.

Challenges:

- None.

Project Prioritization Score: 45 out of 100 possible points.

Environmental Benefit = 20

Safety = 0

Time-Sensitive Opportunity = 0

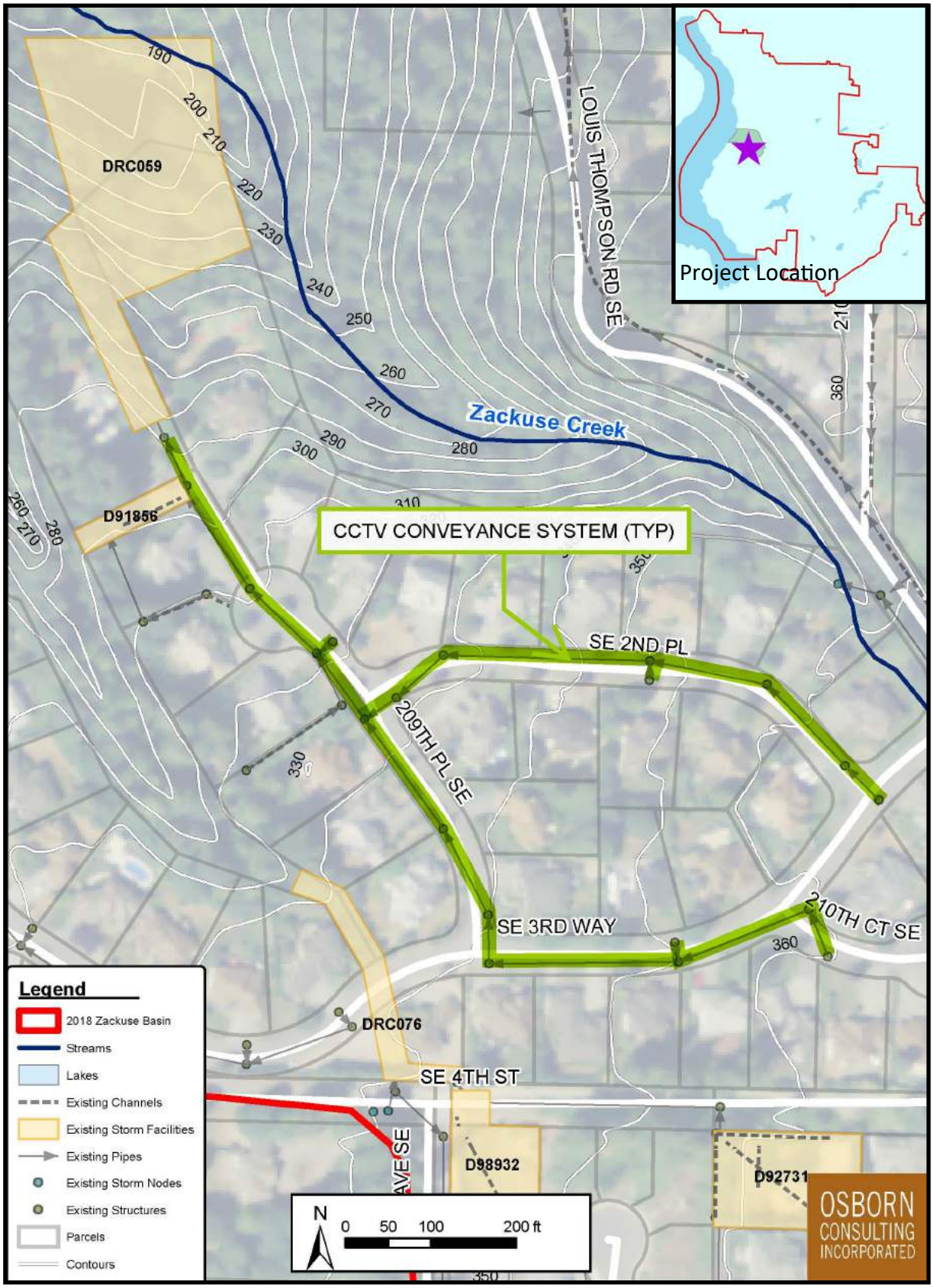
Facility/Maintenance Improvements = 20

Population Benefitted = 5

Assumptions and Considerations:

- CCTV will be effective at identifying sediment sources, such as pipe offsets, or breaks.
- Phased approach will allow for robust, long-term solution, rather than short-term maintenance fixes.

