FARMING IN THE FLOODPLAIN PROJECT
EXISTING CONDITIONS REPORT

Prepared for
PCC Farmland Trust

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Photo of Early Bird Farm

Executive Summary

The *Existing Conditions Report* has been prepared as part of the first phase of the Farming in the Floodplain Project (FFP), which addresses agricultural viability in the Clear Creek area in Pierce County. The report summarizes existing information about physical conditions and trends in the Clear Creek area, identifies information needs, and describes the relationship between physical conditions and viability of agriculture in the area. The report will serve as baseline information to inform additional technical work in future phases of the FFP.

Contents of the Report

The Existing Conditions Report includes the following chapters:

- **Chapter 1** provides background information on the FFP, its relationship to the proposed Clear Creek Floodplain Reconnection Project, its relationship to the Floodplains by Design initiative, and the study area for this report.
- **Chapter 2** defines agricultural viability and provides information on agriculture in Pierce County and the Clear Creek area. The chapter also describes examples of agriculture in other watersheds in Washington State.
- **Chapter 3** describes the Clear Creek Basin setting and characteristics, including historical development, climate, soils, geology, land use, transportation, utilities, and habitat.
- **Chapter 4** describes the relationship between water resources and agriculture in the Puyallup River Watershed and the Clear Creek area. The chapter provides information on existing conditions, the relationship to agricultural viability, and information needs for surface water, flood risk, groundwater, drainage, sediment, water quality, water rights, and irrigation.
- **Chapter 5** describes the integration of agriculture with floodplain projects.
- **Chapter 6** describes the observed trends and projections for climate change in the Puget Sound region and the Puyallup River Watershed, and their relationship with agricultural viability.
- **Chapter 7** presents recommendations and the next steps for the FFP.
- **Chapter 8** includes references cited throughout this report, as well as supplemental bibliographic information used in the analysis.

Project Purpose and Background

The FFP is one of four components of the Floodplains for the Future: Puyallup, White, and Carbon Rivers project, which is funded by a Floodplains by Design grant from the Washington Department of Ecology (Ecology). The purpose of the FFP is to advance progress toward a collectively agreed upon plan for the Clear Creek area that improves agricultural viability in the area while also meeting goals

for flood risk reduction and salmon habitat enhancement. The FFP is intended to clarify the needs and interests of the agricultural community within the Clear Creek area.

The FFP is related to, but independent from, the Clear Creek Floodplain Reconnection Project proposed by Pierce County Surface Water Management. The FFP is intended to analyze the potential farmland impacts of that project. Beyond that specific project, the FFP will also take a broader look at agricultural viability in the Clear Creek area. This will lead to a better understanding of the needs of agriculture so they can be integrated into the proposed project so that it can achieve benefits to farming, salmon habitat, and flood risk reduction.

Project Location

The FFP is focused on the Clear Creek area, located in the Puyallup River Watershed and in Pierce County, Washington. The Clear Creek area is very low-lying with a relatively flat topography, with land elevations ranging from 10 to 20 feet (NAVD88). The low elevation and flat topography contributes to several of the issues facing the area, including flood risk, drainage problems, and vulnerability to climate change. The area is located directly adjacent to the cities of Tacoma and Puyallup, which has led to rapid residential development in upstream areas of the Clear Creek Basin (a sub-basin of the Puyallup River Watershed). Land uses within the Clear Creek area are primarily residential and agricultural. Many farms in the area benefit from being located minutes away from Tacoma, Puyallup, and I-5.

Floodplains by Design

The FFP is funded by a Floodplains by Design grant as part of a broader package of projects in the Puyallup River Watershed. Floodplains by Design is a statewide initiative to increase the pace and magnitude of multiple-benefit floodplain projects. While focused on the needs of agriculture in the Clear Creek area, the FFP is part of a broader effort to integrate flood risk reduction, habitat restoration, and agricultural viability in the Clear Creek area and the Puyallup River Watershed as a whole.

Agriculture is an important resource throughout Puget Sound but is threatened by development, increasing flood risk, and other factors. Throughout the region, the Floodplains by Design initiative has been encouraging floodplain managers and salmon habitat restoration experts to integrate the needs of the agricultural community into the planning of floodplain projects. The FFP was started based on the belief that more technical information is required to understand the needs of agriculture in the Clear Creek area so that these needs can be integrated into the planning of floodplain projects to ensure they enhance agricultural viability. While focused on the Clear Creek area, the FFP is intended to serve as a pilot project both within the Puyallup River Watershed and the Puget Sound region.

Technical Advisory Group and Farmer Input

To solicit input on this report, on future phases of technical work, and on the FFP in general, a Technical Advisory Group (TAG) was formed. The TAG met in April, June, and July 2016. Members of the TAG include farmers in the Clear Creek area, a representative of Drainage District 10, staff of local organizations and entities (including the Pierce County Agricultural Program, Pierce County Surface Water Management, the Pierce Conservation District, and PCC Farmland Trust), the Puyallup Tribe of Indians, the Muckleshoot Indian Tribe, the King-Pierce Farm Bureau, and regional technical experts from the Puget Sound Partnership, the U.S. Geological Survey, and the University of Washington Climate Impacts Group (CIG). The TAG provided input on existing information sources for the Clear Creek area, information needs, agricultural viability, and recommendations and next steps. Input from the TAG is incorporated throughout this report.

In addition to soliciting farmer input through the TAG, the FFP team conducted a site visit to the Clear Creek area on April 14, 2016 to observe conditions in the area and speak with farmers and other residents about their concerns. The FFP team also includes a landowner engagement team which frequently met with farmers in the area for one-on-one or small group conversations. This report also relied on a letter written to the Pierce County Executive in February 2016 and signed by eight Clear Creek area farmers (Johnson et al., 2016) and a PowerPoint presentation given by three Clear Creek area farmers to the Washington Department of Ecology in March 2016 (Clear Creek Farmers, 2016). Information and input from Clear Creek area farmers gathered through these methods is incorporated throughout this report and has been crucial in informing this report's analysis of how physical conditions in the area relate to agricultural viability.

Agriculture in the Clear Creek Area

Farms in the Clear Creek area are close to consumers and local markets in the urban centers of Tacoma and Puyallup. Smaller acreage farms in the Clear Creek area, many of which are certified organic, sell vegetables, berries, eggs, meats, Koi fish, and other farm products direct to consumers on farm or through Community Supported Agriculture (CSA) subscriptions, as well as through outlets such as the Tacoma and Proctor Farmers Markets, Marlene's Market (a local grocery store chain), and the Tacoma Food Co-op. Larger farms also sell fresh produce direct to local consumers through their own on-farm stands as well as to regional grocery retailers and food distributors. Many Clear Creek farms offer agritourism activities such as community potlucks, on-farm events, summer camps, pumpkin patches, and U-pick berries.

The Clear Creek area reflects the trend in Pierce County of a transition to smaller, local market-driven urban edge farming. The area also has several large wholesale farms that have been operated in the same family for generations. The area's proximity to consumers and highly productive soils also are attracting new farmers to Pierce County, with new farmers starting farms or becoming owners of existing smaller farms.

Risk

At the outset of the FFP, several stakeholders expressed a desire to develop "thresholds" that would identify those physical conditions under which farms in the area would no longer be viable. However, farmers in the area have expressed that conditions, crops, techniques, and plans vary so much between farms, even neighboring farms, that setting thresholds for farming as a whole would be neither possible nor useful. The same flooding conditions can be devastating for a farmer growing perennial crops but be a minor two-day nuisance for a farmer focusing on seasonal crops. Drainage conditions that render entire fields unusable for one farmer can be a benefit to a neighboring farm with a different soil type and different topography.

Farmers in the Clear Creek area explained that farmers constantly deal with risks, including weather, flooding and drainage problems, and market conditions. In any given year, some crops are successful and others are not. Farmers individually determine what an acceptable level of risk is and adjust their farming practices accordingly.

Instead of being organized around agricultural thresholds, this report focuses on the concept of risk to agriculture. Current conditions in the Clear Creek area present a range of risks to agriculture each year, and future conditions are anticipated to increase some existing risks, present new risks, or in some cases reduce risks. A variety of actions (designed to meet agriculture, flood risk reduction, or salmon habitat objectives) could be undertaken in the area, and each could increase and/or decrease risks to agricultural viability.

Agricultural viability is a key concept for the Farming in the Floodplain Project. Agricultural viability can be defined as the ability of a farmer or group of farmers to:

- Productively farm on a given piece of land or in a specific area.
- Maintain an economically viable farm business.
- Keep the land in agriculture long-term.
- Steward the land so it will remain productive into the future.

Water Resources and Agricultural Viability

The following sections of this Executive Summary summarize information from Chapter 4, Water Resources and Agricultural Viability, and Chapter 6, Climate Change. Information on flood risk, groundwater, drainage, sediment, water quality, water rights, and climate change are presented. For each of these topics, additional information is provided in Chapters 4 or 6. These summaries focus on the relationship between these conditions and agricultural viability and on the risks they present to agriculture. This chapter also includes future actions that could increase or reduce risks to agriculture. This information is intended to flag topics that need to be explored in greater depth and

could be analyzed in Phase 2 of the FFP. Future actions discussed in these sections are intended to represent a range of actions that could be undertaken by various stakeholders.

Flood Risk

The Clear Creek area currently faces complex flood risks from several directions. Major floods most recently occurred in 1996, 2006, 2009, and three times in 2015. The area is currently protected from flooding of the Puyallup River by two tide gates and by River Road Levee. The U.S. Army Corps of Engineers (Corps) does not consider the levee to provide adequate 100-year flood protection due to a lack of freeboard (defined as additional protection above the 100-year flood elevation). The area also faces flood risks from Clear Creek itself and its four tributaries. Because the interactions of flows from both Clear Creek and the Puyallup River and because of uncertainties about River Road Levee and the tide gates, flood risk in the area is not well understood by residents of the area.

Relationship between Flood Risk and Agricultural Viability

Flooding presents a risk to agriculture in the Clear Creek area. Several farmers in the area have stated that current incidences of flooding from Clear Creek do not represent a threat to their farms. However, future flooding conditions, whether from changed flood infrastructure, climate change, or the threat of River Road Levee overtopping, are concerns.

Due to the risk of flooding in the area, Pierce County regulates the area as a floodway. In general, no development, encroachment, filling, clearing, grading, new construction, or substantial improvement is permitted in a floodway area. However, there are specific exceptions for agricultural activities in the Clear Creek area. These regulations are not well understood by many residents of the Clear Creek area.

Current and Projected Risks to Agriculture from Flooding

The level of risk at each individual farm varies due to differences in elevation, topography, the crops grown, the location, and the techniques used. In general, the types of risks that flooding poses to farms include:

- Flooding represents a threat to human health and safety, particularly for farmers who live on their farms in the floodplain.
- Flooding in winter months represents a risk to perennial crops. Winter flooding can also prevent farmers from planting cover crops, which are an important aspect of agricultural viability for many farms in the area.
- Inundation of farmlands by contaminated floodwaters could negatively impact food safety and organic certification.
- Flooding can inundate and damage agricultural structures, such as barns.
- Flooding is a risk to livestock.

Flooding is projected to increase across Puget Sound, including the Clear Creek area. All of the threats to agriculture listed above could become more severe as floods become more frequent, last longer, and reach higher elevations.

Actions that Could Increase Risks to Agriculture from Flooding

The following changes in the Clear Creek area could increase risks to agriculture:

- More frequent flooding.
- Greater extent of flooding.
- More flooding during the growing season.
- Reduced flood storage capacity.
- Additional aggradation (i.e., fill with sediment) in the Clear Creek or Puyallup River channels.
- Increased flows in Clear Creek due to an urbanizing watershed or variable climate.

Actions that Could Reduce Risks to Agriculture from Flooding

In general, reducing flood risk to agricultural properties in the Clear Creek area would reduce risks to agriculture. However, any flood risk reduction projects would have to be evaluated to ensure that they would not increase other risks to agriculture. For example, construction of a levee in the Clear Creek area could protect some farms from flooding, but could cause new flooding conditions where streams and drainage ditches cross the levee (NHC, 2015). This potential impact requires additional analysis.

The following actions could reduce risk to Clear Creek area farms:

- Protecting agricultural properties from flooding.
- Reducing runoff from upstream areas of the Clear Creek Basin.
- Improving freeboard and addressing potential breach points in River Road Levee.
- Setting back the North Levee Road Levee to provide more flood storage and reduce pressure on River Road Levee.
- Altering the tide gates to improve the reliability of their operation and increase conveyance of flows from Clear Creek to the Puyallup River.
- Improving culverts on 44th Avenue East.
- Elevating homes, farm structures, and farm equipment in the floodplain.
- Constructing "critter pads," elevated areas where livestock can gather during flood events.

Information Needs

Information needed to better understand flood risk in the Clear Creek area includes the following:

- More information on the operation of the tide gates, including information about how well they functioned during past flood events.
- Monitoring and observation of how the tide gates operate under various conditions to improve the confidence in modeling the hydraulics.
- More information on the likelihood of River Road Levee breaching or overtopping.
- Information specific to the Clear Creek area on how climate change could affect flood risk in the future.

Groundwater

The Clear Creek area is underlain primarily by glacial deposits and by a groundwater system consisting of multiple confined and unconfined aquifers. The aquifer with the greatest effect on the groundwater supply and drainage for farmers in the Clear Creek area is the upper alluvial aquifer within the Puyallup River valley. Recharge of this shallow aquifer is important to maintaining base flows in the streams in the dry summer months. Because the Puyallup River adjacent to the Clear Creek area is tidally influenced, alluvial aquifer groundwater levels adjacent to the Puyallup River in the lower reaches of the Clear Creek area also respond to tidal fluctuations.

Current and Projected Risks to Agriculture from Groundwater

Groundwater recharge is a problem in the upstream areas of the Clear Creek Basin because of soils with low infiltrative capacity and land use conversion. Farmers in the Clear Creek area who rely on groundwater for irrigation could have more difficulty or incur more costs from pumping groundwater in the future due to insufficient recharge.

Rising sea levels from climate change could drive saline water farther upstream in the Puyallup River. For portions of the lower Clear Creek area not directly inundated in such a sea-level-rise scenario, impacts to agriculture could still arise from saltwater intrusion in groundwater.

Any factor that raises the already-shallow groundwater levels in the alluvial aquifer system, whether caused by climate change or other factors, could further impede agricultural drainage and could increase the frequency of groundwater ponding on the ground surface.

Actions that Could Increase Risks to Agriculture from Groundwater

Actions that could increase risks to agriculture from groundwater include:

- Increased development and conversion to impervious surfaces, which could reduce groundwater recharge.
- Higher groundwater levels from climate change, which could further reduce drainage.

- Sea level rise, which could cause saltwater intrusion into the aquifer and make groundwater unsuitable for agricultural use.
- Actions that alter the surface water flow, such as removing tide gates or building a levee,, could alter groundwater-surface water interactions and could cause changes to the groundwater table.

Information Needs

- An evaluation of hydrogeologic properties (hydraulic conductivities, flow directions, etc.) in the Clear Creek area to establish baseline conditions.
- Additional study is necessary to determine:
    - The current (baseline) interaction of Clear Creek surface water and alluvial aquifer groundwater throughout the year (relative to seasonal agriculture timing).
    - How sea level rise may affect groundwater levels and groundwater salinity in the Clear Creek area.
    - How the removal of tide gates or construction of a levee would change seasonal surface water-groundwater interactions in the area.

Drainage

The agricultural drainage system in the Clear Creek area is made up of Clear Creek itself (operated and maintained as a drainage ditch by Drainage District 10), several large, privately owned ditches with easements held by the district (including "Nancy's Ditch" and "South Ditch"), smaller privately owned ditches with no easements that convey water from individual parcels, and roadside drainage ditches maintained by Pierce County Road Maintenance. Many ditches in the Clear Creek area suffer from deferred maintenance due to the inactivity of Drainage District 10. The District has recently filled three commissioner positions and is pursuing permitting of drainage maintenance. While the Clear Creek area flooded multiple times in the winter of 2015, the main barrier to agricultural production is high water levels in the drainage system during the growing season. Contributing factors include accumulated fine sediment and vegetation in the drainage system (primarily reed canarygrass), and accumulated coarse sediment where the tributary creeks transition from their ravines to the Puyallup River valley.

Current and Projected Risks to Agriculture from Drainage

Good drainage is essential to agriculture because most crops cannot tolerate saturated soils or standing water during the growing season. Flooded or saturated fields can cause reduced crop yield or total loss of the crop. Saturated soils or standing water in the winter can prevent farmers from planting cover crops, which many farmers in the Clear Creek area use to prevent soil erosion and runoff while adding nutrients to the soil.

According to farmers, the current poor drainage conditions in the Clear Creek area represent the greatest current risk to agricultural viability. Although they were planted in the past, many of the lower lying fields get wet earlier and stay wet longer under current conditions. If the current drainage issues are not addressed, these fields will be less suitable for agriculture, and it is likely that additional fields will become too saturated to plant in the future.

Climate change consequences, such as increased sediment due to increased peak flows and sea level rise, could aggravate poor drainage conditions in the future.

Actions that Could Increase Risks to Agriculture from Drainage

Actions that could increase risks to agriculture in the area include:

- Reductions to the current drainage capacity, including:
    - Additional flow restrictions from culverts or water control structures.
    - Sea level rise, which could raise groundwater levels.
    - Aggradation of streams, including Clear Creek and the Puyallup River.

Actions that Could Reduce Risks to Agriculture from Drainage

Actions that could reduce risks to agriculture and increase agricultural viability in the area include:

- Addressing deferred maintenance of the drainage system in the Clear Creek area.
- Making improvements to the drainage system.
- Altering the tide gates so they increase the flow rate into the Puyallup River and/or further reduce the amount of water that can flow from the Puyallup River into Clear Creek.
- Constructing a pump station designed to supplement gravity drainage from Clear Creek to the Puyallup River would benefit agricultural drainage, but the construction and maintenance costs would likely outweigh the benefits and a large amount of land would be required.

Information Needs

Areas where more information would be helpful to characterize drainage conditions in the Clear Creek area include:

- An inventory of the existing drainage system, including information on:
    - Ownership and maintenance responsibility for drainage features.
    - The current capacity and limitation of drainage features.
    - The capacity of drainage features if properly maintained.
    - Areas of the drainage system that require maintenance.
- Additional information on operation of the tide gates.

- Additional information on the groundwater/surface water interaction.

Sediment

The Puyallup River transports large amounts of sediment. The estimated sediment load for the Puyallup River Watershed is between 890,000 and 980,000 tons per year, the third largest contributor of sediment to Puget Sound. Erosion and sedimentation is also a concern in Clear Creek and its tributaries. The upper portion of the Clear Creek Basin is a large sediment source, with reports of stream channel incision greater than 10 feet in places. This is likely due to elevated runoff rates from a relatively high percentage of impervious surfaces in the upper watershed. Eroded sediment from the upper reaches of the Clear Creek Basin is generally deposited in the lower reaches of Clear Creek or in the mainstem Puyallup River, further adding to the sediment load of that system.

Risks to Agriculture from Sediment

While sediment is a natural river process, current and projected sediment deposition and aggradation in the Puyallup River increases the flood risk to the Clear Creek area, either from overtopping of River Road Levee or from backwater flooding on Clear Creek. In addition, as the river bed of the Puyallup rises due to aggradation, the river level rises relative to the tide gates, which could limit the ability of the Clear Creek area to drain. Sediment deposition and aggradation in Clear Creek reduce the drainage capacity of the system and also increase flood risk.

Actions that Could Increase Risks to Agriculture from Sediment

Increased sediment from either the Puyallup River or from Clear Creek and its tributaries could increase the risk to agriculture in the Clear Creek area from both flooding and drainage impacts. While sediment deposition on agricultural fields is not currently an issue in the Clear Creek area, it could be in the future if the surface water regime changes or if the tide gates are removed and agricultural fields were subject to inundation from backwater flooding from the Puyallup River.

Actions that Could Reduce Risks to Agriculture from Sediment

Managing sediment levels in the Puyallup River and in Clear Creek and its tributaries could reduce risks to agriculture. Analyzing the impact of upstream development on sediment and addressing sources of sediment upstream in Clear Creek Basin would also reduce risks to agriculture.

Information Needs

- Additional information on the current and projected sediment loads in Clear Creek and the Puyallup River, including sediment loads caused by upstream development in the Clear Creek Basin.
- Additional information on the impact of upstream development on sediment loads in the Clear Creek Basin.
- Additional information on the impact of climate change-induced sediment increases in the upper watershed on the Clear Creek Basin.

Water Quality

The Puyallup River is on the 303d list (a list of impaired and threatened waters maintained by the Washington Department of Ecology) for fecal coliform bacteria and mercury, and is listed as a water of concern for dissolved oxygen. However, water quality in the Clear Creek area generally meets the minimum standards for agricultural use set by Ecology, and trends indicate that it will continue to be suitable for agricultural use. Poor water quality can pose a risk to agricultural viability if fields are inundated by floodwaters. If floodwaters leave contaminants in soils after they recede, food safety and organic certification of affected fields could be at risk.

Information Needs

Additional information that would be useful in characterizing water quality in the Clear Creek area includes:

- Reliable long-term monitoring of water quality in Clear Creek.
- Better understanding of the relationship between agriculture and water quality, particularly bacterial water quality.

Water Rights and Irrigation

State laws requires certain users of public waters to receive approval from the state for use of the water. Approval is through a water right or a certificate. Withdrawal of up to 5,000 gallons per day of groundwater is exempt from needing to obtain a permit, but must comply with all other water laws and regulations. The Puyallup River Watershed is one of the most intensely populated and farmed basins in western Washington, and much of the water in the watershed has already been appropriated for irrigation and municipal and domestic supplies. All streams in the Clear Creek Basin are closed to further consumptive appropriations, and any future groundwater withdrawals are restricted if a determination is made that the withdrawal would have a direct and measurable impact on the adopted instream flows for fish. Some farmers in the Clear Creek area have a water right and use it irrigate their fields. Other farmers do not have water rights and use groundwater or municipal water sources.

Relationship of Water Rights and Irrigation to Agricultural Availability

Because the Puyallup River Watershed is a closed basin, it is not possible to obtain new surface water rights, and groundwater withdrawals can also be restricted. For some farmers and farms, a lack of water right could be a limiting factor for agricultural viability. Options for obtaining water rights for irrigation are limited and may require purchasing older water rights. With projected climate change, summer streamflows are projected to be lower and air temperatures higher, which together could require additional water to irrigate their crops. Reduced streamflows could lead to increased restrictions on surface and groundwater use for irrigation.

Information Needs

While the basin is closed to new water rights, some options may be available to area farmers who are interested in exploring water supply. To inform an effort to explore these options, the agricultural water need and the current agricultural water supply could be assessed.

Climate Change

Farmers in the Clear Creek area are very familiar with natural variability in weather, which presents a risk to agricultural operations each year. Under future climate change scenarios, many of the risks that come with natural variations in weather are predicted to increase.

Risks to Agriculture from Changes in Climate and Weather

Increasing air temperatures could be beneficial to some crops but are projected to cause declines in the production of others. For example, raspberries grow best in climates with extended periods between 32 and 45 degrees Fahrenheit, and increased warm air temperatures during the winter could result in lower yields (CIG, 2015b).

Lower summer precipitation may require more farms to irrigate, or to irrigate more than they currently do. At the same time, lower rainfall will lower streamflows, reducing the availability of surface water for irrigation.

Risks to Agriculture from Changes in Streamflow and Flood Risk

Heavier rainfall and increased flooding from climate change present a range of risks to agricultural viability. Potential impacts would include:

- Climate change would make flooding worse, increasing the flood risk to agriculture. Flood-related impacts to agriculture that could increase with climate change include:
    - Floodwaters could damage farm infrastructure and threaten livestock.
    - Increased flooding would prevent farmers from accessing their fields during flood events.
    - More frequent flooding would be a significant problem for farmers growing perennial crops, which grow during the winter flood season.
    - Increased flooding could increase the inundation of agricultural fields from contaminated floodwaters, which could increase the risk to food safety and organic certification.
    - The projected increase in atmospheric river events could increase the number and severity of flooding and pose additional risk to farm operations.
- Increased streamflow in winter and spring would make it more difficult to drain agricultural fields.

- Decreased summer streamflows could reduce the availability of water for farmers who irrigate.

Risks to Agriculture from Changes in Sea Level Rise

Sea level rise could slow the drainage of agricultural lands across Puget Sound by affecting the receding rates of floodwaters or runoff. Sea level rise could cause the saltwater wedge to extend farther up the Puyallup River, potentially reaching the Clear Creek area. If the Clear Creek area is opened to tidal influence, farms could be subject to inundation from saltwater. Sea level rise could also cause saltwater intrusion into groundwater in the area, affecting groundwater quality. Sea level rise could also increase the surface flow elevations of the Puyallup River, Clear Creek, and its tributaries.

Risks to Agriculture from Changes in Sediment

Increased sediment in the Puyallup River and in Clear Creek and its tributaries could cause additional channel aggradation. Aggradation of the Puyallup River could increase flood risk in the Clear Creek area and could raise groundwater levels because the carrying capacity of the river has been reduced. Aggradation of Clear Creek could also reduce drainage capacity in the basin.

Reclaiming Farmland

Pierce County staff and other stakeholders have discussed the possibility of reclaiming residential development in the Clear Creek area for farmland. Residential properties in the Clear Creek area that are susceptible to flooding have been targeted for acquisition by the county. In theory, reclaiming these properties for farmland would be a benefit to agriculture in the area because the scarcity of farmland is a limiting factor for agricultural viability. However, there are several challenges to reclaiming farmland, including soils, cost, ownership and lease structures, floodplain regulations, and food safety concerns. In 2004, the American Farmland Trust analyzed the possibility of reclaiming farmland from developed properties. The report suggests that reclaiming farmland would be difficult and expensive, but would be possible.

Recommendations and Next Steps

This Existing Conditions Report is the product of Phase 1 of the technical work for the FFP and will inform technical work in Phase 2 (scheduled for August 2016 through June 2017). Chapter 7 of the report describes the recommended tasks that could be undertaken during Phase 2 to increase the understanding of physical conditions in the Clear Creek area in the context of agricultural viability. Not all of these tasks can be accomplished in the second phase; some may be undertaken in future phases of work.

Recommended future technical work includes:

- Conducting an agricultural drainage inventory.
- Researching, monitoring, observing, and modeling of the tide gates.

- Conducting additional flood risk research.
- Conducting additional climate change research.
- Analyzing impacts of upstream development.
- Analyzing the farmland impacts of the proposed Clear Creek Floodplain Reconnection Project.
- Exploring the formation of a Watershed Improvement District.
- Continuing to convene the Technical Advisory Group and to collaborate across interests.

Additional information on each of these recommendations is included in Chapter 7.

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Acronyms

ADAP	Agricultural Drainage Assistance Program
ARL	Agricultural Resource Land
BAS	Best Available Science
cfs	cubic feet per second
CIG	Climate Impacts Group
Corps	U.S. Army Corps of Engineers
CRS	Community Rating System
CSA	Community Supported Agriculture
CWA	Clean Water Act
DO	dissolved oxygen
Ecology	Washington Department of Ecology
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FFP	Farming in the Floodplain Project
NAVD88	North American Vertical Datum, 1988
NFIP	National Flood Insurance Program
NRCS	Natural Resource Conservation Service
PHS	Priority Habitats and Species
Port	Port of Tacoma
RCW	Revised Code of Washington
RM	River Mile
RV	recreational vehicle
SR 167	State Route 167
SSA	Sole Source Aquifer
TAG	Technical Advisory Group
TMDL	Total Maximum Daily Load
TSP	Tentatively Selected Plan
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQIP	water quality improvement project
WRIA	Water Resource Inventory Area
WSU	Washington State University

Chapter 1 Introduction

This *Existing Conditions Report* has been prepared as part of the first phase of the Farming in the Floodplain Project (FFP), which addresses agricultural viability in the Clear Creek area in Pierce County. The report summarizes existing information about physical conditions and trends in the Clear Creek area, identifies information needs, and describes the relationship between physical conditions and the viability of agriculture in the area. This report will serve as baseline information to inform additional technical work in future phases of the FFP.

