FINAL
DRAINAGE INVENTORY MEMORANDUM

Farming in the Floodplain Project

Prepared for
PCC Farmland Trust

May 2017

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Acronyms and Abbreviations

Ecology	Washington Department of Ecology
ESA	Environmental Science Associates
FFP	Farming in the Floodplain Project
GPS	Global Positioning System
HPA	Hydraulic Project Approval
NPDES	National Pollutant Discharge Elimination System
PALS	Planning and Land Services
PCC	Pierce County Code
RV	recreational vehicle
SR 167	State Route 167
SWM	Pierce County Surface Water Management

1.0 Project Background and Description

ESA has prepared this Agricultural Drainage Inventory as part of the second phase 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.

As part of the second phase of the FFP, ESA conducted an inventory of the agricultural drainage system in the Clear Creek area. The agricultural drainage inventory provides an improved map and qualitative information on the agricultural drainage system that can be used in the future to inform the planning and design of projects such as the proposed Clear Creek Floodplain Reconnection Project, projects undertaken by Drainage District 10 or individual landowners, and other multiple-benefit projects in the area, and to ensure that these projects improve agricultural drainage. The drainage inventory is for planning purposes only; it is not detailed enough to develop permit applications or design plans for actions that would modify or alter the drainage network.

This analysis includes the findings from field work conducted by ESA staff in September and October 2016 (referred to in this memorandum as the dry season field visit) and January 2017 (referred to in this memorandum as the wet season field visit) as part of the agricultural drainage inventory.

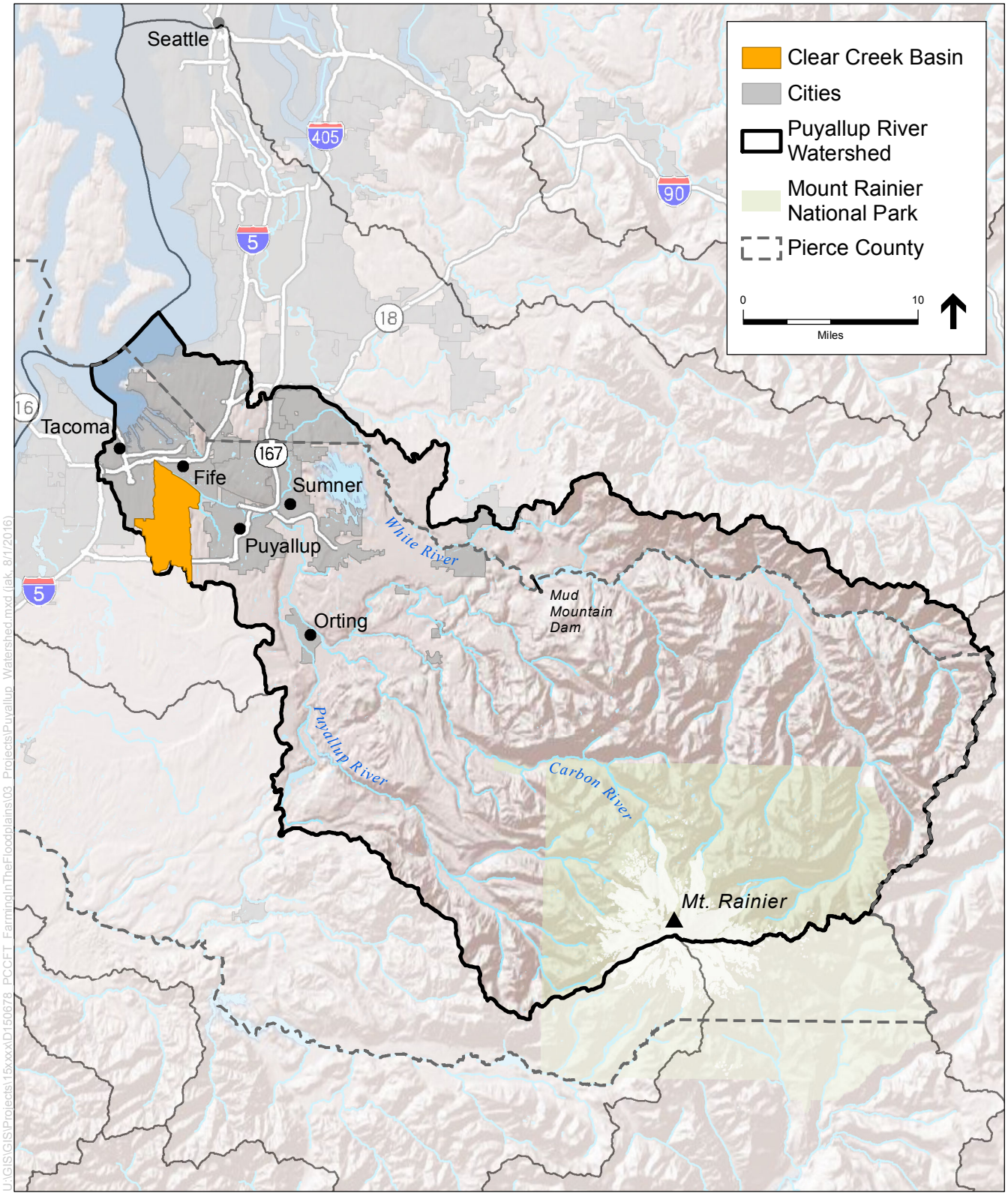
In November 2016, ESA prepared a *Drainage Inventory Preliminary Findings Memo* (ESA, 2016a). The Preliminary Findings Memo included information and general observations from the dry season field work. This memorandum updates the Preliminary Findings Memo with the following additional information:

- Information from the wet season field work.
- Information on ownership and maintenance responsibilities.
- Findings.
- Recommendations.

A draft of this memorandum was released in April 2017. This Final Drainage Inventory Memorandum includes revisions in response to comments received on the draft memorandum. These revisions include information provided by Drainage District 10 about culverts in the Clear Creek area.

2.0 Study Area

The study area for the agricultural drainage inventory 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. The Clear Creek area is located primarily within unincorporated Pierce County, with the northern tip of the area within the City of Tacoma and the southern tip within the City of Puyallup. It encompasses a portion of State Route 167 (SR 167), a section of the BNSF Railway, agricultural lands, single-family residential neighborhoods, a recreational vehicle (RV) park, a few commercial properties, the Riverside Fire District, and two schools (Chief Leschi High School and ReLife School).



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

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Figure 1

Puyallup River Watershed

3.0 Ownership and Maintenance Responsibilities

Three entities own the drainage ditches in the Clear Creek area. Drainage District 10 owns a parcel which includes a portion of Clear Creek and may own other ditches in the area. The extent of Drainage District 10's ownership and maintenance responsibility for ditches in the area is unclear. Pierce County Roads owns the ditches along county roads. Others are owned by private landowners. As part of the drainage inventory, ESA researched the ownership and maintenance responsibilities for drainage features in the Clear Creek area.

To research ownership of the inventoried ditches, ESA reviewed recorded documents from 1900 through current day and found four agreements made by Drainage District 10; however, none of these documents clarified ownership or maintenance responsibilities for the ditches within the District's jurisdiction. Potential next steps to clarify ownership and maintenance responsibilities could include reviewing recorded plats at the auditor's office or requesting that a survey or title assessment be conducted. These tasks were outside of the scope of this technical memorandum. An alternate approach could be to pursue legal agreements clarifying ownership and maintenance responsibilities moving forward. Ownership and maintenance responsibilities for the tide gates at the confluence of Clear Creek and the Puyallup River are also unclear. Additional information about this will be provided in an upcoming Tide Gate Technical Memorandum.

Drainage District 10 was formed in 1912 under authority of Revised Code of Washington (RCW) 85.06, which authorized the formation and operation of special purpose districts. RCW 85.06.080 gives Drainage District commissioners the "*exclusive charge of the construction and maintenance of all drainage systems which may be constructed by said district.*" The Drainage District has the authority to purchase or condemn property on which to build drainage ditches. The District receives revenues from taxes assessed by the District based on the benefit that the property receives from the District and not based on the property value. The commissioners of the Drainage District are authorized to construct, straighten, widen, deepen, and improve existing drains or ditches in the District, as well as dig or construct additional drains or ditches. Additionally, the District may divert, dam, or carry off the waters of any stream or water endangering or causing damage in the District (RCW 85.06.640). In recent years, Drainage District 10 was inactive and was not conducting maintenance on ditches in the Clear Creek area. In 2016, the District was reactivated and elected new commissioners.

Drainage Districts typically focus on maintaining collector ditches that serve multiple properties. In the Clear Creek area, several larger collector ditches carry water from the feeder ditches and roadside ditches to Clear Creek and then to the Puyallup River. It is not known if these ditches are owned by Drainage District 10 or by another entity. A plat for the properties along 47th Avenue East (which are currently owned by Pierce County Surface Water Management (SWM)) shows a 20- to 40-foot wide drainage easement along the edge of several properties, but does not indicate the owner of the easement. It is possible that Drainage District 10 may have drainage easements on these properties. Drainage District 10 does not have a current Drainage Management Plan for the ditches in the area.

The smaller private ditches are owned and maintained by the landowners whose properties they serve. Drainage District 10 does not maintain these ditches. Roadside ditches in the public right-of-way are owned and maintained by Pierce County Roads. For example, the ditches along 44th Street South (identified as DD14 and DD17), are owned and maintained by Pierce County Roads. Roadside ditches are designed and maintained to protect the roadway foundation and to prevent water from flooding the roads. Pierce County Roads does not maintain roadside ditches for agricultural drainage.