Schematic:


Project Location
LOUIS THOMPSON RD SE
Zackuse Creek
DRC059
D91856
CCTV CONVEYANCE SYSTEM (TYP)
SE 2ND PL
209TH PL SE
SE 3RD WAY
210TH CT SE
DRC076
SE 4TH ST
D98932
D92731
Legend
2018 Zackuse Basin
Streams
Lakes
Existing Channels
Existing Storm Facilities
Existing Pipes
Existing Storm Nodes
Existing Structures
Parcels
Contours
N
0 50 100 200 ft
OSBORN CONSULTING INCORPORATED

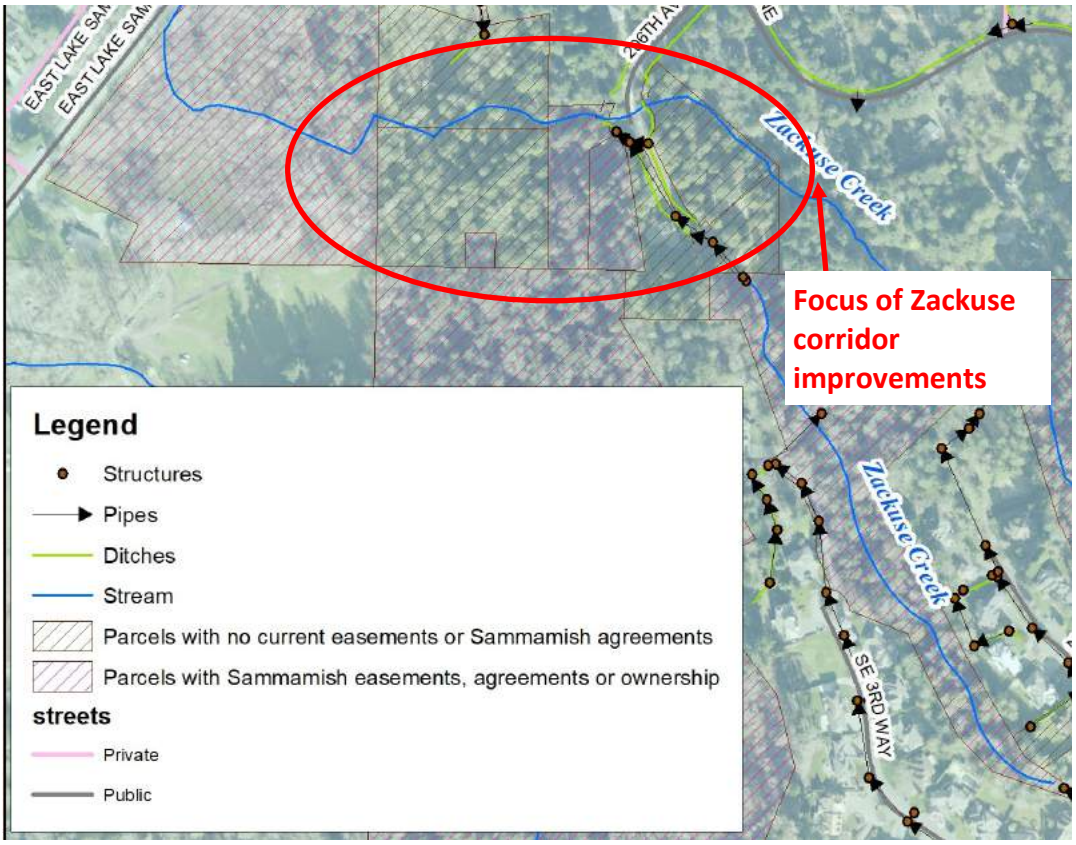
Planning Level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Mobilization	%	10%	0	$1,500
Water Pollution/Erosion Control	%	5%	0	$750
SPCC Plan	LS	$500	0	$0
Traffic Control	%	6%	0	$900
CCTV	LF	$3.50	2000	$7,000
Clean Pipe	LF	$4.00	2000	$8,000
Subtotal				$ 18,150
Washington State Sales Tax			10.0%	N/A
Construction Contingency			50.0%	$ 9,075
Subtotal Construction Costs				$ 27,225
City Staff Time			0%	$ -
Administration and engineering design			20%	$ 5,445
Design Contingency			10%	$ 2,723
Permitting			2%	$ 545
Land acquisition and easements	SF	$5	0	$ -
Total Project Cost				**$ 36,000**