Project Context

The FFP is a collaboration among PCC Farmland Trust, the Pierce County Agricultural Program, the Pierce Conservation District, and Forterra. The purpose of the FFP is to advance progress toward a collectively agreed-upon plan for the Clear Creek area that improves agricultural viability in the area while also meeting the goals of flood risk reduction and salmon habitat enhancement. The project partners anticipate that the FFP will clarify the needs and interests of the agricultural community in the Clear Creek area.

The FFP is one of four components of the Floodplains for the Future: Puyallup, White, and Carbon Rivers project, which is funded by a Floodplains by Design grant from the Washington Department of Ecology (Ecology). The other components are:

- A capital program that includes a broad suite of floodplain reconnection projects throughout the Puyallup River Watershed and includes the Clear Creek Floodplain Reconnection Project, which has an overlapping project area with the FFP and is described in more detail below.
- A monitoring plan and goal-setting process for the watershed.
- An agricultural conservation easement program to conserve active farmland within the broader Puyallup River Watershed.

Work under the FFP includes technical analysis and landowner engagement related to agriculture in the Clear Creek area. When the FFP began in early 2016, it was not clear what technical work was needed, so the project was designed in phases. The first phase of technical work for the FFP involved data gathering, an analysis of existing conditions, and the formation of a Technical Advisory Group. This Existing Conditions Report includes the information gathered during the first phase and provides baseline information for technical work in the second phase of the project.

Proposed Clear Creek Floodplain Reconnection Project

The FFP is related to, but independent from, the Clear Creek Floodplain Reconnection Project proposed by Pierce County Surface Water Management. As conceived, the proposed Clear Creek Floodplain Reconnection Project involves the construction of a ring levee around low-lying portions of Clear Creek to protect farms, homes, and infrastructure from backwater flooding from the Puyallup

River, followed by the removal of two tide gates where Clear Creek enters the Puyallup River. The project is intended to reduce flood risks and improve salmon habitat and is anticipated to take 10 to 15 years or more to implement. Farmers in the Clear Creek area have expressed concerns about the proposed reconnection project's potential impacts on farmland, which could include the loss of farmland and disruption of agricultural drainage, among other impacts. In addition to analyzing the potential impacts on farmland of the reconnection project, the FFP will also take a broader look at agricultural viability in the Clear Creek area. This will lead to a better understanding of the needs of agriculture so they can be integrated into the proposed Clear Creek Floodplain Reconnection Project so that it can achieve benefits to farming, salmon habitat, and flood risk reduction.

Floodplains by Design

The FFP is funded by a Floodplains by Design grant as part of a broader package of projects in the Puyallup River Watershed. Floodplains by Design is a statewide initiative to increase the pace and magnitude of multiple-benefit floodplain projects. While focused on the needs of agriculture in the Clear Creek area, the FFP is part of a broader effort to integrate flood risk reduction, habitat restoration, and agricultural viability in the Clear Creek area and the Puyallup River Watershed as a whole.

Agriculture is an important resource throughout Puget Sound but is threatened by development, increasing flood risk, and other factors. Throughout the region, the Floodplains by Design initiative has been encouraging floodplain managers and salmon habitat restoration experts to integrate the needs of the agricultural community into the planning of floodplain projects. The FFP was started based on the belief that more technical information is required to understand the needs of agriculture in the Clear Creek area so that these needs can be integrated into the planning of floodplain projects to ensure they enhance agricultural viability. While focused on the Clear Creek area, the FFP is intended to serve as a pilot project both within the Puyallup River Watershed and the Puget Sound region.

Technical Advisory Group and Farmer Input

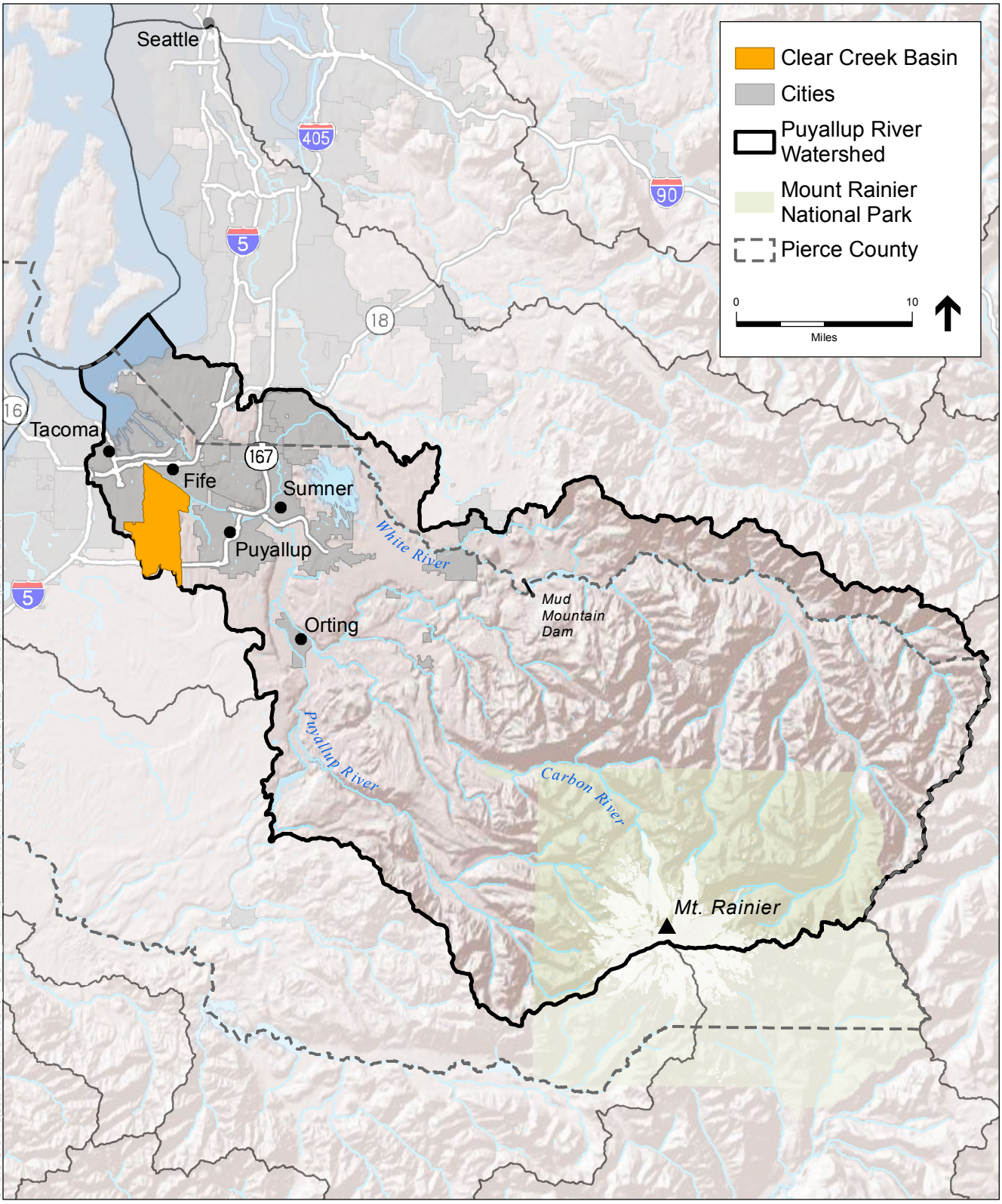
To solicit input on this report, on future phases of technical work, and on the FFP in general, a Technical Advisory Group (TAG) was formed. The TAG met in April, June, and July 2016. Members of the TAG include farmers in the Clear Creek area, a representative of Drainage District 10, staff of local organizations and entities (including the Pierce County Agricultural Program, Pierce County Surface Water Management, the Pierce Conservation District, and PCC Farmland Trust), the Puyallup Tribe of Indians, the Muckleshoot Indian Tribe, the King-Pierce Farm Bureau, and regional technical experts from the Puget Sound Partnership, the U.S. Geological Survey, and the University of Washington Climate Impacts Group (CIG). The TAG provided input on existing information sources for the Clear Creek area, information needs, agricultural viability, and recommendations and next steps. Input from the TAG is incorporated throughout this report. Meeting reports from the TAG meetings are included as Appendix A in this report.

In addition to soliciting farmer input through the TAG, the FFP team conducted a site visit to the Clear Creek area on April 14, 2016 to observe conditions in the area and speak with farmers and other residents about their concerns. The FFP team also includes a landowner engagement team which frequently met with farmers in the area for one-on-one or small group conversations. This report also relied on a letter written to the Pierce County Executive in February 2016 and signed by eight Clear Creek area farmers (Johnson et al., 2016) and a PowerPoint presentation given by three Clear Creek area farmers to the Washington Department of Ecology in March 2016 (Clear Creek Farmers, 2016). Information and input from Clear Creek area farmers gathered through these methods is incorporated throughout this report and has been crucial in informing this report's analysis of how physical conditions in the area relate to agricultural viability.

Study Area

This report focuses on three overlapping study areas:

- The **Puyallup River Watershed**. The Puyallup River Watershed is the drainage area for the Puyallup, White, and Carbon rivers (Figure 1-1).
- The **Clear Creek Basin** is a subbasin within the Puyallup River Watershed. The Clear Creek Basin is south of the Puyallup River, north of 128th Street East, west of 66th Avenue East, and east of McKinley Avenue East (Figure 1-2). The basin includes the drainage areas for Swan Creek, Squally Creek, Clear Creek, and Canyon Creek.
- The **Clear Creek area**. The Clear Creek area consists of the lowland area of the Clear Creek Basin bounded by the Puyallup River to the north, the BNSF Railroad line to the south and west, and 52nd Street East to the east (Figure 1-2). The Clear Creek area is the primary focus area of this report. The proposed Clear Creek Floodplain Reconnection Project is located within the Clear Creek area.

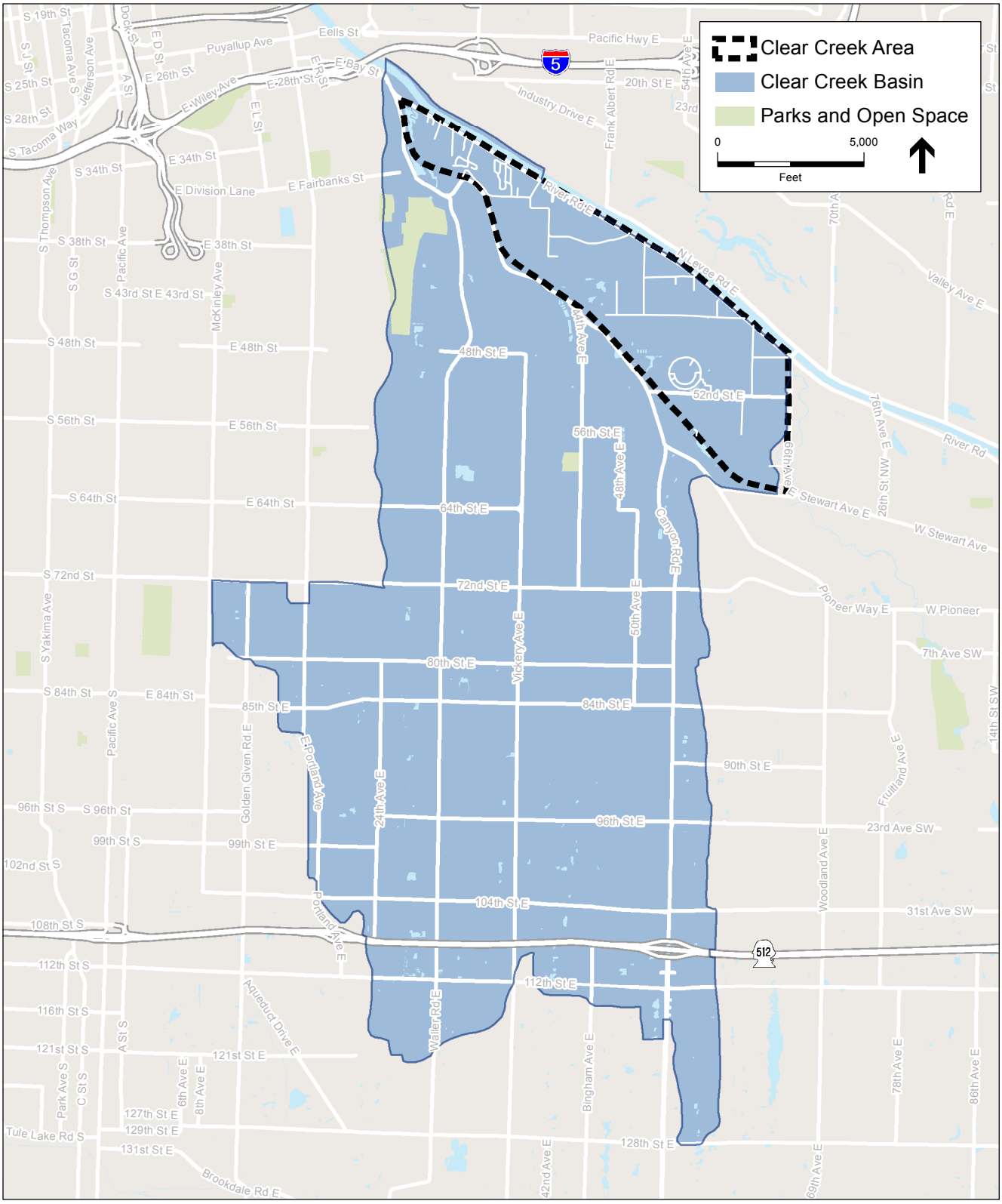


SOURCE:
ESA, 2016; King County, 2015; Pierce County, 2013; Ecology, 2007; OSM, 2016; WDNR, 2010

PCCFT Farming in the Floodplain. 150678

Figure 1-1

Puyallup Watershed



U:\GIS\GIS\Projects\15xxxxD\150678_PCCFT_FarmingInTheFloodplains\03_Projects\Clear_Creek_Basin_and_Area.mxd (jak, 8/1/2016)

SOURCE:
ESA 2016, ESRI 2016

PCCFT Farming in the Floodplain. 150678

Figure 1-2

Clear Creek Basin and Area

Chapter 2 Agricultural Viability

This chapter describes existing agriculture in Pierce County and in the Clear Creek area. The chapter also defines agricultural viability, discusses key components of agricultural viability in the Clear Creek area, and examines examples of floodplain agriculture in other watersheds.

Agriculture in Pierce County

Pierce County is home to almost 1,500 local farms that produce $91 million worth of products, including vegetables, livestock, poultry, eggs, flowers and bulbs, and aquaculture (Pierce County, 2016f). Pierce County is the second largest producer in Washington of both eggs and tulips and is ninth in vegetables. The county is also second in the nation for rhubarb production (Pierce County, 2016f). There are 11 farmers markets in the county (Pierce County, 2016f). Fresh vegetables, fruit, and livestock production are concentrated in the Puyallup Valley.

Farmland throughout the county has historically been converted into residential and other uses and that trend is continuing. Remaining agricultural lands are often adjacent to homes or commercial structures. The Puyallup Valley in particular has experienced a rapid increase in development. In addition, 25 percent of agricultural land in the Puyallup Valley was located within incorporated areas or urban growth boundaries as of 2006 (Pierce County, 2006b).

In 2012, there were 1,478 farms in Pierce County and 49,483 acres in farming, a 4 percent increase of land in farming from 2007. The market value of products sold was $90,933,000, with approximately $24 million of that total coming from crop sales and $67 million from livestock sales. The overall market value of products sold was up 9 percent from 2007. However, 1,214 of the farms (82 percent) made less than $10,000 in sales in 2012, and only 45 (3 percent) made more than $100,000 in sales. Over half of the principal operators of farms in the county did not list farming as their primary occupation, and the average age of principal operators was 59.6 years old (USDA, 2012).

In 2004, American Farmland Trust published the report *The Suitability, Viability, Needs, and Economic Future of Pierce County Agriculture*, which found that agriculture in the county was shifting from industrial, wholesale agriculture to value-added, direct market "urban edge" farming. This shift was caused by the urbanization and fragmentation of the agricultural land base and was made possible by the favorable climate and soil in the county. The report found that successful farmers in Pierce County were taking advantage of their proximity to urban centers and capitalizing on increased consumer concern about the environment. The report also found that urbanization was causing large-scale wholesale farmers to struggle as:

- Processors and suppliers leave the area.
- Residential neighbors complain about farming activities.
- Dogs harass livestock.

- Vandals damage and pilfer crops.
- Non-farm traffic makes it difficult to move equipment from field to field.
- Land and labor prices rise (American Farmland Trust, 2004).

More recent reports (such as the Agriculture Infrastructure Study described below) suggest that the trends identified in the 2004 report have continued throughout the Puyallup River Watershed.

In 2006, Pierce County developed an Agriculture Strategic Plan to better understand the agriculture sector and boost its economic competitiveness. The plan found that both the number and size of farms in the county were declining, but that local agriculture was still diverse. In addition, land prices in the Puyallup Valley are high, which can make purchasing farmland more costly than the economic value of farm production on that land. The plan found that the biggest strengths for Pierce County agriculture were the excellent growing conditions, the proximity to large markets, and rising consumer demand for locally grown produce. The plan recommended that the best benchmarks to monitor the vitality of Pierce County agriculture were agricultural employment, net farm income, and the number of farms (Pierce County, 2006b).

In 2015, Washington State University (WSU) and other partners prepared an Agriculture Infrastructure Study for Pierce County. The study involved a survey of 69 agricultural producers in the county and found that agricultural production was not the primary source of income for most of the respondents. Survey respondents had a much higher level of education than the overall population of Pierce County; 27.5 percent had a graduate or professional degree, while another 34.8 percent had a bachelor's degree. In total, 56 percent of respondents had more than 20 years of farming experience, while another 36 percent had 6 to 20 years of farming experience (WSU et al., 2015).

When asked what the biggest challenges to their farming operations were, the top responses (in order) were: expenses, weather, labor, government regulation, time, land, and government taxes. Drainage and urban development were also listed as challenges. The survey found that drainage conditions were a problem for the majority of producers. Depending on their location in the county, producers listed drainage problems based on riverine flooding, ditch maintenance, or seasonal ponding. Two thirds of respondents were not interested in expanding their farm operations with more land. The study also found that 56 percent of respondents stated that their operation had drainage issues, while only 22 percent said their operation had flooding issues. Specific flooding-related concerns included flooded pasture land restricting livestock and the inability to access land in the spring. A key finding of the study was that weather is always the biggest challenge to production (WSU et al., 2015).

Agriculture in the Clear Creek Area

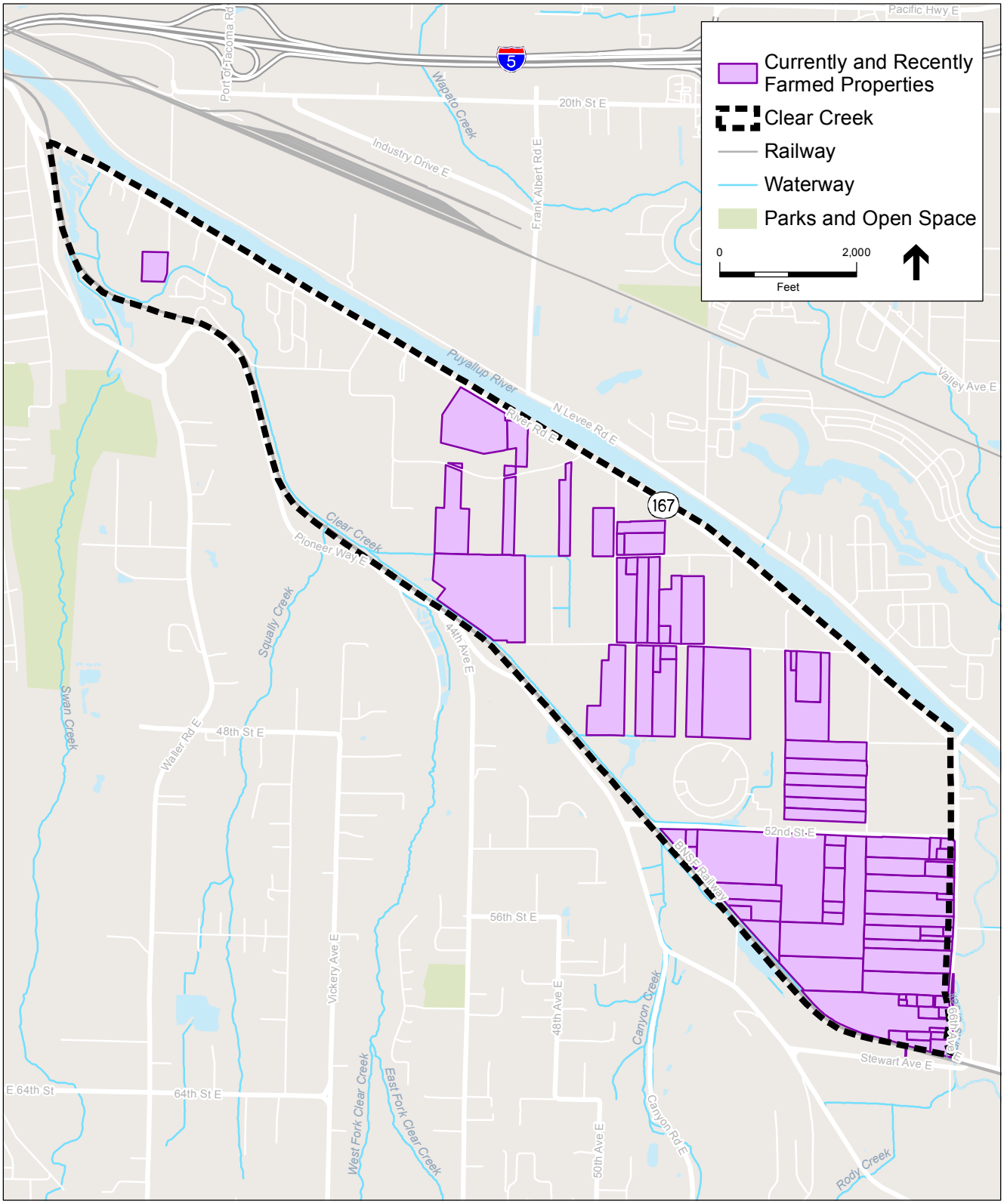
Farms in the Clear Creek area are close to consumers and local markets in the urban centers of Tacoma and Puyallup. Smaller acreage farms in the Clear Creek area, many of which are certified organic, sell vegetables, berries, eggs, meats, Koi fish, and other farm products direct to consumers

on farm or through Community Supported Agriculture (CSA) subscriptions as well as through outlets such as the Tacoma and Proctor Farmers Markets, Marlene's Market (a local grocery store chain), and the Tacoma Food Coop (Johnson et al., 2016). Larger scale farms also sell fresh produce direct to local consumers through their own on-farm stands, as well as to regional grocery retailers and food distributors. Many Clear Creek farms offer agritourism activities such as community potlucks, on-farm events, summer camps, pumpkin patches, and U-pick berries (Clear Creek Farmers, 2016).

The Clear Creek area reflects the trend in Pierce County of a transition to smaller, local market-driven urban edge farming. The area also has several large wholesale farms that have been in the same family for generations. The area's proximity to consumers and highly productive soils also are attracting new farmers to Pierce County, with new farmers starting farms or becoming owners of existing smaller farms.

Farmers in the Clear Creek area note the value of their prime farmland soils, as defined by the Natural Resources Conservation Service (NRCS). Soils in the Clear Creek area produce high value crops and support small farms (Clear Creek Farmers, 2016).

Figure 2-1 shows currently and recently farmed properties in the Clear Creek Area. Information in the figure was gathered through PCC Farmland Trust's landowner engagement effort. The photo montage on the subsequent page describes selected farms in the Clear Creek area, showing both small-scale organic farms and larger wholesale growers.

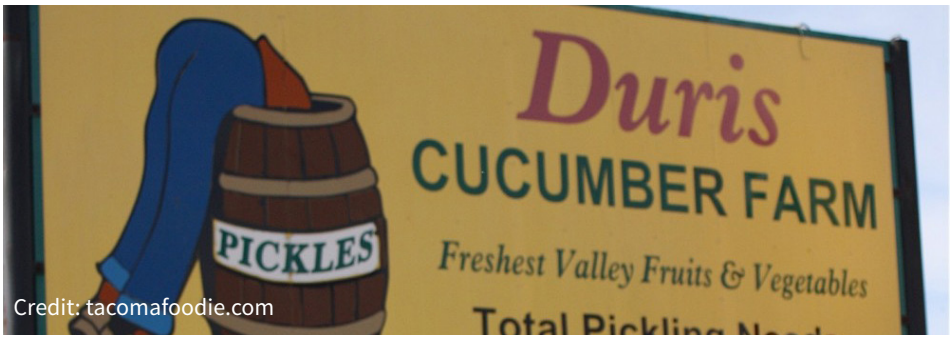


SOURCE:
ESA 2016; Pierce County 2015;

PCCFT Farming in the Floodplain. 150678

Figure 2-1

Currently and Recently Farmed Properties



Credit: tacomafoodie.com

The **Duris Farm** operates over 200 acres. The farm grows strawberries, green beans, picking and slicing cucumbers, zucchini, yellow squash, and dill. The farm offers U-Pick strawberries and on-farm pickling classes. A farm store sells produce from the farm and other local farms as well as supplies needed to make pickles. The farm is currently operated by second-generation farmers.

Early Bird Farm is a small farm using sustainable practices to produce eggs, market vegetables, berries, fruits, and herbs. The 11-acre farm sells products directly to consumers through farmers markets in Seattle and Tacoma, CSA subscriptions, and direct sales.


Credit: M.B. Brown on panoramio.com

Picha Farms grows strawberries, raspberries, and blackberries and also offers a pumpkin patch, corn maze, and farm stand. The farm has been in operation since 1904 and is currently operated by a third generation of farmers.


Credit: wildhareorganicfarm.com

Wild Hare Organic Farm grows certified organic vegetables, fruits, eggs, herbs, and berries and sells them through farmers markets, CSA subscriptions, and a year-round farm stand. The 20-acre farm also offers on-farm educational opportunities.

Zestful Gardens is a 35-acre certified organic farm selling vegetables, fruit, meat, and eggs through CSA subscriptions and farmers markets. The farm also offers a Farm Camp, an annual Farm to Fork dinner, an Annual Bulk Sale, and monthly work parties.

Sources: Clear Creek Farmers, 2016; Duris Cucumber Farm, 2016; Picha Farms, 2016; Puget Sound Fresh, 2016

Agricultural Viability

Risk

At the outset of the FFP, several stakeholders expressed a desire to develop "thresholds" that would identify those physical conditions under which farms in the area would no longer be viable. However, farmers in the area expressed that conditions, crops, techniques, and plans vary so much between farms, even neighboring farms, that setting thresholds for farming as a whole would be neither possible nor useful. The same flooding conditions can be devastating for a farmer growing perennial crops but be a minor two-day nuisance for a farmer focusing on seasonal crops. Drainage conditions that render entire fields unusable for one farmer can be a benefit to a neighboring farm with a different soil type and different topography.

Farmers in the Clear Creek area explained that farmers constantly deal with risks, including weather, flooding and drainage problems, and market conditions. In any given year, some crops are successful and others are not. Farmers individually determine what an acceptable level of risk is and adjust their farming practices accordingly.

Instead of being organized around agricultural thresholds, this report focuses on the concept of risks to agriculture. Current conditions in the Clear Creek area present a range of risks to agriculture each year, and future conditions are anticipated to increase some existing risks, present new risks, or in some cases reduce risks. A variety of actions (designed to meet agriculture, flood risk reduction, or salmon habitat objectives) could be undertaken in the area, and each could increase and/or decrease risks to agricultural viability.

Agricultural viability can be defined as the ability of a farmer or group of farmers to:

- Productively farm on a given piece of land or in a specific area.
- Maintain an economically viable farm business.
- Keep the land in agriculture long-term.
- Steward the land so it will remain productive into the future.

Agricultural Viability in the Clear Creek Area

At the first meeting of the TAG, farmers and other stakeholders discussed the key components of agricultural viability in the Clear Creek area.

In the Clear Creek area, water is a critical component of agricultural viability. Farms in Clear Creek are viable in part because they have so much water. A high water table is a benefit for some farmers because they need less irrigation. However, excessive water causes flooding and drainage issues, both of which reduce agricultural viability.