Most maintenance activities would be subject to federal, state, and local permit requirements. Clear Creek is a modified natural water course (a historically natural system that has been diverted, dredged and/or straightened) and maintenance activities in Clear Creek would be subject to the following regulations:

- Section 404 of the Clean Water Act (Corps of Engineers)
- Endangered Species Act (National Marine Fisheries Service and U.S. Fish and Wildlife Service
- National Pollution Discharge Elimination Permit (NPDES) (Ecology)
- Hydraulic Project Approval (HPA) (Washington Department of Fish and Wildlife)
- Shoreline Master Program (Pierce County Department of Planning and Land Services [PALS]—this only applies to the mouth of Clear Creek which is in a wetland mitigation site)
- Critical areas regulations (PALS)

Aside from Clear Creek itself, the drainage ditches in the Clear Creek area are constructed waterways (ditches with no headwaters or other natural water sources) and may be exempt from some of these regulations. Exemptions would have to be determined on a case-by-case basis. In particular, ditches constructed in historic wetlands may trigger federal permit review.

4.0 Field Investigation Methodology

During the dry season field work, ESA field investigators completed an inventory of drainage ditches and culverts in the Clear Creek area by taking measurements and recording information on channel size and condition. A Global Positioning System (GPS) unit was used to record drainage ditch and culvert locations and other points of interest, which included bends in the drainage channel, road crossings, and junctions with other ditches. All measurements were taken using a stadia rod and/or measuring tape and recorded to the nearest tenth of a foot. At each point of interest within a drainage ditch, the following data were recorded:

- **Channel Measurements** – width and depth of channel banks, surface water (if present), and sediment.

- **Channel Condition** – type of substrate and vegetation within the channel; type and density of vegetation adjacent to the channel; overall condition and stability of channel banks.

Figure 2 is a diagram of a ditch cross-section illustrating where measurements were taken by field investigators.

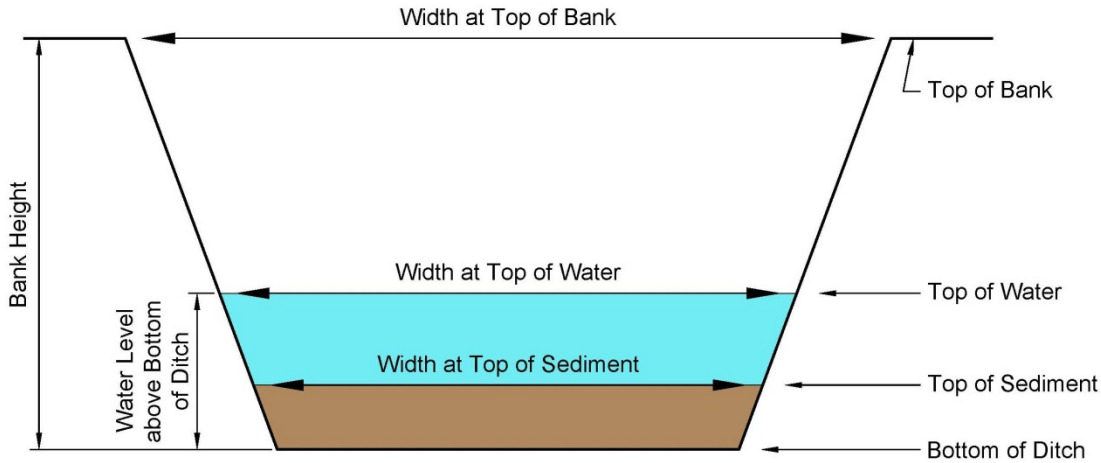


Figure 2. Ditch Cross-section

In addition to the information above, field investigators recorded any observed debris in the channel and noted potential maintenance needs in the surrounding area.

At culvert locations, field investigators recorded the following information at each culvert:

- Culvert diameter.
- Culvert type (corrugated metal, plastic, etc.) and shape (round, rectangular, etc.).
- Crossing type (e.g., road, railroad, etc.).
- Condition – presence of flow impediments at culvert entrance and material condition (rusted, corroded, etc.).
- If the culvert was perched above the channel.

Field investigators returned to the Clear Creek area in the wet season to observe key ditches and culverts when water levels were higher than they were during the dry season. Field investigators observed flow direction, took photographs, measured water depths, and recorded observations about drainage ditch conditions.