Cost Estimate Assumptions:

- The cost estimate includes the Phase 1 efforts for the entire conveyance system (CCTV for the entire system and cleaning 50 percent of the pipes). The overall project cost is unknown until Phase 1 is complete, and the condition of existing infrastructure is determined.
- It is assumed that City personnel will be able to review the CCTV inspection and determine the source of sediment. It is possible that additional engineering review is needed beyond what City officials can provide. This additional engineering review (by others) has not been accounted for in the cost estimate.

2018 Project ID:	Zack-Pol-1
Include Zackuse corridor/206th Ave culvert replacement in long-term property acquisition plan	
Preliminary Cost: To be determined.	



Project Description:

Much of Zackuse Creek is in open space land agreements in place to retain open space in the location of the current stream restoration project. The City should include the entire corridor in long-term plans for property acquisition and stream improvements and potential daylighting of the portion of the South Tributary that is in a pipe. The figure above shows the status of existing parcels in the corridor. The schematic on page 2 shows a close-up of potential improvements.

Benefits and Opportunities:

- Improved fish habitat and fish passage.
- Opportunities for future trails and environmental education.
- Reduce maintenance.

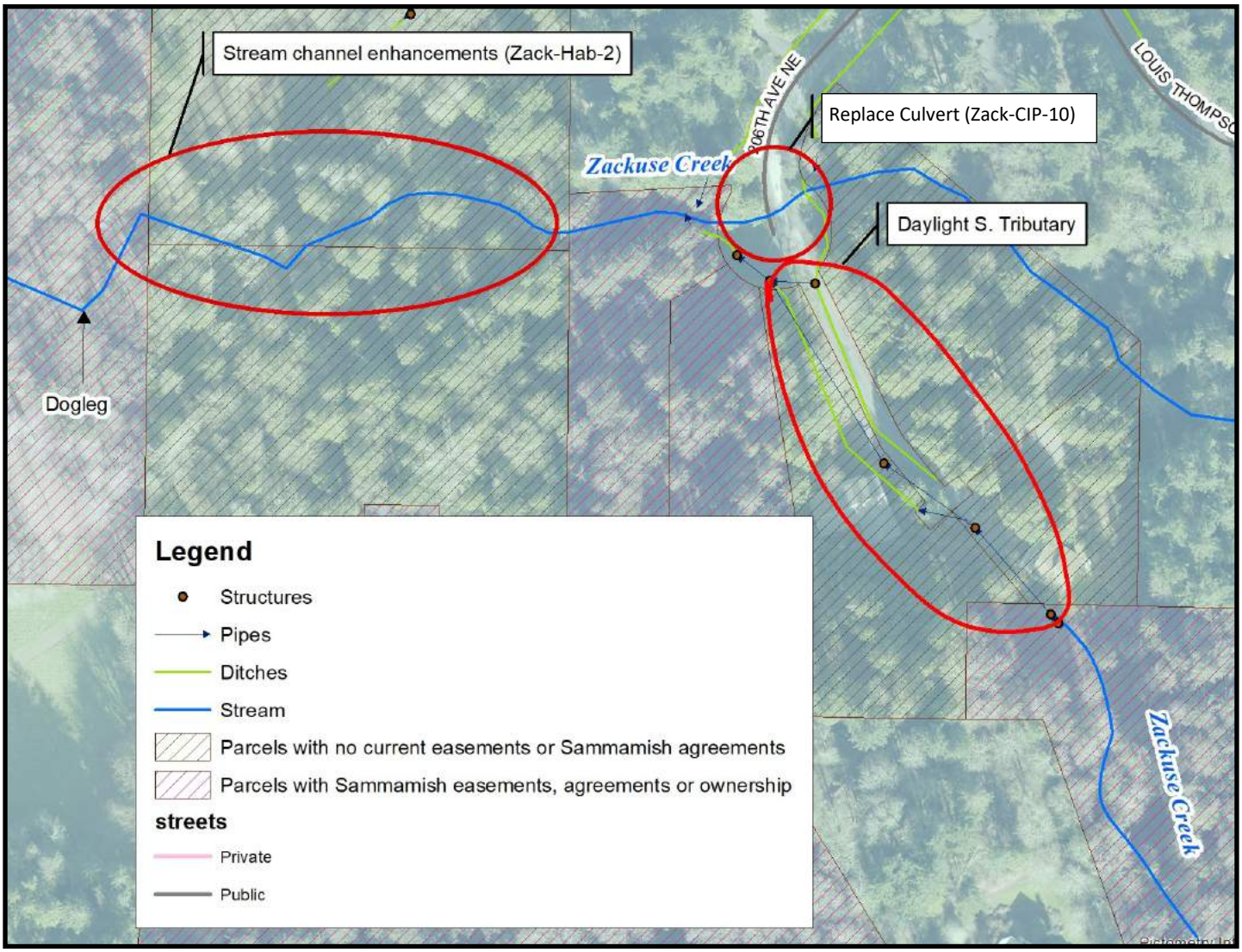
Challenges:

- Long-term strategy that will require patience and ability to move on opportunities when they become available.

Assumptions and Considerations:

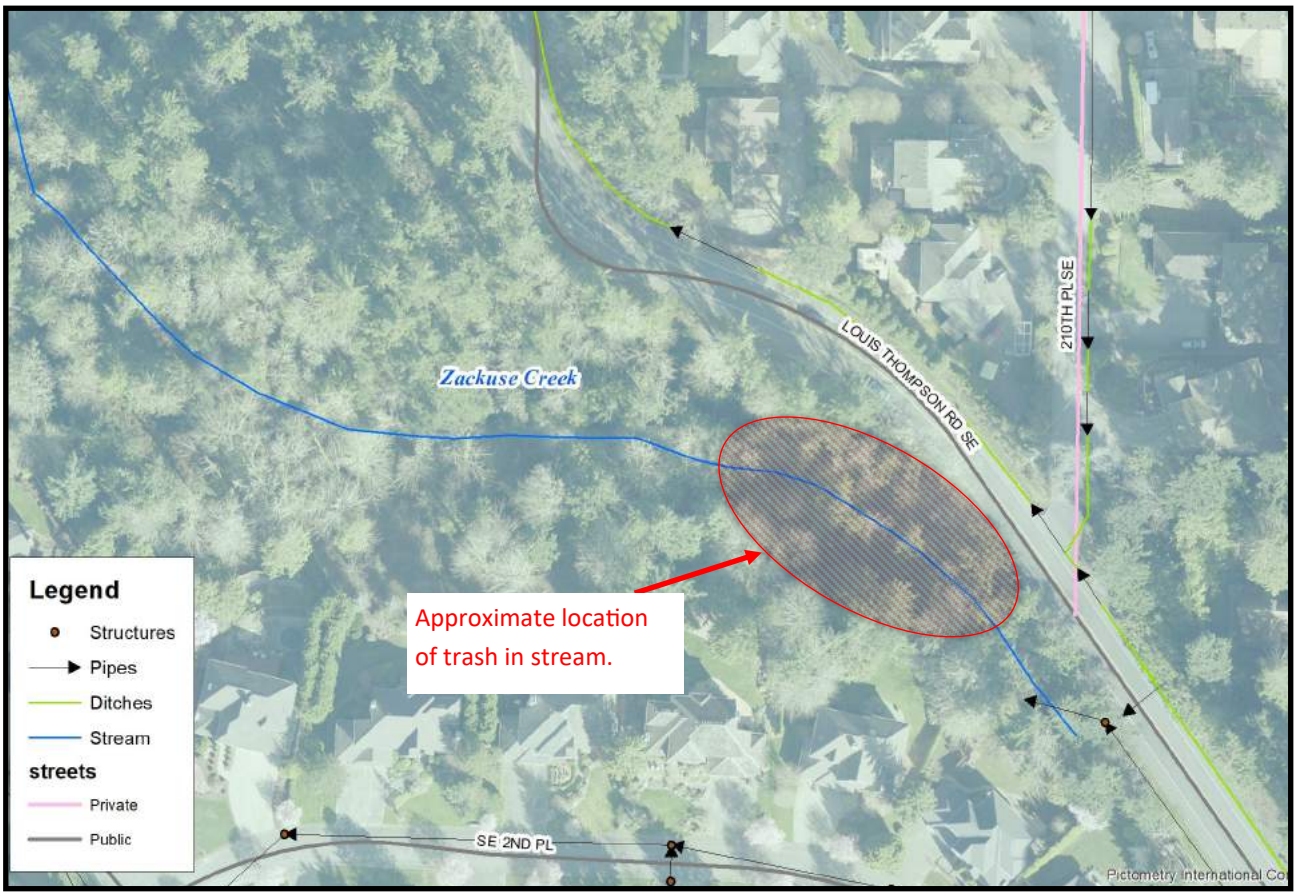
- Culvert is not in need of replacement now, but when it does get replaced, a much larger, fish-passable culvert or bridge will be required.
- Culvert replacement could be done in conjunction with daylighting the South Tributary if properties were acquired.

Schematic of potential improvements in corridor:



Note: Locations of potential improvements shown in areas denoted by red circles require property easements or acquisitions.

2018 Project ID:	Zack-WQ-1
Remove trash in Zackuse Creek	
Estimated Cost: $5,000	



Project Description:

There is evidence of extensive, historical and current dumping in Zackuse Creek in the vicinity of Louis Thompson Rd and 210th Pl SE. It is possible that hazardous materials, such as car batteries, or other discarded chemical containers have been dumped over the side of Louis Thompson Rd and landed in Zackuse Creek, alongside other household trash.

This project is to conduct a major creek clean-up and remove debris from the channel so that hazardous materials do not pollute the water and contribute to poor water quality. No dumping signs will also be posted.

Benefits and Opportunities:

- Improved water quality.

Challenges:

- Could be an on-going problem in this location.
- Ability to prevent future dumping.

Assumptions and Considerations:

- Likely will need a City crew or professional clean-up crew due to the type of material that is in the channel and the difficulty in retrieving it. This is not a good candidate location for volunteer trash pick-up.
- Post “no dumping” signs.
- Approximately 10 to 20 cubic yards of trash will need to be removed.

2018 Project ID:	Zack-WQ-2
Implement water quality monitoring in Zackuse Basin	
Preliminary Costs: $28,000 (committed) to $43,000 (not committed)	

Project Description:

The City in cooperation with King County has developed a water quality monitoring plan that includes Zackuse Creek (King County 2018). By monitoring streams such as Zackuse Creek, the City hopes to acquire baseline data to characterize the condition of Sammamish fresh water streams, ensure streams meet State water quality criteria, and monitor ecological changes. Additionally, the City will be better equipped to address water quality and physical stream condition trends (negative or positive) through the collection of data. The water quality monitoring plan was designed to support Sammamish goals for water quality and aquatic habitat, including:

- Protect and improve lake and stream water quality for kokanee and other fish.
- Protect and improve recreational water quality.
- Protect and improve lake and stream ecosystems.
- Protect and improve wetlands.