Flooding is particularly damaging to perennial crops because they are in the ground during the winter flood season, typically November through March. For annual crops, flooding has less impact because it occurs during the winter. However, flooding can damage farm infrastructure, such as barns, or threaten livestock. Flooding can also keep farmers from working their fields or accessing different areas of the farm. Several Clear Creek farmers said that they can cope with current flooding conditions from Clear Creek, but are concerned that opening the area to floodwaters from the Puyallup River could inundate their farms more frequently. In the Clear Creek area, agricultural viability also depends on the tide gates, through which Clear Creek enters the Puyallup River, being properly maintained and functioning so they protect the area from Puyallup River floodwaters.

Drainage is one of the main limiting factors for agricultural viability in the Clear Creek area. Farmers stated that there is a difference between being flooded and being wet due to poor drainage conditions; in the Clear Creek area, poor drainage conditions are a bigger problem for agricultural viability than flooding. Poor drainage keeps certain fields in the Clear Creek area from being planted at all. In other fields, poor drainage leads to conditions that are too wet to plant cover crops, which reduce the amount of sediment moving into the drainage system, help absorb winter rains, and improve soil fertility. The intrusion of reed canarygrass, the accumulation of sediment, and a general lack of maintenance of drainage ditches are among the main factors causing drainage problems in the area. Increased runoff from upstream areas due to development has also contributed to drainage problems. Many ditches in the Clear Creek area suffer from deferred maintenance due to the inactivity of Drainage District 10 (see the *Drainage* section of Chapter 4). The District has recently filled three commissioner positions and is pursuing permitting of drainage maintenance. To address drainage problems, farmers in the Clear Creek area need Drainage District 10 to be well-funded and to have the ability to get permits for their maintenance activities.

A limited supply of farmland is another limiting factor for agricultural viability in the Clear Creek area. Adjacent farms allow for resource and information sharing, among other benefits for agricultural viability. Having additional nearby small parcels available in farm areas is key for allowing certain types of farmers to expand their farms while keeping their current operation. The minimum parcel size needed for viable farming depends on the farmer and his or her techniques. Transportation access to leased fields is also an important factor for some farmers. Urbanized roads or long distances make transporting farm equipment to leased fields difficult or impossible.

Soils are a critical factor in agricultural viability. The Clear Creek area has prime farmland soil as defined by the NRCS. Other factors important to agricultural viability include an ability to build farm structures, proximity to markets, being located in a safe community, and having the ability to own land. The ability to irrigate greatly enhances agricultural viability. Lack of water rights and reliance on wells are limiting factors for many farms in the Clear Creek area.

Compliance with regulatory requirements is also a critical factor for agriculture in the Clear Creek area. Regulatory requirements, including farm business permit requirements and food safety regulations, were frequently noted by farmers as a barrier to agricultural viability. Farmers are

subject to regulations from Pierce County, Ecology, the Tacoma-Pierce County Health Department, the Washington State Department of Agriculture, and others.

For many of the small farmers in the area, living on the land is essential for their farming practices (Johnson et al., 2016). Safety is another key component of agricultural viability, especially for farmers who live on their land. Safety means being protected from flood risks as well as living within a safe community with good neighbors and without illicit activities (Clear Creek Farmers, 2016).

Concerns and Opportunities for Farming in the Clear Creek Area

Farmers in the Clear Creek area face many risks and uncertainties about the future. Farmers in the area have expressed concerns about drainage, the functioning of Clear Creek tide gates, the impact of increased surface water runoff from upstream development, the safety of the River Road Levee, and the ability of Drainage District 10 to permit its drainage maintenance activities. Clear Creek area farmers have also expressed concerns about Pierce County Surface Water Management's proposed Clear Creek Floodplain Reconnection Project and its effects on farmland, drainage, groundwater, and flood risk.

In response to the proposed Clear Creek Floodplain Reconnection Project, several farmers in the Clear Creek area presented a vision for the future of the Clear Creek area, which included:

- Increased high quality agricultural land available for existing, new, and beginning farmers.
- A trail system that works with habitat, flood, and farm interests.
- Agricultural infrastructure that allows farmers to viably farm in the floodplain.
- A shared project that is an asset to the community (Clear Creek Farmers, 2016).

At the first TAG meeting, a Clear Creek farmer stated that designing a flood risk reduction and habitat enhancement project that preserves farmland in the area is an opportunity to create an area that connects the public with habitat and with local farms. It would be an opportunity to highlight Pierce County as an agricultural district in Washington.

While changing conditions and the proposed Clear Creek Floodplain Reconnection Project represent significant uncertainties for agriculture in the Clear Creek area, there is great potential to develop a vision for the future of the area that improves conditions for agriculture while meeting goals for flood risk reduction and salmon habitat.

Examples of Other Puget Sound Watersheds with Agriculture in the Floodplain

Agriculture is a common land use in Puget Sound floodplains. This section describes floodplain agriculture in two other Puget Sound watersheds, the Skokomish River Valley and the Snoqualmie River Valley, in order to highlight both challenges and opportunities.

Skokomish River Valley

The Skokomish River Valley is an example of an area where changing physical conditions have significantly decreased agricultural viability. The Skokomish River has aggraded, or filled in with sediment and gravel, due to logging, construction of levees and other bank protection measures, closure of side channels, removal of large woody debris from the channel, and other changes in the watershed. This aggradation has reduced the carrying capacity of the river. In addition, the aggradation of coarse gravel in the channel causes streamflows to infiltrate the gravel and flow below the surface in the summer (Corps, 2015). The river used to have a carrying capacity of 12,000 cubic feet per second (cfs) but now carries less than 3,000 cfs before flooding. Aggradation has also caused the water table to rise (The Nature Conservancy, 2016).

High groundwater levels and frequent flooding in the Skokomish River have made it difficult and risky to till the soil, which stays muddy into the summer. Frequent flooding threatens crops and livestock. The Skokomish River Valley had 5,000 acres of tillable farmland in the early 1960s, but only 300 acres remained by the mid-1990s. Dairy farms, fruit orchards, and row crop and berry farms shifted to growing Christmas trees, but groundwater and flooding conditions have limited the viability of those farms as well (Dunagan, 2009). Most agricultural lands in the valley are now limited to hay production and livestock pasturing (The Nature Conservancy, 2016).

Snoqualmie River Valley

The Snoqualmie River Watershed is an example of a watershed with agriculture in the floodplain that continues to be viable despite challenges. King County has designated a Snoqualmie Agricultural Production District, the vast majority of which is within the floodplain of the Lower Snoqualmie River. Major challenges and risks for agriculture in the Agricultural Production District include risks from flooding, drainage issues, lack of irrigation, and concerns over the loss of acreage to habitat projects.

In 2013, King County formed a Fish, Flood, and Farm Committee that met through the spring of 2014 to work collaboratively toward a shared set of strategies for farm, fish, and flood risk. The committee is now working on a set of recommendations (King County, 2015). King County has also developed the Agricultural Drainage Assistance Program (ADAP) to provide technical and financial assistance to agricultural landowners who need to improve drainage on their farm. Property owners in the Agricultural Production District can permit drainage maintenance projects with one streamlined permit if they follow a set of ADAP best management practices (King County, 2016). In December 2015, the Snoqualmie Valley Watershed Improvement District was formed to help the landowners address drainage and irrigation needs. The district is conducting a drainage inventory to build on information that was collected from landowner surveys during the formative period of the district.

Chapter 3 Basin Settings and Characteristics

Location and General Setting

The Puyallup River Watershed covers approximately 970 square miles in the Puget Lowland of Washington State (Ecology, 2016b). It includes the communities of Tacoma, Puyallup, Fife, Sumner, Orting, and Auburn. The Clear Creek Basin is within the Puyallup River Watershed and is located south of the Puyallup River, north of 128th Street East, west of 66th Avenue East, and east of McKinley Avenue East (see Figure 1-2). The Clear Creek area is roughly 1.5 square miles (990 acres) in size and bounded by the Puyallup River to the north, Pioneer Way East to the south and west, and 52nd Street East to the east. The Clear Creek area is located primarily within unincorporated Pierce County, with the northern tip of the area within the City of Tacoma and the southern tip within the City of Puyallup. It encompasses a portion of State Route 167 (SR 167), a section of the BNSF Railroad, agricultural lands, single-family residential neighborhoods, a recreational vehicle (RV) park, a few commercial properties, the Riverside Fire District, and two schools: Riverside Elementary School and Chief Leschi High School.

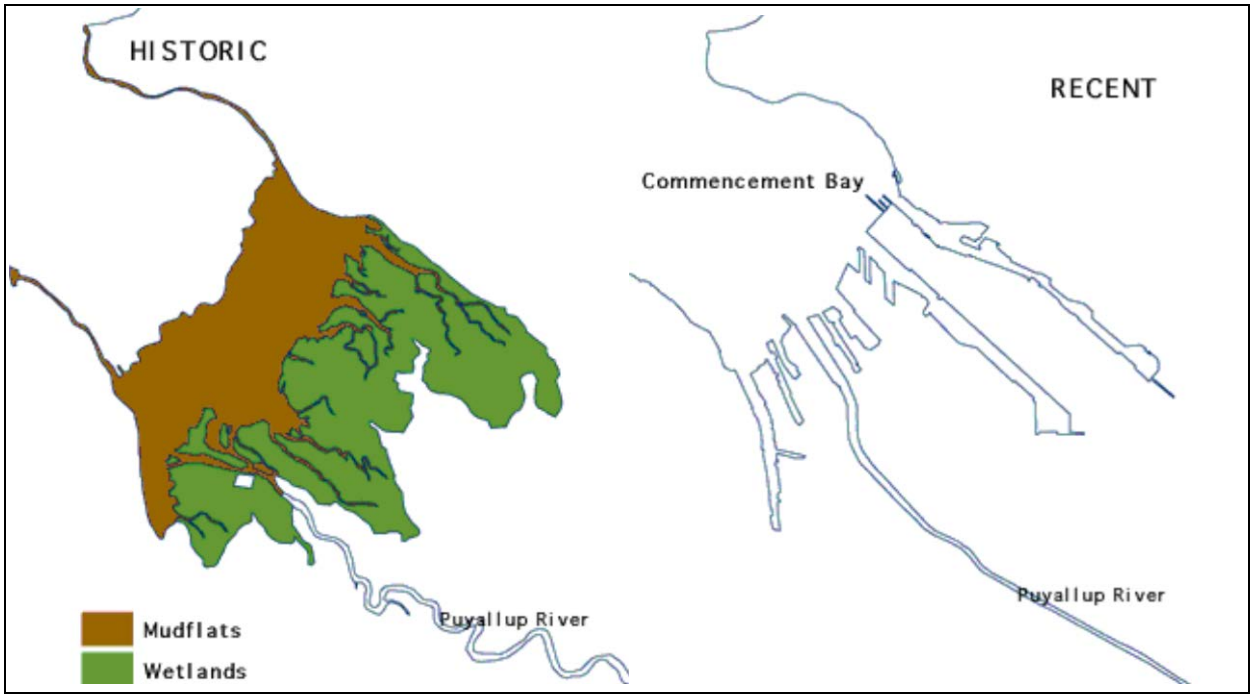
Historical Development

The Clear Creek area is located within the traditional territory of the Puyallup people, part of the Southern Coast Salish cultural group whose descendants are today represented by the Puyallup Tribe (Suttles and Lane, 1990). At the time of Euroamerican settlement, the Puyallup lived in several permanent villages around today's Commencement Bay and traveled inland to places along the upper Puyallup River and throughout the Puget Sound to areas such as Carr Inlet and the southern portions of Vashon Island (Ruby and Brown, 1992; Spier, 1936). With passage of the 1850 Donation Land Claim Act, settlers began to claim homestead lands throughout the Puget Sound region. The traditional mobile subsistence strategies of native hunter-fisher-gatherers were increasingly disrupted as Euroamerican settlement progressed. Increasing impacts on Native Americans in Puget Sound were documented as treaties were signed, lands ceded, and the US Government established reservations intended for the relocation of signatories. Under the Medicine Creek Treaty of 1854, lands stretching from Southern Puget Sound and encompassing the Nisqually and Puyallup River valleys were ceded to the U.S. Government by the Treaty signatories. The Treaty led to the establishment of the Nisqually Reservation, Puyallup Reservation, and Squaxin Island Reservation.

Land clearing for agriculture and settlement in the Puyallup River Basin began with the arrival of the first European settlers in 1851. Historically, the upper and middle portions of the Puyallup River Watershed were heavily forested, and the forests contributed large amounts of large woody debris to the rivers and tributaries. By the early 1930s, most of the valley floor and hillsides downstream from River Mile (RM) 24 had been cleared (GeoEngineers, 2003). Logging of the Puyallup River Basin accelerated from the 1940s through the 1970s. The lower Puyallup River meandered through a broad floodplain, discharging to the estuary at Commencement Bay. The estuary was an extensive expanse of tidal marshes and mudflats with an estimate of more than 2,600 acres of tidal marsh, tide channels,

and salt ponds (Puyallup River Watershed Council, 2014). Figure 3-1 is a simplified diagram of the historic and present extent of the Puyallup estuary and lower river.

Figure 3-1. Historic and Current Conditions of Commencement Bay and Lower Puyallup River.



Source: Puyallup River Watershed Council, 2014

Alteration of Commencement Bay began in the 1890s with dredging of the western channel of the Puyallup River. Development of the Port of Tacoma started in 1905 with construction of the Hylebos Waterway and continued to 1931 when the Thea Foss Waterway was completed. The federal 1937 Flood Control Act authorized channelization and diking of the lower 3 miles of the Puyallup River. Construction began in 1946 and finished in 1965 with creation of the Blair Waterway. The 1937 Flood Control Act also authorized the construction of Mud Mountain Dam (RM 29.6), which was completed in 1948 following a halt in construction during World War II.

In 1919, the White River, which naturally flowed into the Green River and discharged to Elliot Bay in Seattle, was diverted into the Puyallup River Watershed. A debris dam in 1906 blocked the channel and diverted the floodwaters down the Stuck River and into the Puyallup River. A diversion was constructed to permanently divert the White River into the Puyallup River.

The construction of roads and railroads in the floodplain further altered the Puyallup River Watershed. The first railroad into the Puyallup River valley was constructed in 1873, and a railroad was constructed across the tidal marshes of Commencement Bay in 1874. River Road was constructed between Puyallup and Tacoma in 1933.

Climate

The Clear Creek Basin has a moderate climate typical of the coastal to upland areas of Puget Sound, with warm, dry summers and cool, wet winters. The proximity of the Cascade Mountains shields the area from colder, arctic air masses, and increases the tendency for rainfall. On average, the area has a mean annual precipitation of 39.9 inches (Pierce County, 2016b). Approximately 78 percent of the precipitation in the area falls between October and April (Pierce County, 2006a). Rain storms within the region typically arrive from the west or southwest as large frontal storms and are generally low in intensity and long in duration (Pierce County, 2006a).

Geology and Soils

The landscape of the Puyallup River Watershed was shaped by a variety of geologic factors, including volcanic activity, tectonic uplifting, glacial advances and retreats, and erosion by rivers and streams (Pierce County, 2006a). Intermittent volcanic activity and uplift of the volcanic range created the Cascade Mountain Range. The repeated advances and retreats of the Puget Sound lobe of the Cordilleran ice sheet created the Puget Sound lowlands. Geology in the area was most heavily influenced by the Vashon Glaciation (the most recent episode of glaciation). Vashon Age deposits (advance outwash, glacial till, and recessional outwash) cover most of the basin and account for the soil characteristics of the area. Glacially fed rivers carried large amounts of sediment that were deposited along the banks during flood events, creating natural levees.

The upper portion of the Clear Creek Basin consists of relatively flat uplands and long, narrow gorges associated with the tributaries that flow north into the Puyallup River. These deep gorges contain slopes with grades exceeding 40 percent. The upper portions of the basin include terraces and rolling hills with numerous small ponds and wetlands. Elevations range from a high of about 450 feet near the headwaters of the creeks to 20 to 30 feet at the northern edge of the basin where the creeks drain into the Puyallup River valley along Pioneer Way (Pierce County, 2006a).

The portion of the Clear Creek area north of Pioneer Way is comprised of nearly level flatlands of the Puyallup River valley. However, south of Pioneer Way, elevation rises quickly from the floodplain to steep valley walls and the upper basin. Transitions along the streams are characterized by steeply sloped canyons that were created by streams cutting into the valley walls (Pierce County, 2006a).

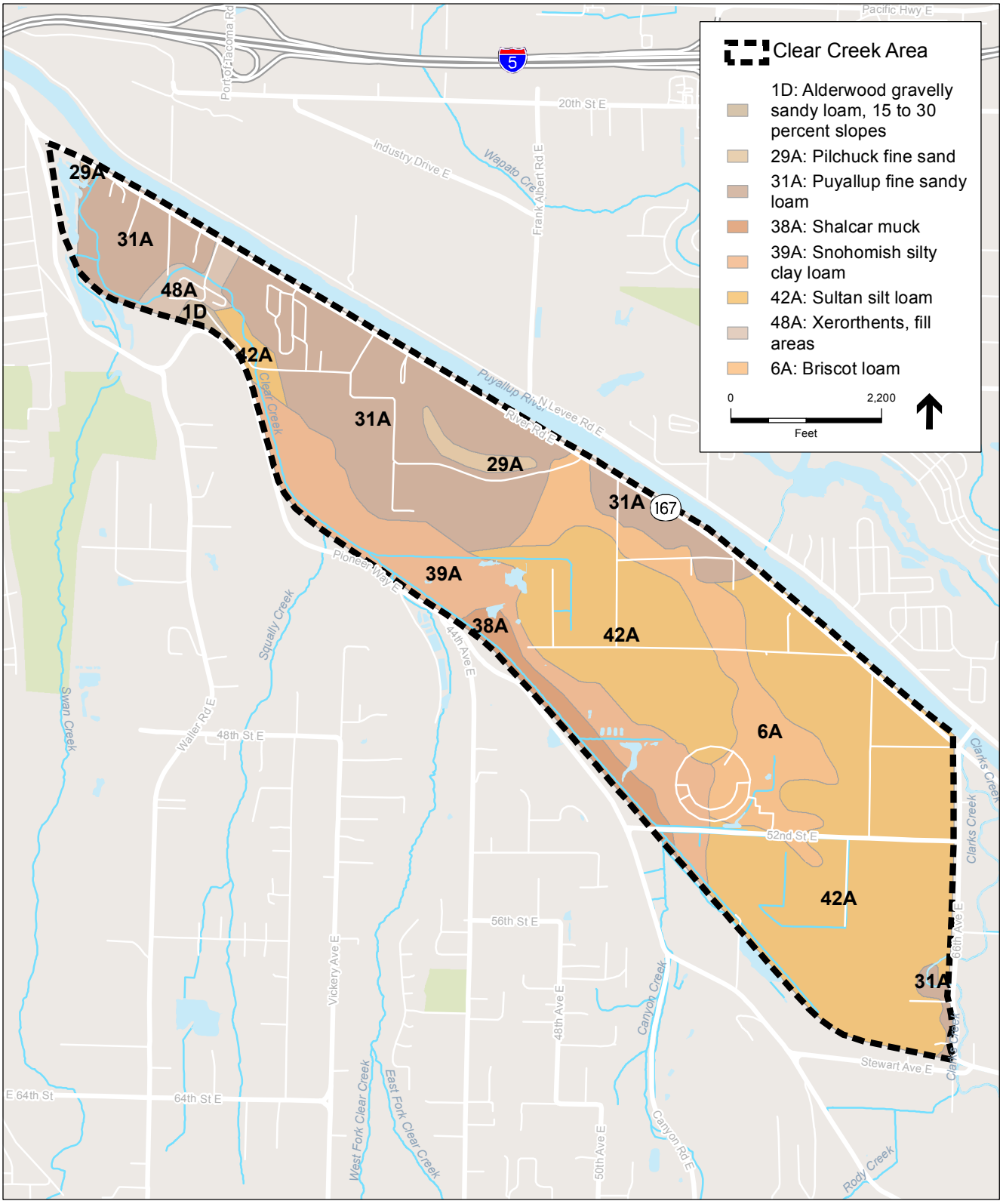
The majority of the land along the Puyallup River is categorized as a potential seismic hazard area, including the Clear Creek area (Pierce County, 2010). Much of the basin is also designated as a landslide hazard and/or an erosion hazard. The Clear Creek area is bounded almost entirely by landslide hazard areas, with intermittent spots of erosion hazard areas located within the area as well (Pierce County, 2016d).

Soils in the Puyallup River Watershed consist of alluvium, which is made up of sand, clay, and gravel deposited by streams and rivers, over glacial till left behind by retreating glaciers (NRCS, 2016). Glacial till is found near the surface in upland areas, but in the valleys it is covered by thicker deposits

of alluvial soils. The alluvial soils are generally good for agricultural production. Based on soil mapping by the NRCS, the two predominant soil series in the Clear Creek Basin are Puyallup and Sultan. Puyallup and Sultan soils are nearly level, well-drained soils that were deposited on the floodplains by rivers. The upper 20 to 30 feet of these soils consist primarily of silt, muck, and fine sand and some gravel deposits (Pierce County, 2006a). In the Clear Creek area, soils are mostly Puyallup fine sandy loam (38.5 percent) or Sultan silt loam (31.6 percent), both of which are considered prime farmland by NRCS (NRCS, 2016) (Figure 3-2). Briscot loam makes up 11.2 percent of soils in the area. This soil type is classified as prime farmland if drained and protected from flooding.

The NRCS classifies soils into four hydrologic soil types (A, B, C, and D) based on a soil's runoff potential. The classifications are based on the conditions in which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not taken into account unless they have significantly changed the morphology of the soil (NRCS, 2016). Consequently, the drainage class assigned by the NRCS may not reflect the current drainage characteristics of the soil as experienced by the farmer. Type A soils typically have a very high infiltrative capacity and generate the least amount of runoff relative to the other soil groups. Conversely, Type D soils are typically associated with saturated soil conditions and have the lowest infiltrative capacity, and generate the highest amount of runoff. Sultan soils are moderately well drained (Type C), and the Puyallup soils are well drained (Type A). Puyallup soils, fine sandy loam soils, underlie most of the City of Puyallup, whereas the remainder of the lowlands area is intermixed with both Sultan and Puyallup soils (Pierce County, 2006a).

The geology of the Clear Creek area led to the particular soil types in the area. Farmers in the Clear Creek area have stated that the high quality of their soils is critical to the viability of their farms. As described above, NRCS classifies soils in the area as prime farmland soils. These physical conditions make the Clear Creek area particularly well suited for agricultural production.



SOURCE:
NRCS 2011; ESA 2016.

PCCFT Farming in the Floodplain. 150678

Figure 3-2
Soils

Land Use

The Puyallup River Watershed is characterized by urban development to the west (Tacoma), rural communities in the center (South Prairie), and open space to the east (Mt. Rainier National Park and Snoqualmie National Forest).

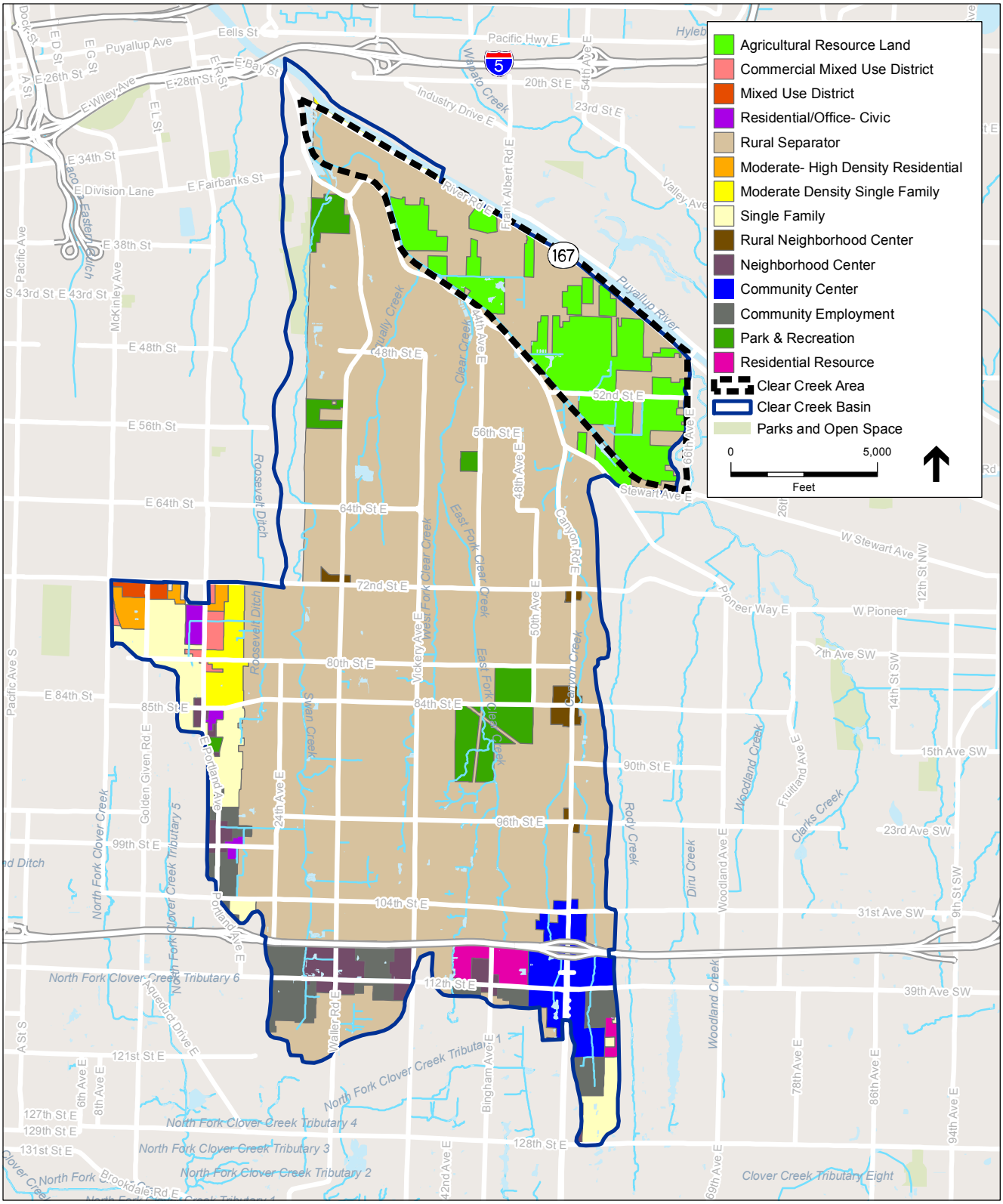
The Clear Creek Basin is located within Pierce County's Mid-County Community planning area. Within the Clear Creek Basin, the majority of land uses are single-family residences (53 percent), vacant land (18 percent), or agricultural and other resource lands (7 percent) (Pierce County, 2015a). Commercial land uses are concentrated primarily along the major transportation corridors in the basin, and the rural-residential landscape becomes more urbanized in areas approaching the cities of Puyallup and Tacoma, the South Hill Mall, and along Meridian Avenue and River Road. Within the Clear Creek area, the majority of the existing land uses include single-family residences (37 percent), agricultural and other resource lands (20 percent), or open space/recreation (18 percent) (Pierce County, 2015a).

Pierce County zoning includes a designation for Agricultural Resource Land (ARL). The ARL classification is designed to protect and promote long-term agricultural use. To be designated ARL, a parcel must:

- Be five acres or greater;
- Contain at least 50% "prime farmland" soils;
- Have a grass or legume production yield of 3.5 tons per acre or greater; and
- Meet the condition that 50% of abutting parcels are larger than 1 acre.

In addition to the criteria above, landowners may request that their property be zoned ARL. The Clear Creek area contains several parcels zoned ARL (Figure 3-3). Pierce County is currently evaluating the ARL criteria for a potential update.

Other lands in the Clear Creek area are zoned Rural Separator (Figure 3-3). Rural Separator zoning includes rural lands that serve as a buffer between urban zone classifications. This zoning classification allows a density of one dwelling unit per 5 acres.



