EXISTING FLOOD RISK CONDITIONS FOR AGRICULTURE IN THE CLEAR CREEK AREA

Technical Memorandum
Farming in the Floodplain Project

Prepared for
PCC Farmland Trust

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1.0 Project Background and Description

This technical memorandum has been prepared as part of Phase 2 of the Farming in the Floodplain Project (FFP). The FFP is one of four components of the Floodplains for the Future: Puyallup, White, and Carbon Rivers project, which is funded by a Floodplains by Design grant from the Washington Department of Ecology (Ecology). The purpose of the FFP is to advance progress toward a collectively agreed upon plan for the Clear Creek area that improves agricultural viability in the area while also meeting goals for flood risk reduction and salmon habitat enhancement. The FFP is intended to clarify the needs and interests of the agricultural community within the Clear Creek area.

In Phase 1 of the FFP, ESA prepared an Existing Conditions Report which identified physical conditions in the Clear Creek area that limit agricultural viability. The report found that flood risk in the Clear Creek area is complicated and is not well understood by all stakeholders involved in the Floodplains for the Future project. As part of Phase 2, ESA has conducted additional research on flood risk, including coordination with Pierce County Surface Water Management (SWM).

The purpose of this memorandum is to provide information on existing flood risk conditions for farms in the Clear Creek area.

The Clear Creek area faces both flooding and drainage issues. ESA is also preparing a Drainage Inventory Memorandum which will focus on drainage issues. For the purposes of these memorandums, drainage refers to conveyance of water through the area and to the Puyallup River and includes topics related to ditches and culverts. Flooding refers to events where water levels are ponded and are generally above the surfaces of local roads.

This memorandum includes sections on the relationship of flood risk to agricultural viability, flood risk to organic certification and crops, vulnerabilities in the Clear Creek area flood system, ongoing and planned actions to reduce vulnerabilities in the Clear Creek area, and findings.

2.0 Study Area

The study area for the FFP is the Clear Creek area, part of the Clear Creek Subbasin of the Puyallup River Watershed (Figure 1). The Clear Creek Subbasin is within the Puyallup River Watershed and is located south of the Puyallup River, north of 128th Street East, west of 66th Avenue East, and east of McKinley Avenue East. The Clear Creek area is roughly 1.5 square miles (990 acres) in size and bounded by the Puyallup River to the north, Pioneer Way East to the south and west, and 52nd Street East to the east.
SOURCE:
ESA, 2016; King County, 2015; Pierce County, 2013; Ecology, 2007; OSM, 2016; WDNR, 2010

Figure 1
Puyallup Watershed
3.0 Relationship of Flood Risk to Agricultural Viability

As described in the Existing Conditions Report, flooding presents a risk to agricultural viability in the Clear Creek area (ESA, 2016b). Several farmers in the area have stated that recent incidences of high water from Clear Creek flooding low-lying areas did not represent a threat to their farms. However, recent high water events were well below record high water elevations and therefore do not represent the maximum potential extent, duration, or depth of floodwater inundation of farms in the Clear Creek area. The greatest risk of flood damage would come from the unlikely but possible chance of River Road Levee being breached because of the erosive water velocities and the resulting rapid rise in water elevation within the Clear Creek area. Overtopping of the River Road Levee without a breach would be a less disastrous but more likely risk.

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

- Human health and safety is threatened for farmers who live on their farms in the floodplain;
- Crops can be killed or their growth stunted from standing water;
- Edible crops coming into contact with floodwaters are not suitable for human consumption (flooding typically does not occur during the growing season for most crops, but some perennial crops, such as blueberries, are grown in the Clear Creek area);
- Flooding can also prevent or discourage farmers from planting cover crops, which are an important tool for soil health and pest management;
- Flooding can inundate and damage agricultural equipment and structures, such as barns; and
- Flooding is a risk to livestock.

4.0 Flooding Risk to Organic Certification and Crops

During Phase 1 of the FFP, farmers in the Clear Creek area expressed concerns that flooding represented a risk to a farm’s organic status. A number of farms in the Clear Creek area use organic growing practices. For small, direct-market farms in the Clear Creek area that rely on selling produce at farmers markets and through Community Supported Agriculture (CSA) subscriptions, maintaining organic certification is an important element of their viability as a farm business. Clear Creek area farmers expressed concern that flooding could trigger an inspection that could lead to loss of organic certification due to contaminants carried by floodwaters that are deposited on their crops or soils.