In this analysis, ditches were classified using the approach defined in the *Drainage Management Guide for Whatcom County Drainage Improvement Districts* (Whatcom Conservation District,

2009). The *Drainage Management Guide* classifies ditches as being natural, modified, or constructed, defined as follows (Whatcom Conservation District, 2009):

- **Natural watercourses** are those "that have not been significantly altered from their historical flow path or floodplain."
- **Modified watercourses** are "historically natural systems that have been diverted, dredged, straightened, and/or diked."
- **Constructed watercourses** are ditches with no headwaters or other natural water sources.

Ditches were assigned identification numbers in the field (Figure 3). Throughout this memorandum, ditches are referred to by name when a name is known. Roadside ditches are referred to by the name of the corresponding road. Other ditches are referred to by the identification number assigned in the field. Because some ditches are referred to by name or by corresponding road, the numbers of ditches described in this memorandum are not consecutive.

The inventory is not comprehensive and does not include all drainage ditches and culverts in the Clear Creek area due to constraints on the amount of field time available. Areas covered in the inventory were prioritized by importance to the overall drainage system, based on preliminary mapping and feedback from farmers and landowners in the area.

Local farmers and landowners provided critical assistance throughout the field investigation, including providing access, showing field investigators the locations of ditches and culverts, and providing additional information on drainage conditions.

5.0 Results of Field Investigation

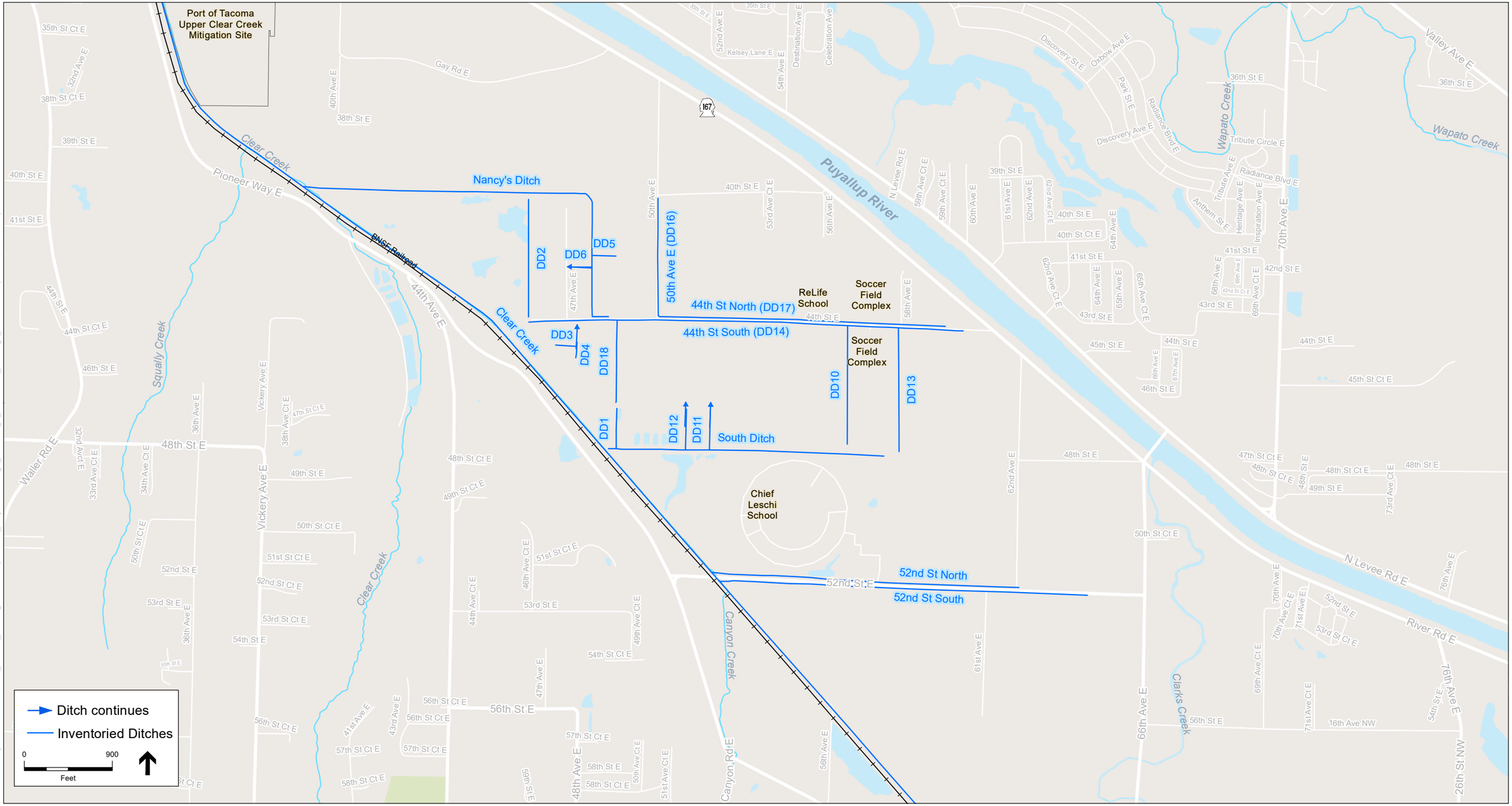
Field investigation for the agricultural drainage inventory took place September 20 through 24, September 27, October 12, 2016, and January 19, 2017. Observations from the field investigation are presented below by drainage ditch. Figure 3 shows the drainage ditches inventoried during the field investigation. Figure 4 shows the drainage ditches inventoried with flow direction arrows where flow direction is known. Figures 5a and 5b show the locations of inventoried culverts. The figures only show drainage features inventoried during the field work. They do not show other drainage features that ESA was informed about or those we observed in the field, but were not able to inventory (such as the roadside drainage ditch on the west side of 50th Avenue). The figures only show connections that were directly observed. Where one end of a ditch was inventoried but the end point of the ditch was not observed, the figures show an arrow to indicate that the ditch continues in that direction, but that the end point was not inventoried.