SOURCE:
ESA, 2016; Pierce Co, 2007,2011

PCCFT Farming in the Floodplain. 150678

Figure 3-3
Zoning

Transportation and Utilities

Two state routes (SR 167 and SR 512), two railroad lines (BNSF Railroad and Tacoma Rail Mountain Division Railroad), and numerous roadways are located within the Clear Creek Basin. SR 167 and the BNSF Railroad traverse the Clear Creek area, with SR 167 heading east-west across the northern boundary and the BNSF Railroad heading east-west along the southern boundary. The rest of the transportation corridors within the Clear Creek area include paved, single-lane county roads serving the schools, single-family residences, commercial businesses, and agricultural lands (Pierce County, 2016d). Roads within the Clear Creek area are not well connected, and it is often necessary for travelers to use Pioneer Way or SR 167 to gain access to neighboring properties. In general, access from SR 167 is better than from Pioneer Way because only two roadways intersect with Pioneer Way within the Clear Creek Area: Gay Road East and 52nd Street East.

Pierce County Roads is currently planning a project that would extend Canyon Road East through the Clear Creek area from Pioneer Way East to 52nd Street East. The project would include constructing a bridge over the BNSF Railroad, expanding Canyon Road East with two lanes in each direction, and installing a new traffic signal at Canyon Road East and Pioneer Way East. An enclosed storm drain system and stormwater treatment and storage facilities would also be constructed. Construction is scheduled to begin in 2020.

Incorporated areas are served by municipal water suppliers, such as the City of Tacoma and the City of Puyallup. However, the Pierce County water utility does not provide drinking water to unincorporated areas, such as the Clear Creek area. The primary water purveyor in the Clear Creek Basin is Summit Water & Supply Co. (Pierce County, 2016c). The RV park and several mobile home parks in the Clear Creek area provide water to residents through groundwater wells. The main source of drinking water for the area is groundwater (Pierce County, 2016c).

The Pierce County sewer conveyance system does not extend to the Clear Creek area (Pierce County, 2012b). Wastewater treatment in the area is primarily through private septic systems.

Habitat Conditions

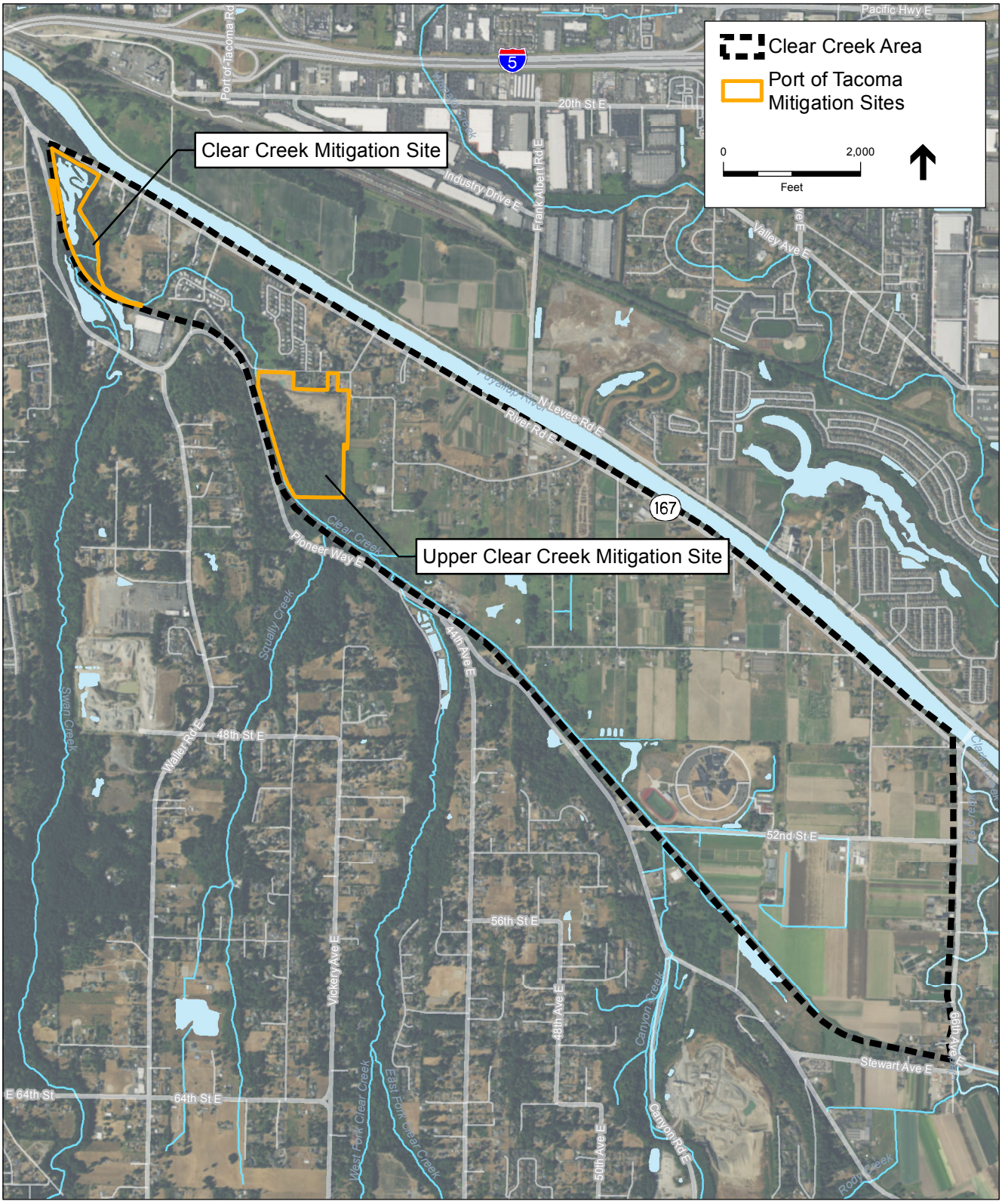
Physical Characterization

Since European settlement, the primary land uses in the Clear Creek Basin have included timber harvest and agriculture (Pierce County, 2006a). As a result, many streams and wetlands in the basin have been cleared of vegetation, diked, drained, or channelized to facilitate logging and farming activities. While the upper reaches of the basin were mostly harvested for timber, the lower reaches were used for agriculture. Although commercial timber harvest no longer occurs in the upper Clear Creek basin, residential development has increased in recent decades, which has converted forest to impervious surface. In 2006, approximately 21 percent of the Puyallup River Watershed was dominated by impervious surfaces, resulting in the further loss and alteration of wetlands and streams, and habitat fragmentation (Pierce County, 2006a).

The major streams in the Clear Creek Basin – Swan Creek, Squally Creek, Clear Creek (including east and west forks), and Canyon Creek – vary in size and condition across the upper, middle, and lower portions of the basin. Both the upper and lower reaches of the Clear Creek Basin are characterized by low gradient and heavily channelized streams. Streams in the upper reaches have little or no surface flow during summer months (May to September) and receive stormwater runoff from surrounding development and impervious surfaces such as roads (Pierce County, 2006a). Streams in the lower floodplain reaches of the basin typically have year-round flow.

Freshwater emergent, scrub-shrub, and forested wetlands are found throughout the basin, primarily in the lower reaches where multiple wetland complexes are associated with the Puyallup River floodplain (Pierce County, 2006a). Some of these lower wetland complexes are Port of Tacoma (Port) mitigation sites and are relatively large in size (Figure 3-4). One 16-acre Port mitigation site, the Clear Creek Habitat Mitigation Project, is at the mouth of Clear Creek and provides salmon habitat. This mitigation project was constructed in two phases, in 1998 and 2003. In addition, the Port is currently developing the 40-acre Upper Clear Creek Mitigation Site wetland complex in the Clear Creek area, directly south of Gay Road. Both Port projects are mitigation sites, which means they provide additional wetland habitat to offset the impacts of other Port actions within the Puyallup River Watershed. The Upper Clear Creek Mitigation Site rehabilitated and reestablished floodplain wetlands, re-meandered the Clear Creek channel, installed floodplain habitat enhancements (such as ponds, alcoves, hummocks, and large woody debris), and enhanced the upland forest habitat on the project site. The port owns an additional property in the Clear Creek area and plans to eventually develop it into a mitigation site. In addition, 12 acres of estuarine wetlands and aquatic habitat in Swan Creek were restored by the City of Tacoma in 2000 and 2001 (Pierce County, 2006a).

Unlike the lower and upper reaches of the basin, the middle reaches are characterized by steep gradient ravines with actively eroding channels. Streamflow regularly becomes subsurface due to underlying permeable soil layers in this portion of the basin (Pierce County, 2006a). The middle reaches are largely undeveloped because of critical areas regulations and conservation easements, as well as construction feasibility. As a result, stream channels have substantial riparian buffers with coniferous and deciduous forest. Most wetlands in the middle reaches are adjacent to stream channels.



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SOURCE:
NOAA 2016; ESA 2016; Pierce County 2015

PCCFT Farming in the Floodplain. 150678

Figure 3-4

Port of Tacoma Mitigation Sites

Fish and Wildlife Use

Salmonid species are found in Clear Creek up to RM 1.9 where a diversion dam is a barrier to anadromous fish passage (Port of Tacoma, 2014). Documented salmonids in the Clear Creek Basin include fall chum, pink, and fall Chinook salmon, as well as cutthroat trout and bull trout. Coho are known to spawn in the basin. Chinook salmon are listed for protection under the federal Endangered Species Act (ESA) and have been observed using spawning habitat in Swan Creek as well as Clear Creek near Pioneer Way (Pierce County, 2006a). Chinook spawning typically occurs in Clear Creek and Swan Creek. Coho in the watershed are all wild populations and only use portions of Clear and Swan creeks, while steelhead use is very limited. Chum is the predominant salmonid in the watershed, spawning in both Clear and Swan creeks (Pierce County, 2006a). Overwintering habitat for migratory bull trout has been identified in mainstem reaches of the Puyallup River by the U.S. Fish and Wildlife Service (USFWS), and spawning potentially occurs in the river's upper reaches. However, there is no currently available information to confirm bull trout presence in the Clear Creek watershed (Pierce County, 2006a).

Physical barriers to fish passage have been identified in every stream in the Clear Creek Basin, with the majority located in the upper reaches (Pierce County, 2006a). Fish passage to the upper basin is also limited by natural barriers including low flow conditions in the summer months.

The Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) database has documented several priority bird species using habitat in the basin. Waterfowl concentrations, as well as great blue heron and bald eagle breeding areas, are mapped in wetlands within the lower Clear Creek Basin (WDFW, 2016).

Key Issues and Recovery Goals

The conversion of forested land for timber production and agricultural uses as well as residential and commercial development has altered the natural hydrologic regimes of wetlands and streams in the Clear Creek Basin. As a result, stream health and habitat conditions have declined. Low base flows, channel confinement, fish passage barriers, erosion, and the loss of riparian cover are the major issues affecting habitat in the basin (Pierce County, 2006a). Other habitat limiting factors in the basin include the loss of floodplain connectivity, large woody debris, pool and riffle habitat, side channels for rearing salmonids, and stormwater. In addition, fine sediments in the system can affect salmon redds through siltation while elevated stream temperatures and low amounts of dissolved oxygen combine to provide poor water quality for fish (Kerwin, 1999). The *Puyallup River Watershed Assessment* identifies Clear and Swan creeks as problem areas along the lower Puyallup River for salmon recovery due to water quality impairments (Puyallup River Watershed Council, 2014).

Within the greater Puyallup River Watershed, the Clear Creek Basin is also identified as a high potential area for remediating contamination in the lower Puyallup River and estuary (Simenstad, 2003). Industrial development in the lower Puyallup River Watershed has resulted in significant contamination and has become a major issue in sustaining healthy wild Chinook populations. The

2003 Commencement Bay Aquatic Ecosystem Assessment identified several potential restoration areas that focus on degraded intertidal and estuarine habitat in the Puyallup River Watershed (Simenstad, 2003). Areas that were located above the mouth of the estuary, like the Clear Creek area, were determined to be the highest priority for creating or enhancing intertidal habitat functions necessary for Chinook salmon recovery.

Similar to the *Commencement Bay Aquatic Assessment*, the *Salmon Habitat Protection and Restoration Strategy: WRIA 10 Puyallup Watershed*, *WRIA 12 Chambers/Clover Creek Watershed* (Strategy) describes Chinook performance in the Puyallup River Watershed as "poor" and provides a list of contributing habitat factors and actions necessary for Chinook recovery (Pierce County, 2012a). Among the list of habitat factors is the loss of mainstem lowland floodplain off-channel and side-channel habitat for juvenile rearing and refuge. Levee setbacks, estuarine habitat creation, and correction of migration barriers were identified in the Strategy as the most beneficial types of actions needed for Chinook recovery. To address these problems, acquisition and restoration actions were recognized as long-term priorities in the Puyallup River from RM 0 to RM 6, which includes the Clear Creek area (Pierce County, 2012a).

Chapter 4 Water Resources and Agriculture

Many of the limiting factors for agricultural viability (flooding, drainage, sediment, and lack of water rights, among others) in the Clear Creek area relate to water resources. This chapter presents background information on surface water in the Puyallup River Watershed and the Clear Creek area, including wetlands. The chapter also describes existing conditions, the relationship to agricultural viability, and information needs for flood risk, groundwater, drainage, sediment, water quality, water rights, and irrigation. This chapter also includes future actions that could increase or reduce risks to agriculture. This information is intended to flag topics that need to be explored in greater depth and could be analyzed in Phase 2 of the FFP. Future actions discussed in these sections are intended to represent a range of actions that could be undertaken by various stakeholders.

Surface Water

Puyallup River Watershed

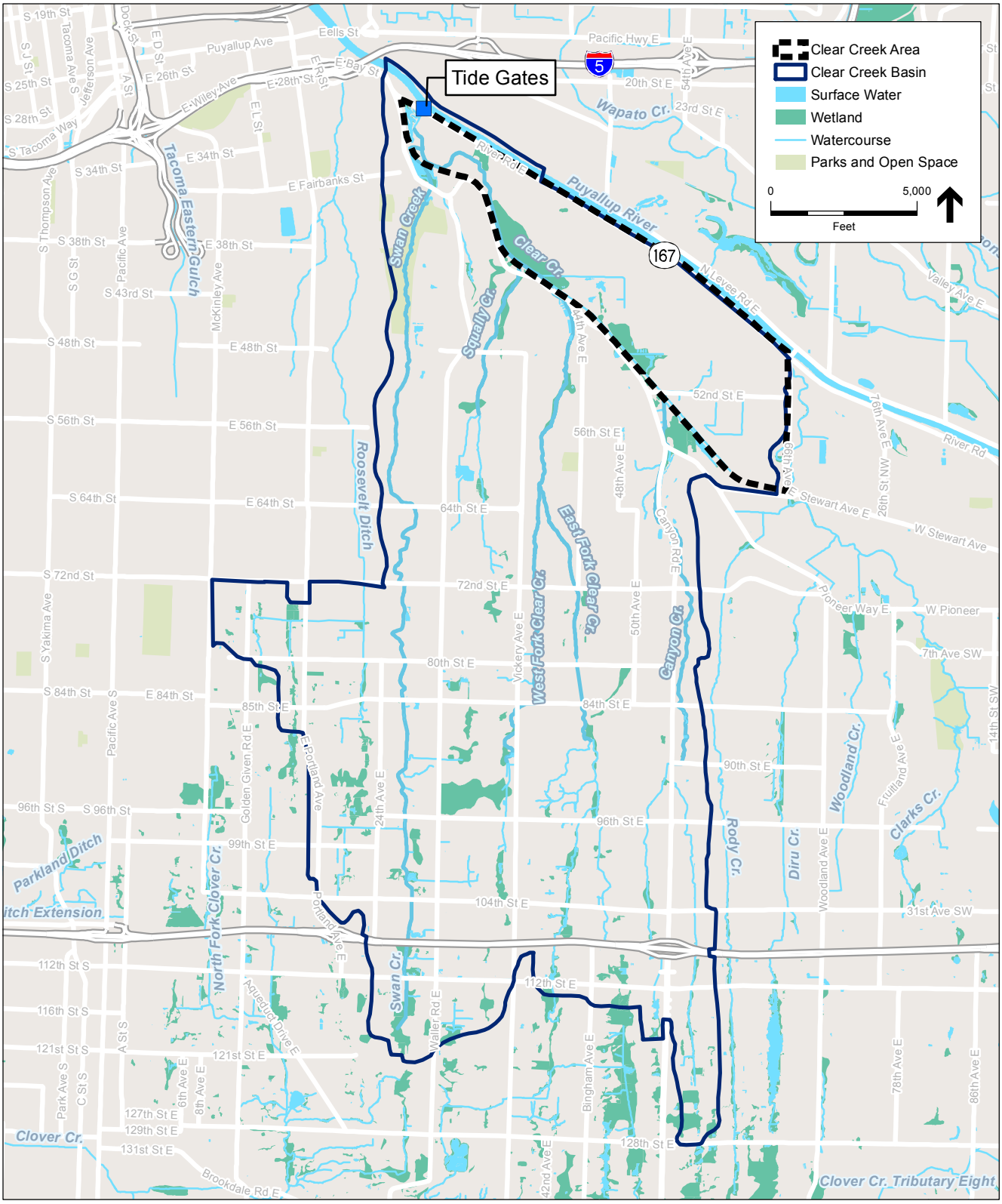
The Puyallup River Watershed is part of the Washington State Water Resource Inventory Area (WRIA) 10, the Puyallup-White River Basin (Figure 1-1, page 1-4). It extends from the Cascade Mountains to Commencement Bay on Puget Sound. The basin drains approximately 1,000 square miles of west-central Washington. The Puyallup River has two main tributaries—the White and Carbon rivers. All three rivers originate on glaciers of Mount Rainier. Elevation in the basin ranges from 14,411 feet on Mount Rainier to sea level. The upper portion of the basin is characterized by steep, mountainous terrain while the lower portion is characterized by broad floodplains and low gradient stream channels.

As part of the Medicine Creek Treaty, the Puyallup Tribe of Indians received title to the Puyallup River bed within the 1873 survey area from approximately RM 1.4 to RM 7.2. The river flows through the cities of Tacoma, Fife, Puyallup, Sumner, and Orting and large areas of unincorporated Pierce County. Due to historic management decisions and changes to the system, the river is highly modified (as described in the Historical Development section of Chapter 3). The lower reaches of the Puyallup River were historically straightened with levees and revetments for flood control. Mud Mountain Dam on the White River at RM 29.6 provides storage of up to 106,000 acre-feet of water to reduce flooding on the White and Lower Puyallup rivers. River Road Levee, constructed in 1917, lines the left bank of the Lower Puyallup River and North Levee Road Levee is located on the right bank.

Clear Creek Basin

Clear Creek joins the Puyallup River at RM 2.6, entering on the south side of the river. Clear Creek has three major tributaries—Swan Creek, Squally Creek, and Canyon Creek (Figure 4-1). These three streams along with Clear Creek flow from north to south in relatively parallel alignments until they emerge from their respective ravines and reach the Puyallup River floodplain. The streams start in the nearly flat upland area south of the Puyallup River, then flow through narrow, relatively steep

channels into the flat floodplain area (Figure 4-2). The cross section on Figure 4-2 shows the change in elevation in the Clear Creek Basin ranging from over 400 feet on the plateau to less than 100 feet near the Puyallup River.



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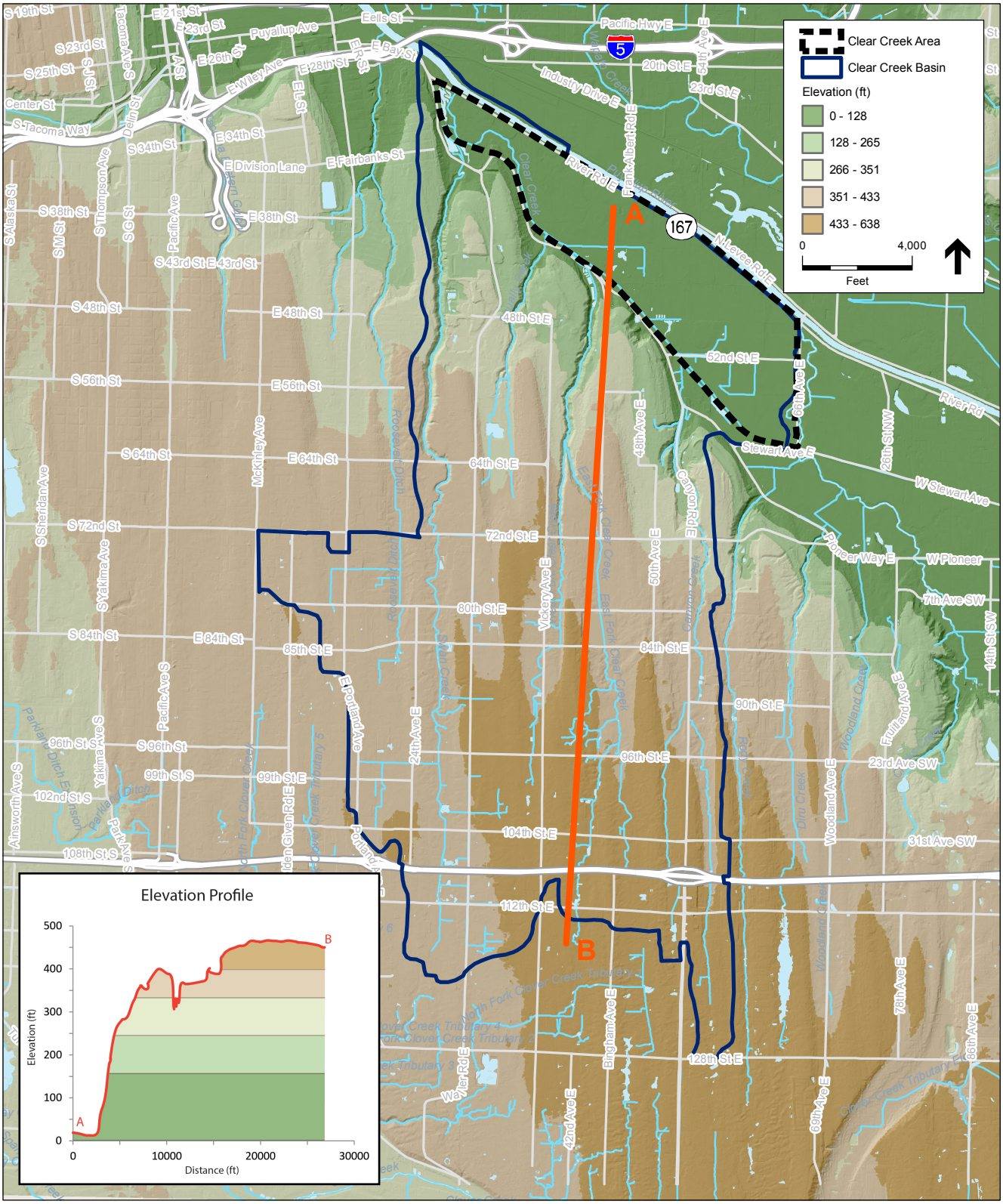
SOURCE:
Pierce Co. 2016; ESA 2016

PCCFT Farming in the Floodplain. 150678

Figure 4-1
Hydrologic Features



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SOURCE:
PSLC 2003; ESA 2016

PCCFT Farming in the Floodplain. 150678

Figure 4-2

Topography (Clear Creek Basin)

The gradient near Pioneer Way East causes a transition in channel types and valley form for all the streams. Upstream of Pioneer Way East, stream gradients range from 2 to 5 percent, while downstream from the road they are generally less than 1 percent. Above Pioneer Way East, the valley form is a parallel series of narrow, deeply incised ravines. Below Pioneer Way East, the valley is a large floodplain created by the Puyallup River. The bottom substrate of the streams also changes near Pioneer Way East. It is primarily gravel above the road and predominantly sand and silt below. Below Pioneer Way East, Canyon and Clear creeks are channelized, straightened, confined, and low gradient. Historic agricultural practices caused channel relocation and confinement, which have created ditch-like channels.

An alluvial fan forms at the transition from steep to low-gradient channels. An alluvial fan is a triangular-shaped deposit of water-transported material (alluvium) that forms at the base of a change in slope. Materials in the fan are coarse-grained (gravel and sand) because the heavier materials drop out as stream velocity slows. Alluvial fans have formed on Swan, Squally, and Clear creeks. Because of sediment removal on Swan and Clear creeks the fans are not well developed.

Drainage in the Clear Creek Basin has been significantly altered by development that has increased impervious surface and altered stormwater drainage systems. The calculated effective impervious area for the Clear Creek Basin is 19 percent. Under current zoning, the expected full build out of the Clear Creek Basin would lead to an effective impervious area of 23 percent (Pierce County, 2006a). The lower mainstem of Clear Creek flows west along the toe of the hill slope parallel to the Puyallup River. Most of this section of the stream has been channelized by adjacent farmlands and the BNSF Railroad right-of-way.

Swan Creek is the westernmost subbasin and discharges to Clear Creek north of Pioneer Way East. Swan Creek originally discharged directly to the Puyallup River downstream of Pioneer Way East, but was routed into Clear Creek as part of flood control efforts undertaken between 1914 and 1919. The Port of Tacoma restoration site is located where Swan Creek used to flow into the Puyallup River, and the former channel is still visible.

The Squally Creek Basin is the smallest of Clear Creek's subbasins, with a tributary area of 0.9 square mile. Squally Creek joins Clear Creek at Pioneer Way East. Clear Creek has two forks—East Fork and West Fork, which combine near 61st Street East before flowing through a deep canyon and discharging to the lower reach of Clear Creek near Pioneer Way and 44th Avenue East. Canyon Creek discharges into Clear Creek near 4th Avenue East and Pioneer Way East.

Streamflow

According to a study conducted by the U.S. Geological Survey (USGS) in the early 1990s, geography, hydrology, and geology affect streamflow characteristics of Clear Creek (USGS, 1994). In the glacial till headwaters, stream channels have gentle slopes, and adjacent wetlands and low areas provide water storage. Most stream channels in the upper reaches have little or no surface flow from late May through September as water is transferred subsurface to groundwater. In the middle sections,

streams enter deeply entrenched ravines with channels that show signs of active down-cutting. In these sections, the channels have little storage capacity, resulting in increased streamflow velocities and quick responses to rainstorms. As the streambeds cut through the till hardpan layers and expose the permeable substratum, streamflows infiltrate the channel bed and recharge the groundwater aquifer. Springs or seeps in the sides of the channels in the floodplain reaches recharge the streams.

Streamflow Monitoring

Both Pierce County and the USGS maintain stream gages in the Clear Creek Basin. The USGS maintains a seasonal gage on Swan Creek (Station 12102190 at 80th Street East). This gage is upstream of the confluence with Clear Creek, so it does not include all of the flows in the Clear Creek Basin. This gage is seasonal and only records flows from October 1 to April 30. The USGS does not report yearly statistics on this gage. A continuous flow gage last operated on Clear Creek at Pioneer Way (Station 12102140) in 1998. Table 4-1 lists the monthly and annual flow statistics from that gage for the years it was in operation.

Table 4-1. Monthly Mean and Maximum Flows for Water Years 1989–1998 in Clear Creek at Pioneer Way (USGS Station 12102140)

Month	Mean Flow (cfs)[1]	Maximum Flow (cfs)[1]
October	9.3	13.8
November	12.7	18.9
December	15.4	28.2
January	18.8	35.3
February	15.9	34.0
March	12.2	18.2
April	12.0	16.2
May	9.4	11.3
June	9.1	10.0
July	8.9	10.1
August	8.6	10.0
September	8.4	10.4
Period of Record	11.9	N/A

[1]cfs = cubic feet per second

Tide Gates

Tidal fluctuations cause the water surface elevation in the Puyallup River to vary at the mouth of Clear Creek. Two tide gates were installed at the mouth of the creek where culverts allow water to flow through River Road Levee (Photo 4-1). The tide gates are designed to close during a flood event on the Puyallup River to protect the Clear Creek area from backwater flooding from the Puyallup River. The first gate consists of a flap-gate mounted on a manually controlled slide-gate. The slide-gate is

designed to remain in the up position until the Puyallup River rises to elevation 12.5 feet, at which point it shuts. The slide-gate is intended to remain shut until the Puyallup River drops to elevation 11.5 feet. The second tide gate is a gravity-controlled flap-gate that only allows Clear Creek to discharge into the Puyallup River when water levels on the Clear Creek side of the gate are higher than water levels in the Puyallup River (NHC, 2015).

Photo 4-1. Clear Creek Tide Gates, view from Puyallup River, 2009.

