# Chapter VII
# Reach Summaries

The following Reach Summaries characterize existing farming and infrastructure, projected impacts to agricultural viability, and prioritized resilience needs for eleven reaches within the Stillaguamish and Snohomish River floodplains (Figures VII-1 and VII-2 below). Through a robust community engagement process, farmers first learned about projected changes to flooding, groundwater, land subsidence and weather. Over 75 local farmers engaged in this process whereby they identified priority actions needed to ensure agricultural resilience into the future. Within each reach summary, the Resilience Needs section represents the primary needs identified by the farmers and categorizes them into tier one and tier two to guide implementation efforts.

The Steering Committee recommends an adaptive, county-wide approach to implementing these needs using criteria that includes likelihood of success, cost-benefit, availability of funding, and benefit to county-wide agriculture.

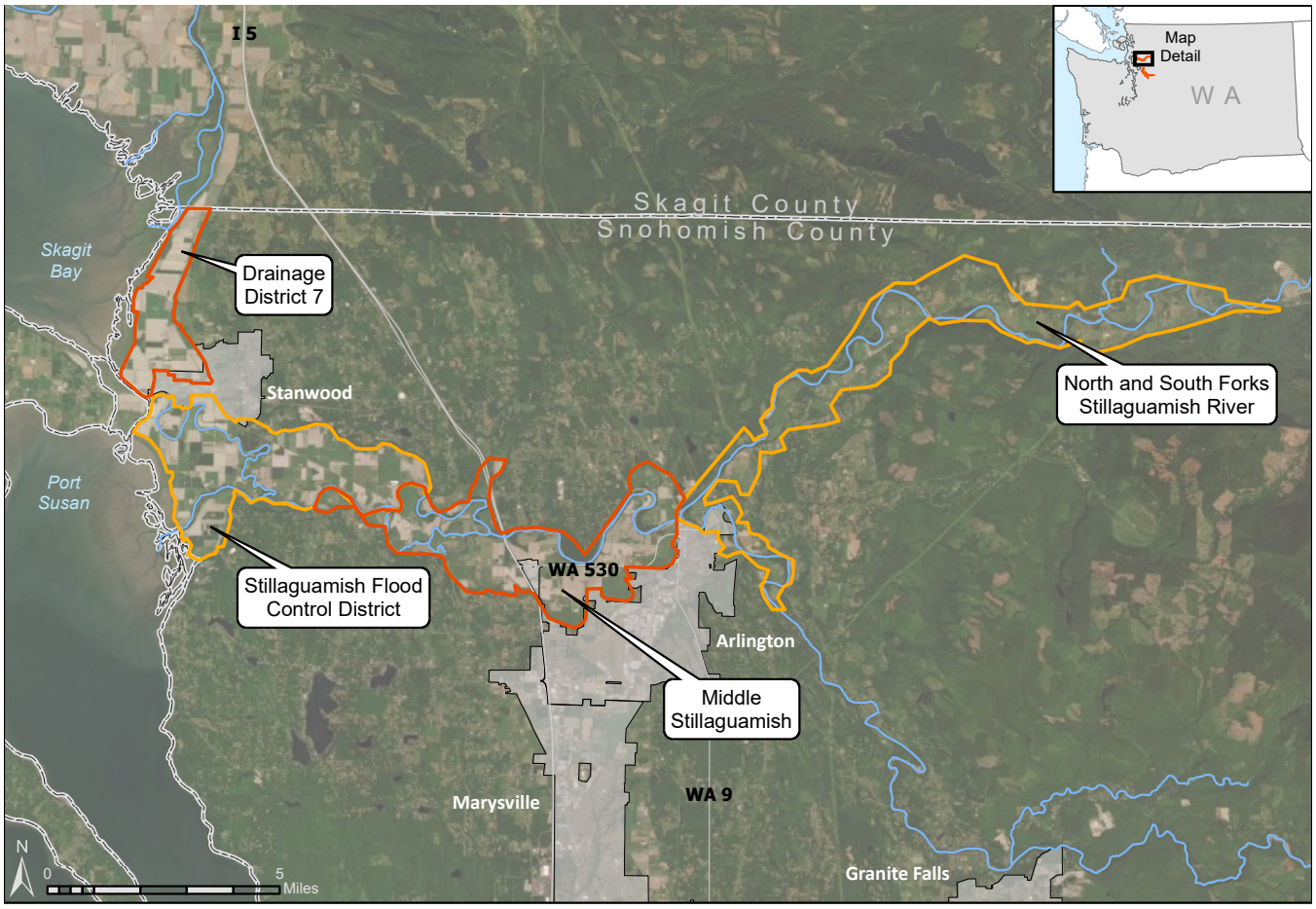


**Figure VII-1. Stillaguamish River floodplain reaches.** Four sections of the floodplain were delineated based on drainage and flood control district boundaries, floodplain dynamics, and agricultural resilience needs.

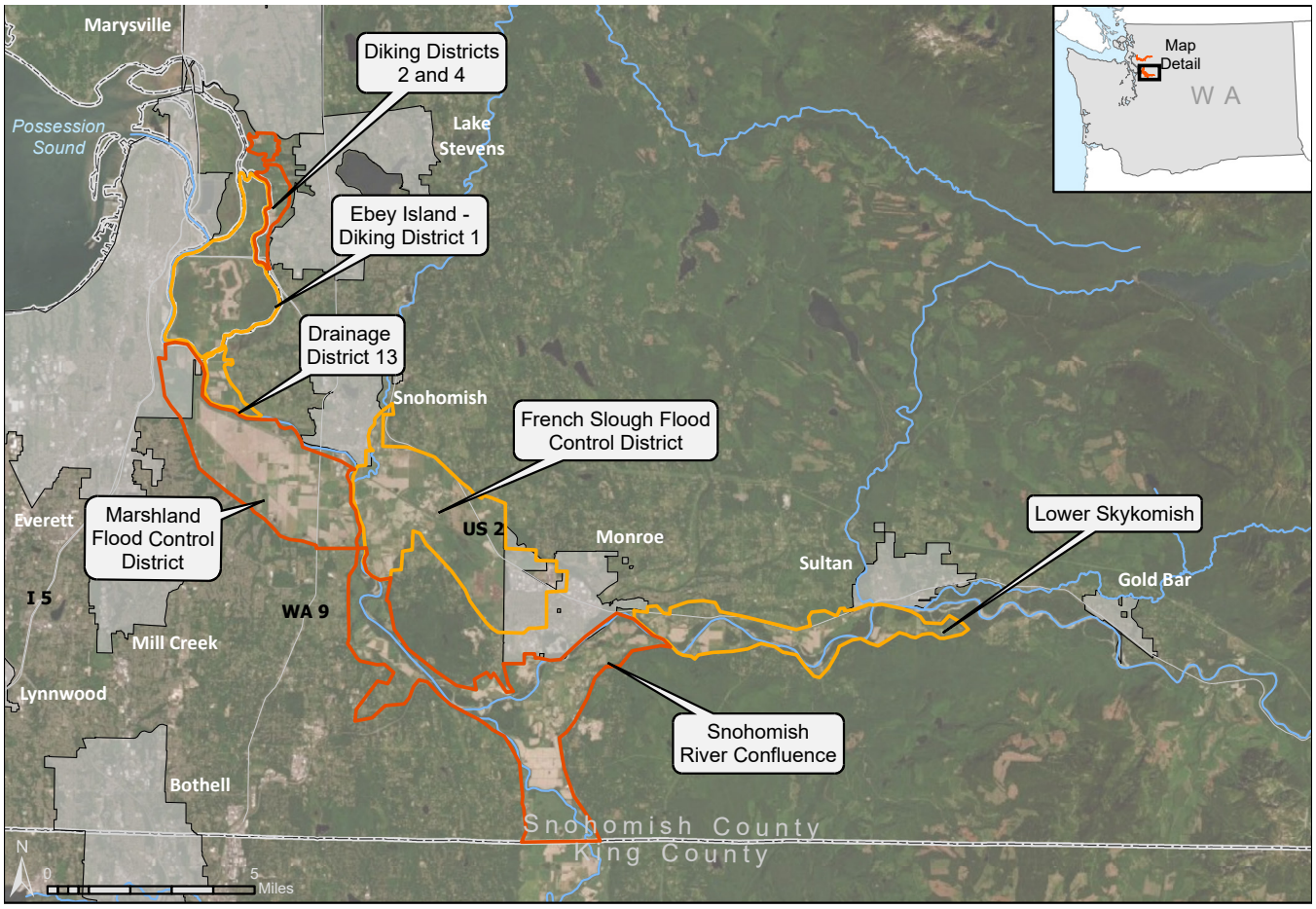


**Figure VII-2. Snohomish River floodplain reaches.** Seven sections of the floodplain were delineated based on diking, drainage and flood control district boundaries, floodplain dynamics, and agricultural resilience needs.

# South Skagit Flats – Drainage and Diking Improvement District 7

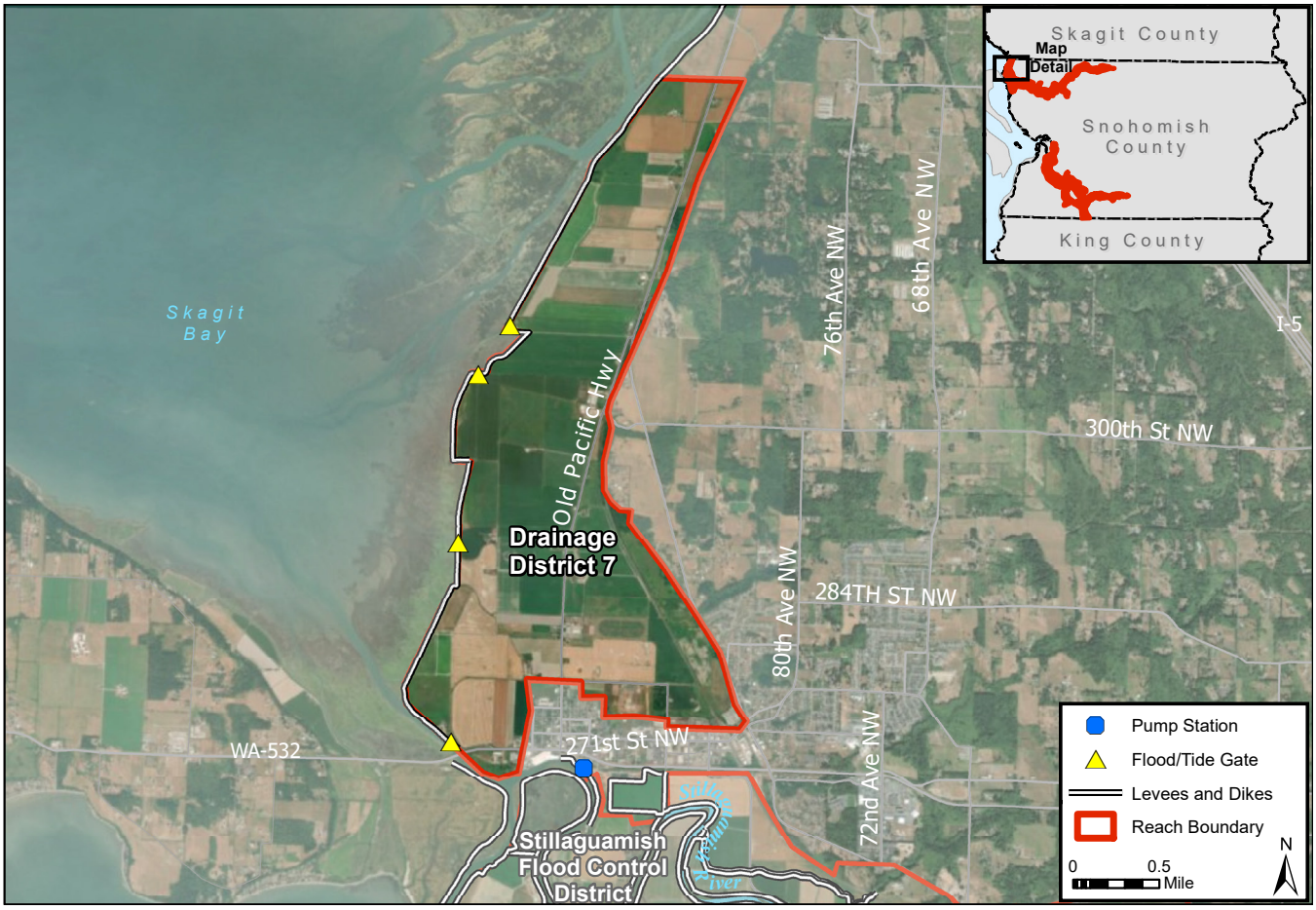


**Figure VII-3. Map of Drainage District 7.** This figure shows the boundary of Drainage and Diking Improvement District 7, along with the locations of existing levees and tide gates.

## Description

Drainage and Diking Improvement District 7 is the agricultural zone north of the City of Stanwood to the County line along Skagit Bay. Of the total 1,850 acres in active agriculture, several hundred acres of high value seed crops are rotated with approximately 800 acres of cereal grains. There is one commercial dairy managing approximately 500 acres of the feed crops along with several hundred acres of vegetables.