This project is to implement water quality monitoring in Zackuse Creek as proposed in the City's water quality monitoring plan. The monitoring plan recommends:

- Monthly routine stream water quality monitoring (bacteria, nitrogen, phosphorus, conductivity, dissolved oxygen, pH, turbidity)
- Annual B-IBI (benthic index of biotic integrity) sampling
- Continuous streamflow and temperature gaging

The monitoring would take place at a station near the mouth of Zackuse Creek.

Benefits and Opportunities:

- Better characterization of Zackuse water quality to help guide future decisions and resource allocation.

Challenges:

- None.

Assumptions and Considerations:

- Monitoring locations(s) will be identified at a future date.
- Monitoring will be conducted by City staff, King County staff or contractors.
- Optional monitoring includes investigation of bacteria sources.

Planning Level Cost Estimate:

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Task	Description	Cost
1	Add stream flow and temperature gage to Zackuse Creek	$ 8,000.00
2	Conduct monthly monitoring for routine parameters at one station in Zackuse Creek	$ 12,000.00
3	Conduct annual B-IBI sampling	$ 2,000.00
4	Investigate sources of bacteria*	$ 15,000.00
5	Conduct sampling for metals	$ 3,000.00
6	Conduct stream sediment embeddedness studies	$ 3,000.00
	Total	**$ 43,000.00**

*Funding is not committed.

2018 Project ID:	Zack-WQ-3
Identify strategies for using water quality data to implement Stormwater Comprehensive Plan Action G.5.1.B Stormwater Opportunity Fund and G.1.2.A. Stormwater Retrofit Strategy in Zackuse Basin	
Preliminary Level of Effort: 230	

Project Description:

The City will be implementing a new water quality monitoring program in Zackuse Creek (Zack-WQ-2). Monitoring will help the City assess the baseline condition of water quality in Zackuse Creek and monitor trends over time (i.e., is water quality improving or being degraded?). The purpose of this project is to develop an approach for implementing targeted water quality improvements in Zackuse Basin that address water quality issues identified through monitoring.

This project will involve the following tasks.

Task 1: Use maps and data from the basin plan that depict the following:

- Water quality treatment facilities in Zackuse Basin to show where treatment is occurring.
- Actions in the plan that have water quality treatment components.

Task 2: Using results from water quality monitoring, identify:

- Constituents of concern in Zackuse Creek.
- Potential sources of constituents of concern (i.e., road runoff, landslides [total suspended solids], septic systems, etc.).

Task 3: Develop strategies for identifying sources of constituents or implementing water quality improvements, including:

- Source-tracing of constituents, if necessary (i.e., fecal coliform bacteria).
- Acceleration of actions in plan to address water quality concerns, if necessary.
- Using Stormwater Opportunity Fund to add water quality treatment to City projects in which water quality treatment would otherwise not be required.
- Assessment of existing facilities for potential retrofit opportunities to optimize water quality treatment.

Benefits and Opportunities:

- Identifies approach for addressing water quality improvements based on need, once supporting data is available.

Challenges:

- Several years worth of water quality data in Zackuse Creek may be necessary to establish conditions and trends.

Assumptions and Considerations:

- Level of effort assumes identification of needs and strategies when data becomes available. Additional analysis, including detailed assessment of existing water quality facilities to determine potential optimization or retrofit opportunities is not included in level of effort evaluation, however, such analysis would be beneficial to identification of and enhancement of water quality improvements.