The Washington State Department of Agriculture (WSDA) Organic Program is accredited to certify organic farms in Washington State in accordance with the United States Department of Agriculture (USDA) National Organic Program (NOP). A certification fact sheet released by the WSDA in January 2012 states clearly that flooding of a farm does not jeopardize the farm’s organic certification (WSDA, 2012).
The certification fact sheet states that crops that have come into contact with floodwaters are considered adulterated and cannot be sold for human consumption. It also states that USDA NOP standards are based on proper practices and do not mandate zero tolerance for residues of prohibited materials in soils. In some cases, the WSDA Organic Program may test crops grown on organically-certified farms following a flood event. If the samples show residues of prohibited materials over certain thresholds (the U.S. Food and Drug Administration (FDA) action level or above 5% of the EPA tolerance), the crops cannot be sold as organic and the farm must develop a plan to prevent additional contamination in the future (WSDA, 2012). Therefore, while flooding does not threaten the organic certification of a farm, it does threaten the viability of the farm business by potentially requiring crops grown after a field was inundated to be sold at lower prices as conventional produce.

After the December 2007 flood on the Chehalis River, the WSDA visited 17 organic farms that had been inundated to walk the fields and observe flood impacts. Inspectors found no signs of synthetic contaminants. Several months later, WSDA staff collected plant samples from the farms and tested them, but did not find any evidences of contamination that would threaten organic status of produce grown that season (WSDA, 2012).

Contaminants in floodwaters still represent a risk to food safety. Any crops that have come into contact with floodwaters are considered “adulterated” by the FDA and cannot be sold for human consumption. The FDA recommends waiting 60 days before replanting flooded fields and keeping a 30 foot buffer between areas that have been flooded and adjacent areas to be harvested for human consumption to prevent cross contamination between flooded and non-flooded areas (FDA, 2011).

The WSDA has produced a video on flood preparation and recovery as part of its “Farm Wisdom” video series on managing risk on small farms. The video is available at [https://www.youtube.com/watch?v=NLcTC19JxD4](https://www.youtube.com/watch?v=NLcTC19JxD4).

### 5.0 Vulnerabilities in the Clear Creek Area Flood System

Flooding in the Clear Creek area is caused by a complex interaction of flows in the Puyallup River and Clear Creek and its tributaries. The flood control system in the area consists of levees, an upstream dam, tide gates, and stormwater detention ponds on Swan, Squally, and Canyon creeks. The flood system includes several vulnerabilities. These vulnerabilities, each of which is described below, include:

- Flooding from the Puyallup River
- River Road Levee
- Mud Mountain Dam
- Flooding from Clear Creek and its four tributaries
- The Clear Creek tide gates
- Climate change
The Clear Creek Floodplain Reconnection Hydrologic and Hydraulic Modeling Final Report, prepared by Northwest Hydraulic Consultants Inc. (NHC) for Pierce County in 2015, identifies four sources of floodwaters in the Clear Creek area:

- Discharges from Swan, Squally, Clear, and Canyon creeks,
- Precipitation falling directly on the floodplain,
- Floodwater entering Canyon Creek via overflow from Clarks Creek during extreme flood events, and
- Floodwaters from the Puyallup River, which enter the Clear Creek floodplain when allowed to by operations of the tide gates (NHC, 2015).

Floodwaters could also enter the Clear Creek area from the Puyallup River by overtopping or breaching River Road Levee, which was not included in NHC’s modeling.

Various components of flooding in the Clear Creek area have been described as “backwater flooding” in the NHC report, previous reports prepared by ESA, and conversations between stakeholders. The National Weather Service glossary defines backwater flooding as “upstream flooding caused by downstream conditions such as channel restriction and/or high flow in a downstream confluence stream” (NOAA, 2017). Based on this definition, this memorandum uses the term backwater flooding to describe flooding in the Clear Creek area caused by the inability of water in the Clear Creek channel to flow into the Puyallup River due to high water levels in the river.

5.1 Puyallup River Flooding

The Clear Creek area is in the Lower Puyallup reach of the Puyallup River. It was historically part of the floodplain of the Puyallup River, but was disconnected from the floodplain when River Road Levee was constructed in the 1910s. Disconnecting the area from the Puyallup River protected it from Puyallup River flooding, but also cut off the supply of sediment that historically was deposited in the area and built up the agricultural soils.

According to the Pierce County Flood Plan, major flooding in the Lower Puyallup River occurred in 1906, 1917, 1919, 1921, 1932, 1933, 1934, 1965, 1977, 1986, 1990 (twice), 1996, 2006, and 2009 (Pierce County, 2013). The Clear Creek area also flooded three times in 2015. The 2009 flood, with a flow of 48,200 cubic feet per second (cfs), was the largest on record since completion of Mud Mountain Dam in 1948 (Pierce County, 2013). The 2009 flood (in the Puyallup River Watershed and throughout Western Washington) was caused by heavy rainfall, warm temperatures, and melting snowpack (Corps, 2016). Runoff in the watershed has increased since 2005 and extensive sediment deposition has reduced the capacity of the Puyallup River channel, which the Corps considers the primary driver of changes in flood risk in the area (Corps, 2016). Additional information on sediment conditions in the Puyallup River can be found in the Sediment Memorandum prepared for the FFP (ESA, 2016c).