### DRAINAGE AND FLOOD PROTECTION

Drainage District 7 manages the water conveyances that flow from the uplands through the District into Skagit Bay. The District also manages a sea dike protecting farmland and the City of Stanwood from tidal inundation and storm surges. Most of the waterways in this area gravity-drain through tide gates at the bay, with the exception of Irvine

Slough at the southern end which drains through a pump station operated by the City of Stanwood. The District is actively working to secure funds to bring the sea dike up to Army Corps of Engineers standards so the agency will assist with dike maintenance and repair flood damages. Several areas of the dike are currently too low and/or too narrow to meet standards.

### ZONING

The agricultural land in this area is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make development in this area difficult. Subdivision of larger farms into smaller farms, however, does threaten the viability of the interconnected system of forage, feed, and seed crops.

## Current and future impacts

### FLOODING

Currently, the main source of flooding in the District is surface water runoff from the uplands, but sea level rise projections point toward the likelihood of increasing impacts from coastal flooding. This area is also at risk if the levee along the Skagit River breaks near Conway.

New modeling work completed for this planning effort shows a projected increased frequency of sea dike overtopping as a result of sea level rise and the associated coastal flooding.[1] The modeling work completed is at a coarse scale (10m) and is thus most appropriate for general risk assessment and planning purposes, not for site-level analysis. It shows, however, that current overtopping occurs during the 25-year coastal flood event (4% annual chance) and is expected to occur at the 2-year coastal flood event (50% annual chance) by mid-century.[1] There are plans currently underway to raise and fortify the sea dike in several places, which would reduce this frequency. More detailed site-specific hydraulic modeling would better inform the understanding of the future risk of saltwater inundation.

### GROUNDWATER LEVELS AND DRAINAGE

Groundwater levels in this area correlate with the height of Puget Sound. While the projected rise in local sea levels ranges greatly, median values indicate an increase of 8 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] This translates into an increase in the height of the groundwater table on agricultural lands, which can impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise projections and found projected median delays of several weeks throughout the lower portion of the Stillaguamish Valley. While the study does not include most of Drainage District 7, assumptions that the same mechanisms are at play indicate similar projections as those shown for Florence Island. This would mean median delays of five weeks predicted by the year 2080 (RCP 8.5).[3]

These projected sea level rise impacts on groundwater will exacerbate already occurring drainage challenges caused primarily by flooding from upland runoff. Snohomish County completed a study of drainage needs for the lower portion of the District (Unnamed Slough, Douglas Creek, and Irvine Slough) in 2014 and 2015 to develop a plan to decrease lowland flooding.[4,5] Modeling indicated that projects aimed at increasing water detention in the uplands would only marginally reduce the impact upland runoff has on lowland flooding.[4] Several scenarios for improving flood water conveyance through culvert replacements and channel excavation within the District were recommended to improve drainage for farmers.

### SALTWATER INTRUSION TO GROUNDWATER

As sea level continues to rise, the intrusion of salt into the groundwater could have yield impacts on crops grown in the District. A groundwater study completed as part of this plan indicates that a portion of Florence Island may already be experiencing yield impacts.[3] While the study does not include Drainage District 7, similar mechanisms are likely at play and would indicate similar projections as those shown for Florence Island. Producer testimony confirms this is true in patches. The amount of freshwater coming off the hill, however, may mean reduced

saltwater impacts in the groundwater as compared to the projections for Florence Island. Installation of pumps and drainage infrastructure to reduce the impacts of rising groundwater levels in Drainage District 7 may result in pulling salty groundwater upward and further negatively impacting crop yields.

### OTHER

Other current and projected impacts:

- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights threatens crop yields and the willingness of seed companies to sign contracts with local farmers.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. With rising sea levels, existing ditches may or may not be able to provide freshwater for irrigation into the future. There is a need for creative approaches to sourcing freshwater for irrigation in this District.

- **Sea dike improvements.** The goal of the District is to bring the sea dike up to Army Corps of Engineers standards and enroll it in the PL84-99 program to better protect farmland and the City of Stanwood and to provide the assurance that breaches will be repaired by the agency. This would require raising and widening the dike in places. This may also result in re-routing lower Douglas Creek and/or adding a pump station.

- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. Snohomish County identified numerous culverts that need to be upsized and channels that need to be excavated to increase capacity in the southern section of the District.[5] An assessment of the northern section would likely yield similar results. In addition, upgrades to tide-gates would improve farmland drainage and potentially provide benefits to fish habitat.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

### TIER TWO (LOWER PRIORITY)

- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and increased flooding as a result of climate change will stress an already financially limited drainage district. Assisting the District in securing agreements with local jurisdictions to compensate for upland stormwater runoff would support ditch and waterway maintenance. Farmers would also benefit from assistance with replacing or installing drainage infrastructure on individual farms.

- **Additional groundwater well data collected and analyzed.** Projections developed in this study used data from wells just south of Hatt Slough and on Camano Island. Additional well data and analysis in Drainage District 7 and the surrounding area could validate the projections.

- **Reduce upland runoff.** A modeling effort completed for Snohomish County concluded marginal improvements to lowland drainage would result from implementation of upland detention efforts.[4] However, this work could help mitigate for future climate change and development.

- **Research on new crop varieties.** Research into new crop varieties and markets that are more resilient to changes in the landscape may help farmers offset losses in production of existing crops. Funding for infrastructure and processing may also be needed.

# Lower Stillaguamish River – Stillaguamish Flood Control District

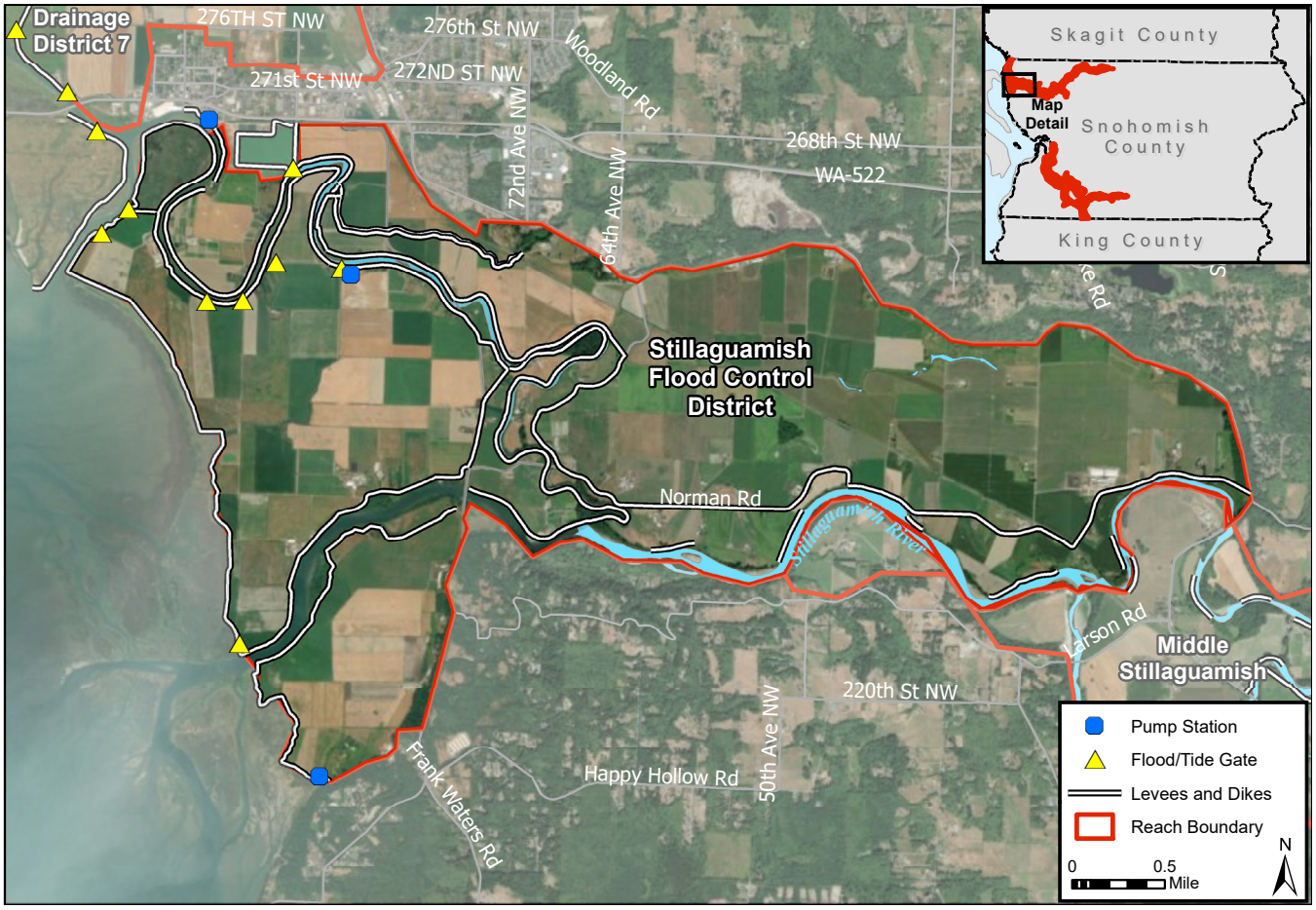


**Figure VII-4. Map of the Stillaguamish Flood Control District.** This figure shows the boundary of the Flood Control District and the locations of existing levees, flood control gates, and pump stations.

## Description

The Lower Stillaguamish River Valley contains one of the largest areas of contiguous commercial agriculture in Snohomish County. The valley supports an integrated system of cropping that relies on field rotations and coordination between multiple farmers to support the seed production industry. Feed crops (hay and corn), cereal grains, potatoes, and seed crops rotate through approximately 4,500 acres of the total 5,100 acres of active agricultural land. There are six commercial dairies managing the bulk of the forage and feed crops along with numerous beef and smaller livestock-based farming operations. In addition, there are smaller areas of agricultural land dedicated to growing berries, vegetables, and other crops.

### DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by the Stillaguamish Flood Control District, an entity that uses fees collected from landowners within this area to maintain a system of river levees, sea dikes, tide gates, and a pump station. Most of the area gravity-drains through maintained tide and flood gates, and the District maintains a pump station that assists with drainage on Florence Island in the winter and spring. The portion of land south of Hatt Slough (the Port Susan Pooling Agreement area) also has a pump station that is used infrequently in the spring to augment gravity drainage through a tide-gated culvert. Nearly the entirety of Drainage District 12 is located within the boundaries of the Flood Control District. The District collects landowner fees specifically for drainage system maintenance within its boundaries.

The levees, along with multiple shoreline armoring projects, were built between 1870 and 1950, largely by local farmers. The river levees were raised in 2016, and both these and the sea dikes are in good condition. In 2013, most of the levee was certified to Army Corps of Engineers standards and enrolled in the PL84-99 program, which means that the federal agency will repair levees that have been damaged as a result of a flood. The agency will also assist with the costs, permitting, and design of regular levee maintenance, although this is ultimately the responsibility of the District.

### ZONING

Aside from the small portion of the Lower Stillaguamish Valley within the city limits of Stanwood, the agricultural land in this reach is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make development in this area difficult. Subdivision of larger farms into smaller farms, however, does threaten the viability of the interconnected system of feed, cereal grains, and seed crops as farmers rotate ground amongst each other regularly.

## Current and future impacts

### FLOODING

Flow records for the Stillaguamish River are available from 1928 to the present and show that the five largest recorded floods have occurred in the last 15 years.[6] New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Stillaguamish River watershed, the current flooding extent for the 2-year flood (50% annual chance event) is projected to more than quadruple by the middle of the century, increasing from 9,095 acres inundated to 38,575 acres.[1] The frequency of flood events is also projected to increase. Farmers in this area identified the 17-ft and 19-ft flood stages (at the Stillaguamish River at Arlington #34 gauge) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen three times as often by the 2080s.

### LAND SUBSIDENCE

A study of land subsidence completed for the Flood Control District indicates that some areas of the landscape may be sinking minimally due to the cultivation and subsequent decomposition of organic soils as well as the depletion of groundwater.[8] The area of greatest impact appears to be northeast of the railroad in the Miller Creek drainage, although the rate of 4 inches of subsidence between 2003 and 2015 had such a high margin of error that the result was inconclusive.

### GROUNDWATER LEVELS

Groundwater levels in the lower valley correlate with the height of Puget Sound and river flood levels. While projections of the rise in local sea levels range greatly, median values indicate an increase of 8 inches by 2050 and over 2 feet by 2100 (using RCP 8.5 50th percentile values).[2] This translates into an increase in the height of

the groundwater table on agricultural lands which can impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise projections and found a projected median delays of several weeks throughout the lower portion of the valley. On Florence Island, median delays of five weeks are predicted by the year 2080 (RCP 8.5).[3]

### SALTWATER INTRUSION TO GROUNDWATER

As sea levels continue to rise, the intrusion of salt into groundwater could have yield impacts on crops grown in the Lower Stillaguamish. A groundwater study completed as part of this Plan indicates that a portion of Florence Island may already be experiencing yield impacts, and producer testimony confirms this is true in patches.[3] The projections show yield impacts expanding to include nearly all of Florence Island by 2100. Installation of pumps and drainage infrastructure to reduce the impacts of rising groundwater levels in the lower portion of the District could result in pulling salty groundwater upward and further impacting crop yields.

### OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased drainage issues.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers who are dependent on land rotation.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. Tide and flood gates in several locations need to be upsized to pass higher projected flood and stormwater flows as well as improve drainage in the spring.
- **Additional groundwater well data collected and analyzed.** Projections developed for groundwater levels and saltwater intrusion used data from wells just south of Hatt Slough and on Camano Island. Additional well data and analysis on Florence Island and the surrounding area could validate the projections provided.
- **Reduction in flood damages.** Infrastructure damage caused by flooding puts added financial burden on an already economically distressed industry. Increasing the capacity of the river and floodplain to hold floodwater, if done strategically, could reduce flood impacts on surrounding farms.
- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and increased flooding as a result of climate change will stress an already financially limited flood control district. Assisting the District in securing agreements with local jurisdictions to compensate for upland stormwater runoff would support ditch and waterway maintenance. Farmers would also benefit from assistance with replacing or installing drainage infrastructure on individual farms.
- **Increased funding for larger levee and drainage infrastructure projects.** Although levees and pumps are in good condition, there is no contingency plan

for future repair and/or replacement needs. Options and partnerships for developing a grant and/or loan program for larger resilience projects should be explored.

- **Research on new crop varieties.** Research into new crop varieties and markets that are more resilient to changes in the landscape may help farmers offset losses in production of existing crops. Funding for infrastructure and processing may also be needed.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

## TIER TWO (LOWER PRIORITY)

- **Conserve existing farmland.** The system of crop rotations in the valley necessitates maintenance of the existing agricultural land base. Loss of farmland to subdivision or habitat restoration threatens the viability of seed farms and will continue to result in loss of agricultural services that support farmers. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights and also allow for other potential uses such as restoration if farming is no longer viable in the future.
- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.

# Middle Stillaguamish River – Silvana to Arlington

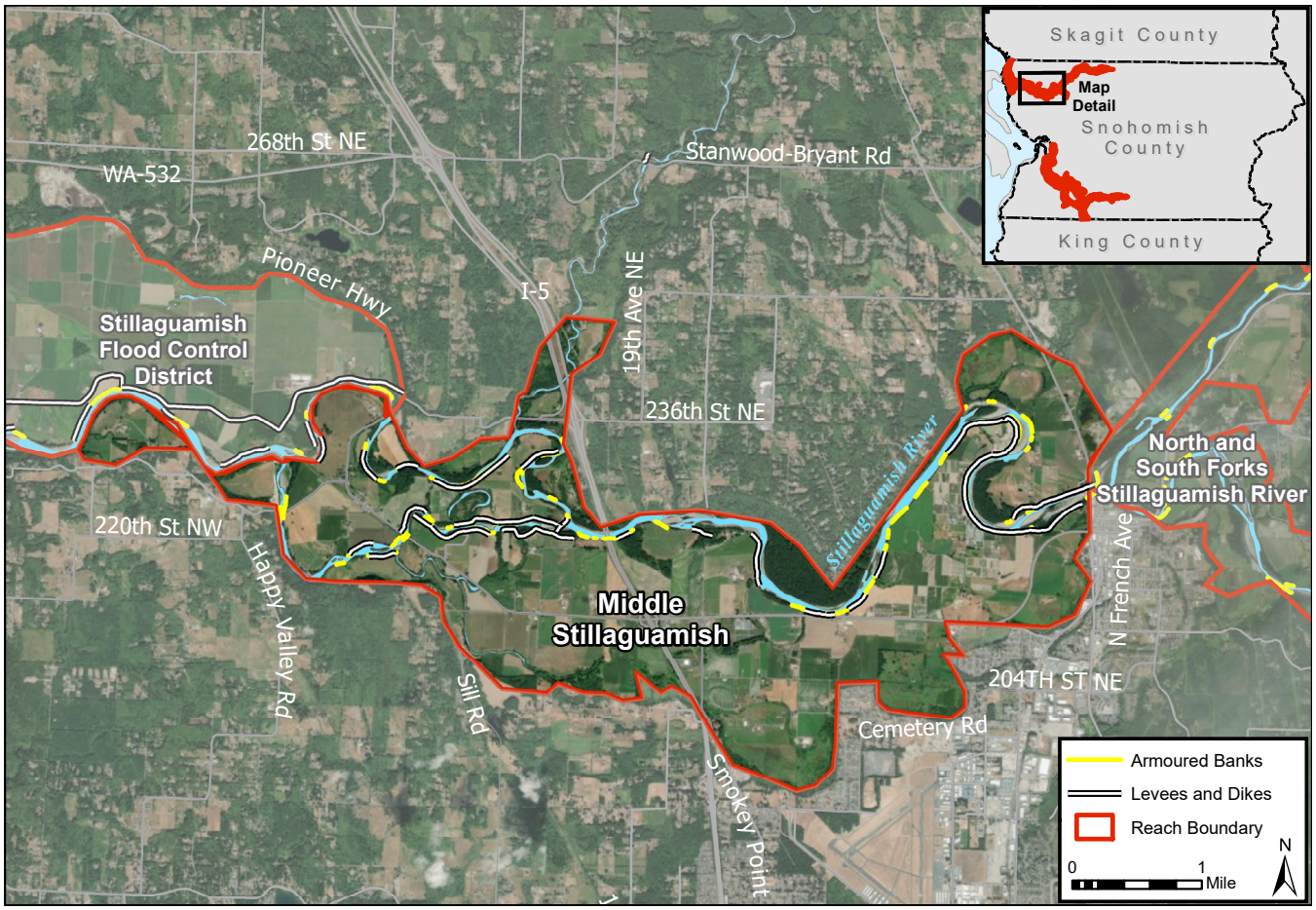


**Figure VII-5. Map of Middle Stillaguamish River floodplain.** This figure shows the boundary of the Middle Stillaguamish River reach along with existing levees and revetments.

## Description

The Middle Stillaguamish River Valley supports a robust commercial agricultural industry yet faces development pressures due to its proximity to Interstate 5 and the City of Arlington. Feed crops (hay, pasture, and silage corn), cereal grains, and seed crops dominate the landscape, utilizing approximately 2,800 acres of the total 3,800 acres in active agriculture. There are four commercial dairies managing the bulk of the feed crops, along with smaller areas dedicated to growing vegetables or nursery stock, and raising beef and small livestock.

### DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. The levees are not contiguous as in the Lower Stillaguamish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees were largely built by the U.S. Army Corps of Engineers between 1920 and 1950 and continue to be managed by the agency today. The Corps also constructed many shoreline armoring projects that

are now managed by individual farmers. There are a few sections of levee that are managed by Snohomish County.

### ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre, aside from the small portion of the floodplain that was annexed into the City of Arlington. Extra protections against development or subdivision of large farms are provided by the density fringe regulatory framework, although these protections do not extend east of Interstate 5. Loss of commercial farmland to development or subdivision is a real threat in this reach due to the proximity to a growing urban center and the lack of density fringe protections east of Interstate 5.

## Current and future impacts

### FLOODING

Flow records for the Stillaguamish River are available from 1928 to the present and show that the five largest recorded floods have occurred in the last 15 years.[6] New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events), with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Stillaguamish River watershed, the current flooding extent for the 2-year flood (50% annual chance event) is projected to more than quadruple by the middle of the century, increasing from 9,095 acres inundated to 38,575 acres.[1] The frequency of flood events is also projected to increase. Farmers in this area identified the 17-ft and 19-ft flood stages (at the Stillaguamish River at Arlington #34 gauge) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen three times as often by the 2080s. Flood damage was a primary concern of producers in this reach, who have already noticed more intense and longer duration flooding than in the past. Farmers are concerned about the potential impacts recent development near the intersection of Highway 530 and Interstate 5 will have on local flooding.

The major impacts of flooding in this reach include:

- Sand and silt deposition on fields, which can result in decreased yields
- Soil erosion, which occurs along concentrated flow paths in fields
- Flood debris on fields, which requires costly clean-up and repair
- Damage to structures, which results in costly repair
- Threats to livestock, including harm to animals, decreased milk production, or impacted milk transport
- Bank erosion, which causes loss of farmland and threats to levees

### GROUNDWATER LEVELS AND SALTWATER INTRUSION

Groundwater levels and saltwater intrusion in the Middle Stillaguamish are not expected to be impacted by rising sea levels due to the steep gradient of the valley and distance from the Puget Sound.[3] Groundwater levels may be impacted by increased riverine flooding or upland stormwater runoff, although these effects are predicted to be shorter in duration than the sustained impacts of sea level rise downriver.

### OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.

- Economic pressures for producers are resulting in subdivision of large farms and reducing the available acreage needed for current commercial farmers to be viable.

# Resilience Needs

## TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.

- **Reduction in flood damages.** Crop yield impacts caused by flood-deposited sediment, soil erosion, and flood debris removal costs put added financial burden on an already economically distressed industry. Flood protection projects such as flood fencing and waterbreak planting in strategic locations could lessen the impact of inundation on individual farms. Bank erosion also damages levees or results in loss of farmland. Increasing the capacity of the river and floodplain to hold flood waters, if done strategically, could reduce flood impacts on surrounding farms.

- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.

- **Conserve existing farmland.** The proximity of this floodplain reach to the City of Arlington and Interstate 5, in addition to the lack of density fringe protections east of the freeway, make farmland protection a high priority. Subdivision of farms threatens the viability of farming and will continue to result in loss of agricultural services that support farmers. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

## TIER TWO (LOWER PRIORITY)

- **Financial assistance to repair shoreline armoring.** In the event of a large flood, which is projected to occur more frequently, existing shoreline armoring may be damaged on individual properties.

- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and increased flooding as a result of climate change will increase the drainage burden of farmers in the floodplain. There is a need to explore ways to increase the funding available to include compensation for upland stormwater runoff impacts.

- **Reduce upland runoff.** There is a need to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious surfaces or implement drainage projects on their properties.

- **Farm pads.** Assistance with funding and permitting to install farm pads for livestock sanctuary and equipment storage during floods would help mitigate the impacts of projected higher intensity and more frequent flooding.

- **Research alternative on-farm drainage infrastructure techniques.** There is a need to fund research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.

# North and South Fork Stillaguamish River

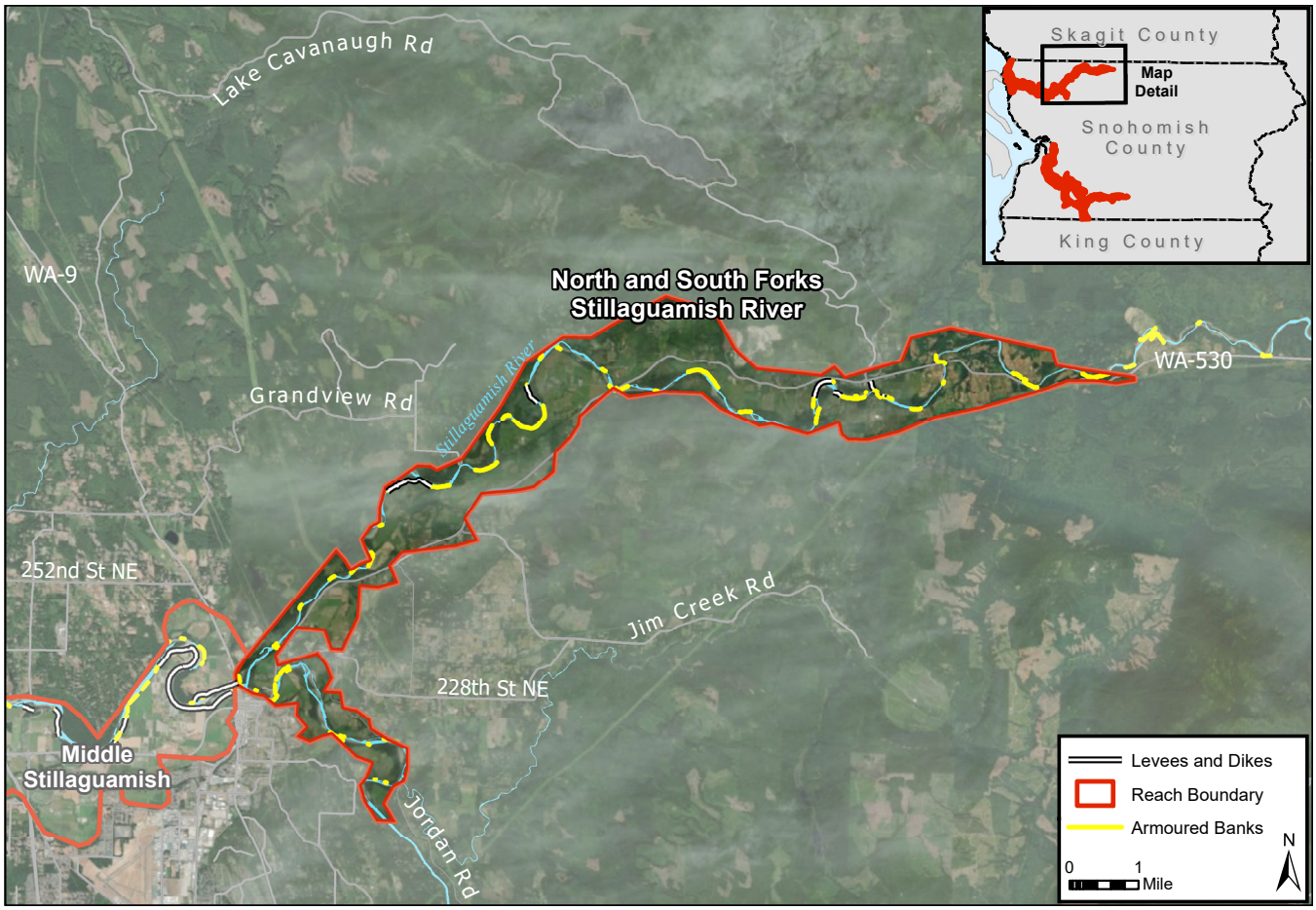


**Figure VII-6. Map of North and South Forks of the Stillaguamish River floodplain.** This figure shows the boundary of the North and South Fork Stillaguamish River reach along with existing levees and revetments.