Results of the field investigation are summarized below, organized by the eight main drainage ditches identified during the inventory:

- Clear Creek

- Nancy's Ditch
- 44th Street North Ditch
- 44th Street South Ditch
- South Ditch
- 50th Avenue East Ditch
- 52nd Street East Ditches (North and South)

Information collected included observations of water flow, condition of the channel, presence of vegetation, connecting private ditches, and culverts.



SOURCE: ESA 2016; OSM 2015; Wa Ecology 2015

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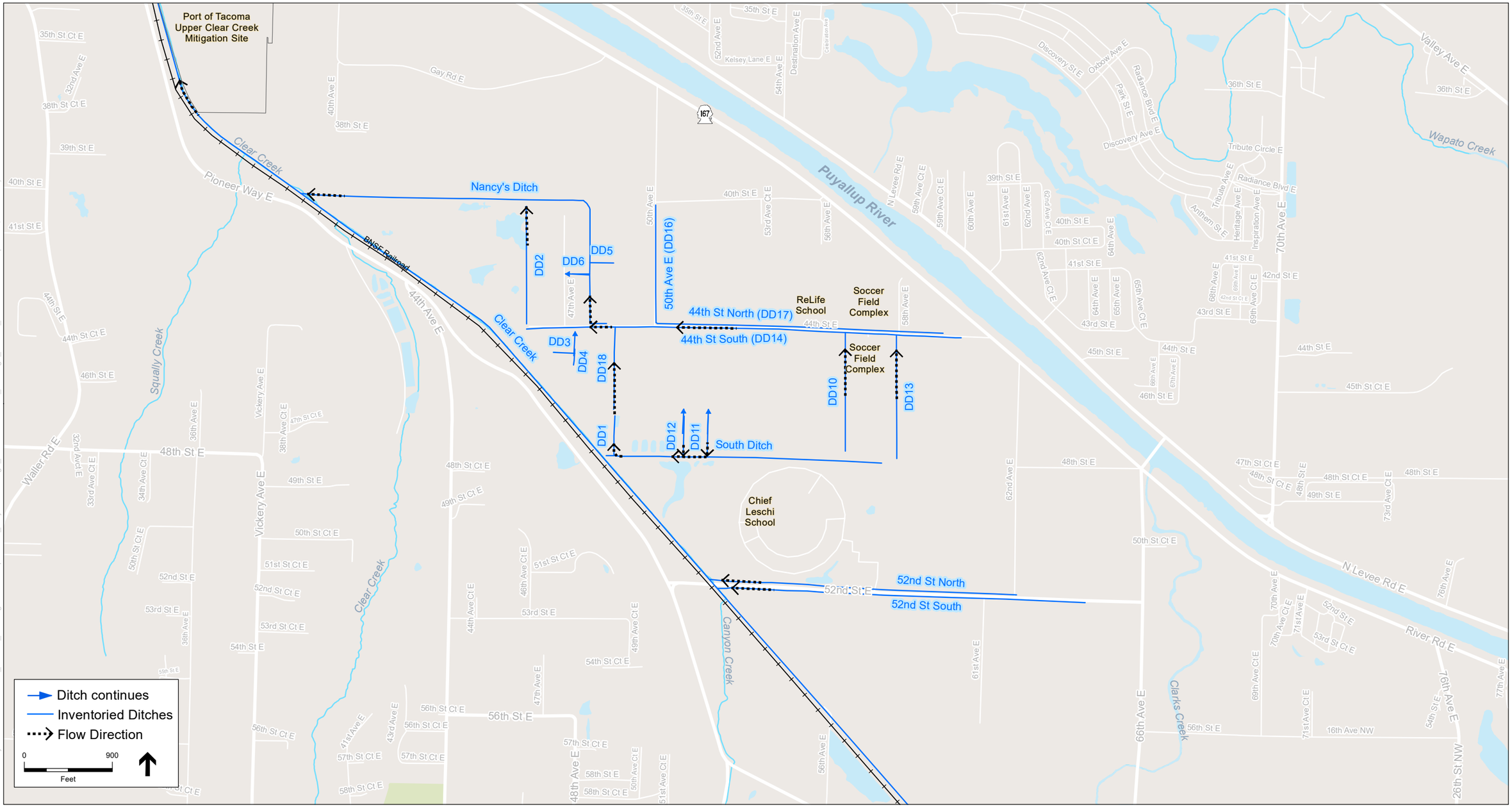
Figure 3