Photo courtesy of Pierce County.

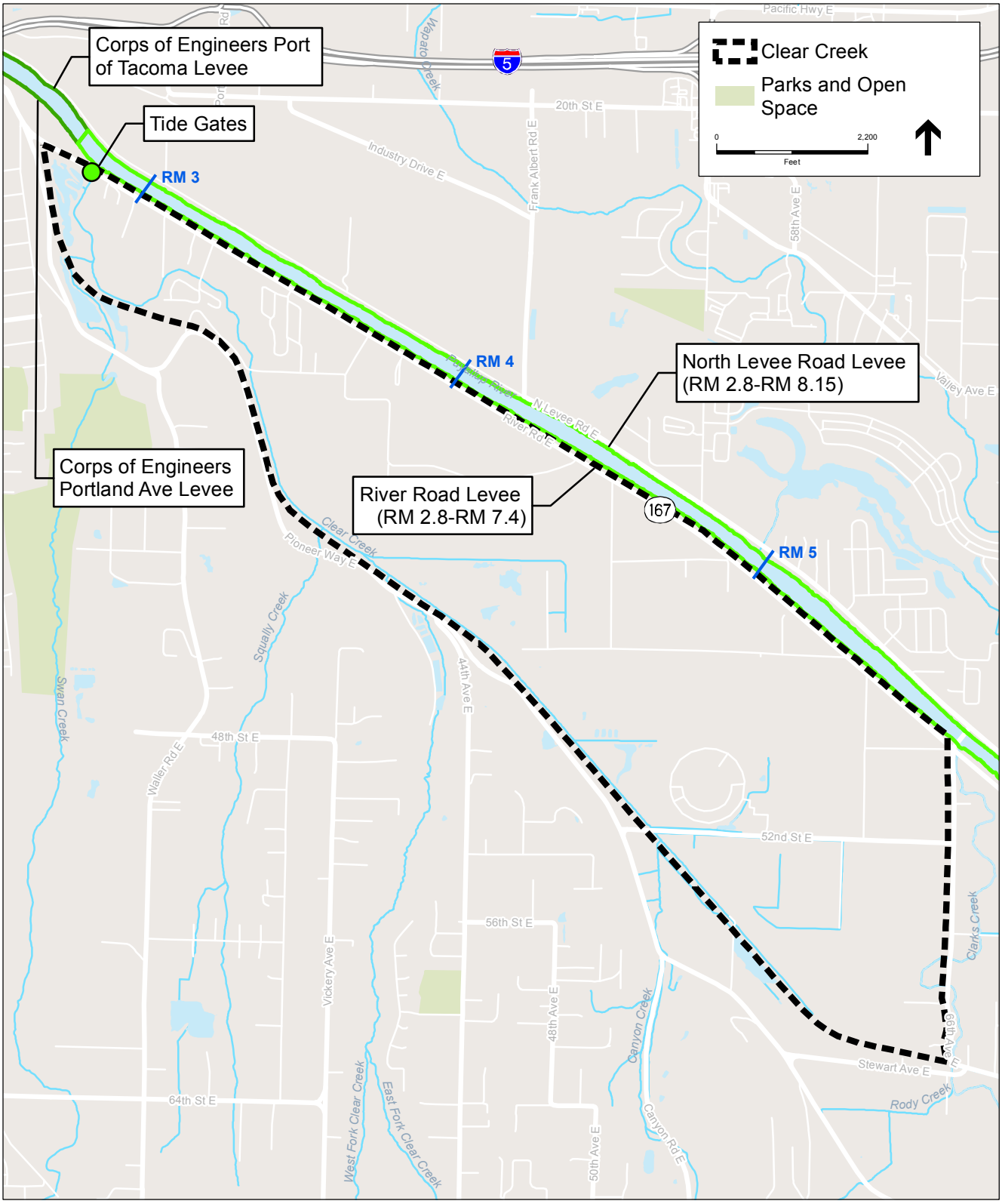
Wetlands

Wetlands in the Clear Creek Basin are primarily associated with the streams (Figure 4-1). Historically, wetlands extended throughout the floodplain area, but were lost or altered by residential development, dewatering of land with drainage tiles, and stream channelization. The Swan, Squally, Clear, and Canyon Creek subbasins had approximately 450 acres of wetlands in 2006. Wetlands in the northern end of the basin are bounded by steep topography as the ravines drop off the plateau into the Puyallup River Valley. Wetlands in the ravines are part of the riparian corridor and are hydrologically connected with the streams. Because the ravines are steep and largely undevelopable, the wetlands are relatively undisturbed. Two large Port of Tacoma wetland mitigation sites are located in the Clear Creek area (see the *Habitat Conditions* section of Chapter 3).

Flood Risk

The Clear Creek area faces complex flood risks from several directions. Major floods most recently occurred in 1996, 2006, 2009, and three times in 2015. The area is currently protected from flooding of the Puyallup River by the two tide gates and by River Road Levee. The U.S. Army Corps of Engineers (Corps) does not consider the levee to provide adequate 100-year flood protection due to a lack of freeboard (defined as additional protection above the 100-year flood elevation). The area also faces flood risks from Clear Creek itself and its tributaries. Because of the interactions of flows from both Clear Creek and the Puyallup River and because of uncertainties about River Road Levee and the tide

gates, flood risk in the area is not well understood by residents of the area. Figure 4-3 shows the flood infrastructure in the Clear Creek area.



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SOURCE:
NOAA 2016; ESA 2016; Pierce County 2015

PCCFT Farming in the Floodplain. 150678

Figure 4-3

Flood Control Infrastructure

Puyallup River Flooding

The majority of rainfall in the Puyallup River Watershed (approximately 75 percent) occurs between October and March, and the majority of floods occur between November and February. Larger floods typically occur due to atmospheric rivers (also known as "Pineapple Express" events), which occur seasonally. Atmospheric rivers are narrow corridors of moisture transport in the atmosphere that carry water vapor from the tropics to the Pacific Northwest. The average duration of floods in the Puyallup River Watershed is typically 1 to 2 days.

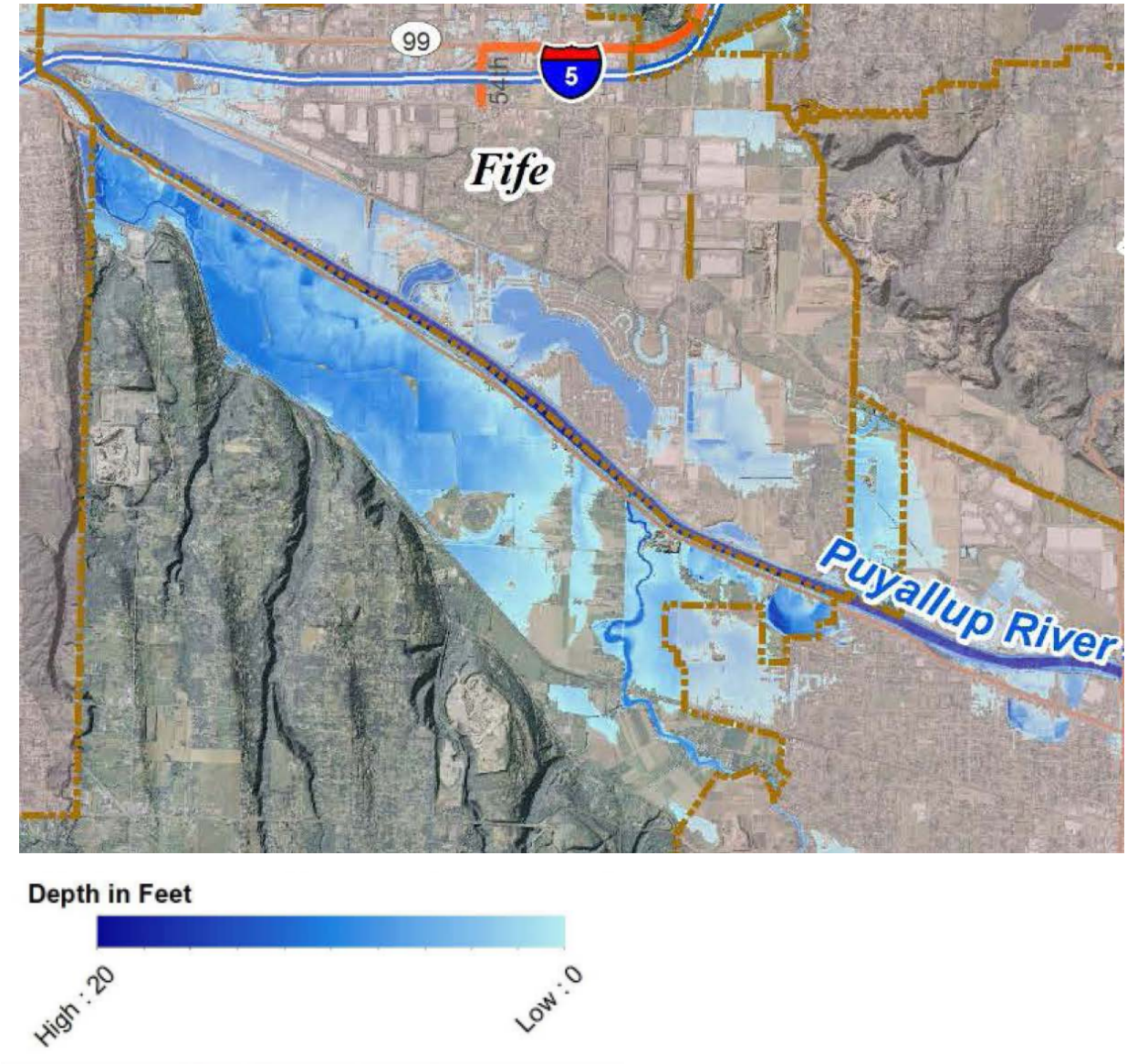
Major flooding in the Lower Puyallup River occurred in 1917, 1933, 1965, 1977, 1986, 1990, 1996, 2006, and 2009. The 2009 flood, with a flow of 48,200 cfs, was the largest on record since completion of Mud Mountain Dam in 1948 (Pierce County, 2013). The 2009 flood (in the Puyallup River Watershed and throughout Western Washington) was caused by heavy rainfall, warmer temperatures, and melting snowpack (Corps, 2016). Runoff in the watershed has increased since 2005 and extensive sediment deposition has reduced the capacity of the Puyallup River channel, which the Corps considers the primary driver of changes in flood risk in the area (Corps, 2016).

The levees on the Puyallup River upstream of RM 2.8 are owned and operated by Pierce County, including the North Levee Road Levee and the River Road Levee (Figure 4-3) (Pierce County, 2103). North Levee Road Levee, located on the right bank of the Puyallup River, protects the City of Fife and other areas north of the Puyallup River from flooding. Levee constraints on both sides of the river increases pressure against River Road Levee and increases flood levels at the Clear Creek tide gates. River Road Levee directly protects the Clear Creek area from flooding from the Puyallup River. Potential damage to the levees is considered the highest flood risk on the Puyallup River system (Pierce County, 2013). Without the levees, annual damage from flooding in the Lower Puyallup River is estimated to be $7.6 million, with damages of $78.7 from a 100-year flood event.

According to the *Pierce County Rivers Flood Hazard Management Plan* (Flood Plan), both levees are in good condition and structurally sound (Pierce County, 2013). However, the Corps has de-accredited both levees because they lack adequate freeboard (Corps, 2016). The Corps requires 3 feet of freeboard (additional height above the base flood elevation) for accredited levees. In 2009, a study of the levees found that a 100-year flood event would overtop the North Levee Road Levee at RM 3.3, but would not overtop the River Road Levee. The simulation found that a 500-year flood event would overtop the North Levee Road Levee at RM 3.3 and would also overtop the River Road Levee at RM 3.1, causing flooding in adjacent areas for over 24 hours. River Road Levee was also simulated to overtop at RM 4.5, 5.55, and 7.2 for shorter durations (Corps, 2016)

Although the Flood Plan indicates that the levees are structurally sound, the Corps General Investigation states that several levees in the area have the potential to breach before being overtopped during a flood event. The Corps developed a figure (shown below as Figure 4-4) simulating flood depths during a 100-year flood event with simulated levee breaches. As context, the 2009 flood was approximately equivalent to a 100-year flood event.

Figure 4-4. Detail from Map Showing Flood Depths in the Clear Creek Area during a 100-year Flood with Simulated Levee Breaches.



Source: Corps, 2016.

Mud Mountain Dam on the White River is operated by the Corps to provide flood control for the lower Puyallup River (Figure 1-1). The dam is operated to keep the peak flood flow on the lower Puyallup River to less than 45,000 cfs by reducing flows on the White River. After the peak flow on the Puyallup River has passed, the water stored behind Mud Mountain Dam is released into the White River (Corps, 2016). In recent years, sedimentation of the White River channel has required changes in the operation of Mud Mountain Dam. After the 2006 flood, 12,000 cfs were released from Mud Mountain Dam without incident. In 2009, a release of the same amount of water caused flooding in the town of Pacific. It was determined that the channel capacity in the area had been reduced to approximately

6,000 to 8,500 cfs. In 2015, a release of 6,000 cfs from the dam again caused flooding in Pacific, showing that the channel capacity continues to decrease (Corps, 2016). The loss of channel capacity in the White River requires that floodwaters held behind Mud Mountain Dam be released more slowly, reducing the ability to draw down the reservoir in anticipation of future flood events. As noted above, flows on the Lower Puyallup exceeded 45,000 cfs (up to 48,200 cfs) in the January 2009 flood despite the operation of Mud Mountain Dam.

Flood risk throughout Puget Sound is projected to increase with climate change, and winter streamflows are projected to increase. Heavy rainfall events will become heavier, and peak flows are projected to increase. At the same time, sediment loads are projected to increase, reducing channel capacity to handle the increased peak flows. Climate change and the associated flood risk are described in more detail in Chapter 6 of this report.

Clear Creek Flooding

The low-lying portion of the Clear Creek Basin is mapped as being within the 100-year floodplain of Clear Creek. In addition, each of the four tributaries to Clear Creek (Swan Creek, Squally Creek, Clear Creek, and Canyon Creek) has a mapped floodplain. The 100-year flood flows in Clear Creek are over 700 cfs (Schmidt, 2016), as compared to a mean December flow of 15.4 cfs. Base flood elevations are 19 to 23 feet (Pierce County, 2013). The Pierce County Flood Plan shows over 20 repetitive loss properties (i.e., properties with more than one flood insurance claim within a 10-year period) in the Clear Creek area. Floodwaters reached an elevation of 18 feet in the Clear Creek area in the 2009 flood and over 10 people had to be rescued. Flooding in the Clear Creek area inundates approximately 400 acres of land, with properties estimated to be worth over $42 million.

The two tide gates in the River Road Levee where Clear Creek enters the Puyallup River (see *Surface Water* section above) were designed to close during a flood event on the Puyallup River. Closure of the tide gates also prevents Clear Creek from draining into the Puyallup River, increasing flooding from the creek. The Flood Plan reports that backwater flooding of Clear Creek caused extensive flooding in 1996 and 2009 and some flooding in 2006 (Pierce County, 2013). However, residents of the Clear Creek area have questioned whether the tide gates were functioning (completely closed) during those flood events and whether some of the floodwater in the Clear Creek area was from the Puyallup River. Aerial photographs of the area during the 2009 flood show that floodwaters were brown, suggesting they may have been Puyallup River waters.

Pierce County Flood Regulations

Pierce County participates in the National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA), which requires member jurisdictions to regulate development in the floodplain. Pierce County is also a member of the Community Rating System (CRS) and is a Class 2 community, which means that residents of the county receive discounts on flood insurance premiums because the county implements floodplain management activities that go above and beyond the minimum requirements of the NFIP. These activities include the distribution of

an annual Flood Bulletin, implementation of a flood warning system, a flood buyout program, and free flood maps (Pierce County, 2012c). Development in the floodplains of Pierce County is regulated by Pierce County Code Chapter 18E.70, *Flood Hazard Areas*.

Because River Road Levee was de-accredited by the Corps due to insufficient freeboard, Pierce County regulates the Clear Creek area as a floodway. Under the NFIP, a regulatory floodway is defined as the area of the floodplain that must remain free of encroachments in order to prevent a rise in the base flood elevation of greater than 1 foot. Pierce County Code defines a floodway as "an extremely hazardous area due to the depth and/or velocity of floodwaters which carry debris, potential projectiles, and have erosion potential" (PCC 18E.70.020 B). Pierce County regulates the following areas as floodways:

- The regulatory floodway (as defined by FEMA)
- Potholes and B zones
- Channel migration zones
- "Deep and/or Fast Flowing Water Areas"

Any development in a flood hazard area requires an analysis of deep and/or fast flowing water to determine the floodway limits (PCC 18E.70.030 D). The analysis must be calculated based on the Corps hydraulic flood model (PCC 18E.70.050 Appendix A IV C). Pierce County has conducted an analysis of deep and/or fast flowing water of the Clear Creek area, which determined that some portions of the Clear Creek area would be regulated as deep and/or fast flowing floodways regardless of the accreditation of River Road Levee because flood depths in those areas would be greater than 3 feet (Pierce County, 2016e).

In general, no development, encroachment, filling, clearing, grading, new construction, or substantial improvement is permitted in a floodway area (PCC 18E.70.040 B). However, there are specific exceptions for agricultural activities in the Clear Creek area, and each property owner should contact Pierce County for specific review of the restrictions on their parcel. Exceptions include:

- Farmhouses and non-residential agricultural structures can be repaired, reconstructed, replaced, and improved if design considerations to minimize flood damage are followed.
- New agricultural accessory structures such as barns and storage buildings can be built if design considerations to minimize flood damage are followed.
- New buildings that are less than 120 square feet can be built since they do not trigger a building permit.
- Compost can be imported, stored, manufactured, or applied – with some conditions – without violating the County's no fill regulations (Farming in the Floodplain Project, 2016).

Proposed Flood Risk Reduction Projects

Two proposed flood risk reduction projects in the Clear Creek area and its vicinity would affect flooding conditions in the Clear Creek area: a Corps project and the Clear Creek Floodplain Reconnection Project. Neither project is currently scheduled for implementation and both must go through several additional steps before implementation.

Corps General Investigation

The Corps is pursuing a Flood Risk Management General Investigation of the Puyallup River Watershed. In March 2016, the Corps released a Draft Integrated Feasibility Report and Environmental Impact Statement, which includes details of a Tentatively Selected Plan (TSP) (Corps, 2016). The TSP includes several actions throughout the Puyallup River Watershed to reduce flood risk, including two projects adjacent to the Clear Creek area. North Levee Road Levee, located across the Puyallup River from the Clear Creek area, would be set back approximately 1,000 feet between RM 2.7 and RM 8.1 (the portion of the project directly across the Puyallup River from the Clear Creek area). The additional flood storage provided by the setback project would reduce pressure on the River Road Levee, which protects the Clear Creek area from Puyallup River flooding. The additional flood storage would also reduce river elevations at the Clear Creek tide gates during flood events. In addition, floodwalls would be constructed along River Road Levee, which currently has insufficient freeboard. The floodwall height would range from 4 to 8 feet above the existing levee, with an average height of 6 feet. The floodwall would reduce the risk of River Road being overtopped by floodwaters, and would protect the Clear Creek area from being inundated (Corps, 2016). The Corps of Engineers web site for the General Investigation is available at http://www.nws.usace.army.mil/Missions/Civil-Works/Programs-and-Projects/Projects/Puyallup-River-GI/.

Clear Creek Floodplain Reconnection Project

The Pierce County Rivers Flood Hazard Management Plan, adopted in 2013, includes proposed projects throughout the county to address flood hazards. The proposed Clear Creek Acquisition and Levee project would address flood risks in the Clear Creek area. The Flood Plan proposes construction of a levee at approximately the existing 14-foot or 18-foot contour to provide flood protection to commercial and residential structures. The proposed levee would reach a top elevation of approximately 22 feet and would be constructed with manual emergency relief gates to use in the event of the Puyallup River overtopping River Road. Once the levee were constructed, the tide gates could be removed (Pierce County, 2013). Pierce County has used grant funding from FEMA and other sources to purchase repetitive flood loss properties within the project footprint and is pursuing the acquisition of additional properties within the project footprint using funding from a Floodplains by Design grant issued by Ecology. The Pierce County Surface Water Management website for the Clear Creek project is available at https://www.co.pierce.wa.us/index.aspx?NID=3321.

Relationship between Flood Risk and Agricultural Viability

As described in Chapter 2 (*Agricultural Viability*), flooding presents a risk to agriculture in the Clear Creek area. Several farmers in the area stated that current incidences of flooding from Clear Creek do not represent a threat to their farm. However, future flooding conditions, whether from changed flood infrastructure, climate change, or the threat of River Road Levee overtopping, are concerns.

Due to the risk of flooding in the area, Pierce County regulates the area as a floodway. In general, no development, encroachment, filling, clearing, grading, new construction, or substantial improvement is permitted in a floodway area. However, there are specific exceptions for agricultural activities in the Clear Creek area. These regulations are not well understood by many residents of the Clear Creek area.

Current and Projected Risks to Agriculture from Flooding

The level of risk at each individual farm varies due to differences in elevation, topography, the crops grown, the location, and the techniques used. In general, the types of risks that flooding poses to farms include:

- Flooding represents a threat to human health and safety, particularly for farmers who live on their farms in the floodplain.
- Flooding in winter months represents a risk to perennial crops. Winter flooding can also prevent farmers from planting cover crops, which are an important aspect of agricultural viability for many farms in the area.
- Inundation of farmlands by contaminated floodwaters could negatively impact food safety and organic certification.
- Flooding can inundate and damage agricultural structures, such as barns.
- Flooding is a risk to livestock.

As described in Chapter 6 (*Climate Change*), flooding is projected to increase across Puget Sound, including the Clear Creek area. All of the threats to agriculture listed above could become more severe as floods become more frequent, last longer, and reach higher elevations.

Actions that Could Increase Risks to Agriculture from Flooding

The following changes in the Clear Creek area could increase risks to agriculture:

- More frequent flooding
- Greater extent of flooding
- More flooding during the growing season
- Reduced flood storage capacity
- Additional aggradation in the Clear Creek or Puyallup River channels
- Increased flows in Clear Creek due to an urbanizing watershed or variable climate

Actions that Could Reduce Risks to Agriculture from Flooding

In general, reducing flood risk to agricultural properties in the Clear Creek area would reduce risks to agriculture. However, any flood risk reduction projects would have to be evaluated to ensure that they would not increase other risks to agriculture. For example, construction of a levee in the Clear Creek area could protect some farms from flooding, but could cause new flooding conditions where streams and drainage ditches cross the levee (NHC, 2015). This potential impact requires additional analysis.

The following actions could reduce risk to Clear Creek area farms:

- Protecting agricultural properties from flooding
- Reducing runoff from upstream areas of the Clear Creek Basin
- Improving freeboard and addressing potential breach points in River Road Levee
- Setting back the North Levee Road Levee to provide more flood storage and reduce pressure on River Road Levee
- Altering the tide gates to improve the reliability of their operation and increase conveyance of flows from Clear Creek to the Puyallup River
- Improving culverts on 44th Avenue East
- Elevating homes, farm structures, and farm equipment in the floodplain
- Constructing “critter pads,” elevated areas where livestock can gather during flood events

Information Needs

Information needed to better understand flood risk in the Clear Creek area includes:

- More information on the operation of the tide gates, including information about how well they functioned during past flood events.
- Monitoring and observation of how the tide gates operate under various conditions to improve the confidence in modeling the hydraulics.
- More information on the likelihood of River Road Levee breaching or overtopping.
- Information specific to the Clear Creek area on how climate change could affect flood risk in the future.

Groundwater

Aquifers

The underlying geology of the Clear Creek area produces a groundwater system with multiple confined and unconfined aquifers, which store groundwater. The aquifer with the greatest effect on the groundwater supply and drainage for farmers in the Clear Creek area is the upper alluvial aquifer within the Puyallup River Valley. Although deeper, confined aquifers are present below this layer, it is unlikely that they affect surface conditions (USGS, 2015a).

The shallow groundwater within the alluvial aquifer is in direct hydraulic continuity[1] with surface waters of Clear Creek, the Puyallup River, and the constructed drainage ditches on the valley floor. Shallow groundwater fluctuates with changes in surface water flows. Depending on the location and season, the shallow groundwater system is recharged from, or discharges to, the adjacent surface water body. Because the Puyallup River is tidally influenced, groundwater levels adjacent to the Puyallup River in the lower reaches of the Clear Creek area also respond to tidal fluctuations.

Although no USGS monitoring wells are located in the study area, water level measurements from nearby wells indicate that groundwater levels are within 5 feet of the ground surface for much of the year, and can be at the ground surface during the winter months (USGS, 2015b). These shallow groundwater levels reduce the capacity to infiltrate surface water and contribute to flooding during periods of intense precipitation and high groundwater levels.

In 1989, the Environmental Protection Agency (EPA) designated the aquifer underlying much of the Puyallup River Watershed as a Sole Source Aquifer (SSA) (EPA, 2016). The SSA designation protects groundwater aquifers that supply at least 50 percent of the drinking water to the area overlying the

[1] Hydraulic continuity refers to the hydraulic interactions between surface and groundwater in a watershed. In areas with high continuity, streamflows are affected by groundwater withdrawals.

aquifer and where there are no reasonably available alternative drinking water sources if the aquifer becomes contaminated (EPA, 2016). The SSA designation gives EPA the authority to review federally funded projects in the overlying area. The Clear Creek Basin is on the northern edge of the Central Pierce County SSA.

Groundwater Recharge

Recharge of the shallow aquifer is important to maintaining base flows in the streams in the dry summer months. Reduced groundwater recharge is a problem in the Clear Creek Basin, with conversion of pervious land to impervious surfaces the main cause of the problem (Pierce County, 2006a). Increased impervious surfaces cause more stormwater to discharge to the stream system more quickly and less water to permeates to the groundwater aquifers.

The upland areas in the western part of the basin are most affected by reduced groundwater recharge. The till soils have a low infiltrative capacity, and groundwater recharge rates in this area are sensitive to land use conversion. The soils on the east side of the basin are overlain by outwash soils, which have very high infiltration rates and are less likely affected by the conversion to impervious land cover. Within the valley, the shallow alluvial aquifer system is recharged during the wet season both by infiltration of precipitation and discharge from streams when their flows exceed the elevation of the adjacent water table.

Current and Projected Risks to Agriculture from Groundwater

Groundwater recharge is a problem in the upstream areas of the Clear Creek Basin because of soils with low infiltrative capacity and land use conversion. Farmers in the Clear Creek area who rely on groundwater for irrigation could have more difficulty or incur more costs from pumping groundwater in the future due to insufficient recharge.

Rising sea levels from climate change could drive saline water farther upstream in the Puyallup River. For portions of the lower Clear Creek area not directly inundated in such a sea-level-rise scenario, impacts to agriculture could still arise from saltwater intrusion in groundwater.

Any factor that raises the already-shallow groundwater levels in the alluvial aquifer system, whether caused by climate change or other factors, could further impede agricultural drainage and increase the frequency of groundwater ponding on the ground surface in some areas.

Actions that Could Increase Risks to Agriculture from Groundwater

Actions that could increase risks to agriculture from groundwater include:

- Increased development and conversion to impervious surfaces, which could reduce groundwater recharge.
- Higher groundwater levels from climate change could further reduce drainage.
- Sea level rise could cause saltwater intrusion into the aquifer, making groundwater unsuitable for agricultural use.
- Any actions that would alter the surface water flow, such as removing tide gates or building a levee, could alter groundwater-surface water interactions and could cause changes to the groundwater table.