## Description

While the floodplain narrows above the confluence of the North and South Fork Stillaguamish River, commercial agriculture remains viable and is critical in supporting the larger agricultural industry in Snohomish County. The primary agricultural production zone extends partway up the South Fork where the floodplain width allows, and up the North Fork past Oso.

The North and South Fork Stillaguamish area represents approximately 3,000 acres of commercial agricultural land predominately in feed and forage production to support the livestock industry and two commercial dairies. In addition, smaller acreages support production of cereal grains, seed crops, and forestry.

### DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. Existing levees are not contiguous as in the Lower Stillaguamish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees along with multiple shoreline armoring projects were built primarily between 1920 and 1950, largely by the Army Corps of Engineers. Individual farmers maintain drainage infrastructure as well as shoreline armoring projects on their properties.

### ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre, although there are some areas where active commercial agricultural land is zoned Rural-5 Acre. The density fringe regulatory framework protections that exist in downstream floodplain reaches do not extend into this area, although much of the area is designated as floodway. The floodway designation carries significant restrictions on development (SCC 30.65.220), yet loss of commercial farmland to development or subdivision is a threat near the City of Arlington.

## Current and future impacts

### FLOODING

Flow records for the Stillaguamish River are available from 1928 to the present and show that the five largest recorded floods have occurred in the last 15 years.[6] New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Stillaguamish River watershed, the current flooding extent for the 2-year flood (50% annual chance event) is projected to more than quadruple by the middle of the century, increasing from 9,095 acres inundated to 38,575 acres.[1] The frequency of flood events is also projected to increase. Flood debris and the associated damage and clean-up costs are a concern for producers in this reach. In a few areas, bank erosion also threatens agricultural land.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Reduction in flood damages.** Crop yield impacts caused by flood-deposited sediment, soil erosion, and flood debris removal costs put added financial burden on an already economically distressed industry. Flood protection projects such as flood fencing and waterbreak planting in strategic locations could lessen the impact of inundation on individual farms. Bank erosion also damages levees or results in loss of farmland. Increasing the capacity of the river and floodplain to hold flood waters, if done strategically, could reduce flood impacts on surrounding farms.
- **Protect farmland from riverbank erosion.** Numerous bank stabilization projects were put in place in the early to mid-1900s. Several of these have started to erode but new permit requirements have made it difficult and costly for farmers to repair them or construct new projects.
- **Conserve existing farmland.** The proximity of this floodplain reach to the City of Arlington makes farmland protection a high priority. Subdivision of farms threatens the viability of farming and will continue to result in loss of agricultural services that support farmers. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights.
- **Access to water for irrigation.** Most farms do not have sufficient water rights and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.

# Snohomish River Estuary – Diking Districts 2 and 4

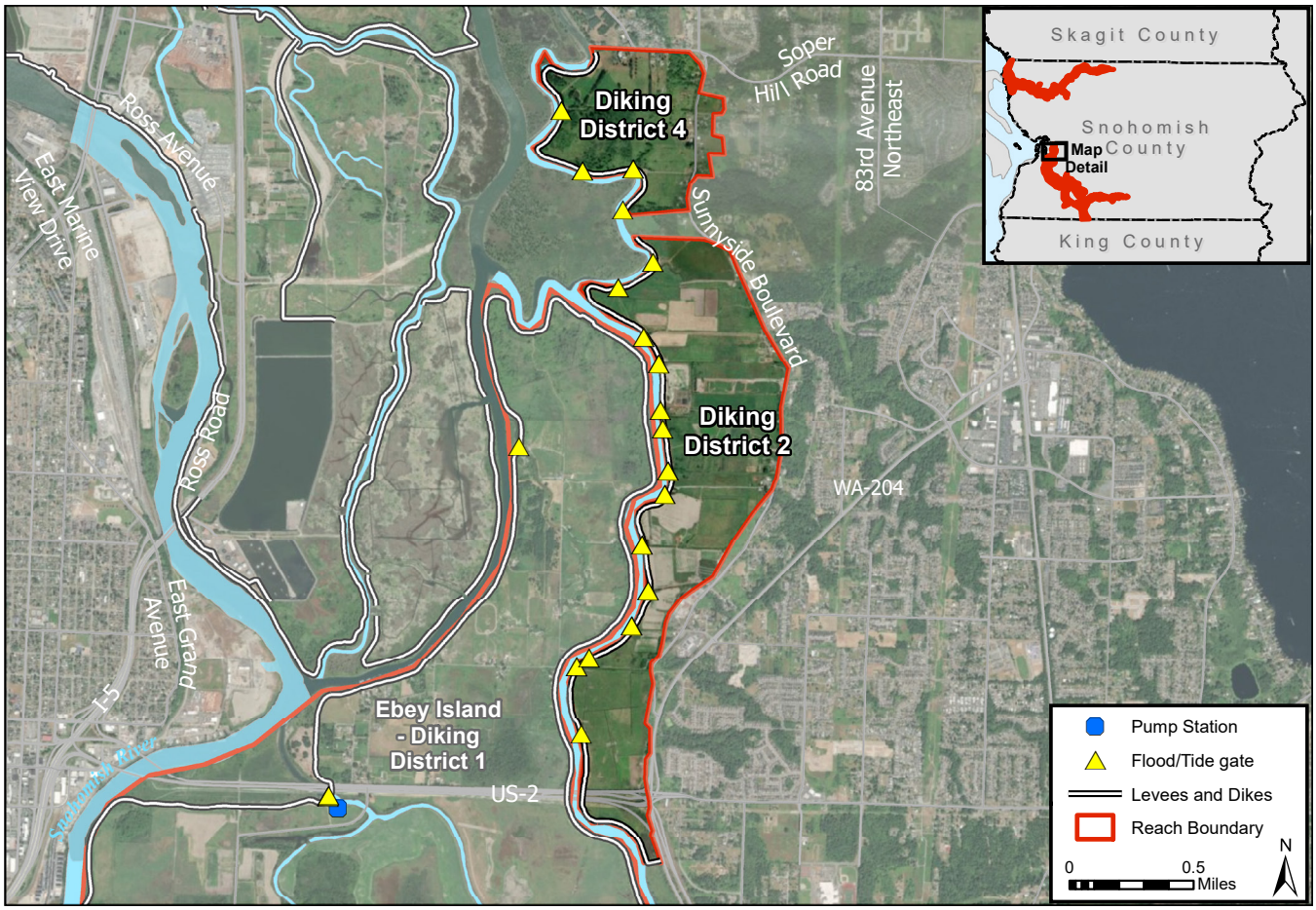


**Figure VII-7. Map of Diking Districts 2 and 4.** This figure shows the boundary of the diking districts, along with existing levees and tide gates.

## Description

Diking Districts 2 and 4 are small districts along the eastern border of the estuary floodplain. Approximately 525 acres of the total 790 acres within the two districts is in agricultural use. Farming consists of pasture (300 acres), hay and silage (150 acres), and agritourism and vegetable production (75 acres).

### DRAINAGE AND FLOOD PROTECTION

Flood protection and limited agricultural drainage is managed by Diking Districts 2 and 4, entities that use fees collected from landowners within the area to maintain river levees and tide gates. Historically, the County and City of Lake Stevens provided funding to Diking District 2 for drainage maintenance to compensate for upland runoff impacts, but that agreement has expired. Water gravity drains through the districts and out

a series of tide gates along the levee. Flooding in these districts is primarily a result of upland drainage flowing off the hill, as the levees rarely overtop.

The levees were built in the early 1900s. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that Diking Districts 2 and 4 rarely experience overtopping levees as flood pressure is released in upriver floodplain areas first.

The levees are not currently enrolled in the PL84-99 Army Corps of Engineers program; therefore, levee repair and maintenance are the responsibility of the districts. Diking District 2 is actively working to bring their levee up to Army Corps of Engineers standards so the agency will provide assistance.

### ZONING

Diking District 2 is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms, as well as conversion to non-agricultural uses, threatens the viability of commercial agriculture in this area so close to the urban centers of Everett and Lake Stevens.

Diking District 4, however, has approximately half its acreage in Agriculture-10 Acre zoning and half in Rural-5 Acre zoning. The portion zoned Agriculture-10 Acre also has protections provided by the density fringe regulatory framework, making non-agricultural related development in this area more difficult. Losing farmland to non-agricultural uses is a threat in the portion of the District zoned Rural-5 Acre.

## Current and future impacts

### FLOODING

Flooding of farmland in the Snohomish River Estuary is highly influenced by sea levels (tides and local storm surge) as well as river levels. In addition, Diking Districts 2 and 4 receive considerable upland runoff during floods, making drainage maintenance in these districts highly complex.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

While this modeling effort did not include flood projections for the smaller drainages coming from the uplands, we can expect both land use changes (development) and climate change to exacerbate the impacts of upland runoff in Diking Districts 2 and 4.

### GROUNDWATER LEVELS

Groundwater levels in Diking Districts 2 and 4 are projected to be impacted by sea level rise. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] Diking District 4 is over 3.5 miles from the mouth of the Snohomish River, yet the low gradient of the river translates into groundwater level impacts from sea level

rise throughout both districts. These increases may impact the timing of crop planting and hay cultivation in the spring as well as the length of water inundation on fields. A groundwater study completed as part of this plan shows that Diking Districts 2 and 4 are predicted to experience increases in the groundwater table similar to projected increases in sea level, resulting in considerably higher water tables by 2100.[3]

### SALTWATER INTRUSION TO GROUNDWATER

A groundwater study completed as part of this Plan indicates that saltwater intrusion in groundwater is not likely to be a threat to soils in these districts or other agricultural lands in the vicinity due to the distance from the Puget Sound.[3] Data from wells further upriver showed no sign of saltwater intrusion, so data from Snohomish County wells on Smith Island were used to determine the potential impact in this area. Further study of groundwater levels and salinity is recommended in Diking Districts 1 (Ebey), 2, and 4 and Drainage District 13 to improve the predictions calculated from the Smith Island well dataset. In particular, if active pumping is considered as a replacement to the existing gravity drainage system, further study would be necessary to determine if this may result in pulling salty groundwater upward and impacting crop yields.

There are several locations where salinity is currently impacting water in drainage ditches that had been used for irrigation in the past. If applied to farm fields unknowingly, this saline water could impact soil health and crop yields. This lack of surface water for irrigation is impacting several local farms.

### OTHER

Other current and projected impacts:

- Loss or subdivision of farmland in these districts is reducing the available acreage needed for current commercial farmers to be viable as well as the feasibility of maintaining drainage infrastructure.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and higher groundwater tables (as a result of climate change) will stress already financially limited diking districts. There is a need to renew (District 2) and develop (District 4) agreements with cities and the county to compensate for upland stormwater and sediment impacts to drainage.

- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. These include improvements to through-flow for streams and replacement of failed culverts. Capacity of existing tide gates is sufficient, but these may require upsizing if upland runoff increases.

- **Conserve existing farmland.** The proximity of these districts to the cities of Lake Stevens and Marysville put development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape-scale. Innovative approaches should be pursued to increase the funding available to remove development rights.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem services markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

## TIER TWO (LOWER PRIORITY)

- **Access to water for irrigation.** Most farms do not have sufficient water rights or are no longer able to withdraw from ditches now inundated with saltwater. While many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Reduce upland runoff.** There is a need to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious surfaces or implement drainage projects on their properties.
- **Assistance with beaver management.** Beaver presence along some waterways is impacting farmland drainage.