Inventoried Drainage Ditches



SOURCE: ESA 2016; OSM 2015; Wa Ecology 2015

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Figure 4

Flow Direction of Inventoried Drainage Ditches

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SOURCE: ESRI, 2016; ESA, 2016

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Figure 5a

Inventoried Drainage Ditches and Culverts

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SOURCE: ESRI, 2016; ESA, 2016

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Figure 5b

Inventoried Drainage Ditches and Culverts

5.1 Clear Creek

Overview. Clear Creek is a modified watercourse that serves as the primary agricultural drainage channel in the Clear Creek area. Drainage District 10 owns a narrow parcel that covers much of its length. It has four major tributaries: Canyon Creek, Upper Clear Creek, Squally Creek, and Swan Creek. Clear Creek flows north from its headwaters in the south portion of the Clear Creek basin to near 44th Avenue East. It then flows northwest along the western boundary of the Clear Creek area (Pioneer Way and the BNSF Railway line). At 52nd Street East, Canyon Creek flows into Clear Creek via a railroad crossing culvert (CC-Culvert 6). Upper Clear Creek enters Clear Creek near Pioneer Way and 44th Avenue East via a culvert (CC-Culvert 3). Squally Creek enters Clear Creek, approximately 500 feet downstream of Nancy's Ditch via a railroad crossing culvert (CC-Culvert 40). From this point, Clear Creek continues northwest through a largely residential area, before Swan Creek joins Clear Creek just upstream of the lower Port of Tacoma wetland mitigation site, north of Pioneer Way East. Clear Creek then flows approximately 0.15 mile to its confluence with the Puyallup River. The Puyallup River empties into Commencement Bay approximately 3 miles downstream from the Clear Creek confluence.

Water Flow Observations. At the time of the dry season site visits, field investigators observed continuous water flow in Clear Creek from the Canyon Creek confluence to Gay Road East. The presence of water varied in the reach of Clear Creek upstream from the Canyon Creek crossing. Field investigators did not observe water in the west and east ends of this reach of Clear Creek; however, they did observe standing water and limited flow in the central part of this reach. During the wet season site visit, the creek appeared to have flooded the Port of Tacoma Upper Clear Creek mitigation site, and standing water was observed from the mitigation site downstream to Gay Road East.

Channel Condition. Several stretches of the Clear Creek channel were observed to have stable banks. In other areas, unstable and undercut banks were observed. A majority of the channel bed was covered with a thick layer of soft, very fine sediment, 1 foot deep in some areas and over 3 feet deep in other areas. The bank height ranged from 3.8 feet to 10 feet, and the channel width ranged from 18 to 40 feet at the top of the bank. Water depth, measured from the top of the soft sediment, ranged from just under 1 foot to approximately 7 feet. During the wet season site visit, field investigators observed increased turbidity in Clear Creek from the Canyon Creek junction downstream to Gay Road East. In addition, water depths had increased to more than 11.5 feet.

Vegetation. Throughout Clear Creek, field investigators commonly observed dense reed canarygrass growth within the channel and on the channel banks. Within the channel, reed canarygrass was often so dense that it appeared to impede water flow. In other areas, recent maintenance activities had cleared the channel of reed canarygrass (Photo 1). Other vegetation species observed growing in the channel in moderate density included duckweed and another aquatic plant species assumed to be elodea. Himalayan blackberry was common on the channel banks and made areas of the channel inaccessible to investigators.

Along Clear Creek immediately downstream of where South Ditch formerly connected to it, dense patches of black twinberry, Pacific willow, Sitka willow, red-osier dogwood, red alder, and bigleaf maple were observed adjacent to the channel. Along the rest of Clear Creek downstream

of South Ditch, investigators observed very limited and scattered shrubs and trees. On the right bank, the width of the vegetated riparian area averaged approximately 40 feet. On the left bank, the width of the vegetated area was limited by the railroad tracks.