Planning Level of Effort:

Task	Description	Deliverable	Level of Effort (hours)
1. Use maps and data to identify existing and planned facilities	Use map to show (1) existing water quality treatment facilities and presumed treatment area, (2) planned facilities that will provide water quality treatment.	Map showing water quality treatment areas.	20
2. Identify water quality concerns and potential sources	Identify water quality constituents of concern from monitoring.	List of constituents of concern and potential sources	60
3. Develop strategies	Develop and prioritize strategies for implementing water quality improvements in the Zackuse Basin that address constituents of concern including source tracing (if necessary), improving existing treatment facilities, and adding treatment where none exists. Strategies will include implementation of Stormwater Comprehensive Plan Actions, such as the Stormwater Opportunity Fund and Retrofit Strategy.	Matrix of strategies and priority improvements.	150
		Total	230

2018 Project ID:	City-Pol-1
Develop stormwater recommendations to address impacts of climate change	
Preliminary Level of Effort (staff hours): 320	

Project Description:

Predicted climate in the Pacific Northwest is for winters to be warmer and wetter and summers to be drier. Stormwater design standards are predicated on historical data and probability analysis to predict future flow conditions (design storms and flows). As storm events become more frequent and more intense, the design storms that existing infrastructure was built to convey are no longer relevant. Additionally, currently functioning culvert crossings could become fish barriers in the future if climate change results in higher flows that are too large for the existing culverts. This project is to develop a strategy for addressing potential surface and stormwater associated consequences of climate change, including infrastructure impacts, operation and maintenance impacts, and impacts to natural resources.

Stormwater recommendations will focus on balancing infrastructure lifecycle with predicted rate of climate change, according to the most relevant and up-to-date research and models. The University of Washington Climate Impacts Group provides a well-respected, local resource for documents and analysis tools for stormwater managers and decision makers. Additionally, King County is developing a new climate change hydrology model.

This project will (1) identify the range of potential surface and stormwater associated problems associated with climate change, (2) evaluate timeframe of potential impacts, (3) determine affected population and stakeholders, (4) propose policies, development code, and stormwater program changes to address potential impacts, and (5) evaluate adoption of new King County climate change hydrology model.

The flowchart of steps to be taken for this project are shown on page 2.

Benefits and Opportunities:

- Allows the City to be forward-thinking and construct stormwater facilities that are lasting and effective.
- Minimizes detrimental effects of climate change by addressing anticipated impacts before they occur.

Challenges:

- Uncertainty on climate predictions. Changing climate models as data improves.
- Climate change horizon is longer than most planning timeframes, which could be challenging for implementing recommendations.
- There are costs associated with preparing for future impacts; if costs are borne by private developers, there could be push-back on any changes to development code or design standards.

Assumptions and Considerations:

- Climate models and recent literature will be researched, including data from the University of Washington Climate Impacts Group, to evaluate potential weather pattern changes in Sammamish as a result of climate change, and predicted impacts to utilities and natural resources.
- Climate change strategies and programs used by other jurisdictions in their stormwater programs will be researched for applicability to Sammamish.
- King County climate change hydrology model will be evaluated for adoption for Sammamish.

Flowchart of Methodology

Step 1– Identify Potential Impacts

Predicted climate changes in the Pacific Northwest:

- Wetter winters, more intense storms
- Drier summers

Potential surface and stormwater impacts from predicted climate change:

- Need for larger pipes and ditches to convey more water. Models that rely on historical data may become invalid.
- More landslides from saturated hillslopes, and more sediment deposition in streams and lakes from the landslides.
- Stormwater infrastructure needs more frequent maintenance due to greater sedimentation, and erosion (i.e., ditches).
- Vegetated stormwater facilities (i.e., rain gardens, biofiltration) may require irrigation for plants to survive dry summers.
- Fish passage may be impacted by culverts that are undersized for larger flows or low flows in summer dry periods.
- Wetlands enlarge, due to frequent inundation, but also may exhibit different plant assemblages because of drier summer conditions.
- Lakefront residents may experience greater sediment deposition near outfalls and mouths of streams, resulting in potential impacts to docks.

Step 2– Determine Timeframe of Potential Impacts

Review climate models for expected timeframe of different magnitude changes. For example, what is the % increase in rainfall for a 24-hour storm expected to be in 20 years, 50 years or 100-years?