The majority of rainfall in the Puyallup River Watershed (approximately 75 percent) occurs between October and March, and the majority of floods occur between November and February. Larger floods typically occur due to atmospheric rivers. Atmospheric rivers are concentrated but
relatively narrow streams of moisture that carry significant volumes of water vapor. The storms that bring atmospheric rivers to the Pacific Northwest from the tropics are also known as “Pineapple Express” events. The average duration of floods in the Puyallup River Watershed is typically 1 to 2 days, which can be extended by several days in the lower White and Puyallup rivers by flow regulation at Mud Mountain Dam.

As described in the “River Road Levee” section below, flooding of the Puyallup threatens to overtop River Road Levee, which would inundate farm businesses and residences in the Clear Creek area. If the Clear Creek tide gates are not properly functioning, they may not close, which would cause Puyallup River water to back up into the Clear Creek area, also inundating farm businesses and residences. This occurred in the 2006 and 2009 floods (Hunger and Schmidt, 2016). Even if River Road Levee does not overtop, increased flooding levels on the Puyallup River directly lead to flooding in the Clear Creek area. While the Puyallup River is flooding, the Clear Creek tide gates shut, causing Clear Creek to back up, flooding farm businesses and residences. The more frequently the Puyallup River floods, the more frequently the Clear Creek area floods due to this backwater flooding. The higher flood levels are on the Puyallup River, the longer the tide gates will be closed, increasing the level and duration of backwater flooding from Clear Creek.

**River Road Levee**

The levees on the Puyallup River upstream of River Mile (RM) 2.8 are owned and operated by Pierce County, including the North Levee Road Levee and the River Road Levee (Pierce County, 2013). North Levee Road Levee, located on the right bank of the Puyallup River, reduces flood risk to the City of Fife and other areas north of the Puyallup River. River Road Levee reduces flood risk to the Clear Creek area from Puyallup River. Potential damage to the levees is considered the highest flood risk on the Puyallup River system (Pierce County, 2013). If the levees were not in place, annual damage from flooding in the Lower Puyallup River would be an estimated $7.6 million, with damages of $78.7 million estimated from a 100-year flood event.

According to the Pierce County Rivers Flood Hazard Management Plan (Flood Plan), both levees are in good condition and are structurally sound (Pierce County, 2013). However, the levees were constructed before there were federal standards for levees. Current standards adopted by Federal Emergency Management Agency (FEMA) require three feet of freeboard (height of levee above the 100-year flood elevation) for accredited levees. During flood modeling conducted in 2004, it was discovered that both levees do not provide adequate freeboard, and FEMA subsequently de-accredited both levees.

FEMA requires the following standards be met for accredited levees:

- **Freeboard.** A minimum freeboard of 3 feet above the base flood elevation all along the length of the levee, with an additional 1 foot within 100 feet of structures (such as bridges) or wherever the flow is restricted, and an additional 0.5 foot at the upstream end of a levee.

- **Closures.** All openings must be provided with closure devices that are structural parts of the system during operation and designed according to sound engineering practices.
• **Embankment Protection.** Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation direly or indirectly through reduction of the seepage path and subsequent instability.

• **Embankment and Foundation Stability Analyses.** Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided must evaluate expected seepage during loading conditions associated with the base flood and must demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability.

• **Settlement Analyses.** Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained.

• **Interior Drainage.** An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than 1 foot, the water-surface elevation(s) of the base flood (FEMA, 2016b).

River Road Levee was de-accredited due to lack of freeboard. No analysis of whether River Road Levee would meet the other accreditation standards has been conducted at this time.

In 2009, a study of the levees conducted for Pierce County by TetraTech found that a 100-year flood event would overtop the North Levee Road Levee at RM 3.3, but would not overtop the River Road Levee (Pierce County, 2013). The simulation found that a 500-year flood event would overtop the North Levee Road Levee at RM 3.3 and would also overtop the River Road Levee at RM 3.1, causing flooding in adjacent areas for over 24 hours. River Road Levee was also simulated to overtop at RM 4.5, 5.55, and 7.2 for shorter durations (Pierce County, 2013). Specific rive mile locations at overtopping locations are based on modeling; due to dynamic flood conditions, overtopping in an actual flood event could vary in location. In 2006 and 2009, flood levels were projected to overtop the River Road Levee, and Pierce County called for an evacuation of the Clear Creek area (Pierce County, 2016a; Hunger and Schmidt, 2016). Fortunately, in both events, precipitation patterns changed and the levee was not overtopped. In recent events, such as the 2009 flood, floodwaters have reached the edge of the Highway 167 road surface (Hunger and Schmidt, 2016).

The potential exists for River Road Levee to overtop or breach. This represents the biggest potential flood risk to farms in the Clear Creek area. Overtopping of the levee could significantly affect farms (as well as human health and safety) in the Clear Creek area. Homes, barns, fields, and equipment throughout the Clear Creek area could be inundated. Humans in the area could be physically at risk and evacuations could be called for by Pierce County based on flood forecasts. Livestock would also be threatened by an overtopping flood event.