Photo 1. Clear Creek facing downstream from the 52nd Street East culvert

Photo 2.Squally Creek flows through a culvert under the railroad tracks and into Clear Creek

Photo 3. Upper Clear Creek flows into Clear Creek via two culverts that cross under the railroad tracks (photo is of culvert outlets)

Photo 4. Canyon Creek (left) flows into Clear Creek

Culverts. Canyon Creek, upper Clear Creek, and Squally Creek enter Clear Creek through several culverts under the BNSF Railway line (Photos 2 through 4). The majority of these culverts range between 4 and 6 feet in diameter. A number of culverts appeared to be partially obstructed by sediment and/or reed canarygrass. Another culvert under the BNSF Railway line, between the outlets of Canyon Creek and upper Clear Creek, drains a stormwater retention pond into Clear Creek. Based on information provided by Drainage District 10, the stormwater retention pond appears to drain stormwater from around 30 residential properties on the south side of the BNSF Railway line and Pioneer Way. This culvert was not inventoried during ESA's field work, but it was observed by ESA staff on April 24, 2017. Clear Creek flows through culverts under 52nd Street East and Gay Road East. At the inlets of the Gay Road East culverts, woody debris, a very large rock, and trash debris were observed**.** During the wet season field visit, water levels in Clear Creek were near the top of the Gay Road East culverts.

5.2 Nancy's Ditch

Overview. Nancy's Ditch is a constructed watercourse that originates at 44th Street East approximately 250 feet east of 47th Avenue East. It continues north for a quarter mile, then turns west and continues for approximately a half mile before draining into Clear Creek via four small culverts. Photo 5 shows the north end of the north-south reach of Nancy's Ditch, where it turns toward the west.

Photo 5. North end of north-south reach of Nancy's Ditch, facing south.

Water flows into Nancy's Ditch from the 44th Street roadside ditches and from at least two private drainage ditches. The 44th Street ditches convey flows from South Ditch and private ditches.

Water Flow Observations. Standing water depths in Nancy's Ditch ranged from 1.9 feet to 4.9 feet during the dry season field visits, but little to no water movement was observed. During the wet season field visit, Nancy's Ditch was near bankfull and visibly flowing into Clear Creek.

Channel Condition. The majority of the channel banks appeared to have limited areas of erosion and undercutting. Field investigators observed a thick layer of silty sediment along the channel bed, roughly 2.5 feet deep in places. The channel ranged between 15 and 26 feet in width at the top of the bank.

Vegetation. A high density of duckweed was observed on the water surface (Photo 6). Reed canarygrass was very dense along both banks for the entire length of Nancy's Ditch. In many areas of the channel, reed canarygrass was observed growing within the channel, impeding water flow and potentially increasing water levels upstream. During the wet season site visit, field investigators observed little to no duckweed on the water surface; however, reed canarygrass growth within the channel remained the same.

Photo 6. East-west reach of Nancy's Ditch. Reed canarygrass is dense on the banks and edges of the channel. Duckweed dominates the water surface

Most of Nancy's Ditch lacks a vegetated riparian corridor. However, there were points along the east-west portion of the channel where large shrubs and trees dominated an approximately 45-foot-wide zone on both banks. Dominant tree and shrub species observed at these points included red alder, black cottonwood, Oregon ash, Pacific willow, Sitka willow, and red osier dogwood. Dense reed canarygrass growth dominated the herbaceous cover at these points. Close to the south end of Nancy's Ditch, investigators observed dense Himalayan blackberry on the west bank of the channel.

Culverts. Nancy's Ditch flows into Clear Creek via several small culverts. Drainage District 10 records suggest there are five culverts. However, only four culverts were observed during the field investigation. During the wet season site visit, the water surface was less than 0.3 feet from the top of these culverts.

Photo 7. Water in western portion of 44th Street North Ditch and DD17-Culvert 5

Two culverts were observed at the south end of Nancy's Ditch. One culvert connects the 44th Street North Ditch to Nancy's Ditch (ND Culvert 5), and the other connects 44th Street South Ditch to Nancy's Ditch (DD14 Culvert 7).

Connecting Private Ditches. Two private drainage ditches, Drainage Ditch 5 and Drainage Ditch 6, flow into the north-south portion of Nancy's Ditch. Drainage Ditch 5 flows west from private property, and connects to the east bank of Nancy's Ditch. A culvert was observed in the ditch (DD5-Culvert 1), which appeared to be partially obstructed by sediment and dense reed canarygrass. No water flow was observed. Drainage Ditch 6 drains east through private property and connects to the west bank of Nancy's Ditch. Water was observed flowing into Nancy's Ditch from Drainage Ditch 6.