Information Needs

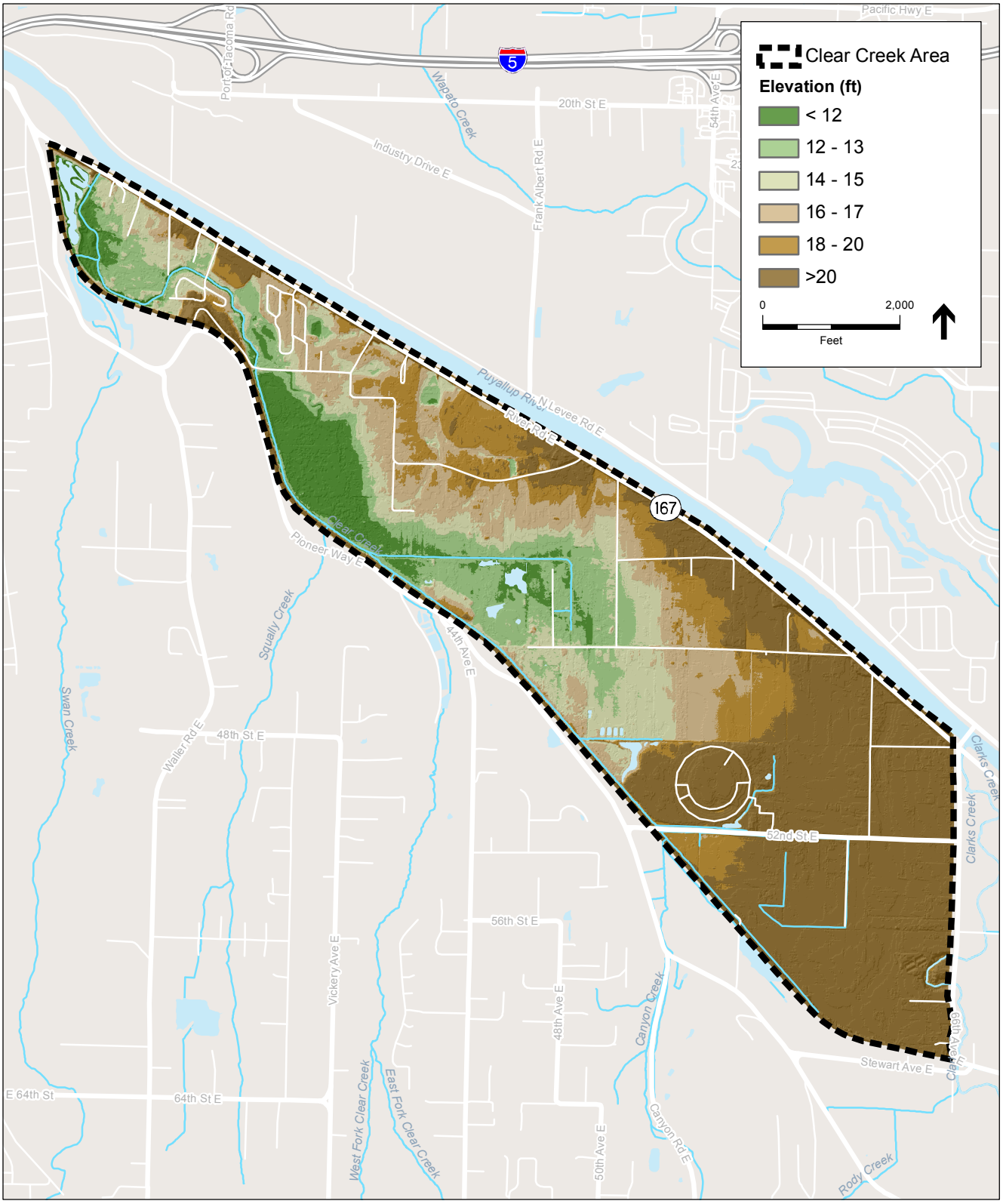
- An evaluation of hydrogeologic properties (hydraulic conductivities, flow directions, etc.) in the Clear Creek area to establish baseline conditions.
- Additional study is necessary to determine:
    - The current (baseline) interaction of Clear Creek surface water and alluvial aquifer groundwater throughout the year (relative to seasonal agriculture timing).
    - How sea level rise may affect groundwater levels and groundwater salinity in the Clear Creek area.
    - How the removal of tide gates or construction of a levee would change seasonal surface water-groundwater interactions in the area.

Drainage

Topography

The low-lying Clear Creek area has relatively flat topography, with land surface elevations ranging from 10 to 20 feet (NAVD88) (Figure 4-5). The land slopes gently to the south from the Puyallup River toward Clear Creek. This gently sloping topography is due to the historic actions of the Puyallup River, where floods would cause the river to overflow its banks, depositing layers of sediment on the floodplain. The coarser, heavier sediments (sands and gravels) fall out of suspension next to the river, forming natural levees, while the finer, lighter sediments (clays and silts) do not settle out as easily and are carried out into the floodplain, depositing in lower elevation, marshier areas farther from the main channel.

The land surface elevation not only indicates the direction of surface flow, but also the relative vertical distance to groundwater. Higher elevation properties near the Puyallup River are likely to have a greater depth to groundwater and are less susceptible to drainage problems due to infiltration capacity. These areas may require irrigation to produce a crop because of the lower water holding capacity of the coarser soils. Lower elevation soils near Clear Creek have a shallower groundwater table, and the fine-grained soils have a higher water holding capacity. This results in less need for irrigation, but a greater need for drainage to remove excess water.



SOURCE:
PSLC 2003; ESA 2016

PCCFT Farming in the Floodplain. 150678

Figure 4-5

Elevation (Clear Creek Area)

Soils and Drainage Class

As described in Chapter 3, the NRCS classifies soils into drainage classes. Soils in the Clear Creek area demonstrate significant variation in both soil type and drainage class. In general, soils with higher proportions of silts and clays are more likely to become saturated and tend to hold water longer compared to soils with higher proportions of sand and gravel. Bordering the Puyallup River, the soil surface is slightly higher, and the soil texture is coarser. Soils in this area are classified as fine sandy loam or silt loam and are assigned drainage classes of moderately well- to well-drained (NRCS, 2016). The soils bordering Clear Creek are primarily fine grained and are described by NRCS as mucks and silty clay loams. These soils are assigned drainage classes of poorly- to very poorly-drained. Other drainage classes that cover significant portions of the Clear Creek area include somewhat poorly-drained loams and excessively well-drained fine sands (NRCS, 2016). While the soils in the Clear Creek area are considered prime farmland by NRCS and are conducive to farming, the NRCS mapping also shows that drainage is of particular concern for agricultural viability in the area.

Agricultural Drainage

The agricultural drainage system in the Clear Creek area is made up of Clear Creek itself (operated and maintained as a drainage ditch by Drainage District 10), several large privately owned ditches with easements held by the district (including "Nancy's Ditch" and "South Ditch"), smaller privately owned ditches with no easements that convey water from individual parcels, and roadside drainage ditches maintained by Pierce County Roads.

Drainage District 10 and County Maintenance

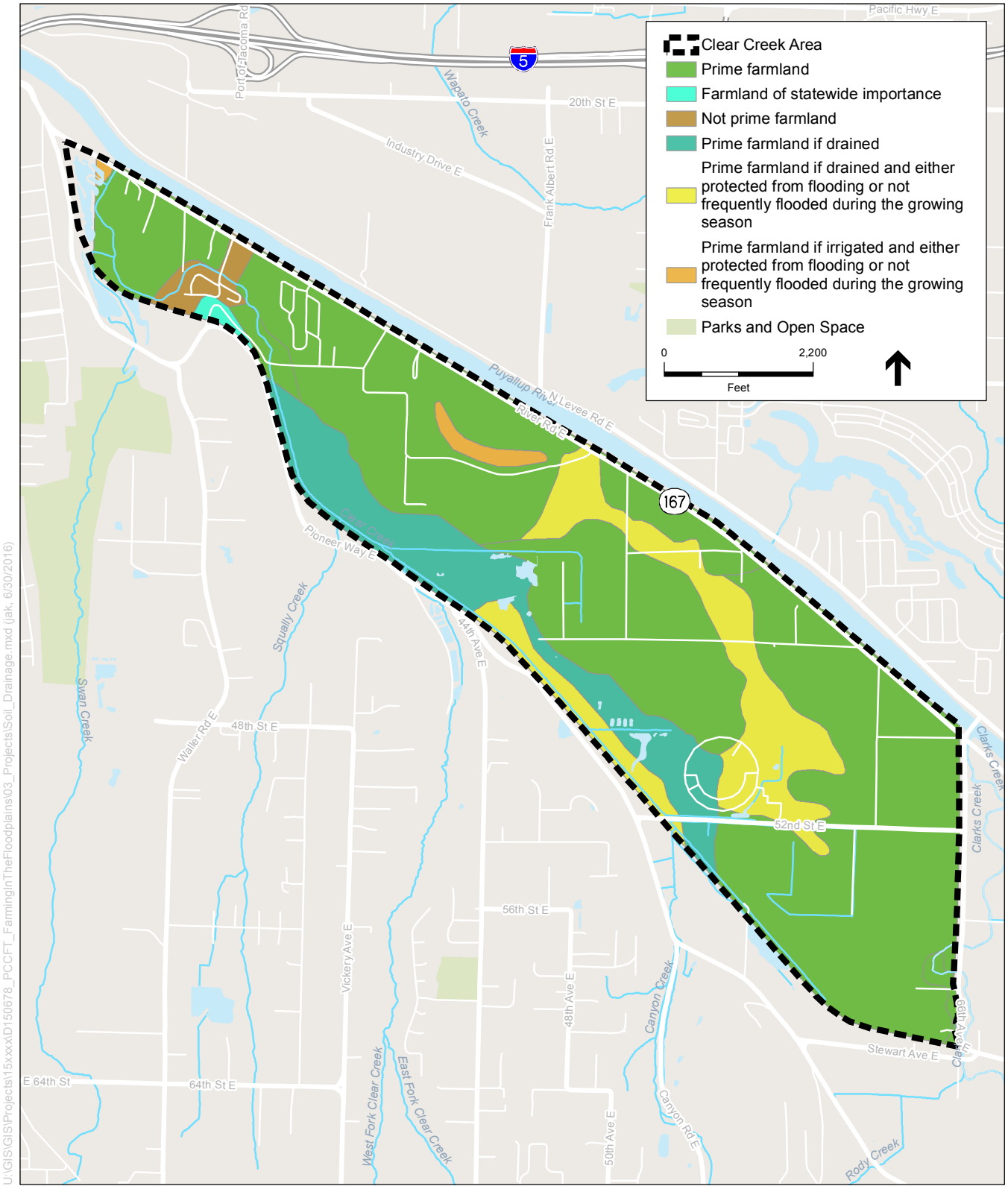
The majority of the Clear Creek area is within the boundaries of Drainage District 10. Most of Swan Creek from 120th Street East downstream to 80th Street East is within the boundaries of Drainage District 14. Drainage District 10 was established in 1912 under authority of Revised Code of Washington (RCW) 85.06 (Drainage Districts and Miscellaneous Drainage Provisions) and RCW 85.38 (Special District Creation and Operation). The districts have the authority to construct and maintain drainage ditches, to condemn property for drainage ditches, and to assess taxes on real estate within the district. Drainage District 10 maintains a network of ditches to convey agricultural drainage to Clear Creek. After being inactive for several years, Drainage District 10 recently filled the three commissioner positions and is seeking approvals to perform drainage system maintenance. Drainage District 10 is responsible for maintaining Clear Creek within the boundaries of the district as a drainage ditch.

County maintenance staff is generally not allowed to perform ditch maintenance work within the boundaries of a Drainage District or on private property. County maintenance staff can perform work within a road right-of-way or an easement, but can only address problems within unincorporated Pierce County boundaries and are not responsible for work in incorporated areas. County drainage facilities are generally maintained only to the extent needed for the benefit of the county's infrastructure.

Drainage Problems

Figure 4-6 shows the NRCS soil map according to its prime farmland designations. Much of the soil near the river is mapped as prime farmland. However, there are zones within the area, particularly along the toe of the hill along the Clear Creek corridor and in a band running from Gay Road toward Chief Leschi School, where the soils are classified as "prime farmland, if drained." This means that the soil characteristics are good for growing crops, but the water table needs to be managed to yield good results. Good drainage is essential to agriculture because most crops cannot tolerate saturated soils or standing water during the growing season. Flooded or saturated fields can cause reduced crop yield or total loss of the crop.

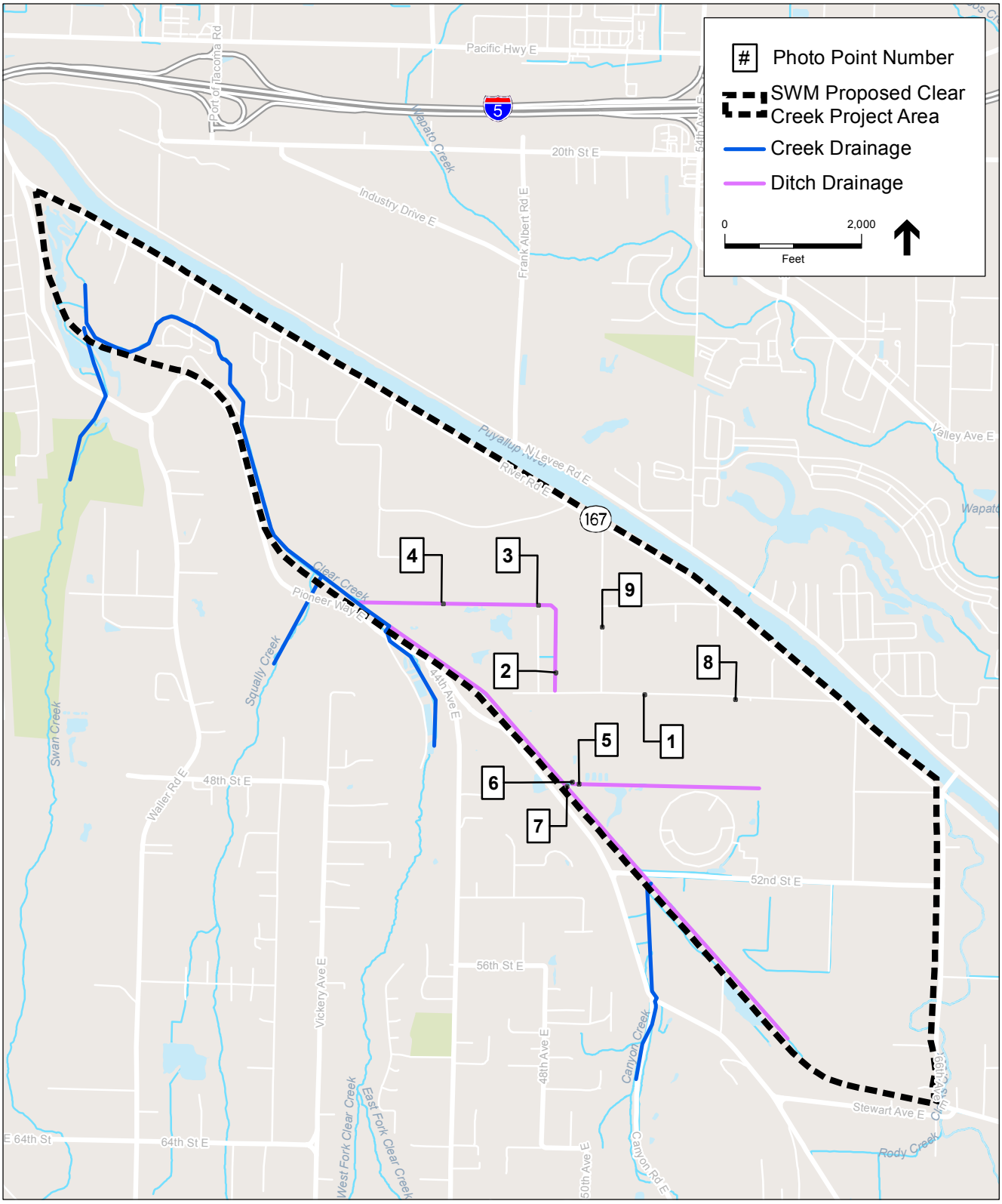
Many ditches in the Clear Creek area suffer from deferred maintenance due to the inactivity of Drainage District 10 over the past several years. ESA staff toured multiple properties in the district on April 14, 2016 and talked with landowners to get their perspectives on the drainage system and the drainage-related challenges for farming. The comments indicate that while the Clear Creek area flooded multiple times in the winter of 2015, the main barrier to agricultural production is the high water levels in the drainage system during the growing season. Contributing factors include accumulated fine sediment and vegetation in the drainage system (primarily reed canarygrass), and accumulated coarse sediment where the tributary creeks transition from their ravines to the Puyallup River Valley. Figure 4-7 shows the agricultural drainage system in the Clear Creek area. The following pages present a photo montage showing the condition of the drainage ditches in the Clear Creek area.



SOURCE:
NRCS 2011; ESA 2016.

PCCFT Farming in the Floodplain. 150678

Figure 4-6
Soil Drainage



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PCCFT Farmin in the Floodplain. 150678

Figure 4-7

Drainage Features

Roadside Ditch & Culvert on 44th Street

Nancy's Ditch

Nancy's Ditch

Nancy's Ditch

Photos taken on April 14, 2016

South Ditch

Private Ditch

Clear Creek

Soccer Field Ditch

Roadside Ditch on 50th Street

Drainage problems in the Clear Creek Basin are compounded by the cumulative effects of historic and ongoing development. Residential development increases impervious surface area and surface water runoff. Development results in the loss of floodplain storage area along the creeks. Undersized culverts and the loss of flow capacity due to invasive vegetation in the roadside channels and streams compound drainage problems.

Current and Projected Risks to Agriculture from Drainage

Good drainage is essential to agriculture because most crops cannot tolerate saturated soils or standing water during the growing season. Flooded or saturated fields can cause reduced crop yield or total loss of the crop. Saturated soils or standing water in the winter can prevent farmers from planting cover crops, a key approach used by many farmers in the Clear Creek area to prevent soil erosion and runoff while adding nutrients to the soil.

According to farmers, the current poor drainage conditions in the Clear Creek area represent the greatest current risk to agricultural viability. Although they were planted in the past, many of the lower lying fields get wet earlier and stay wet longer under current conditions. If the current drainage issues are not addressed, these fields will continue to be less suitable for agriculture, and it is likely that additional fields will become too saturated to be planted in the future.

Climate change consequences, such as increased sediment due to increased peak flows and sea level rise, could aggravate poor drainage conditions in the future.

Actions that Could Increase Risks to Agriculture from Drainage

Actions that could increase risks to agriculture in the area include:

- Reductions to the current drainage capacity, including:
    - Additional flow restrictions from culverts or water control structures.
    - Sea level rise, which could raise groundwater levels.
    - Aggradation of streams, including Clear Creek and the Puyallup River.

Actions that Could Reduce Risks to Agriculture from Drainage

Actions that could reduce risks to agriculture and increase agricultural viability in the area include:

- Addressing deferred maintenance of the drainage system in the Clear Creek area.
- Making improvements to the drainage system.
- Altering the tide gates so they increase the flow rate into the Puyallup River and/or further reduce the amount of water that can flow from the Puyallup River into Clear Creek.
- Constructing a pump station designed to supplement gravity drainage from Clear Creek to the Puyallup River would benefit agricultural drainage, but the construction and maintenance costs would likely outweigh the benefits and a large amount of land would be required.

Information Needs

Areas where more information would be helpful to characterize drainage conditions in the Clear Creek area include:

- An inventory of the existing drainage system, including information on:
    - Ownership and maintenance responsibility for drainage features.
    - The current capacity and limitation of drainage features.
    - The capacity of drainage features if properly maintained.
    - Areas of the drainage system that require maintenance.
- Additional information on operation of the tide gates.
- Additional information on the groundwater/surface water interaction.

Sediment

Puyallup River

The Puyallup River transports large amounts of sediment. The estimated sediment load for the Puyallup River Watershed is between 890,000 and 980,000 tons per year, the third largest contributor of sediment to Puget Sound (USGS, 2011; Czuba et al., 2010). Much of this sediment is due to glacial activity on Mount Rainier. The Puyallup River, as well as its major tributaries the Carbon and White rivers all originate from glaciers, which supply prodigious amounts of sediment. As a result, the Puyallup River is in a general state of sediment surplus, and is expected to continue to experience aggradation in the reaches where the sediment conveyance capacity is less than the supply of sediment. Areas of the Puyallup River are experiencing severe aggradation (which means the

streambed is rising), as much as 7.5 feet from 1984 to 2009 in the upper Puyallup River (Jaeger, 2015). In the lower Puyallup River, aggradation rates from 1985 to 2009 were approximately 0.3 inch/year (or about 7 inches total). This is a moderate rate relative to other areas in the watershed (Czuba, 2010). Sedimentation in the Puyallup River has substantially decreased the channel capacity, resulting in an increase in channel migration and flood risks throughout the Puyallup River Watershed. Sedimentation is projected to increase as climate change increases runoff in the upper Puyallup River.

Clear Creek and Tributaries

Erosion and sedimentation are also concerns in Clear Creek and its tributaries (shown on Figure 4-1). The upper portion of the Clear Creek Basin is a large sediment source, with reports of stream channel incision greater than 10 feet in places (Pierce County, 2006a). This is likely due to elevated runoff rates from a relatively high percentage of impervious surfaces in the upper watershed.

Swan Creek is subject to similar issues, and has also been the site of illegal sediment dumping from gravel pit operations (Ecology, 2011b). Pierce County Surface Water Management constructed a sediment detention pond on Swan Creek in 1991, which allows sediments to settle after rain events. This pond requires maintenance to remove sediments, and doing so helps eliminate the need for regular dredging of the channel downstream (Pierce County, 2006a). In addition, the City of Tacoma has constructed an off-channel wetland adjacent to Swan Creek. The vegetation and low flows within the wetland improve water quality and allow settling of sediment, as well as providing salmonid habitat (Pierce County, 2006a).

Squally Creek is a source of sand and fine sediments, with some component possibly from road fill from construction of Pioneer Way East (Pierce County, 2006a). A stormwater detention facility constructed along Squally Creek in 1995 provides some reduction in peak storm events and corresponding erosion and sediment deposits (Pierce County, 2006a).

Risks to Agriculture from Sediment

While sediment is a natural river process, current and projected sediment deposition and aggradation in the Puyallup River increases the flood risk to the Clear Creek area, either from overtopping of River Road Levee or from backwater flooding on Clear Creek. In addition, as the river bed of the Puyallup River rises due to aggradation, the river level rises relative to the tide gates, which could limit the ability of the Clear Creek area to drain. Sediment deposition and aggradation in Clear Creek reduce the drainage capacity of the system and also increase flood risk.

Actions that Could Increase Risks to Agriculture from Sediment

Increased sediment from either the Puyallup River or from Clear Creek and its tributaries could increase the risk to agriculture in the Clear Creek area from both flooding and drainage impacts. While sediment deposition on agricultural fields is not currently an issue in the Clear Creek area, it could be in the future if the surface water regime changes or if the tide gates are removed and agricultural fields were subject to inundation from backwater flooding from the Puyallup River.

Actions that Could Reduce Risks to Agriculture from Sediment

Managing sediment levels in the Puyallup River and in Clear Creek and its tributaries could reduce risks to agriculture. Analyzing the impact of upstream development on sediment and addressing sources of sediment upstream in Clear Creek Basin would also reduce risks to agriculture.

Information Needs

- Additional information on the current and projected sediment loads in Clear Creek and the Puyallup River, including sediment loads caused by upstream development in the Clear Creek Basin.
- Additional information on the impact of upstream development on sediment loads in the Clear Creek Basin.
- Additional information on the impact of climate change-induced sediment increases in the upper watershed on the Clear Creek Basin.

Water Quality

Existing Conditions

The Clean Water Act (CWA) is the primary law regulating pollution of waterways in the United States. In Washington, water quality standards for surface water are set by Ecology and approved by the EPA. Water bodies that do not meet the minimum standards established by Ecology are designated "impaired," and those that currently meet the minimum standard but are predicted to violate standards by the time of the next update are considered "threatened." Under Section 303d of the CWA, states are required to develop lists of impaired and threatened waters, which are then submitted to the EPA. This list of impaired waters is referred to as the "303d list." To improve water quality in impaired waters, states are required to create a Total Maximum Daily Load (TMDL) for each pollutant that exceeds standards in each impaired water body. A TMDL is a pollutant budget and serves as a planning tool and starting point for restoration and protection activities, with the goal of

attaining and maintaining water quality standards. The most recent approved 303d list for Washington is from 2012 (Ecology, 2016a).

Puyallup River

The Puyallup River is designated by Ecology for primary contact recreation use, which includes swimming and other activities with direct and extended body contact (Ecology, 2011a). It is also designated for all water supply and miscellaneous uses. Several water quality issues currently prevent the lower Puyallup River from meeting this standard. Ecology placed the Puyallup River on the 2012 303d list for fecal coliform bacteria and mercury, and it is listed as a water of concern for dissolved oxygen (DO) (Ecology, 2012). Ecology prepared a TMDL for fecal coliform in 2011, along with a water quality improvement project (WQIP). EPA approved the TMDL in September 2011, and Ecology is now implementing the WQIP. Low DO is also a concern in the Puyallup River, likely caused by elevated nutrient concentrations. In general, DO concentrations are within the lower limits for water quality as defined by Ecology (Ebbert, 2003).

Clear Creek and Tributaries

Clear Creek is also designated by Ecology for primary contact recreation use and for all water supply and miscellaneous uses. Clear Creek is listed on the Ecology 303d list for fecal coliform bacteria, and is a water of concern for DO (Ecology, 2012). Clear Creek was originally included on the TMDL and WQIP for the Puyallup River Watershed; however, recent monitoring indicated that fecal coliform levels in the Clear Creek Basin are low enough to warrant removal from 303d listing and TMDL requirements (Ecology, 2011a). Low DO levels are also an issue in the Clear Creek Basin, likely caused by elevated nutrient concentrations. The likely source of these problems is a combination of land development, runoff, on-site septic sewer systems, pastureland, animal management areas, stream channelization, dredging, vegetation removal, stream bank modifications, and highway runoff (Pierce County, 2006a).

Relationship of Water Quality to Agricultural Viability

The Puyallup River is on the 303d list (a list of impaired and threatened waters maintained by the Washington Department of Ecology) for fecal coliform bacteria and mercury, and is listed as a water of concern for dissolved oxygen. However, water quality in the study area generally meets the minimum standards for agricultural use set by Ecology, and trends indicate that it will continue to be suitable for agricultural use. As discussed on page 4-15, poor water quality can pose a risk to agricultural viability if fields are inundated by floodwaters. If floodwaters leave contaminants in soils after they recede, food safety and organic certification of affected fields could be at risk.

Information Needs

Additional information that would be useful in characterizing water quality in the Clear Creek area:

- Reliable long-term monitoring of water quality in Clear Creek.
- Better understanding of the relationship between agriculture and water quality, particularly bacterial water quality.

Water Rights and Irrigation

Existing Conditions

State law requires certain users of public waters to receive approval from the state for use of the water. Approval is through a water right or a certificate. Water rights are regulated by Ecology under the authority of the Surface Water Code of 1917 (RCW 90.03) and the Groundwater Code of 1945 (RCW 90.44). Diverting any amount of surface water requires a water right. Withdrawal of up to 5,000 gallons per day of groundwater is exempt from needing to obtain a permit, but must comply with all other water laws and regulations. To qualify for the exception from obtaining a water right, groundwater use must meet the following requirements:

- Water for livestock (no gallon per day limit).
- Water for a non-commercial lawn or garden watering up to ½ acre in size (no gallon per day limit).
- Water supply for a single home or group of homes (limited to 5,000 gallons per day).
- Water for industrial purposes, including irrigation (limited to 5,000 gallons per day).

The Puyallup River Watershed is one of the most intensely populated and farmed basins in western Washington, and much of the water in the watershed has already been appropriated for irrigation and municipal and domestic supplies (Ecology, 2011c). Ecology established an Instream Resources Protection Program rule for WRIA 10 in 1988 (Washington Administrative Code [WAC] 173-510). The rule establishes instream flows on the upper and lower Puyallup River, the Carbon River, and all their tributaries. The purpose of the rule is to retain streamflows necessary to protect "wildlife, fish, scenic-aesthetic, environmental values, recreation, navigation, and to preserve high water quality standards." All future water withdrawals are subject to protection of the instream flows. This rule closed all streams in the Clear Creek Basin to further consumptive appropriations. The rule also requires that any future groundwater withdrawals be restricted if a determination is made that the withdrawal would have a direct and measurable impact on the adopted instream flows. If the groundwater use would impact instream flows, groundwater use could be permitted if the impact is mitigated. Typically, mitigation for such impacts requires the groundwater user to purchase an existing water right and dedicate it to protecting streamflows.