Regardless of whether the levee overtops or otherwise fails to protect the area, the vulnerability of the levee currently affects agricultural viability because it causes the area to be mapped as a floodway. This is discussed in more detail below in Section 6.2.
Mud Mountain Dam

The White River flowed north to the Duwamish River until an avulsion (an incident in which a river rapidly abandons its channel and forms a new channel) in 1906 rerouted the river into the Puyallup River Watershed, doubling the size of the basin. Mud Mountain Dam is located on the White River and is operated by the Corps to provide flood control for the Lower Puyallup River. The dam was authorized by Congress after the 1933 flood, which destroyed levee systems in the Lower Puyallup River valley. The operation of the dam, completed in 1948, is intended to keep the peak flood flow on the Lower Puyallup River to less than 45,000 cfs by holding back flows on the White River. After the peak flow on the Puyallup River passes, the water stored behind Mud Mountain Dam is released into the White River (Corps, 2016). In recent years, sedimentation in the White River channel, encroachment into the floodplain by development, and other factors have required changes in the operation of Mud Mountain Dam (Pierce County, 2013). After the November 2008 flood, a flow of 12,000 cfs was released from Mud Mountain Dam without incident. For comparison, the average November flow in the White River downstream of Mud Mountain Dam at the USGS gaging station in Auburn is 1,870 cfs. In January 2009, a release of the same flow rate of water caused flooding in the town of Pacific. It was determined that the channel capacity in the area had been reduced to approximately 6,000 to 8,500 cfs. In 2015, a release of 6,000 cfs from the dam again caused flooding in Pacific, indicating that the channel capacity continues to decrease (Corps, 2016). The loss of channel capacity in the White River causes the Corps to release floodwaters held behind Mud Mountain Dam more slowly when possible, reducing the ability to draw down the reservoir in anticipation of future flood events. Flows on the Lower Puyallup exceeded 45,000 cfs (up to 48,200 cfs) in the January 2009 flood despite the operation of Mud Mountain Dam. For comparison, average January flows on the Puyallup River at the USGS gaging station in the City of Puyallup are 4,375 cfs.

Changes in the operation of Mud Mountain Dam affect agricultural viability in the Clear Creek area. Because of the loss of channel capacity, floodwaters from Mud Mountain Dam are released more slowly. Therefore, it takes longer to move floodwaters through the system, causing the Lower Puyallup River to be at elevated levels for longer. This in turn delays water draining from the Clear Creek tide gates, during which time Clear Creek and its tributaries continue to drain into the area, increasing the water levels in the Clear Creek area.

Climate Change and Puyallup River Flooding

Flood risk throughout Puget Sound is projected to increase with climate change. Heavy rainfall events are projected to become heavier, increasing peak flows. Sea levels are projected to rise. At
the same time, sediment loads are projected to increase and the Puyallup River is predicted to aggrade, reducing channel capacity to handle the increased peak flows.

The Puyallup River Watershed is a “mixed rain and snow” watershed, meaning that about 30 percent of the total volume of precipitation in the basin falls as snow while the rest falls as rain (CIG, 2015b). The percentage of precipitation that falls as snow is relatively high because the headwaters of the rivers include high elevation areas on Mount Rainier. Accumulated snowpack within a watershed effectively stores water through the winter until it starts to melt in the spring, shifting a portion of streamflow to later in the year. The Puget Sound region as a whole is projected to see a decrease in snowpack and an associated increase in the percentage of precipitation falling as rain. Mixed rain and snow watersheds are projected to see the largest changes in flooding as they transition to a greater balance of rain relative to snow (CIG, 2015b).

Flood risk is projected to increase in the Puyallup River Watershed and across Puget Sound. Peak daily river flows are projected to increase between 18 and 55 percent by the 2080s, and peak daily rainfall events are projected to become 5 to 34 percent more intense (CIG, 2015b). Under a climate change projection based on a moderate greenhouse gas emissions scenario, the volume of the 10-year flood in the Puyallup River is projected to increase 12 to 85 percent by the 2080s (CIG, 2016). Increased flooding would increase the cost of flood protection and stormwater management. Highways and other roads adjacent to rivers would flood more frequently. Existing flood control infrastructure, such as levees and tide gates, could be stressed by more frequent floods and from floods that exceed the magnitude of events the infrastructure was designed for (CIG, 2015b).

In addition, sea level is projected to rise an additional 14 to 54 inches in the Puget Sound region by 2100, although changes at specific locations will vary because of local variations in the rates of land subsidence and uplift (CIG, 2015b).

As flood water levels on the Puyallup River increase with climate change, the probability of River Road Levee overtopping and inundating farms in the Clear Creek area will also increase. Increased water levels from sea level rise and river flooding will also delay drainage from the Clear Creek tide gates, increasing backwater flooding of Clear Creek area.

### 5.2 Clear Creek Flooding

Large portions of the Clear Creek area are mapped as being within the 100-year floodplain. Mapped flood elevations within the floodplain are at about 18 feet NAVD in a 100-year flood (Pierce County, 2013). In addition, each of the four tributaries to Clear Creek (Swan Creek, Squally Creek, Clear Creek, and Canyon Creek) has a mapped floodplain along these creeks going upstream through their respective canyons.