# Snohomish River Estuary – Diking District 1 – Ebey Island

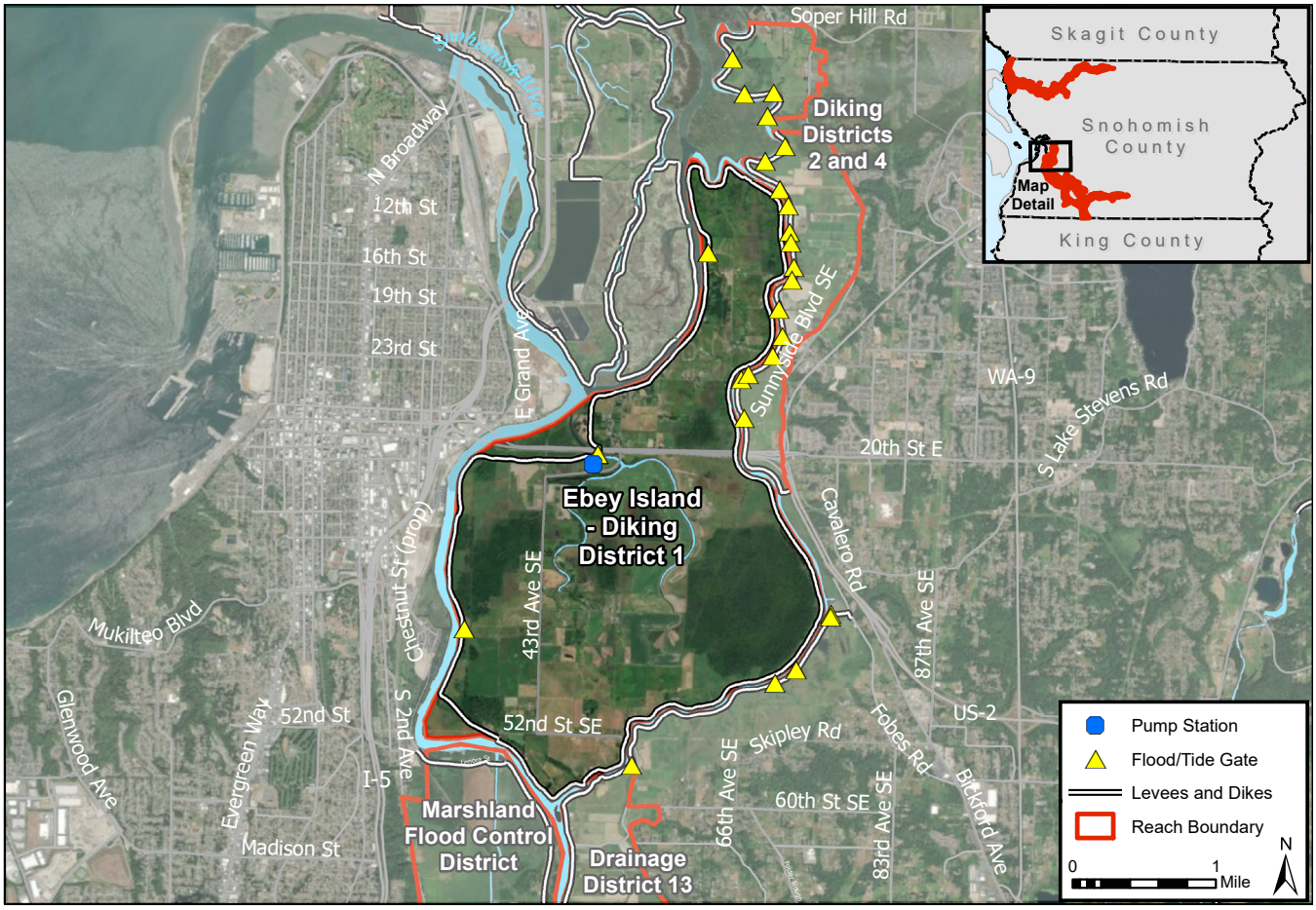


**Figure VII-8. Map of Diking District 1 – Ebey Island.** This figure shows the boundary of Diking District 1, along with existing levees, tide or flood control gates and pump station.

## Description

Ebey Island, in the estuary of the Snohomish River, supports commercial agriculture, but in a limited capacity due to the many challenges associated with this tidally influenced, low lying, and low gradient section of the floodplain. Approximately 41% of the island is in active agricultural use, with successful farms producing cereal grains, hay, and forage (pasture grass). The cooler temperatures associated with the proximity to the Puget Sound create a challenge for some slower ripening crops like corn.[10] The Washington Department of Fish and Wildlife owns a significant portion of the island, managing 1,285 acres of the total 3,940, which they lease a portion of for farming.

### DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage are managed by Diking District 1, an entity that uses fees collected from landowners within the area to maintain a drainage system including ditches, tide/flood gates, a pump station, and river levees.

The levees were built by the District and local farmers in the early 1900's along with multiple shoreline armoring projects. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to exclude water from larger events. In 1991, the Coordinated Diking Council was formed through an Interlocal Agreement between Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers agreeing to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that Ebey Island levees rarely overtop since the upstream districts overtop and fill up first, thus alleviating flood flows downstream.

South of Highway 2, the island drains through several managed ditches and waterways to Deadwater Slough, near the highway, through a series of tide gates and a pump station. The District relies on gravity drainage most of the time, but typically pumps water between February and May to prepare for spring cultivation and pasture growth. North of Highway 2, a section of the levee overtops every winter, but this back-watering effect from the tides just fills the ditches with freshwater that sits on top of the saltwater and does not negatively impact farmland production.

### ZONING

Ebey Island is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Subdivision of larger farms into smaller farms, however, does threaten the viability of traditional commercial agriculture in this area.

## Current and future impacts

### FLOODING

The Snohomish River floodplain is low gradient with tidal influence extending 16 miles upriver. Flooding in the estuary around Ebey Island is influenced by river levels, tides and sea level rise, creating a "coastal squeeze" that can exacerbate flooding issues and negatively impact drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s. In addition, sea level rise may further exacerbate flooding in the Lower Snohomish as higher water levels translate to higher storm surge heights.

Although the current 100-year flood (1% annual chance) does not overtop the levee on Ebey Island, the flood modeling projections indicate that the 100-year flood could start to overtop levees in the 2080s. While overtopping is infrequent, the increased pressure of higher floodwaters may threaten the integrity of levees and lead to failure.

To protect from current and future flood pressures, the levees protecting Drainage District 1 need to be reinforced in several places as a result of erosion on the river side. It can be difficult to get permits to place rip-rap, so the District resorts to reinforcing the levee

on the inland side, resulting in a loss of farmland. Levee breaches, as opposed to overtopping, are the real threat to farmland in the District. A recent levee breach was quickly plugged but posed a serious risk, while a levee breach in 1990 caused destruction to agricultural infrastructure and viability.

An additional threat to levee integrity is the Highway 2 trestle, where bridge pilings rack large amounts of debris during large floods. If not removed quickly, the debris acts as a dam, backing up water and threatening to blow out the levee behind the trestle.

### GROUNDWATER LEVELS

Groundwater levels in the lower valley correlate with the height of the Puget Sound and river flood levels. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] This translates into a similar but muted increase in the height of the groundwater table on agricultural lands which can impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan showed that Ebey Island groundwater levels were based both on river levels and sea levels making it hard to determine the projected impacts of sea level rise.[3] Maps of existing and predicted ponded levels, however, show higher impacts into the future with a need for greater pumping in the spring to allow for planting and crop growth (Figures V-5 and V-6). From the southernmost tip of Ebey Island and extending upriver through French Slough Flood Control District, delays in spring cultivation based on sea level rise predictions were calculated. The study found projected median delays of 4 weeks by 2050 and 5 weeks by 2080 on the southern tip of Ebey Island (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this district to actively pump water out of the system. Increased pumping, therefore, could mitigate the impacts of these rising groundwater levels.

### SALTWATER INTRUSION TO GROUNDWATER

A groundwater study completed as part of this Plan indicates that saltwater intrusion is not likely to be a threat to agricultural viability on Ebey Island or other agricultural lands in the vicinity due to the distance from the Puget Sound.[3] Data from wells further upriver showed no sign of saltwater intrusion, so data from Snohomish County wells on Smith Island were used to determine the potential impact on Ebey Island. Further study of groundwater levels and salinity is recommended in Diking Districts 1 (Ebey), 2, and 4, and Drainage District 13 to improve the predictions calculated from the Smith Island well dataset. In particular, if increased pumping is implemented to combat drainage issues into the future, further study is necessary to determine if this may result in pulling salty groundwater upward and impacting crop yields.

### LAND SUBSIDENCE

Much of the land in the District was wetland associated with the floodplain of the Snohomish River that has since been drained for agricultural use. Approximately 1,200 acres are soils high in organic matter content that built up over years of saturation. While only a portion of these soils are cultivated, cultivation has likely resulted in higher decomposition rates, causing the land to subside over time. A study of subsidence rates completed for this planning effort in the Lower Snohomish River floodplain was inconclusive in this area.[11] If subsidence is occurring, the impacts of sea level rise are likely to cause more significant impacts to drainage than subsidence.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Drainage infrastructure repair and improvements.** The existing pumps are old and frequently being repaired or rebuilt. There is a need to replace the pumps to support continued and potentially increased pumping. In addition, many tide gates are failing and in need of replacement, repair, or upsizing to protect against floodwaters and projected increases in flood heights and frequency.

- **Levee improvements.** Sections of the levee are in need of repair and reinforcement. Most of these are north of Highway 2. The District is currently working to upgrade levees to Army Corps of Engineers standards so they can be enrolled in the PL84-99 program. This will reduce the possibility of a levee breach and provide

assurance that levee breaches or damage will be repaired by the agency.

- **Additional groundwater well data collected and analyzed.** Projections developed for groundwater levels and saltwater intrusion used data from wells downriver on Smith Island. Additional well data and analysis on Ebey Island and the surrounding area is needed to validate predictions and inform the impact of additional pumping on groundwater salinity.

- **Protect levee from impacts of Highway 2 trestle.** Several actions can be taken to lessen the impact and protect levees from debris racking on the Highway 2 pilings during flood events. One action could be to work with the State to develop a more proactive approach to removing debris before it poses a threat to farming infrastructure. Improvements to the levee adjacent to the trestle may also lessen the threat of a levee breach.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water-holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

## TIER TWO (LOWER PRIORITY)

- **Financial assistance for drainage system maintenance.** The drainage and pumping needs associated with higher groundwater tables as a result of sea level rise will stress an already financially limited diking district. There is a need explore ways to increase the funding available for drainage assistance.

# Lower Snohomish River – Drainage District 13 – Swans Trail Slough

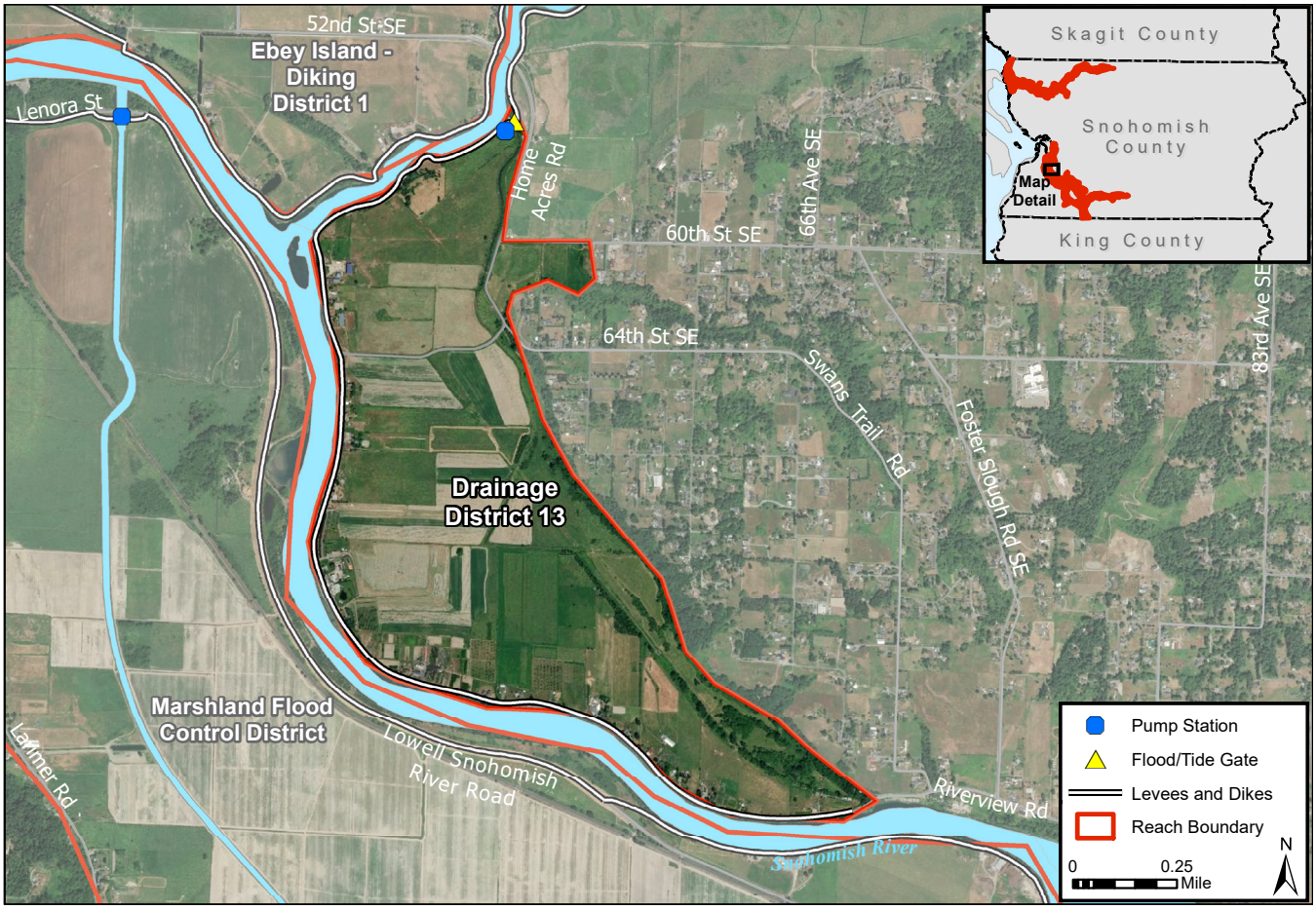


**Figure VII-9. Map of Drainage Improvement District 13.** This figure shows the boundary of the Drainage District 13 reach, including existing levees, tide and flood control gates and a pump station.