Ecology does not regulate the collection of rainwater through a rooftop or guzzler. Rooftop collection must be from a roof that is part of a fixed structure that has a primary purpose other than the collection of rainwater. A guzzler is a device used to catch and store rain water to provide drinking water for livestock or wildlife.

Some farmers in the Clear Creek area have a water right and use it to irrigate their fields with water from Clear Creek. Other farmers do not have water rights and use groundwater or municipal water sources for irrigation.

Relationship of Water Rights and Irrigation to Agricultural Availability

Because the Puyallup River Watershed is a closed basin, it is not possible to obtain new surface water rights, and groundwater withdrawals can also be restricted. For some farmers, a lack of water right could be a limiting factor for agricultural viability. Options for obtaining water rights for irrigation are limited and may require purchasing older water rights. With projected climate change (see Chapter 6), summer streamflows are projected to be lower and air temperatures higher, which together could cause farmers in the area to require additional water to irrigate their crops. Reduced streamflows could increase restrictions on surface and groundwater use for irrigation.

Information Needs

While the basin is closed to new water rights, some options might be available to Clear Creek area farmers who are interested in exploring water supply. To explore these options, the agricultural water need and the current agricultural water supply could be assessed.

Chapter 5 Integrating Agriculture and Floodplain Projects

The FFP was initiated because one goal of the Floodplains for the Future project is to explore the possibility of integrating agriculture with large floodplain improvement projects throughout the Puyallup River Watershed, including in the Clear Creek area. As the proposed Clear Creek Floodplain Reconnection Project has moved forward, several questions have been asked about the possibility of integrating agriculture and floodplain projects. This chapter addresses two related questions: whether agriculture is compatible with salmon habitat, and whether it is possible to reclaim residential lands for agriculture.

Agriculture and Salmon Habitat

The proposed Clear Creek Floodplain Reconnection Project would include the construction of a ring levee around a portion of the Clear Creek area, and the creation of salmon habitat within the levee. The project could potentially place agricultural lands within the ring levee, directly adjacent to salmon habitat. FFP stakeholders have asked whether agriculture and salmon habitat can be coexisting land uses (Johnson et al., 2016). This section draws on information available in Best Available Science (BAS) documents on the potential impacts of agriculture on salmon habitat. Additional detail from BAS documents is included in Appendix B.

Relatively flat and broad river floodplains, which are common in the lower, middle, and upper Puyallup River, have been closely associated with agriculture since European settlement. The majority of agricultural properties are located within floodplains where cultivating crops and raising livestock can coexist with occasional inundation of pastures and agricultural lands. Like other types of land-based activities, farming and agricultural uses can adversely affect floodplains as well as their associated streams and wetlands. These potential impacts include impaired water quality, altered hydrology (movement of water), and degraded wildlife habitat.

In Washington State, the primary pollutants of concern for agricultural uses reported in BAS documents are pesticides and herbicides, nutrients (e.g., nitrate), and sediment. Some of these can enter streams and wetlands. Stormwater runoff can also have indirect adverse effects on the function of streams and wetlands. For example, excess sediment can accumulate in wetlands, reducing the ability of the wetland to store flood waters or filter surface runoff over time.

The primary hydrologic impacts from agricultural activities reported in BAS documents are changes in the hydrologic characteristics within wetlands and streams, a reduction in floodplain storage capacity, and blockage of water movement through floodplains (as summarized in Whatcom County, 2005; Sheldon et al., 2005). In the Clear Creek Basin, the major agricultural impacts on streams and floodplains historically began when Clear Creek and its tributaries were channelized to allow for farming. Other activities such as tilling, soil compaction, irrigation, maintenance of drainage systems, and new fill or structures in the floodplain can contribute to ongoing impacts to the movement of surface water.

Fish and wildlife habitat can be directly impacted by agriculture through the channelization of streams and removal of native vegetation. Indirect effects on habitat include, for example, blocking the natural movement of water through floodplain areas, which in turn prevents large wood (an important habitat structure) from reaching floodplain wetlands. As another example, infestation by nonnative invasive vegetation such as reed canarygrass can reduce the diversity of native plants that provide wildlife habitat. Conversely, a stream channel overgrown by reed canarygrass can impact agricultural activities by reducing drainage capacity of the field. Removal of native vegetation can lead to habitat fragmentation, and removal of riparian vegetation increases stream temperatures.

Historic and current agricultural practices have had an ongoing impact on salmonid habitat in the Clear Creek Basin, as noted in the Chapter 3, *Habitat Conditions* section. Factors affecting salmonids include a lack of riparian vegetation and associated high water temperature in the summer, lack of large woody debris and channel complexity, periods of low levels of dissolved oxygen and elevated stream temperatures, reed canarygrass infestations, and reduced juvenile spawning and rearing habitat.

Many of the impacts of agriculture on salmon habitat described in BAS documents are the result of historic land use and management decisions and do not necessarily result from current agricultural practices. For example, pesticides and herbicides are not a concern from certified organic farms. The adoption of adequate stream buffers also limits adverse impacts of agriculture on habitat. In Washington State, farms can receive Salmon-Safe Certification if they adopt agricultural practices that protect fish habitat and water quality. More information on Salmon-Safe Certification can be found at www.salmonsafe.org.

Reclaiming Farmland

Pierce County staff and other stakeholders have discussed the possibility of reclaiming residential development in the Clear Creek area for farmland. Residential properties in the Clear Creek area that are susceptible to flooding have been targeted for acquisition by the county. In theory, reclaiming these properties for farmland would be a benefit to agriculture in the area because the scarcity of farmland is a limiting factor for agricultural viability. However, there are several challenges to reclaiming farmland, including soils, cost, ownership and lease structures, floodplain regulations, and food safety concerns. In 2004, the American Farmland Trust analyzed the possibility of reclaiming farmland from developed properties. The report suggests that reclaiming farmland would be difficult and expensive, but would be possible.

The American Farmland Trust report found that topsoil is typically removed from the site prior to development. If topsoil has not been removed, covering it with pavement and structures destroys the biological function of the soil. Therefore, reclaiming farmland from development may require the full replacement of topsoil. Development also tends to destroy the layer of soil underneath the topsoil, also known as the "B" horizon soil. The "B" horizon has little biological activity or nutrient value, but is typically not compacted and can be penetrated by plant roots. In Pierce County's river valleys, soil

depths (including topsoil and "B" horizon soils) can be 40 to 60 inches deep. On developed properties, "B" horizon soils typically have been heavily compacted by pavement, construction activities, structures, and human activities and are no longer tillable. Therefore, the soil needs to be extensively loosened before it can be reclaimed as farmland. Current technology only allows loosening of the soil to a depth of 20 to 24 inches, so the original depths of 40 to 60 inches cannot be reclaimed. While the original depths of 40 to 60 inches would be ideal, a 20- to 24-inch depth of "B" horizon soils would likely be sufficient for agriculture. However, the report concluded that loosening soil to a "farmable consistency" may not be possible (American Farmland Trust, 2004).

The American Farmland Trust study found that reclaiming farmland from development would require the following steps:

- Demolishing structures and their foundations.
- Breaking up pavement.
- Removing subsurface utilities.
- Removing debris.
- Backfilling and re-grading the land.
- Loosening soils.
- Replacing topsoil.
- Replacing structures needed for agricultural operations (e.g., barns, fencing, and farm buildings).

The study estimated the cost of some elements of farmland reclamation. For reclamation of 50 acres of single-family residential construction, the report estimated a cost of $3,781,250 (in 2004 dollars) for demolition and removal of debris, removal of driveway pavement, and removal of public roadways. Topsoil replacement for the same acreage was estimated to cost $4,033,000 (in 2004 dollars). The study did not estimate the cost of removal of subsurface utilities, restoration of agricultural drainage, or loosening of soil (American Farmland Trust, 2004). Residential development within the Clear Creek area is likely much less dense than the hypothetical 50 acres of single-family residential development considered in the American Farmland Trust analysis, but the same reclamation actions would be required.

The Clear Creek area is currently regulated as a floodway by Pierce County, which limits the construction of some types of structures. The limited ability to construct farm infrastructure would limit the agricultural viability of reclaimed properties. In particular, with the limited ability to construct farm infrastructure or homes on site, reclaimed farmland properties in the Clear Creek area would not be suitable for small farmers who rely on the ability to live on their farmland.

If reclaiming developed properties in the Clear Creek area were pursued, additional research on the potential for soil contamination from septic systems, other underground utilities, and household and automotive chemicals would be needed. Clear Creek area farmers have expressed concerns that development-related contamination could be a food safety concern or could threaten farmers' ability to achieve or maintain organic certification.

Chapter 6 Climate Change

One of the key findings of the *Agriculture Infrastructure Study for Pierce County* was that "weather is always the biggest challenge to production" (WSU et al., 2015). Farmers in the Clear Creek area are familiar with natural variability in weather, which presents a risk to agricultural operations each year. Under future climate change scenarios, many of the risks that come with natural variations in weather are predicted to increase. This chapter describes the observed trends, climate change projections, and the risks they present to agriculture for climate and weather, streamflows and flood risk, sea level rise, and sediment in the Puget Sound region and the Puyallup River Watershed.

Information in this chapter is primarily based on the 2015 report *State of Knowledge: Climate Change in Puget Sound* prepared by the Climate Impacts Group at the University of Washington (CIG, 2015b). The *State of Knowledge* report is available online at https://cig.uw.edu/resources/special-reports/ps-sok/.

Key effects of climate change in the Puget Sound region include:

- Warming temperatures.
- Variations in precipitation patterns.
- More frequent heavy rainfall events.
- Rising sea levels.
- Ocean acidification.
- Natural variability.

The Puyallup River Watershed is a "mixed rain and snow" watershed, with between 10 and 40 percent of precipitation in the basin falling as snow while the rest falls as rain (CIG, 2015b). The percentage of precipitation that falls as snow is so high because the headwaters or the rivers are on the heavily glaciated Mount Rainier. The portion of precipitation that falls as snow within a watershed is key to understanding projected changes to streamflows. Accumulated snowpack within a watershed effectively stores water through the winter until it starts to melt in the spring, shifting a portion of streamflow later in the year. The Puget Sound region as a whole is projected to see a decrease in snowpack and a shift from precipitation falling as snow to precipitation falling as rain. Mixed rain and snow watersheds are projected to see the largest changes in streamflows and flooding as they transition to "rain-based" watersheds (CIG, 2015b).

Climate change projections always carry uncertainty. The amount of greenhouse gas emissions that will occur in the future is not certain, and exactly how the climate will change in response to varying levels of emissions is also not certain. All climate projections are based on a range of greenhouse gas

emission scenarios and consider a range of projections. Typically, high, medium, and low scenarios are used to establish a range of projections (CIG, 2015b).

Climate and Weather

Observed Trends

Air temperature in the Puget Sound region has increased over the last century. Between 1980 and 2014, all but 6 years had higher temperatures than the 20th century average (CIG, 2015b). Temperature stations in Buckley and McMillan have recorded an average historical temperature increase of 0.6 degree and 1.11 degrees Fahrenheit over the period from 1895 to 2014, respectively (CIG, 2015a). From 1920 to 2014, the frost-free season in the Puget Sound has lengthened by 30 days. In addition, heavy rainfall events in western Washington have increased in both frequency and intensity (CIG, 2015b).

Projections

Precipitation is projected to decline in the summer months by an average of 22 percent by the 2050s. Heavy rainfall events in the winter (also known as atmospheric rivers or "Pineapple Express" events) are projected to increase as elevated air temperatures increase the amount of moisture in the air. Historically, heavy rainfall events have occurred 2 days per year. By the 2080s, heavy rainfall events are projected to occur about 8 days per year and to be 22 percent heavier on average (CIG, 2015b).

All climate change scenarios project that temperatures in the Puget Sound region will continue to increase throughout the 21st century. By the 2050s, air temperature is projected to rise to 4 to 6 degrees Fahrenheit higher than temperatures in the late 20th century. The freeze-free period for the Puyallup River Watershed is anticipated to increase by 14 to 30 days (CIG, 2015a).

Increased air temperature is projected to change the distribution, spring arrival dates, and life-cycle durations of pests. While no specific projections of impacts on agricultural pests are available, it is likely that increased air temperatures will lead to a mixture of increases and decreases in pest damage (CIG, 2015b). Increased air temperature is expected to cause production declines in some agricultural crops, but could be beneficial to other crops. Agriculture in western Washington is considered less vulnerable to climate change than in eastern Washington due to the availability of water, milder climate, and greater access to markets (CIG, 2015b).

Risks to Agriculture from Changes in Climate and Weather

Increasing air temperatures could be beneficial to some crops but are projected to cause declines in production of others. For example, raspberries grow best in climates with extended periods between 32 and 45 degrees Fahrenheit, and increased warm air temperatures during winter could result in lower yields (CIG, 2015b).

Lower summer precipitation may require more farms to irrigate, or to irrigate more than they currently do. At the same time, lower rainfall will lower streamflows, reducing the availability of surface water for irrigation.

Streamflows and Flood Risk

Observed Trends

Between the mid-20th century and 2006, spring snowpack levels in the Washington Cascades declined by about 25 percent. Due to decreased snowpack, peak spring river flows occur earlier in the year in many Puget Sound watersheds (CIG, 2015b).

Projections

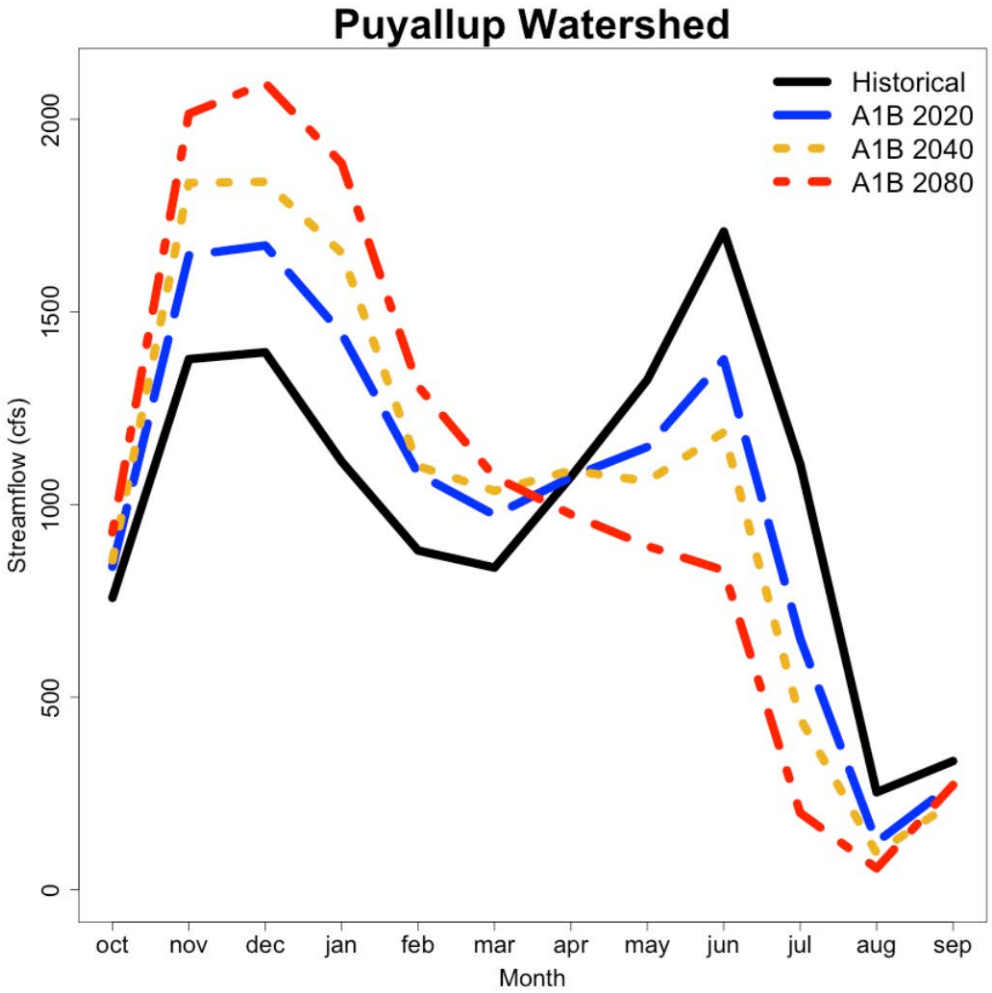
Some Puget Sound watersheds are projected to become increasingly rain-dominant, which will shift peak streamflow to earlier in the year. By the 2080s, peak spring streamflow is projected to occur 2 to 6 weeks earlier (CIG, 2015b). The depth of snowpack on April 1 (the approximate current timing of peak annual snowpack in Northwest mountains) in the Puyallup River Watershed is projected to decline between 52 and 58 percent by the 2050s. Winter streamflows in the Puyallup River are projected to increase by 27 to 34 percent by the 2050s, while summer streamflows are projected to decrease by 18 to 20 percent by the 2050s (CIG, 2015a). Natural variability will continue, and some years will be abnormally dry while others will be abnormally wet (CIG, 2015b). Decreased summer streamflows are projected to increase stream temperatures by about 4 degrees Fahrenheit by the 2080s (CIG, 2015b).

Flood risk is projected to increase in the Puyallup River Watershed and across Puget Sound. Peak river flows are projected to increase between 18 and 55 percent by the 2080s, and heavy rainfall events will become heavier (CIG, 2015b). Under a climate change prediction based on a moderate emissions scenario, the volume of the 100-year flood on the White River at Buckley is projected to increase by 22 to 115 percent over 1980s flood levels (CIG, 2015a). The volume of the 10-year flood in the Puyallup River is projected to increase by 12 to 85 percent by the 2080s (CIG, 2016). Increased flooding would increase the cost of flood protection and stormwater management. Highways and other roads adjacent to rivers would flood more frequently. Existing flood control infrastructure, such as levees and tide gates, would likely be less effective as more frequent and larger floods exceed the events the infrastructure was designed for (CIG, 2015b).

The municipal water supply for the City of Tacoma is projected to be largely unaffected by climate change. Assuming no change in demand, water supply reliability is projected to be 93 to 96 percent through the 2080s. However, water management is projected to be the most affected in "snow-dominated" watersheds where water conflicts already exist (CIG, 2015b).

Figure 6-1 shows the projected changes in the seasonality of streamflow in the Puyallup River Watershed at three dates in the future under a moderate-emission climate change scenario. The figure shows a projected decrease in spring/summer flows and an increase in winter flows.

Figure 6-1. Change in the Seasonality of Streamflow[1].



Source: CIG, 2015a.

[1] Graph shows monthly average runoff for the water year (October–September) for the 20th century (1916–2006, black line), the projected values for 2020s (2010–2039, blue line), the projected values for 2040s (2030–2059, gold line), and the projected values for 2080s (2070–2099, red line), all based on a medium (A1B) greenhouse gas scenario.

Risks to Agriculture from Changes in Streamflow and Flood Risk

Heavier rainfall events and increased flooding from climate change would present a range of risks to agricultural viability. Potential impacts would include:

- Climate change would make flooding worse, increasing the flood risk to agriculture. Flood-related impacts to agriculture that could increase with climate change include:
    - Floodwaters could damage farm infrastructure and threaten livestock.
    - Increased flooding would prevent farmers from accessing their fields during flood events.
    - More frequent flooding would be a significant problem for farmers growing perennial crops, which grow during the winter flood season.
    - Increased flooding could increase the inundation of agricultural fields from contaminated floodwaters, which could increase the risk to food safety and organic certification.
    - The projected increase in atmospheric river events could increase the number and severity of flooding and pose additional risk to farm operations.
- Increased streamflow in winter and spring would make it more difficult to drain agricultural fields.
- Decreased summer streamflows could reduce the availability of water for farmers who irrigate.

Sea Level Rise

Observed Trends

Sea level is rising at most locations in Puget Sound due to a combination of global factors (i.e., global glacier melt) and regional factors (such as ocean currents, wind patterns, and regional glacier melt). For example, sea levels rose 8.6 inches in Seattle between 1900 and 2008 (CIG, 2015b).

Projections

Sea level is projected to rise an additional 14 to 54 inches in the Puget Sound region by 2100, although changes at specific locations will vary. Sea level rise and reduced summer flows are projected to increase the risk of saltwater intrusion into groundwater, especially if groundwater extraction increases (CIG, 2015b).

Risks to Agriculture from Changes in Sea Level Rise

Sea level rise could slow the drainage of agricultural lands across Puget Sound by affecting the receding rates of floodwaters or runoff. Sea level rise could cause the saltwater wedge to extend farther up the Puyallup River, potentially reaching the Clear Creek area. If the Clear Creek area is opened to tidal influence, farms could be subject to inundation from saltwater. Sea level rise could also cause saltwater intrusion into groundwater in the area, affecting groundwater quality. Sea level rise could also increase the surface flow elevations of the Puyallup River, Clear Creek, and its tributaries.

Sediment

Observed Trends

Since 1984, the upper Puyallup River has aggraded (which means the streambed has risen) by 7.5 feet (CIG, 2015a). Aggradation rates in the lower Puyallup River have been slower, approximately 0.3 inch per year between 1985 and 2009 (Czuba, 2010).

Projections

Erosion and the transport of sediment from the upper Puyallup River Watershed are both expected to increase in the future as heavy rainfall causes increased erosion and sediment transport and as higher streamflows and larger floods transport more sediment downstream. Glacier retreat is also expected to increase sediment loads as new soil is uncovered. The Puyallup River Watershed is one of the two most glaciated basins in the Puget Sound region (along with the Skagit River Watershed), so the potential for new sediment transport generated from soils uncovered by glacier retreat is greater than in most other Puget Sound watersheds (CIG, 2015b).

Risks to Agriculture from Changes in Sediment

Increased sediment in the Puyallup River and in Clear Creek and its tributaries could cause additional channel aggradation. Aggradation of the Puyallup River could increase flood risk in the Clear Creek area and could raise groundwater levels because the carrying capacity of the river would be reduced. Furthermore, aggradation of Clear Creek could reduce drainage capacity in the basin.

Information Needs

- Future precipitation forecasting for the Puyallup River Watershed is based on statistical downscaling, which is not the most accurate method. Dynamic downscaling of predicted precipitation patterns would provide a more accurate forecast of heavy rainfall statistics.
- Precipitation projections could be translated into streamflow levels.
- There is no flood projection model for the Puyallup River Watershed or the Clear Creek area, but one could be developed. An example of a flood projection model for the Skagit River Watershed is available at http://www.skagitclimatescience.org/flood-scenario-map/.
- The implications of increased sediment transport from the tributaries of Clear Creek could be analyzed.
- Water availability in the summer during low flows under climate change scenarios could be analyzed.
- The impact of sea level rise on groundwater, particularly on salinity in groundwater, is unclear in the Clear Creek area.
- Existing information about how climate change could affect specific crops grown in the Clear Creek area could be reviewed.
- Sediment loading on the Puyallup River could be analyzed to project changes in the depositional and erosional environment in the Puyallup River near Clear Creek.

Chapter 7 Recommendations and Next Steps

This Existing Conditions Report is the product of Phase 1 of technical work for the FFP and will inform the technical work in Phase 2 (scheduled for August 2016 through June 2017). This chapter identifies recommended tasks that could be undertaken during Phase 2 to further the understanding of physical conditions in the Clear Creek area in the context of agricultural viability. Not all of these tasks can be accomplished in the second phase; some may be undertaken in future phases of work.

Conduct a Drainage Inventory

Farmers stated that drainage is the most critical limiting factor for agricultural viability in the Clear Creek area. As described in Chapter 4, the agricultural drainage system in the Clear Creek area suffers from deferred maintenance. Conducting an inventory of the drainage system would allow FFP stakeholders to identify actions that would best address drainage issues.

Drainage District 10, which includes the Clear Creek area, recently filled its three commissioner positions after being inactive for several years. The District is now planning actions to address the maintenance backlog and to improve drainage conditions. Drainage District 10 commissioners and members of the Floodplains for the Future Integrated Management Group are exploring potential solutions to drainage issues that would also be fish friendly or improve habitat conditions for fish. A drainage inventory would inform these actions. In addition, questions about the impacts of the proposed Clear Creek Floodplain Reconnection Project relate to how it would affect agricultural drainage. A clearer understanding of the existing drainage system would help address these questions.

Conducting an inventory of the agricultural drainage system in the Clear Creek area would largely be a field reconnaissance task to document the locations and current capacity of drainage ditches and culverts. The inventory could also include estimates of the capacity of drainage features if they were properly maintained. The inventory could also include a set of recommendations for next steps, such as the identification of both short- and long-term solutions for drainage issues in the area.

Analyze the Tide Gates

The tide gates located where Clear Creek enters the Puyallup River are a critical piece of the flood control infrastructure in the Clear Creek area. However, it is unclear whether the tide gates operate as designed during flood events. It is also possible that the tide gates inhibit agricultural drainage. The gates protect the Clear Creek area from backwater flooding from the Puyallup River, but also subject the area to backwater flooding from Clear Creek. In addition, the tide gates are a barrier to salmon habitat restoration in the Clear Creek area. Research, monitoring, observation, and modeling of the tide gates would increase understanding of how they function under current conditions and identify potential changes to the gates that could provide short-term or long-term solutions to the problems the gates present.

Analyze Flood Risk

As described in Chapter 4, flood risk in the Clear Creek area is complicated and not well understood by farmers and residents. In particular, the vulnerability of River Road Levee to overtopping or breaching during flood events is unclear to many residents of the area. To increase understanding of flood risk, FFP staff and consultants could work with Pierce County Surface Water Management to research existing information about flood risk in the area and update the flood risk section of this report.

Conduct Research on Climate Change

As described in Chapter 6, climate change will alter physical conditions in the Clear Creek area and could increase risk to agricultural viability. Climate change would also affect any flood risk reduction or habitat enhancement projects built in the area. Technical work could be done to develop an understanding of climate change projections specific to the Clear Creek area. Regional precipitation projections could be adjusted to be representative of conditions in the Clear Creek area. It would also be possible to work with regional climate experts at the University of Washington Climate Impacts Group to further develop the climate change analysis in Chapter 6 of this report.

Developing other climate change projections for the Clear Creek area would require the creation of a hydrologic or hydrodynamic model. If such a model were created, it would be possible to extrapolate localized precipitation projections into streamflows and flood elevations. Summer low flows and sediment transport from the tributaries of Clear Creek could also be projected.

Evaluate Upstream Impacts

Throughout the first phase of the FFP, residents of the Clear Creek area asked how development in upstream areas of the Clear Creek Basin has affected flooding, drainage, and sediment conditions in the Clear Creek area. To explore this issue, it is possible to evaluate historic and current aerial imagery to estimate the increase in impervious surface and stormwater runoff. Research on how stormwater regulations mitigate the downstream impacts of development would add valuable context.

Analyze Impacts from the Reconnection Project

The proposed Clear Creek Floodplain Reconnection Project would cause major changes to physical conditions in the Clear Creek area, and its potential effects on agricultural viability are unclear at this point. Because the project is conceptual and there is no defined project footprint or design, it is not possible at this time to run hydraulic or other models to analyze the project impacts. However, potential impacts still need to be identified. A qualitative analysis of the farmland impacts from the proposed Clear Creek Floodplain Reconnection Project, focusing on the physical conditions described in Chapter 4 of this report, would help clarify the potential impacts.

Explore Formation of a Watershed Improvement District

As described in Chapter 4, the basin is closed to new water rights. However, other options relating to water supply in the Clear Creek area could be explored, including the formation of a Watershed Improvement District, which could potentially allow for downstream transfer of surface water.

Continue Collaboration with the Technical Advisory Group

In the first phase of the FFP, PCC Farmland Trust formed the TAG, made up of local farmers, staff of local organizations and entities, and regional technical experts. By the end of Phase 1, the TAG will have met three times. Over the course of Phase 1, the TAG has been a valuable resource for the FFP as a venue for open discussions among interested parties in the Clear Creek area. It would be beneficial for the TAG continue to meet throughout future phases of the project.

Throughout Phase 1, the TAG was the only venue for conversations about the proposed Clear Creek Floodplain Reconnection Project at a project-level scale (as opposed to the basin-wide scale approach of the Floodplains for the Future Integrated Management Group). At times, the TAG meetings hosted discussions about aspects of the reconnection project that are not directly related to agricultural viability. For the TAG to function as intended as part of the FFP, it would help to create a separate venue for discussion of the proposed Clear Creek Floodplain Reconnection Project.