The 100-year flood flows in Clear Creek are over 700 cfs (Schmidt, 2016), as compared to a mean December flow of 15.4 cfs. The Pierce County Flood Plan shows over 20 repetitive loss properties (i.e., properties with more than one flood insurance claim within a 10-year period) in the Clear Creek area. Other properties without flood insurance also have had repetitive flooding (Dixon, 2017). Floodwaters reached an elevation of 18 feet above sea level in the Clear Creek area.
area in the 2009 flood and over 10 people had to be rescued (Pierce County, 2013). Flooding of this elevation in the Clear Creek area inundates approximately 400 acres of land (Pierce County, 2013).

SWM staff have stated that, in the 2015 flood, water came from the south and flowed over 44th Street south to north, which they stated is the opposite direction of typical flood flows in the area (Hunger and Schmidt, 2016). It is unclear why this occurred, but the County speculates that it could be connected to South Ditch being blocked from draining directly into Clear Creek, as reported in the Agricultural Drainage Inventory Preliminary Findings Memo (ESA, 2016a). Drainage District 10 has speculated that this occurred due to overgrowth of reed canarygrass in the channel of Clear Creek (Neville, 2017).

Clarks Creek is directly to the east of the Clear Creek subbasin and the Clear Creek area. According to SWM staff, some landowners in the Clear Creek area believe that, in the 2009 flood, floodwaters from Clarks Creek overflowed into the Clear Creek area (Hunger and Schmidt, 2016).

**Tide Gates**

ESA is currently conducting an assessment of the Clear Creek tide gates for an upcoming technical memorandum. The following description of the tide gates is based on information gathered for that effort, including the Pierce County Rivers Flood Hazard Management Plan (Pierce County, 2013); Port of Tacoma technical information, construction plans, and as-built plans (Port of Tacoma, 1995; Port of Tacoma, 1997a; Port of Tacoma 1997b); and Pierce County’s tide gate fact sheet (Pierce County, 2016b).

There are tide gates at the end of two large rectangular concrete conduits under the River Road Levee where Clear Creek enters the Puyallup River. These rectangular tide gates are both located at the river-side end of the conduits and are hinged at their tops. This configuration prevents water from flowing backwards through the conduit and into the Clear Creek area when the river level is higher than the water level on the other side of the tide gates. Any time the water level in the river is lower than in the Clear Creek area, the difference in water elevation pushes the gates open to let water out. In the mid-1990s, the Port of Tacoma replaced one of the tide gates with a top-hinged tide gate mounted on a sliding frame. The intent of this configuration is to slide the tide gate assembly up away from the conduit most of the time. An actuator slides the tide gate assembly back down into place when the water elevation in the river rises to a set elevation. The tide gates may act as a barrier to fish passage during high flow events on the Puyallup River, when juvenile salmon need refuge from high velocity flows.

In the 2006 and 2009 floods, the newer tide gate assembly was slid up away from the end of the conduit, which allowed Puyallup River floodwaters to flow into the Clear Creek area (Hunger and Schmidt, 2016). Flood elevations in the Clear Creek area in the 2009 flood topped out at approximately 18 feet above sea level. In the 2015 floods, the tide gate was slid into position at the end of the conduit, and consequently the flood water elevation in the Clear Creek area during this event only reached 14.5 feet (Hunger and Schmidt, 2016).

Modeling conducted by NHC for the Clear Creek Floodplain Reconnection Project included a variety of scenarios for the outlet of Clear Creek into the Puyallup River. The modeling results...
allow comparison of existing conditions to conditions with two open culverts (i.e., removal of the tide gates) (NHC, 2016). Model results indicate that removal of the tide gates would:

- increase the 10-year flood stage from approximately 16.9 feet to approximately 18.6 feet (1.7 foot increase);
- increase the 50-year flood stage from 19 feet to approximately 20 feet; and
- increase the 100-year flood stage from approximately 20.1 feet to approximately 20.4 feet (NHC, 2016).

These results indicate that the tide gates, when operating properly, protect agricultural properties (particularly those at elevations between 17 and 21 feet) from more frequent flood inundation.

The Clear Creek tide gates contribute to agricultural viability in the Clear Creek area by preventing flooding from the Puyallup River. The largest recent flood event in the Clear Creek area occurred when the newer tide gate was slid up away from the end of the conduit during river flooding conditions, which is not the way it was intended to be operated (Hunger and Schmidt, 2016). Floodwater elevations in the Clear Creek area are lower when the tide gate is slid into position at the end of the conduit to prevent flow of water from the river into the area. However, increases in the Puyallup River water levels, such as from higher tides or larger river flows due to climate change or from changes in the operation of Mud Mountain Dam as discussed below, result in longer periods of time when the water from the Clear Creek area collects, waiting to flow out through the tide gates. Anything that would increase the flow of water into the Clear Creek area compounds the problem and would result in higher water levels there.