Step 3– Determine Affected Population and Stakeholders

Determine areas where built environment (i.e. residents, commercial properties and parks) overlap with areas that will likely be impacted (i.e., steep slopes, low-lying poorly drained areas, stormwater infrastructure, lakefront properties). These are the most likely portion of the population to be affected. Maintenance personnel will also be affected in how and when they are needed for the work they do.

Step 4– Propose policies, development code, and stormwater program changes to address potential impacts

Policies, development code and stormwater program changes will be identified to address potential climate change impacts, including:

- City policies that consider the lifecycle of new infrastructure being proposed against predicted timing of climate impacts to ensure new infrastructure is functional for its full lifecycle.
- Development code changes that require stormwater conveyance and culverts be designed for larger design storms to account for predicted changes (based on predictive modeling and best available data).
- A focus on stormwater infrastructure that is less prone to maintenance.

PLANNING LEVEL OF EFFORT:

Task	Description	Deliverable	Level of Effort (hours)
Evaluate climate changes in Sammamish	Research climate models and documentation available for the Puget Sound and King County area	Predicted changes (% change in different rainfall metrics for different times in the future)	60
Identify potential impacts	Based on predicted changes, identify what parts of the surface and stormwater system might be affected by changes and what the impacts might look like (i.e., undersized pipes, more landslides, etc.)	List of potential impacts, and locations in Sammamish that would be affected.	40
Determine timeframe of potential impacts	Based on predicted changes, and current surface water and stormwater functionality and design standards, evaluate when might impacts be realized?	Timeline of predicted climate changes in juxtaposition to predicted impacts in Sammamish	100
Determine affected population and stakeholders	Overlay areas that could be potentially impacted with built environment (residents, commercial areas, parks, etc.) to evaluate what part of Sammamish population is most affected	Map of affected population	20
Develop list of possible strategies to address climate change	Research climate change strategies used by other jurisdictions	Summary matrix	20
	Develop policies to reduce or prevent future impacts		
	Identify development code modifications, design standard changes, and models		
	Identify new maintenance strategies	List of possible solutions	80
		Total	320

2018 Project ID:	City-Prog-1
Improve city maps and public accessibility	
Preliminary Level of Effort (hours): Greater than 160	

Project Description:

The City GIS department produces maps that depict information about the City, such as transportation routes, critical areas, parks, zoning, and other information that is useful to City planners and the public. Many jurisdictions have implemented on-line mapping tools that allow citizens to access and create maps using available City data.

This project is to update the City's on-line map inventory for all City assets and develop tools to provide greater access to the public.

Benefits and Opportunities:

- More informed public.
- Less staff time to fill specific requests for information.

Challenges:

- Keeping maps and on-line system up-to-date.

Assumptions and Considerations:

- City will research how other jurisdictions make maps accessible to the public for potential application in Sammamish.
- The level of effort assumed in this project is to develop an initial set of improved maps and accessibility but does not include ongoing updates or system maintenance.

Planning Level of Effort:

Task	Description	Deliverable	Level of Effort (hours)
1. Research on-line maps in other jurisdictions	Evaluate possible methods for improving Sammamish maps, based on what other jurisdictions are doing, ranging from (1) just updating existing .pdf maps available to the public to (2) creating on-line GIS-based system to create map layers with different sets of data.	List of potential options for updating maps and public accessibility.	60
2. Evaluate costs and level of effort for most feasible options	Determine resources needed to develop and maintain options identified in Task 1.	Matrix of costs, and resource needs (i.e., computer support, server space, etc.) for different options.	60
3. Present options to decision makers.	Summarize options and resources necessary to revamp public-facing maps and/or City website that hosts data. Recommend preferred staff option.	Presentation outlining pros and cons of different options.	40
4. Move forward with recommended option	Update maps, create web platform for hosting map tool (if this is the desired approach).	Maps and tool for public accessibility	To be determined
		Total	>160