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Appendix A Technical Advisory Group Meeting Reports

To solicit input on this report, on future phases of technical work, and on the FFP in general, a Technical Advisory Group (TAG) was formed. The TAG met in April, June, and July 2016. Members of the TAG include farmers in the Clear Creek area, a representative of Drainage District 10, staff of local organizations and entities (including the Pierce County Agricultural Program, Pierce County Surface Water Management, the Pierce Conservation District, and PCC Farmland Trust), the Puyallup Tribe of Indians, the Muckleshoot Indian Tribe, the King-Pierce Farm Bureau, and regional technical experts from the Puget Sound Partnership, the U.S. Geological Survey, and the University of Washington Climate Impacts Group. The TAG provided input on existing information sources for the Clear Creek area, information needs, agricultural viability, and recommendations and next steps. Input from the TAG is incorporated throughout this report. This appendix includes meeting reports summarizing the TAG meetings held in April, June, and July 2016.

Technical Advisory Group Meeting #1
Meeting Report

April 5, 2016, Puyallup Library

The first meeting of the Technical Advisory Group (TAG) for the Farming in the Floodplain Project (FFP) was held on April 5, 2016 at the Puyallup Library. About 25 people participated, including Clear Creek area farmers, Pierce County staff, Farming in the Floodplain Project staff, and regional technical experts. The meeting was led by PCC Farmland Trust and by ESA, the technical contractors working on the project.

Topics discussed at the meeting included the purpose and structure of the FFP; agriculture in the Clear Creek area; agricultural viability; concerns, opportunities, and information needs in the Clear Creek area; and observed trends and projections in the Puget Sound area and the Puyallup Watershed.

Members of the newly-formed Clear Creek Farmers Collective (CCFC) presented information on their collective and its position on the Farming in the Floodplain Project and on Pierce County's proposed Clear Creek levee project. The CCFC represents 21 farmers and residents who own approximately 212 acres of land and who do not want to sell their property to the County. CCFC members presented a list of requests for the technical work in the FFP, including:

- a redesign of the proposed Clear Creek levee project that would not include any of the farmland owned by members of the CCFC;
- an evaluation of drainage patterns and ditches in the Clear Creek area;
- an analysis of the status of the existing tidegates at the mouth of Clear Creek;
- preliminary research needed to establish water rights for farms in the area; and
- assistance in reaching a compromise allowing for the construction of agriculturally-specific and flood-conscious structures in the Clear Creek area.

Information, questions, and conversations at the TAG meeting will be used by ESA to inform an Existing Conditions Report. Ideas for future technical work, including those presented by the Clear Creek Farmers Collective, will be used to develop the scope of work for the next phase of technical analysis scheduled to begin in August 2016.

Discussions at the TAG meeting are summarized below.

Agricultural Viability

The TAG discussed how agricultural viability should be defined and what the critical components of agricultural viability are.

TAG members explained that farmers deal in **risks**. In any given year, some crops work out and others don't. Farmers need to determine the acceptable level of risk and what their threshold is. Farmers in Clear Creek feel that they already have enough risks to manage.

In the Clear Creek area, **water** is a critical component of agricultural viability. Farms in Clear Creek are viable in part because they have so much water. A high water table is a benefit for some farmers because they need less irrigation. However, excessive water causes flooding and drainage issues, both of which detract from agricultural viability.

Flooding is particularly damaging to farms planting perennials. For farms that do not plant perennials, flooding doesn't necessarily affect farming in the off-season. But flooding can damage farm infrastructure, such as barns. And flooding can keep farmers from getting back onto their fields if the water doesn't recede quickly enough. Farmers at the TAG meeting stated that there is a big difference between being flooded and being wet due to poor drainage conditions. TAG members felt that they can cope with current flooding conditions from Clear Creek, but are concerned that opening the area to floodwaters from the Puyallup River could cause their farms to be inundated by more water more frequently. In the Clear Creek area, agricultural viability also depends on the tide gates being properly maintained and functioning.

TAG members were clear that **drainage** is currently one of the main limiting factors for agricultural viability in the Clear Creek area. Poor drainage keeps certain fields in the Clear Creek area from being planted at all. In other fields, poor drainage can lead to conditions that are too wet to plant cover crops, which reduce the amount of sediment moving into the drainage system, help absorb winter rains, and improve soil fertility. The intrusion of reed canary grass and lack of maintenance are two of the main factors causing drainage problems in the area. To address drainage problems, farmers in the Clear Creek area need Drainage District 10 to be well supported and to have the ability to get permits for their maintenance activities. Increased runoff from upstream areas due to development has also contributed to drainage problems.

Lack of farmland is another limiting factor for agricultural viability in the Clear Creek area. Having small parcels available in farm areas is key for allowing farmers to expand their farms. Farms in the area are shrinking because of development. TAG members said that there is no minimum parcel size for farming – it depends on the farmer and their techniques. Being located adjacent to other farms allows for resource and information sharing, among other benefits for agricultural viability. Transportation access to leased fields is also an important factor.

Soils are a critical factor in agricultural viability. The Clear Creek area has world class soil. Other factors important to agricultural viability include an ability to build farm structures, proximity to markets, being located in a safe community, and having the ability to own land. The ability to irrigate greatly enhances

agricultural viability. Lack of water rights and reliance on wells are limiting factors for many farms in the Clear Creek area.

Opportunities and Information Needs

TAG members identified several opportunities for projects in the Clear Creek area. Designing a flood risk reduction and habitat enhancement project that preserves farmland in the area presents an opportunity to create a habitat area that connects the public with habitat and with local farms. It would be an opportunity to highlight Pierce County as an agricultural district in Washington. TAG members also saw an opportunity for this process to lead to better dialog between Pierce County and the farm community.

The group discussed questions and information needs for the Clear Creek area. Questions raised include:

- How frequently did Drainage District 10 use to dredge the ditches?
- How do the tide gates work? How should they work? Who owns them and who is responsible for them? How were the gates working during different flood events?
- How often is the river high enough to raise or lower the tide gates?
- What are the flooding scenarios with properly functioning tide gates and with gates removed? How would different culvert sizes affect these scenarios?
- Is there a way to make the tide gates fish friendly?
- Is there a way to alleviate runoff from the developments upstream of the Clear Creek area? Can the quantity of hardscaping upstream and the amount of surface water discharge it causes be quantified? Are there projects that could be done upstream to reduce stormwater? Has any research been done on adding storage upstream?
- What are the limits of the existing hydrologic and hydraulic modeling? What more needs to be done to understand the system?
- How many floodgates would be needed on a levee constructed in the area? What would be required for maintenance?
- What is the current capacity of the channel? What do we need to plan for when considering future sediment and gravel conditions? How much gravel do we expect to see coming down the river? How does that impact the prospects for a levee project in the area? Is there any dredging planned?
- Will the Canyon Road project add more surface water runoff to the Clear Creek area? How will that project's impacts be mitigated?
- What were the historic sediment maintenance practices in the area? What are the current practices? What is needed to manage the existing sediment conditions? What are the sediment sources?
- Will future sediment deposits and floodwaters carry a greater risk of toxicity on farm fields? Could they threaten the organic certification of farms? Will there be food safety concerns?
- What would the weight of an earthen levee be? What would it do to the groundwater table? How would that affect flow and drainage?

- Could the drainage district expand or change the route of its ditches? What permits would that require?
- What habitat areas already exist in the Clear Creek area? How much habitat is needed?
- Is there any Pierce County fund that could be used to provide assistance to the drainage district?
- How safe is the River Road levee? If another levee is constructed in the Clear Creek area, many farmers and residents would be between the two levees. What would happen if one overtopped? More information is needed about the flood risk. There has been mixed messaging from the county on this topic.
- Why are flood regulations different in Fife than in the Clear Creek area?
- How would the height of the proposed Clear Creek levee be affected by climate change projects?
- Could some of Drainage District 10's water be diverted to Clarks Creek to alleviate some of the drainage pressure in Clear Creek?

Existing Conditions Report

ESA provided information on what will be included in the Existing Conditions Report (ECR). The report will be available in July. TAG members suggested that the ECR could also include information on economics and historic information. The ECR could discuss groundwater, including past versus current conditions and changes in groundwater levels. TAG members were also interested in information about the type of agriculture going on and how it affects drainage.

Trends and Projections

Guillaume Mauger of the Climate Impacts Group at the University of Washington presented information on observed trends and projections in the Puget Sound region and Puyallup Watershed. Key points from the presentation and discussion included:

- Temperature and precipitation in the Puget Sound region both vary annually. There is an upward trend in temperature but not in precipitation.
- Projected conditions that would increase flooding in the area include sea level rise, heavier rainfall events, and reduced snowpack.
- Sea level rise will move the saltwater wedge up the Puyallup system. Sea level rise will also make it harder for the system to drain.
- Sediment moves into the river system during heavy rainfall events. More heavy rainfall events are anticipated, so the system is projected to move more sediment. Sea level rise will make it harder to flush that sediment out of the system.
- Lower summer flows and higher winter flows are predicted. Lower summer flows will cause the water temperature in the river to be higher.
- Pineapple express events are the most risky for Clear Creek farmers.
- A TAG member mentioned that the Puyallup system didn't have the same groundwater problems that other watersheds in Western Washington had during the 2015 drought.

Technical Advisory Group Meeting #2
Meeting Report

June 6, 2016
Puyallup Library

The second meeting of the Technical Advisory Group (TAG) for the Farming in the Floodplain Project (FFP) was held on June 6, 2016 at the Puyallup Library. About 25 people participated, including Clear Creek area farmers and residents, a Drainage District 10 commissioner, Pierce County staff, Farming in the Floodplain Project staff, and regional technical experts. The meeting was led by PCC Farmland Trust and by ESA, the technical contractors working on the project.

Topics discussed at the meeting included flood modeling done for the proposed Clear Creek Floodplain Reconnection Project; the definition of agricultural viability; and potential work plan elements for future phases of technical work on the FFP. Discussions at the meeting are summarized below.

Flood Modeling

Chris Long and Sam Gould of Northwest Hydraulics Consultants (NHC) presented information on the Clear Creek floodplain reconnection modeling NHC performed for Pierce County Surface Water Management (SWM). NHC's role was to investigate the flooding impacts of the proposed Clear Creek Floodplain Reconnection Project at a feasibility level, focusing on large flood events. The model did not take into account the agricultural drainage system in the Clear Creek area. The model was based on the 2002 flood insurance study model build by FEMA, which NHC updated based on tide and precipitation data through 2012 and elevation data from 2010.

The model elevated three scenarios for floodplain storage (existing conditions, a levee built along the 14-foot contour, and a levee build along the 18-foot contour) and four scenarios for the outlet of Clear Creek (the existing culverts, two open culverts, one slide-gate culvert, and an open bridge) for a total of 12 scenarios. The modeling showed that flood elevations would be similar between existing conditions and the 18-foot levee under all four outlet scenarios, but the 10-year, 50-year, and 100-year flood stages would vary between the four outlet scenarios. For example, the 10-year flood stage would be up to 2 feet higher than existing conditions if there were two open culverts or an open span bridge. Water surface elevations would be higher than existing conditions with a 14-foot ring levee. For example, with the existing outlet, the water surface elevation would increase by approximately 2 feet with a 14-foot ring levee. NHC said that future modeling would include consideration of the culverts under Gay Road and would evaluate the velocity of water at the outlet of Clear Creek.

Following NHC's presentation, TAG members discussed and asked questions about the model. Questions included:

- How would areas outside of the levee footprint drain through the levee? This was not covered by the model.
- Does the modeling examine whether the tide gates are large enough? Do we know why they are six feet wide?
- How wide was the modeled bridge opening?
- Does the model tell us what the durations of peak flows would be?
- How would a well maintained drainage system affect these results? The model looked at large flood events and assumed that the drainage system was well maintained and functioning properly.
- Would it be possible to look at climate change projects in this model? NHC said it is possible, but it would make the model more complicated.
- Would a ring levee containing a smaller area than the 14-foot levee have enough storage capacity to hold floodwaters?

A Clear Creek area farmer stated that many farmers in the area are living and farming between the 14 and 18 foot contours. They are most interested in the 5- or 10-year flood stage, and the results of the modeling show that without the tide gates they will see water above 17 feet more frequently. It would be helpful to know how frequently and for what duration the fields would be underwater. NHC said that information exists in the model, but the model is not geared to speak well to smaller events so their confidence in those results is low. Another Clear Creek resident said that members of the Clear Creek Farmers Collective are concerned about saturation of soils on the outside of the levee and how long it would take that soil to dry out.

Video of NHC's presentation is available online at http://farmingintheﬂoodplain.org/resources/.

Agricultural Viability

ESA staff presented a draft definition of agricultural viability. Agricultural viability can be defined as the ability of a farmer or group of farmers to:

- productively farm on a given piece of land or in a specific area,
- maintain an economically viable farm business,
- keep the land in agriculture long-term, and
- steward the land so it will remain productive into the future.

TAG members commented that regulations, access to farmland, and affordability of farmland are important factors of agricultural viability.

Potential Future Work Plan Elements

ESA staff presented a list of potential future work plan elements for the FFP. This work could be done in Phase 2 of the FFP or in the future. The potential future work plan elements presented were:

- Inventory of the drainage system in the Clear Creek area. Including:
    - Mapping of owned parcels, easement, creeks, drainage ditches and structures, and culverts
    - Current capacity of drainage features
    - Capacity if property maintained
    - Recommendations for short- and long-term solutions
- Analysis of tide gates
    - Research on how tide gates work currently and how they have worked in the past
    - Monitoring and observation of gates under various conditions
    - Modeling of current gate operations and of potential alternative operations
- Flood risk analysis
    - Research on vulnerability of River Road Levee to overtopping and breaching
    - Develop climate change prediction information specific to the area
        - Precipitation data
        - Sea level rise
        - Sediment
        - Salinity in groundwater
- Analysis of stormwater, runoff, and sediment from upstream areas of the Clear Creek Basin
- Findings and Recommendations Report
    - Conclusions, recommendations, and next steps from other technical work in Phase 2
    - Analyze what the findings tell us about various proposals for the Clear Creek area
    - Qualitative analysis of farmland impacts from the proposed Clear Creek Floodplain Reconnection Project

TAG members discussed the proposed future work plan elements. Comments and questions included:

- Will the drainage inventory look at historic information about design assumptions?
- It would be interesting to know how much volume of streamflow is projected to increase with upstream development.
- The tide gate analysis should research fish friendly tide gates.
- The Corps of Engineers has a geotechnical analysis report that should help inform the flood risk research.
- The upstream impacts analysis is important to help Clear Creek area residents understand whether trends will continue.
- How would sediment affect the proposed Clear Creek Floodplain Reconnection Project levee? Would the effectiveness of that levee decline due to sediment?

- Clear Creek area residents are worried about unknown impacts from the Clear Creek Floodplain Reconnection Project. The analysis of farmland impacts from the project should help farmers in the area understand what impact the project would have on their livelihoods.
- The Phase 2 work should include looking at ideas from other jurisdictions and what they are doing to address similar issues.
- Issues about climate change could be bigger than the scope of the FFP and should be tackled elsewhere.
- Would having the proposed Clear Creek Floodplain Reconnection Project make flood damages from overtopping of River Road Levee better or worse?
- Is research of River Road Levee the highest priority?
- For several meeting participants, technical work that would help Drainage District 10 is the highest priority.
- The drainage inventory should help the District prioritize the worst problem areas with their limited funding.
- It would be helpful to know what the options are for getting water through a proposed levee to drain the area outside of the levee. What has been done in other places?
- Getting data on the frequency and duration of flooding events from the NHC model would be helpful for the analysis of farmland impacts.

Technical Advisory Group Meeting #3
Meeting Report

July 12th, 2016
Puyallup Library

The third meeting of the Technical Advisory Group (TAG) for the Farming in the Floodplain Project (FFP) was held on July 12th, 2016 at the Puyallup Library. About 23 people participated, including Clear Creek area farmers and residents, Pierce County staff, Farming in the Floodplain Project staff, and regional technical experts. The meeting was led by PCC Farmland Trust and by ESA, the technical contractors working on the project.

Attendees discussed the public draft of the Existing Conditions Report and the plan for Phase 2 Scope of Work and heard an update on the Floodplains by Design 3 Grant Application. Discussions are summarized below.

Existing Conditions Report:

ESA staff presented key findings from the public draft of the Existing Conditions Report (ECR). The ECR examines trends in physical conditions and their relationship to agriculture in three overlapping study areas: the Puyallup Watershed, the Clear Creek Basin, and the Clear Creek area. The ECR discusses agricultural viability, basin settings, water resources, climate change, and the integration of agriculture into floodplain projects. It uses the framework of "risk" to address these issues, and concludes with recommendations and next steps for meeting information needs and conducting research in the coming years. Feedback from the Clear Creek community and FFP partners will be incorporated into a final draft.

ESA developed an interactive web map to view some of the figures and data from the ECR. This map is available at: http://arcg.is/29zQVMi

Key findings from the ECR include:

- Agriculture in Clear Creek reflects the trends in agriculture in Pierce County as a whole. Agriculture in the county is shifting from large wholesale farms to smaller direct market farms. The shift is caused by urbanization and fragmentation of the land base but is also made possible by the favorable climate and soil in the county. Clear Creek has both larger, wholesale farms and smaller, direct-market farms. The agriculture in the Clear Creek area is the type of agriculture that is starting to thrive in the county.
- The ECR presents **risks** rather than **thresholds**. Conditions are so varied between farms that identifying specific, quantified thresholds for those physical conditions under which farms would

no longer be viable is not possible or useful. Farmers in the area explained that they deal in risks (such as weather, flooding, and market conditions). Farmers in the Clear Creek area experience a range of risks, and future conditions are anticipated to increase these risks, introduce new risks, and in some cases lessen risks. The ECR presents current and projected risks, actions to increase or decrease risk, and areas where more information is needed.

- Flood risk in the area is complicated and not well understood outside of the Pierce County Surface Water Management department. In the area, there is a limited understanding of the performance and function of tide gates and levees, flood risk from Clear Creek and tributaries and the effect of aggradation on flood risk, among other issues.
- Drainage is the biggest limiting factor for agriculture in the area at this time. Farmers expressed that there is a difference between being flooded and being wet. Flooding recedes after a relatively short period of time, but drainage problems last for extended periods. Poor drainage can keep cover crops from being planted or limit access to a field. Drainage ditches in the area are hindered by intrusion of reed canary grass, accumulation of sediment and lack of maintenance. Drainage District 10 has recently been reactivated and is beginning to address these problems. Increased runoff from development in upstream basin may also be contributing to drainage issues.
- Sediment is a concern for drainage and will likely be a bigger concern in the future. The Puyallup River is the third largest contributor of sediment to Puget Sound. Portions of the Puyallup River are experiencing severe aggradation. Aggradation increases flooding risk and can exacerbate drainage problems. Glacier retreat on Mt. Rainier could increase sediment load in the river.
- Climate Change represents many risks to agriculture in Clear Creek. Direct impacts to agriculture from changes in air temperature and the freeze-free period are anticipated to be neutral or positive. However, precipitation is projected to decline while occurrence of winter heavy rainfall events are expected to increase. Drainage problems could increase due to sea level rise. Climate change information tailored to the Clear Creek area is limited.
- Reclaiming residential development for farmland would be complicated and expensive but is possible. Top soil is removed prior to development, therefore, reclaiming land would require full replacement of topsoil and remaining soil would need to be loosened. A 2004 report by American Farmland Trust estimated costs for 50 acres of reclamation (in Pierce County) at $4 million for demolition and another $4 million to replace topsoil. This cost is not inclusive of all work that would be needed to reclaim farmland. Additional research on potential soil contamination would also be needed.

<u>ECR Discussion</u>

TAG members discussed the draft ECR. Comments and questions included:

- Clear Creek farmers and landowners felt the ECR was representative of their concerns, questions, and interests.
- TAG members asked why the report didn't include more information on the co-existence of habitat projects and farming. ESA staff explained that relevant examples were very limited.

- TAG members discussed concerns about sediment, including the effects of climate change on sediment.
- TAG members discussed whether aggradation within the proposed levee could present drainage issues throughout the Clear Creek Area.
- One TAG member expressed concerns that the ECR presents speculative statements as conclusions.
- One TAG member asked how the report will inform the Clear Creek Floodplain Reconnection Project. Hans Hunger (Pierce County SWM) said the report will help SWM identify questions that still need to be answered as part of the project design process.
- One TAG member expressed interest for greater analysis and monitoring of groundwater.
- A Clear Creek farmer said the ECR should include a discussion of water quality risks from field contamination by industrial pollutants during flood events. This is particularly a concern for farmers whose farms are Certified Organic. Flooding can trigger additional testing from certifiers, the costs of which are carried by the farmer.
- TAG members discussed the recommendation in the ECR to have a separate forum for discussion of the Clear Creek Floodplain Reconnection Project. There is an identified need for more discussion space to address issues broader than agriculture and to discuss Clear Creek project designs. Conversations between Surface Water Management, the Floodplains for the Future Integrated Management Group, and TAG members will continue around this subject.

<u>Phase 2 Scope of Work</u>

ESA staff presented the proposed tasks to be completed under the Phase 2 Scope of Work. Proposed tasks include:

1. **Drainage System Inventory**. This would be a field reconnaissance task, gathering info on the locations, capacity and conditions of drainage ditches and culverts. It would include identification of barriers to maintenance and recommended next steps. Deliverables would include a map folio.
2. **Tide Gates Analysis**. ESA would conduct research on how the tide gates work currently and how they have worked in the past. Depending on existing information, this may include potential monitoring and observation of the tide gates. ESA would model current gate operations and potential alternative operations (new gates, modified gates, modified operations).
3. **Flood Risk Research**. This task would include research and coordination with SWM to increase understanding of flood risk in the Clear Creek area. The research would have a particular focus on the vulnerability of River Road levee to overtopping or breaching.
4. **Sediment Research**. ESA would facilitate a TAG meeting in the fall or winter to discuss sediment and would produce a memo updating the ECR with additional sediment information.
5. **Stormwater Analysis**. This task would include an analysis of historic and current aerial imagery to estimate the increase in impervious surface and storm water runoff from upstream areas in the Clear Creek basin.

6. **Farmland Impacts Analysis**. ESA would conduct a semi-quantitative analysis of farmland impacts from the proposed Clear Creek Floodplain Reconnection Project. The analysis would focus on changes to flood risk, groundwater, drainage, sediment, and water quality as they relate to farmland. The analysis would include impacts to potential farmland on the wet side of the proposed levee as well as impacts to the dry side of proposed levee.
7. **Findings and recommendations report**. ESA would develop a report synthesizing conclusion and recommendations from tasks 1 through 6.
8. **Technical Advisory Group**. PCC Farmland Trust and ESA would continue to hold meetings of the TAG (3 to 4 meetings, with the next meeting in late Fall).
9. **Coordination with Landowner Engagement**.
10. **Coordination with PCC Farmland Trust**.

Clear Creek Farmer Update

Clear Creek farmers gave their response to the proposed Phase 2 scope. One Clear Creek farmer expressed that the Phase 2 scope addresses many of the key questions identified in the ECR. Clear Creek farmers said they appreciated the work done by the Farming in the Floodplain Project to understand the needs of farmers in the area. Farmers emphasized the importance of soil types in understanding how individual farms react to different flooding and drainage conditions. Clear Creek area farmers encouraged TAG members to visit their farms and see the current conditions. This has been an excellent production year for many farmers in the area. Farmers expressed concern that building a levee through the farm ecosystem could have negative impacts on the drainage and beneficial water table of the area's prime soils.

Discussion of Phase 2 Scope of Work

The discussion of the Phase 2 Scope was opened up to all TAG members. Issues discussed included:

- Coordination between ESA and Pierce County SWM on Task 6, particularly on which conceptual levee alignments would be analyzed
- Potential future groundwater monitoring
- How the recent culvert legal decision might affect project options
- How the Phase 2 scope relates to the information needs identified in the ECR
- How ESA's technical work will be coordinated with SWM's flood model

Floodplains by Design Round 3 Grant Application

Jacob Pederson, the Puyallup Floodplain Reconnections Project Coordinator, presented an update on the Floodplains by Design Round 3 grant application. The application was submitted on July 1. The application requests a total budget of $15.5 million, a 50 percent increase over the current round of funding. The current Puyallup Floodplains by Design grant (round 2) is funded at $9.8 million.

Major components of the grant application include:

- Capital improvement projects, including acquisition, design, and construction. There are 17 identified projects throughout the watershed. Acquisitions would not include any currently farmed properties.
- Agricultural conservation easements.
- The Farming in the Floodplain Project, including continued work in the Clear Creek area, work in other areas proposed for capital improvement projects, a regional workshop, and precipitation modeling.
- A basin-wide monitoring project.

Next TAG Meeting

The next TAG meeting will be held in the late fall or winter.

Appendix B Habitat Impacts from Agriculture

Table B-1 first describes the types of impacts in each category (water quality, hydrology, and habitat) and the types of agricultural activities most likely to cause each type of impact.

Best available science (BAS) references for Table B-1 include additional BAS reviews and guidance documents, including the Whatcom County Critical Areas Ordinance – Best Available Science Review and Recommendations for Code Update (Whatcom County, 2005), and Pierce Conservation District (PCD) *Tips on Land & Water Management for Puget Sound Rural Living* (2013). While the Whatcom County BAS document was prepared for Whatcom County, it is based on available science that applies to the Puget Sound region as a whole, including the Puyallup River Watershed.

Table B-1. Types of Potential Impacts from Agricultural Activities

Type of Impact	Agricultural Activities Potentially Resulting in Impact	Areas Affected			References
		Wetlands	Floodplains	Streams	
Water Quality					
Increased sediment in surface runoff.	Tilling Grading	X		X	Sheldon et al., 2005 GEI, 2005
Pesticides and herbicides in surface runoff, erosion, subsurface drains, groundwater leaching, or airborne spray drift.	Pesticide, herbicide application	X		X	Cornell, 2012 GEI, 2005
Excess nutrients in surface water or groundwater; potential eutrophication of wetlands (excess algal blooms and reduced oxygen in the water).	Fertilizers Runoff of animal waste	X		X	USGS, 2013 Burkart and Stoner, 2007 Smolders et al., 2007 GEI, 2005
Reduced opportunity for floodplain to provide water quality improvement functions due to faster surface water flow.	Channelizing streams in floodplain areas		X		Whatcom County, 2005
Hydrology					
Changes in amount or timing of water within or feeding existing wetlands through modification of hydrologic regime or topography.	Irrigation Tilling	X			Sheldon et al., 2005
Reduction in floodplain capacity to store water.	Filling for flood-proofing		X		Whatcom County, 2005 PCD, 2013
Increased surface runoff and reduced infiltration.	Paving Soil compaction Expansion or new (additional) agricultural structures			X	Whatcom County, 2005

Type of Impact	Agricultural Activities Potentially Resulting in Impact	Areas Affected			References
		Wetlands	Floodplains	Streams	
Restricted movement of water through floodplain areas.	Constructing barriers (levees, embankments, bridges, culverts, walls)		X		Whatcom County, 2005
Fish and Wildlife Habitat					
Removal or fragmentation of wildlife habitat.	Clearing of native vegetation	X		X	Sheldon et al., 2005
Conversion of wetlands to fields or pasture.	Tilling Filling Draining Removal of wetland vegetation	X		X	Sheldon et al., 2005
Changes to the vegetation structure of riparian wetlands.	Livestock grazing	X		X	Sheldon et al., 2005 PCD, 2013
Harm to aquatic species (e.g., amphibians) due to degradation of water quality.	Pesticide, herbicide application Fertilizers Runoff of animal waste	X		X	De Solla et al., 2002 Zedler, 2003
Spread of nonnative invasive plant species (e.g., reed canarygrass, purple loosestrife) that can outcompete native plants and degrade wildlife habitat.	Runoff from fields containing weeds Wheels from mechanized farm equipment transport weed seeds from infested areas to areas of native vegetation	X	X	X	Sheldon et al., 2005 Zedler, 2003 Pierce County Noxious Weed Control Board website
Degradation of fish and wildlife habitat in floodplains.	Channelizing streams		X	X	Whatcom County, 2005
Restricted movement of fish and wildlife, along with sediment and wood that help to form habitat features.	Constructing barriers (levees, embankments, bridges, culverts, walls)		X	X	Whatcom County, 2005