If the newer sliding tide gate were positioned up away from the end of the conduit when the river levels are high, Puyallup River water would back up into the Clear Creek area, possibly inundating farm businesses and residences. This occurred in the 2006 and 2009 floods (Hunger and Schmidt, 2016).

Additional information on the operation of the tide gates is being researched as part of ESA’s work on Phase 2 of the Farming in the Floodplain Project. A technical memorandum on this topic, including information needs for understanding the relationship of the tide gates to flood risk, will be released in spring 2017. In addition, Pierce County has installed water elevation recorders on both sides of the tide gates. This data will confirm how the newer sliding tide gate assembly is being operated, which will be described in ESA’s memo on the tide gates.

**Climate Change and Clear Creek Flooding**

Climate change information specific to Clear Creek and its tributaries has not been developed. The Clear/Clarks Creek Basin Plan, written in 2006, does not refer to climate change. The more recent Swan Creek Watershed Action Plan (2015) also does not refer to climate change, though the sediment loading analysis included as an appendix does state that “As urbanization (and climate change) progress and the stream continues to see increased flow, the stream may be in a continual state of adjustment” (Pierce County, 2015). It is likely that all four tributaries of Clear Creek will be in a state of adjustment as climate change and development change streamflow and sediment dynamics. Unlike the Puyallup River, Clear Creek and its tributaries do not have glacial headwaters, so the impacts of climate change on flooding are likely to be less dramatic than on
the Puyallup. However, heavy precipitation events are projected to become more intense, meaning that climate change is likely to increase the frequency, volume, and duration of flood events on Clear Creek. In addition, increased sediment due to climate change could increase aggradation and reduce channel capacity in Clear Creek. Climate change could make inundation of farmlands in the Clear Creek area more likely in the future.

6.0 Ongoing and Planned Actions to Reduce Vulnerabilities in the Clear Creek Area

6.1 Federal Regulations and Programs

Pierce County is a participating community in the National Flood Insurance Program (NFIP), which provides affordable insurance to property owners in communities that join the NFIP. The County is also active in the Community Rating System (CRS), which is an incentive program for communities in the NFIP that provides discounts to the flood insurance rates for property owners when the community takes action to meet the floodplain management goals of the CRS, which are: (1) reduce flood damage to insurable property; (2) strengthen and support the insurance aspects of the NFIP; and (3) encourage a comprehensive approach to floodplain management (FEMA, 2016a).

Being a part of the CRS is voluntary and involves a high degree of effort on behalf of the communities that participate. Pierce County is one of the few communities that are within the highest levels (equating to the largest discounts on flood insurance premiums for property owners) of the CRS. The classes range from 1 (being the highest) through 10, and Pierce County is one of three Washington counties that have achieved a CRS class of 2 (out of a total of five communities nationwide), which results in a 40 percent discount on flood insurance premiums. Only one community in the U.S. is listed as a class 1 (FEMA, 2016a).

Other communities in the area are either not participating in the CRS or are listed in a lower class which does not afford discounts as high as Pierce County residents receive. The City of Fife, for example, participates in the NFIP but is not an active member of the CRS and therefore receives no discount. The Puyallup Tribe is not a participant in the NFIP and therefore is not subject to the same regulations for floodplain development.

Flood maps for Pierce County have recently been updated, and the current maps became effective on March 7, 2017. The new flood maps can be viewed online at msc.fema.gov. The flood maps show portions of the Clear Creek area as being within the 100-year floodplain of Clear Creek but protected from Puyallup River flooding by River Road Levee. As described above, River Road Levee has been de-accredited by FEMA, which means that it is no longer considered to provide 100-year flood protection. However, this is not reflected on the maps because the Clear Creek area is secluded from the map updates while FEMA works to determine a new method to map flood risk behind levees that do not provide 100-year flood protection. The areas secluded from FEMA map updates show the flood hazard information as depicted in previous FEMA flood maps – in this case 1987. FEMA intends to update secluded areas on flood maps “at a later time” (FEMA, 2015).
6.2 Local Regulations

Pierce County has codified its development regulations in Title 18E of the Pierce County Code (PCC). Chapter 18E.70 contains regulations related to Flood Hazard Areas, including standards that are applied to all development or new construction in the flood hazard areas throughout the county. Most of the Clear Creek area is in unincorporated Pierce County and is regulated by PCC 18E. The listed purposes of these regulations include protection of human life and health, minimization of net loss of ecological functions of floodplains, and qualification of Pierce County for participation in the NFIP. Adopting these regulations is a component of being a community that is participating in the NFIP, which allows for property owners to be eligible to receive subsidized flood insurance.