## Description

Drainage Improvement District 13 is a narrow district nested between the Snohomish River and the largely developed Fobes Hill uplands. Just over 400 of the 580 total acres in the District support commercial agriculture, primarily growing hay and silage as well as supporting cattle, small livestock, vegetables, fruit, agritourism, and other smaller enterprises.

### DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by Drainage Improvement District 13, an entity that uses fees collected from landowners within the area to maintain a system of ditches, river levees, and a pump station. Swans Trail Slough is a natural drainage that collects water off the uplands and flows south to north

along a sliver of farmland north of the old railroad grade. The railroad grade separates this drainage from a system of managed ditches draining most of the farmland in the District. These two systems meet up approximately halfway up the District. The water from both systems gravity-drains into Ebey Slough through a 6 ft diameter tide gate when the water level in Ebey Slough is lower than Swans Trail Slough. When the water level in Ebey Slough is high due to snow melt or storms, the District runs its 12-inch diameter fish-friendly pump to move water out of the District, primarily in the spring. In 2007, the District installed a new tide gate and pump.

The levees were built in the early 1900s by local farmers. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that Drainage District 13 levees overtop at the same time as both the Marshland and French Slough Flood Control District levees, relieving flood pressures and the risk of levee failure. The levee is not enrolled in the PL84-99 Army Corps of Engineers program and as such, levee repair and maintenance is the responsibility of the District.

### ZONING

Drainage Improvement District 13 is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms as well as conversion to non-agricultural uses threaten the viability of traditional commercial agriculture in this area so close to the urban centers of Everett and Snohomish.

## Current and future impacts

### FLOODING

The Snohomish River estuary is low gradient with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. Flooding in Drainage District 13 is influenced primarily by river levels, but also by tides and sea level rise which can exacerbate flooding issues and impact drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

Higher intensity floods will mean more frequent overtopping of levees, although flood damage is not a major concern for farmers in this area. Higher and more frequent floods could, however, increase the potential for a levee failure, which would cause extensive damage to farm and community infrastructure.

### GROUNDWATER LEVELS

Groundwater levels in Drainage District 13 are projected to be impacted by sea level rise. While the projected rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] Drainage District 13 is over eight miles from the mouth of the Snohomish

River, yet the low gradient of the river translates into groundwater level impacts from sea level rise throughout the District. These increases may impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise predictions. The study found projected median delays of 3-4 weeks by 2050 and 5 weeks by 2100 throughout Drainage District 13 (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this district to actively pump water out of the system. Increased pumping, therefore, could mitigate the impacts of these rising groundwater levels.

The existing tide gates are sufficient for the amount of acreage that is drained, although increased flooding and groundwater levels in the future may necessitate the addition of another tide gate to improve gravity drainage and reduce the need for additional pumping. The tide gate pipes are over 30 years old and will need replacement soon along with needed improvements to the adjacent levee.

### SALTWATER INTRUSION TO GROUNDWATER

A groundwater study completed as part of this plan indicates that saltwater intrusion is not likely to be a threat to agricultural viability in Drainage District 13 or other agricultural lands in vicinity due to the distance from the Puget Sound.[3] Data from wells further upriver showed no sign of saltwater intrusion, so data from Snohomish County wells on Smith Island were used to determine the potential impact in this area. Further study of groundwater levels and salinity is recommended in Drainage District 13 and Diking Districts 1 (Ebey), 2, and 4 to improve the predictions calculated from the Smith Island well dataset. In particular, if increased pumping is implemented to combat drainage issues into the future, further study is necessary to determine if this may result in pulling salty groundwater upward and impacting crop yields.

### OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. These include improvements to the levee in specific locations, pump station capacity upgrades, and drainage system culvert replacements.
- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden of farmers in this district. It would help to explore ways to increase the funding available to include compensation from upland stormwater runoff impacts to pay for ditch and waterway maintenance as well as to assist with electricity costs for the pump station.
- **Reduce upland runoff.** Explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or educating and incentivizing urban/suburban landowners to reduce impervious or drainage projects on their properties. Restoration of Swans Trail Slough north of the railroad grade could also help to store or infiltrate upland runoff.
- **Assistance with permitting for drainage system maintenance.** Assist the District with the state and federal permitting process to allow for improved drainage system maintenance.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

## TIER TWO (LOWER PRIORITY)

- **Conserve existing farmland.** The proximity of this floodplain reach to the cities of Everett and Snohomish put development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights.

- **Manage impact of nutria on levee integrity.** Nutria are non-native invasive rodents whose burrowing can damage levee infrastructure and result in levee failure. It would help to assist with nutria control and/or eradication.

# Lower Snohomish River – Marshland Flood Control District

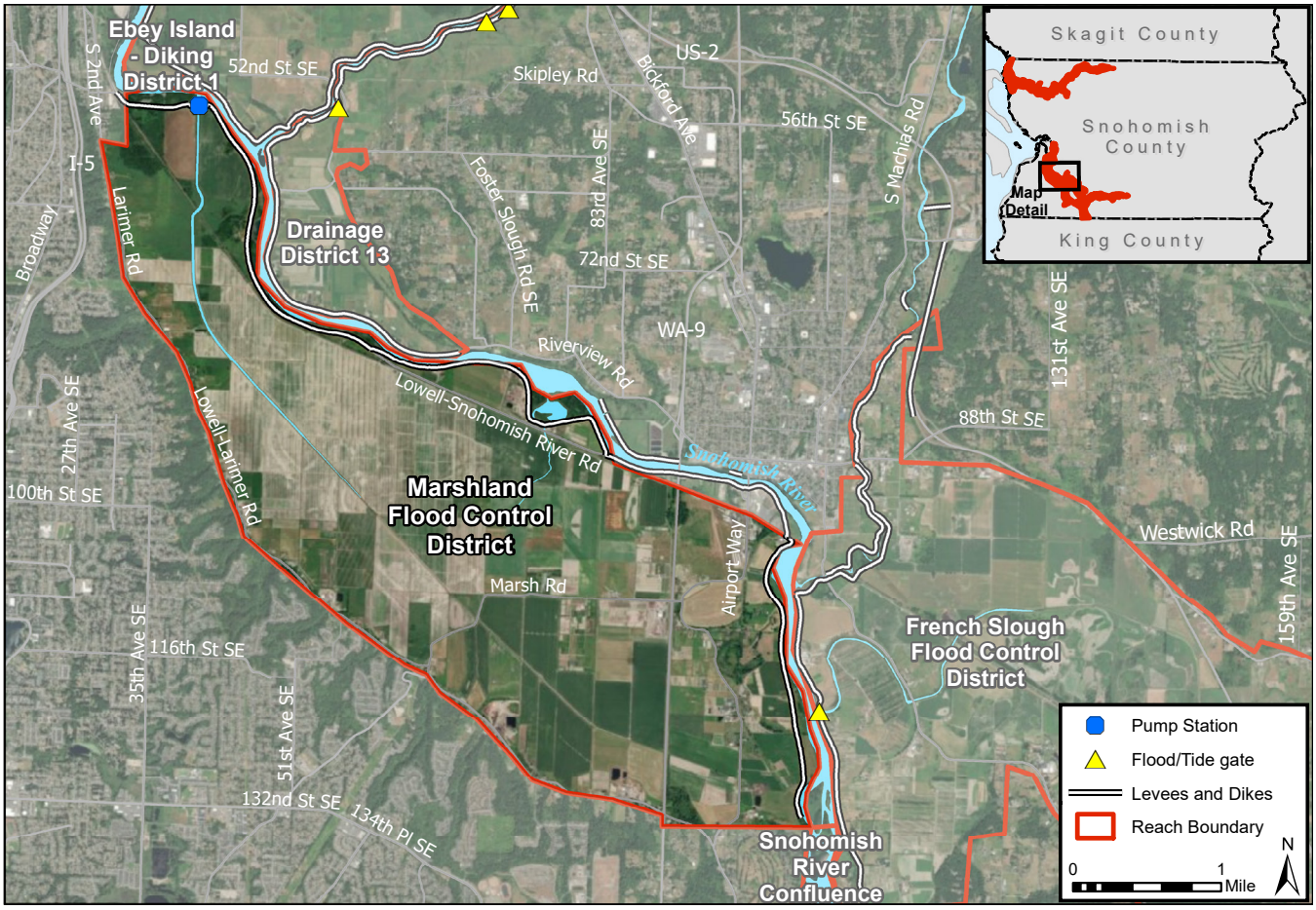


**Figure VII-10. Map of Marshland Flood Control District.** This figure shows the boundary of the Flood Control District, along with existing levees, tide or flood gates, and pump stations.

## Description

The Marshland Flood Control District spans the floodplain south of the Snohomish River between the cities of Everett and Snohomish. Despite the proximity to these two growing urban centers, over 70% of the District's 6,400 acres is maintained as commercial agriculture. The largest landholder operates a 1,500-acre blueberry farm. The other primary commercial farming enterprises include cereal grains (1,000 acres), hay or silage (800 acres), a commercial dairy, and other local livestock producers. The District also supports grazing, vegetable production, turf grass, and other agricultural related businesses such as composting and agritourism.

### DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by the Marshland Flood Control District, an entity that uses fees collected from landowners within the area and from local jurisdictions to maintain a system of ditches, river levees, a flood canal, and a pump station.

The levees were built in the early 1900s and upgraded with help from the Soil Conservation Service (now Natural Resources Conservation Service) in the early 1960s. The flood canal was dug and the pump station built with federal help at that same time. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that the Marshland levee overtops at the same time as other district levees, relieving flood pressures and the risk of levee failure. In 2015, most of the levee was certified to Army Corps of Engineers standards and enrolled in the PL84-99 program so the federal agency will repair levees if damaged as a result of a flood. The agency will also design, obtain permits, and assist with 80% of the cost of repairs, although levee maintenance is ultimately the responsibility of the District.

The Marshland Flood Control District receives a considerable volume of water draining off the upland areas within both unincorporated Snohomish County and the City of Everett. This runoff results in deposition of large volumes of sediment in the District's ditches and flood canals. Sediment ponds have been built at six locations adjacent to Lowell Larimer Road to capture these deposits. The waterways within the District require ongoing maintenance to clean out sediment and grass to maintain flow. The District receives funding from Snohomish County and the City of Everett to compensate for the increased impact of stormwater and sediment inputs.

The pump station consists of two 100 hp pumps and four 250 hp pumps that move water from the District into the Snohomish River. The pumps run throughout the year, but primarily between October and June. The pump station does not provide fish access between the Snohomish River and the District, allowing for a more streamlined permitting process for drainage infrastructure maintenance.

### ZONING

The Marshland Flood Control District is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms as well as conversion to non-agricultural uses threaten the viability of traditional commercial agriculture in this area so close to the urban centers of Everett and Snohomish.

## Current and future impacts

### FLOODING

The Snohomish River estuary is low gradient with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. Flooding in the Marshland Flood Control District is influenced primarily by upland runoff and river levels, although sea level rise is also projected to exacerbate flooding issues and impact drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must

be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

Most flood-prone structures in the District have been raised in recent years, so while higher intensity and more frequent floods will mean more levee overtopping, the greater risk is a levee failure. A levee breach would cause extensive damage to farm and community infrastructure. One section of levee, in particular, is at risk of damage as it receives considerable pressure from Pilchuck River flood flows and deposited sediment.

### GROUNDWATER LEVELS

Groundwater levels in the Marshland Flood Control District are projected to be impacted by sea level rise. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] The Marshland Flood Control District is over seven miles from the mouth of the Snohomish River, yet the low gradient of the river translates into groundwater level impacts from sea level rise through most of the District. These increases may impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise predictions. The study found median predicted delays of 2-4 weeks by 2050 and 5 weeks through most of the District by 2100 (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this district to actively pump water out of the system. Increased pumping, therefore, could mitigate the impacts of these rising groundwater levels.