As described above, portions of the Clear Creek area are mapped as a floodplain, but none of the area is mapped by FEMA as a floodway. Under the NFIP, a regulatory floodway is defined as the area of the floodplain that must remain free of encroachments in order to prevent a rise in the 100-year flood elevation of greater than 1 foot. However, Pierce County Code defines a floodway as “an extremely hazardous area due to the depth and/or velocity of floodwaters which carry debris, potential projectiles, and have erosion potential” (PCC 18E.70.020 B). Pierce County regulates “Deep and/or Fast Flowing Water Areas” as floodways. This designation includes areas where flood depths would be greater than 3 feet, floodwaters would be moving faster than 3 feet per second, or a combination of the two. Pierce County has conducted an analysis of deep and/or fast flowing water of the Clear Creek area, which determined that some portions of the Clear Creek area would be regulated as a floodway based on the deep and/or fast flowing water criterion regardless of the accreditation of River Road Levee because flood depths in those areas would be greater than 3 feet (Pierce County, 2016a). Because the Clear Creek area is secluded from the recent updated maps, the most recent data from FEMA is from the 1987 Flood Insurance Study, which showed a base flood elevation in the Clear Creek area of 17.6 feet NAVD. Based on this information, areas at an elevation of 14.6 feet NAVD or lower would have flood depths of 3 feet or greater. If River Road Levee were to become accredited, FEMA would presumably remap the Clear Creek area with newer data and establish a new base flood elevation.

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

- Farmhouses and non-residential agricultural structures can be repaired, reconstructed, replaced, and improved if design considerations to minimize flood damage are followed.
- New agricultural accessory structures such as barns and storage buildings can be built if design considerations to minimize flood damage are followed.
- New buildings that are less than 120 square feet can be built since they do not trigger a building permit.
- Compost can be imported, stored, manufactured, or applied – with some conditions – without violating the County’s no fill regulations.
While the floodway designation makes it difficult to build farm infrastructure and reduces the value of the agricultural lands, it also follows best practices for resilient floodplain management by keeping new infrastructure and people out of high risk floodplain areas.

6.3 Emergency Management

During major flood events on the Puyallup River, Pierce County staff open an Emergency Operations Center to coordinate emergency response. The County has River Watch volunteers who observe flood levels in specific areas, including along the River Road Levee, in order to help inform emergency response. If flood projections show that River Road Levee could overtop, the Clear Creek area would be evacuated. Residents would be notified through reverse 911 and by police and firefighters going door to door through the area. Flood levels were projected to overtop the levee in 2006 and 2009, and the Clear Creek area was evacuated (Hunger and Schmidt, 2016).

6.4 Corps of Engineers General Investigation

The Corps is pursuing a Flood Risk Management General Investigation of the Puyallup River Watershed due to the frequent flooding and its resulting damage throughout the basin. Pierce County is the local sponsor for the General Investigation. The goal of the General Investigation is to identify, evaluate, and recommend solutions to flood risk in the basin. In March 2016, the Corps released a Draft Integrated Feasibility Report and Environmental Impact Statement, which includes details of a Tentatively Selected Plan (Corps, 2016). The Tentatively Selected Plan includes several actions throughout the Puyallup River Watershed to reduce flood risk, including two projects adjacent to the Clear Creek area. In one project, North Levee Road Levee, located across the Puyallup River from the Clear Creek area, would be set back approximately 100 to 1,000 feet between RM 2.7 and RM 8.1 (the portion of the project directly across the Puyallup River from the Clear Creek area). In the second project, floodwalls would be constructed along River Road Levee, which currently has insufficient freeboard. The floodwall height would range from 4 to 8 feet above the existing levee, with an average height of 6 feet. The floodwall would reduce the risk of River Road being overtopped by floodwaters (Corps, 2016). The Corps of Engineers web site for the General Investigation is accessible at http://www.nws.usace.army.mil/Missions/Civil-Works/Programs-and-Projects/Projects/Puyallup-River-GI/. The Corps is currently responding to comments from the Environmental Protection Agency (EPA) and others on the draft report and EIS, and plans to release a new scope for the project by the end of 2017.

6.5 Clear Creek Floodplain Restoration Project

Pierce County SWM is proposing to implement the Clear Creek Floodplain Reconnection Project as part of its Rivers Comprehensive Flood Hazard Management Plan (Pierce County, 2013). The purpose of the project is to relieve flooding issues, maximize agricultural use in the area, and improve habitat for wildlife. The Clear Creek Project would remove the tide gates to allow Puyallup River water to flow into the Clear Creek area, reconnecting the river to a portion of its historic floodplain. The reconnected floodplain would establish a more natural connection with
the Puyallup River and allow free passage for fish in and out of Clear Creek. To reduce property
damage, Pierce County would acquire property from willing sellers and construct a ring levee
between the reconnected floodplain and remaining properties in the Clear Creek area. NHC has
conducted hydrologic and hydraulic modeling of the proposed project for Pierce County.
Information on NHC’s modeling efforts is included in the Clear Creek Floodplain Reconnection
Hydrologic and Hydraulic Modeling Report (NHC, 2015). NHC is currently conducting
additional modeling for Pierce County.

Because this memorandum focuses on existing conditions for flood risk to agriculture in the Clear
Creek area, it does not evaluate the impacts of the proposed project on flood risk. An upcoming
Farmland Impacts Evaluation Memorandum will evaluate this issue.

7.0 Findings

7.1 The Clear Creek Area and Flood Resilience

Flood events are inevitable and, with climate change, are expected to increase in frequency and
magnitude in the future. Because there will be flood events on the Puyallup River and Clear
Creek, a resilient flood system is needed to protect the viability of agriculture in the Clear Creek
area.

Resilience concepts applied to flood risk management strategies is a relatively new use of the
resilience planning framework. Using a definition that can be described as “engineering
resilience,” a resilient flood system can be defined as one that can “bounce back and recover”
from the disturbance of a flood event (Zevenbergen, 2016). According to this concept, resilient
flood risk strategies aim to reduce flood risk through a combination of protection, prevention, and
preparedness spanning a wide range of flood probabilities (Zevenbergen, 2016). A resilient flood
system relies on the following attributes:

- Robustness (the capacity to withstand a disturbance without functional degradation),
- Redundancy (the extent to which system components are substitutable), and
- Rapidity (the capacity to restore the system in a timely manner) (Zevenbergen, 2016).

In a truly resilient flood environment, floodwaters can rise and fall without excessive damage. A
truly resilient flood environment will also not have catastrophic failure if one component of the
system fails during a flood.

The Clear Creek area does not have a resilient flood system. It is not robust – when the area
floods, homes flood and are damaged, farm businesses are threatened, and people need to be
evacuated. There is no redundancy – there are a number of vulnerable components of the flood
management system that, if they fail, would cause significant flood damage. Some farms in the
Clear Creek area may be able to rapidly restore their farm after a flood event, but that depends on
the time of year the flood occurs and would not be the case if barns, equipment, or crops are
inundated.
Pursuing a project that would increase flood resilience in the Clear Creek area would be a benefit to agricultural viability. However, any flood risk reduction projects would have to be evaluated to ensure that they would not increase other risks to agriculture. Alternatives should be looked at for how to address flood risk in the area. Potential actions that could be taken include:

- Directly protecting agricultural properties from flooding,
- Reducing runoff from upstream areas of the Clear Creek Basin,
- Improving freeboard on River Road Levee,
- Altering the tide gates to improve the reliability of their operation and increase conveyance of flows from Clear Creek to the Puyallup River,
- Replacing undersized culverts in the area, particularly those under 44th Street East and Gay Road,
- Elevating homes, farm structures, and farm equipment in the floodplain, and
- Constructing “critter pads,” elevated areas where livestock can gather during flood events.

7.2 Information Needs

Through the Floodplains for the Future program, farmers and residents in the Clear Creek area are being asked to participate in a collaborative process that may result in the construction of a large ring levee in the Clear Creek area. In the short term, residents are being asked to consider voluntarily selling their property to Pierce County to remove properties from flooding areas and for eventual construction of the levee project. Throughout the Farming in the Floodplain Project, farmers have made it clear that they do not have the information about both current and future flood risk to make decisions or collaborate in the Floodplains for the Future Program. In addition, more information is needed in order for farmers to be assured that any levee project in the area has fully accounted for both flood risk and agricultural needs.

In order to address these issues, the following information is needed:

- Information on stream flows and recurrence intervals for both the Puyallup River and Clear Creek during recent flooding events;
- Data on streamflow in Clear Creek and its tributaries;
- Information on the frequency of the Clear Creek tide gates closing and the average duration of closure;
- Future precipitation projections for the Puyallup River Watershed based on dynamic downscaling (current projections are based on statistical downscaling, which is not the most accurate method);
- Precipitation projections translated into projected seasonal streamflow levels for the Puyallup River and Clear Creek and its tributaries;
- Hydraulic model simulations of flood projections and sea level rise with climate change for the Puyallup River Watershed and the Clear Creek area;
• Analysis of climate vulnerabilities on Clear Creek and its tributaries affecting agriculture in the Clear Creek area;
• The flood frequency at which River Road Levee would be overtopped and future changes to that risk of flooding;
• The modeled elevation of floodwaters in the Clear Creek area if the levee is overtopped;
• The modeled velocity of floodwaters in the Clear Creek area if the levee is overtopped;
• A complete review of whether River Road Levee meets the FEMA accreditation standards other than freeboard, including a full geotechnical assessment of the levee;
• The portion of the Clear Creek area that would still be mapped as floodway if the River Road levee provided adequate 100-year flood protection;
• Future projections for operations of Mud Mountain Dam, considering current and projected future levels of aggradation in the channel downstream of the dam and future changes in peak flows;
• The likelihood of Clarks Creek floodwaters flowing into the Clear Creek area, including which flood events might trigger this and what areas could be vulnerable to this threat; and
• Whether changes in the drainage of South Ditch are affecting flooding conditions in the Clear Creek area.
8.0 References


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