### LAND SUBSIDENCE

Much of the land in this district was wetland associated with the floodplain of the Snohomish River that has since been drained for agricultural use. As such, approximately 1,600 acres are soils high in organic matter. Cultivation and drainage of these soils has resulted in higher decomposition rates, causing the land to subside quickly. A study of subsidence rates completed for this planning effort in the Lower Snohomish River floodplain indicates rates of approximately 1 to 6 inches of subsidence every 10 years in some areas, although there is a large amount of error associated with this estimation.[11]

### OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Reduce upland runoff.** There is a need to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious surfaces or implement drainage projects on their properties.
- **Reduce subsidence.** Explore creative approaches to reducing subsidence in areas where organic soils are decomposing, potentially through soil augmentation.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay

sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

## TIER TWO (LOWER PRIORITY)

- **Additional financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden on farmers in the floodplain. It would help to explore ways to increase the amount of stormwater runoff funding received from local jurisdictions to support ditch and waterway maintenance as well as assist with electricity costs to run the pump station. Farmers would also benefit from assistance with replacing or installing drainage infrastructure on individual farms.
- **Flood risk training for new landowners.** New farmers moving into the District could benefit greatly from training on how to minimize flood risk by accessing flood data and predictions available through Snohomish County and preparing for floods.
- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated projections, and improved notification to farmers are needed.
- **Conserve existing farmland.** The proximity of this floodplain reach to the cities of Everett and Snohomish puts development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. There is a need to pursue innovative approaches to increasing funding available to remove development rights.
- **Research alternative on-farm drainage infrastructure techniques.** The District could benefit from funding for research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.

# Lower Snohomish River – French Slough Flood Control District

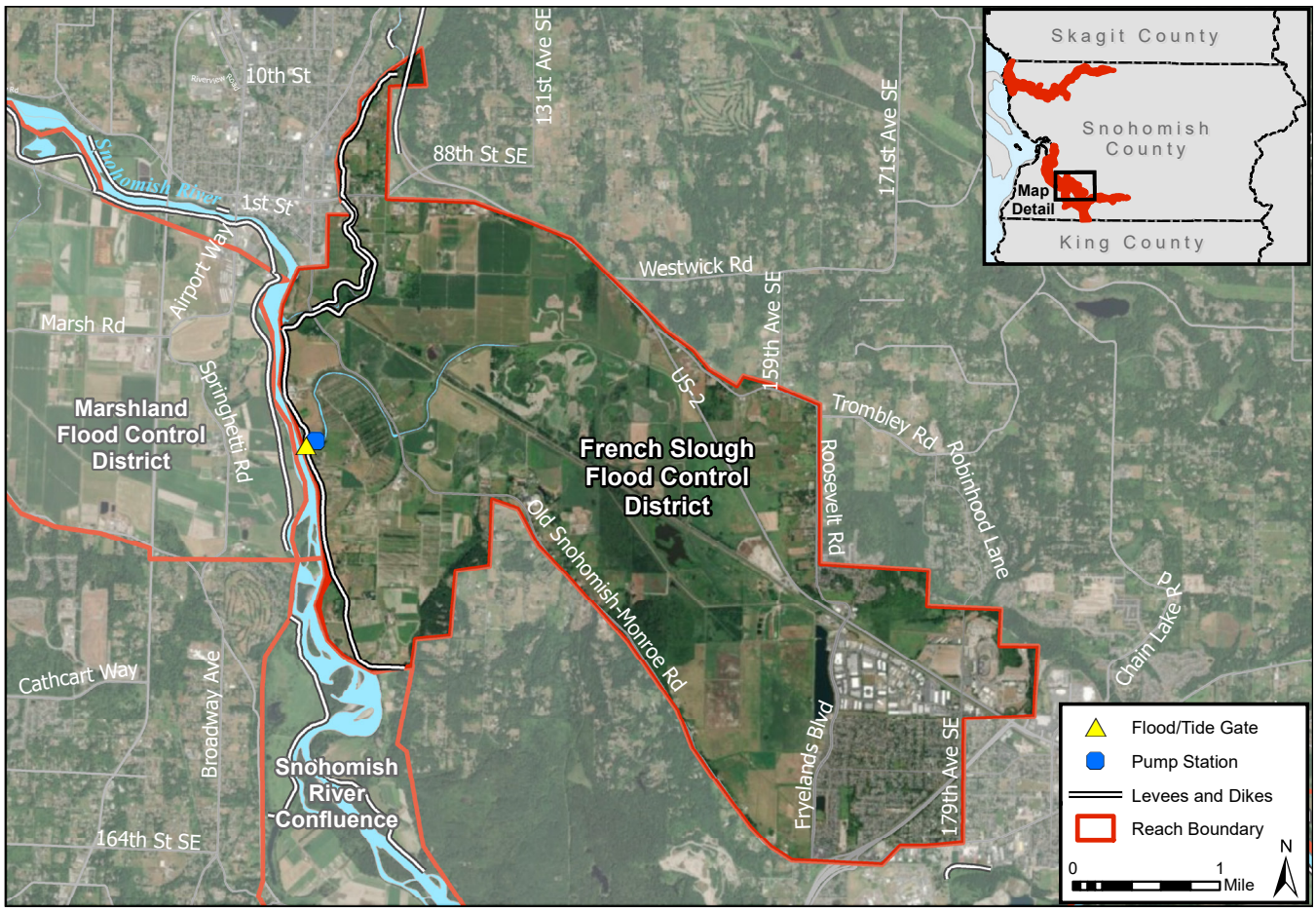


**Figure VII-11. Map of French Slough Flood Control District.** This figure shows the boundary of the Flood Control District, along with existing levees, tide or flood gates, and pump stations.

## Description

The French Slough Flood Control District spans the floodplain between the cities of Snohomish and Monroe. Despite the proximity to these growing urban centers, over half of the 7,600 acres are maintained as commercial agriculture. A large portion of the agricultural land produces commercial grains or hay and silage (800 acres) to support local dairies (one of which is within the District). Another large portion (1,000 acres) is managed as private duck hunting clubs, which utilize a portion of their ground for cereal grains and silage. Nursery operations cover just under 300 acres, and vegetable and flower operations cover approximately 200 acres. There are also many small livestock operations and commercial horse stables.

### DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by the French Slough Flood Control District, an entity that uses fees collected from landowners within the area to maintain a system of ditches, river levees and a pump station. A significant portion of the District is lower than mean river levels for much of the year and extremely flat. For this reason, the levees and pump station are necessary to keep the land drained so present farming practices can occur.[12]

The levees were built in the early 1900s and upgraded with help from the Soil Conservation Service (now Natural Resources Conservation Service) in the early 1960s, at the same time the pump station was built and French Slough was widened and straightened. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that the French Slough levee overtops at the same time as other district levees, relieving flood pressures and the risk of breaches. In 2013, most of the dike was certified to Army Corps of Engineers standards and enrolled in the PL84-99 program, so the federal agency will repair levees if damaged as a result of a flood. The agency will also assist with the costs, permitting, and design of regular levee maintenance, although this is ultimately the responsibility of the District.

The land within the French Slough Flood Control District receives considerable water from the uplands. The waterways require frequent maintenance to clean out sediment and grass to maintain flow. The District receives minimal funding from Snohomish County to compensate for upland stormwater and sediment inputs. The pump station consists of two 150 hp pumps and four 450 hp pumps that move water from French Slough to the Snohomish River, although one pump can handle most of the pumping needs for about seven months of the year. All water leaving the District is pumped, except the water leaving through the flood gates after a flood. A fish ladder provides access to adult salmon migrating up French Creek in the fall and a pair of fish-friendly pumps provides downstream access to juveniles in the spring and early summer.

### ZONING

The French Slough Flood Control District is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms as well as conversion to non-agricultural uses threaten the viability of traditional commercial agriculture in this area so close to the urban centers of Snohomish and Monroe.

## Current and future impacts

### FLOODING

The Snohomish River estuary is low gradient with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. Flooding in the French Slough Flood Control District is influenced primarily by river levels and upland runoff, although sea level rise is also projected to exacerbate flooding issues and impact the drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show

that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

Most flood-prone structures in the District have been raised in recent years, so while higher intensity and more frequent floods will mean more levee overtopping, the greater risk is a levee failure. A levee breach would cause extensive damage to farm and community infrastructure. A section of levee at the mouth of the Pilchuck River, for example, has received pressure from both flood waters and sediment deposition in recent years and has needed repair and fortification.

### GROUNDWATER LEVELS

Groundwater levels in the French Slough Flood Control District are projected to be impacted by sea level rise. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] French Slough Flood Control District is 13 miles from the mouth of the Snohomish River, yet the low gradient of the river translates into groundwater level impacts from sea level rise into a portion of the District. These increases may impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on these sea level rise predictions. The study found median projected delays of 4 weeks by 2080 and 5 weeks by 2100 in the downstream (western) portion of the District (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this District to actively pump water out of the system. Increased pumping, therefore, could mitigate the impact of these rising groundwater levels.

### LAND SUBSIDENCE

Much of the land in this district was once a 4,000-acre scrub-shrub wetland in the lower French Creek watershed that has since been drained for agricultural use.[13] As such, approximately 2,000 acres are soils high in organic matter. Cultivation and drainage of these soils has resulted in higher decomposition rates, causing the land to subside quickly. A study of subsidence rates completed for this planning effort in the Lower Snohomish River floodplain indicates rates of approximately 1-6 inches of subsidence every 10 years in some areas, although there is a large amount of error associated with this estimation.[11]

### OTHER

Other current and projected impacts:

- Continued increases in surface water runoff coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. The lack of available water rights threatens viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden of farmers in the floodplain. New permitting requirements for increased protections for fish during ditch cleaning have also resulted in higher costs to complete maintenance. There is a need to explore ways to increase the amount of stormwater runoff funding received from local jurisdictions to support ditch and waterway maintenance as well as assist with electricity costs to run the pump station. Farmers would also benefit from assistance replacing or installing drainage infrastructure on individual farms.
- **Increased funding available for larger levee and drainage infrastructure projects.** Although levees and pumps are in good condition, a levee breach would mean costly repairs that would exhaust the existing

contingency funds available. It would help to explore options and partnerships for developing a grant and/or loan program for larger resilience projects.

- **Access to water for irrigation.** Most farms do not have sufficient water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Flood risk training for new landowners.** New farmers moving into the District could benefit greatly from training on how to minimize flood risk by accessing flood data and predictions available through Snohomish County and by preparing for floods.
- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.
- **Reduce subsidence.** There is a need to explore creative approaches to reducing subsidence in areas where organic soils are decomposing, potentially through soil augmentation.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

## TIER TWO (LOWER PRIORITY)

- **Conserve existing farmland.** The proximity of this floodplain reach to the cities of Snohomish and Monroe put development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape-scale. There is a need to pursue innovative approaches to increasing funding available to remove development rights.
- **Research alternative on-farm drainage infrastructure techniques.** The District could benefit from funding for research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.
- **Assistance with permitting for drainage system maintenance.** Every 5 years, the District is required to renew their Hydraulic Project Approval permit with the Department of Fish and Wildlife, allowing them to maintain their drainage infrastructure. The District could use assistance with this process through staff capacity and funding.
- **Reduce upland runoff.** It would help to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious or drainage projects on their properties.

# Snohomish River Confluence – Tualco Valley and Vicinity

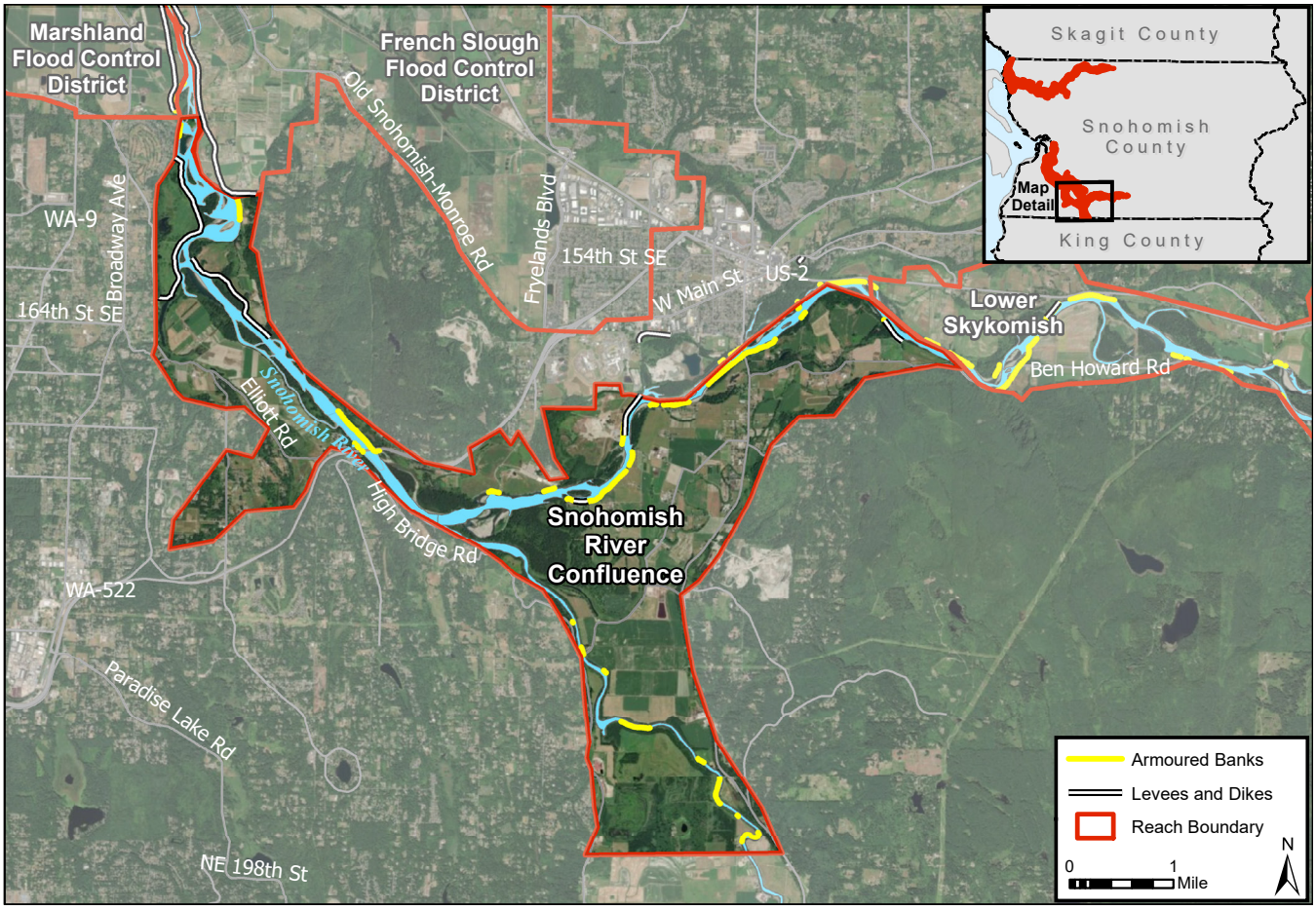


**Figure VII-12. Map of the Snohomish River Confluence.** This figures shows the boundary of the Tualco Valley and vicinity along with existing levees and revetments.

## Description

The agricultural area in the vicinity of the Tualco Valley supports a thriving agricultural industry which is able to take advantage of a wide floodplain with rich soils, yet is far enough from larger urban centers to remove some of the pressures associated with development and to keep land prices low. Of the 8,800 acres in this area, approximately half is actively used for commercial agriculture. The livestock industry dominates this area, with approximately 1,000 acres in hay and silage (to support the five small and large-scale dairies) and 1,300 acres in pasture. Smaller acreages are dedicated to producing cereal grains, vegetables, and flowers. Between 2004 and 2011, this area was the focus of a farmland protection effort by Snohomish County

that resulted in more than 450 acres of farms being protected from future development through a Purchase of Development Rights program.

### DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. The levees are not contiguous as in the Lower Snohomish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees along with multiple shoreline armoring projects were built primarily between 1920 and 1950, largely by the Army Corps of Engineers. Individual farmers maintain drainage infrastructure as well as shoreline armoring projects on their properties.

### ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre. The density fringe regulatory framework protections that exist in downstream floodplain reaches do not extend into this area, although much of the area is designated as floodway. The floodway designation carries significant restrictions on development (SCC 30.65.220). For this reason, loss of commercial farmland to development or subdivision is not a major threat.

## Current and future impacts

### FLOODING

The Snohomish River estuary is low gradient, with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. While there is a muted tidal signal in and around the Tualco Valley, flooding is largely dependent on river flows and not tides or sea level.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1]

Local farmers have already noticed more intense and longer duration flooding than in the past. The major impacts of flooding in this reach include:

- Sand and silt deposition on fields, which can result in decreased yields
- Flood debris on fields, which requires costly clean-up and repair
- Damage to structures, which results in costly repair
- Threats to livestock, including harm to animals, decreased milk production, or impacted milk transport
- Pasture inundation, which can harm pasture grass
- Bank erosion, which causes loss of farmland in limited locations

### GROUNDWATER LEVELS

Groundwater levels and saltwater intrusion in the Snohomish Confluence area are not expected to be impacted by rising sea levels due to the large distance from the Puget Sound.[3] Groundwater levels may be impacted by increased riverine flooding or upland stormwater runoff, although these effects are predicted to be shorter in duration than the sustained impacts of sea level rise downriver.

### RIVER CHANNEL AGGRADATION

Local farmers report that they have noticed channel aggradation in this reach of the Snohomish and Skykomish Rivers. In a study of aggradation completed as part of this plan, channel aggradation was identified between river miles 12 and 17 (from the City of Snohomish just past the confluence of the Skykomish and Snoqualmie Rivers) between 2001 and 2017.[11] The overall capacity of the channel to carry flood waters, however, was not reduced, likely due to channel widening.[11] This study, therefore, concluded that changes in flooding on agricultural land are not a result of river channel aggradation.

### OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation. Permitting constraints also make it difficult to clean these waterways in a timely manner.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden of farmers in the floodplain. There is a need to explore ways to increase funding available to include compensation from upland stormwater runoff impacts to pay for ditch and waterway maintenance.
- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several types of actions are recommended. Both on-farm drainage improvements (e.g. tile systems) and landscape-scale drainage projects along waterways (e.g. culvert replacements and channel excavation) will increase resilience to changes in hydrology.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

### TIER TWO (LOWER PRIORITY)

- **Flood risk training for new landowners.** New farmers moving into the District could benefit greatly from training on how to minimize flood risk by accessing flood data and predictions available through Snohomish County and by preparing for floods.
- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.
- **Research alternative on-farm drainage infrastructure techniques.** The District could benefit from funding for research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.
- **Reduce upland runoff.** Explore the use of green stormwater infrastructure, regulatory changes to county code, and/or education and incentives for urban/suburban landowners to reduce impervious or drainage projects on their properties.

# Lower Skykomish River

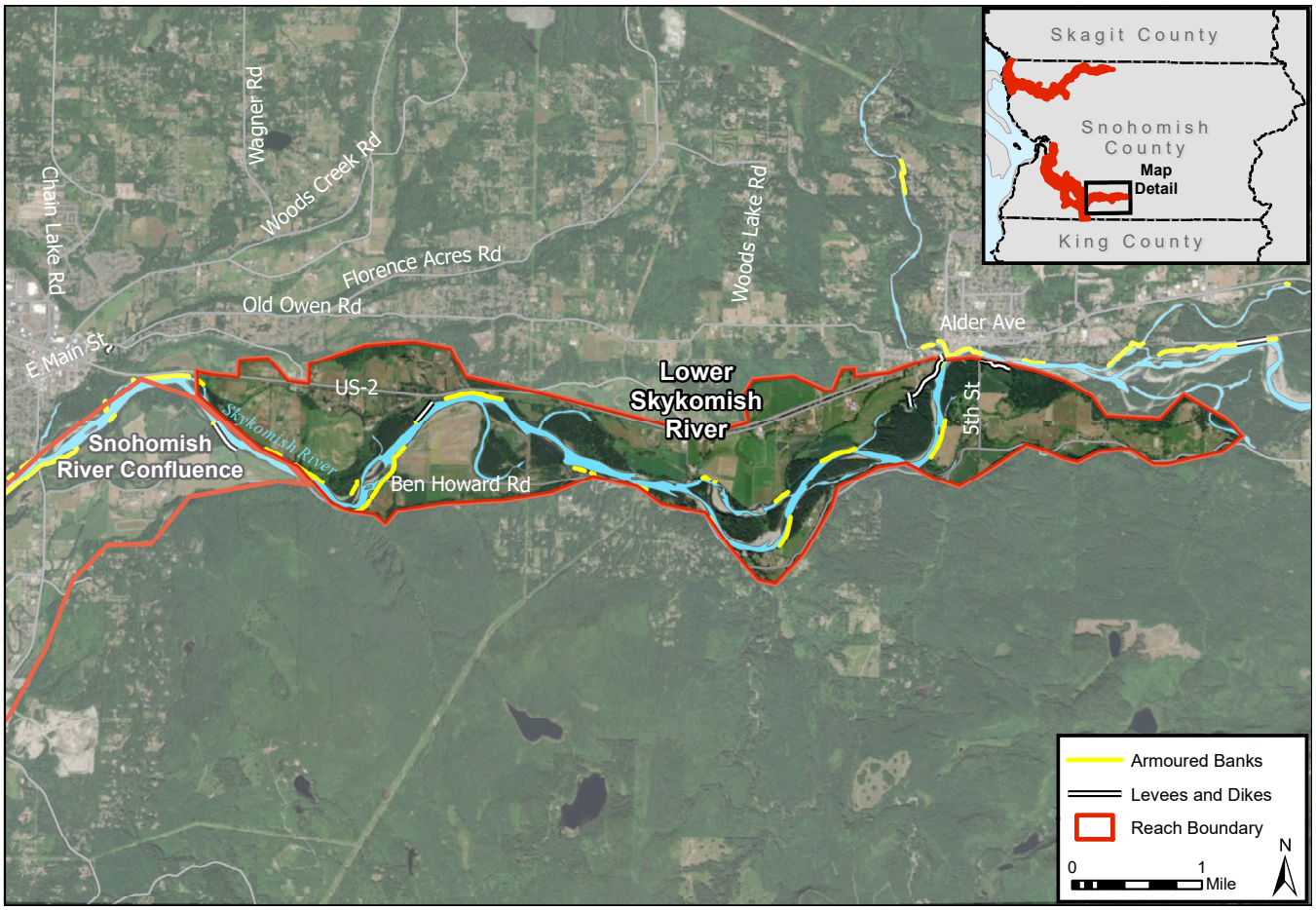


**Figure VII-13. Map of Lower Skykomish River floodplain.** This figure shows the boundary of the Lower Skykomish River, along with existing levees and revetments.

## Description

The floodplain narrows above the confluence of the Skykomish and Snoqualmie Rivers, but commercial agriculture remains viable up the Skykomish River for approximately fifteen additional miles. The Lower Skykomish area represents approximately 1,700 acres of commercial agricultural land predominately in feed and forage production to support the livestock industry and local dairies. In addition, smaller acreages support production of vegetables, cereal grains and nursery plants.

### DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. Existing levees are not contiguous as in the Lower Snohomish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees along with multiple shoreline armoring projects were built primarily between 1920 and 1960, largely by the Army Corps of Engineers. Individual farmers maintain drainage infrastructure as well as shoreline armoring projects on their properties.

### ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre. The density fringe regulatory framework protections that exist in downstream floodplain reaches do not extend into this area, although much of the area is designated as floodway. The floodway designation carries significant restrictions on development (SCC 30.65.220). For this reason, as well as the large distance from urban areas, loss of commercial farmland to development or subdivision is not a major threat.

## Current and future impacts

### FLOODING

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events).[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] In the Lower Skykomish River floodplain, the current modeled 2-year event does not leave the river channel, yet by the 2050's it is expected to inundate much of the floodplain. The frequency of flood events is also projected to increase.

The largest projected impact of these higher intensity floods will be loss of farmland to eroding riverbanks. Much of this reach has been armored with rip rap along banks, locking the channel into place to reduce channel migration. This has had the added effect of causing channel incision in some areas, further exacerbating bank erosion by disconnecting the river from the floodplain during larger floods.

## Resilience Needs

### TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Protect farmland from riverbank erosion.** Numerous bank stabilization projects were put in place in the mid-1900s. Several of these have started to erode, but new permit requirements have made it difficult and costly for farmers to repair them or construct new projects.

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3 Cardno, 2019. Climate impacts to groundwater in the Lower Snohomish and Stillaguamish River basins. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

4 Northwest Hydraulic Consultants (NHC), 2014. Douglas Creek and vicinity hydrologic and hydraulic modeling. Report prepared for Snohomish County. Everett, WA.

5 Snohomish County Public Works Surface Water Management (SWM), 2015. Douglas Creek and vicinity basin characterization report. Everett, WA.

6 Snohomish County Surface Water Management (SWM) and the SLS Executive Committee, 2018. Mainstem Stillaguamish River Reach-scale Plan. Snohomish County Department of Public Works and the Executive Committee of the Sustainable Lands Strategy. Everett, Washington.

7 Mauger, G.S., S.-Y. Lee, and J.S. Won. 2019, Mapping the future of flood risk for the Stillaguamish and Snohomish Rivers. Report prepared for the Snohomish Conservation District. Climate Impacts Group, University of Washington, Seattle.

8 Cardno, 2019. Technical Memo: Stillaguamish Flood Control District subsidence and sedimentation study. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

9 Snohomish County Public Works Surface Water Management (SWM), 1991. Snohomish River Comprehensive Flood Control Management Plan. Everett, WA.

10 Bartelheimer, D., 2019. Personal communication with Cindy Dittbrenner (Snohomish Conservation District). October 20, 2019.

11 Cardno, 2019. Technical Memo: Lower Snohomish River District subsidence and sedimentation study. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

12 Wheeler, Neil, 2019. Personal communication with Cindy Dittbrenner (Snohomish Conservation District). August 27, 2019.

13 Snohomish County, 2004. French Creek Watershed Management Plan. Everett, WA.