Photo 8. Culvert partially obstructed by reed canarygrass in 44th Street North ditch

Another private drainage ditch (Drainage Ditch 2) parallels the north-south portion of Nancy's ditch and ends approximately 12 feet south of the east-west portion of Nancy's Ditch. According to the owner of the property that includes Drainage Ditch 2, an unmaintained culvert connects Drainage Ditch 2 to Nancy's Ditch at this point. However, field investigators did not observe the culvert during the dry season site visits. Investigators did observe silty substrate and dense reed canarygrass growth in the channel. If a culvert is present, it is likely buried and not functioning properly. PCC Farmland Trust staff observed water in Drainage Ditch 2 flowing north toward Nancy's Ditch on March 24, 2017.

The other end of Drainage Ditch 2 is just north of the 44th Street North Ditch and west of 47th Avenue East.

5.3 44th Street North Ditch

Overview. The 44th Street North Ditch is a roadside drainage ditch (constructed watercourse) on the north side of 44th Street. The ditch begins near River Road East and flows west to a junction with the 50th Avenue East Ditch. From this point west, no ditch was observed on the north side of 44th Street, except for a short, separate portion of the ditch starting approximately 150 feet east of Nancy's Ditch.

Water Flow Observations. During the dry season site visits, field investigators did not observe any water in the east portion of the channel from River Road East to 50th Avenue East. During the wet season visit, field investigators observed standing water less than 1 foot deep in the channel just east of the 50th Avenue East intersection.

It was unclear where water in the 44th Street North Ditch would flow at the junction with 50th Avenue East. No culvert connecting this portion of the ditch to the west portion of the ditch was observed. However, very dense reed canarygrass was observed at the end of both segments of the ditch and may be obscuring a culvert. Unlike the east portion of the channel, water in the short, separate western portion of the channel was up to 1 foot deep. Flow was very slow and toward Nancy's Ditch.

Channel Condition. The channel had stable banks and ranged between 10 and 18 feet in width at the top of the bank. Silty sediment was observed on the channel bed. Increased turbidity was observed in the west portion of the channel during the wet season site visit.

Vegetation. Very dense reed canarygrass was growing in the channel and on the banks along the majority of 44th Street North Ditch (Photo 7). The separate, west portion of the ditch had lower densities of reed canarygrass, and duckweed was dominant where water was present. The channel appeared to be maintained from the front of the ReLife School to the east end of the ditch. There was short weedy vegetation in the channel, but little to no reed canarygrass along this reach.

Culverts. Ten culverts were observed in the 44th Street North Ditch, mostly under driveway and road crossings. All culverts ranged between 1 and 2 feet in diameter. Some culverts appeared to be partially obstructed by sediment and by dense reed canarygrass growing in the channel (Photo 8).

The culvert (ND-Culvert 5) at the west end of the 44th Street North Ditch drains this portion of the ditch into Nancy's Ditch. It was unclear during the dry season site visits if a culvert connects the east and west portions of the 44th Street North Ditch past 50th Avenue East.

5.4 44th Street South Ditch

Overview. The 44th Street South Ditch is a roadside drainage ditch (constructed watercourse) along the south side of 44th Street. It begins at River Road East and continues west to the end of 44th Street. Several adjacent agricultural and soccer fields likely drain through private ditches into 44th Street South Ditch. In addition, three private north-south oriented ditches likely drain South Ditch into the 44th Street South Ditch. Water drains from 44th Street South into Nancy's Ditch, eventually draining into Clear Creek.

Water Flow Observations. During the initial dry season site visit, no water was observed in most of the east portion of the 44th Street South Ditch, except for some stagnant water directly east of Nancy's Ditch. At a later site visit on October 12, 2016, following a short period of rain, water was observed in the channel farther east toward 50th Avenue East.

The water in the channel just west of Nancy's Ditch was approximately 1 foot deep, with little to no water flow. Water was observed entering Nancy's Ditch from the 44th Street South Ditch through the connecting culvert.

Channel Condition. In general, the channel appears to have stable banks. A layer of silty sediment was observed along the channel bed, measuring over 1 foot deep in some areas. The channel

ranged between 10 and 14 feet wide at the top of the bank. During the wet season site visit, increased turbidity was observed in the channel.

Vegetation. Similar to the 44th Street North Ditch, dense reed canarygrass was observed growing in the channel and on the banks for the majority of its length. In areas with less dense reed canarygrass and where standing water was present, duckweed was dominant. The ditch appeared to be maintained starting at the west side of the soccer field parking lot (Photo 9). There was short weedy vegetation in the ditch and little to no reed canarygrass from this point to the east end of the channel. During the wet season site visit, little to no duckweed was observed.

Culverts. Twenty-four culverts were observed along the length of the 44th Street South Ditch, mostly under driveways and the road shoulder. Photo 10 shows one of the culverts on the 44th Street South Ditch. Many culverts were partially obstructed by sediment, reed canarygrass, and/or Himalayan blackberry.

Field investigators observed two culverts that drain the 44th Street South Ditch. One culvert (DD14-Culvert 7) crosses north under 44th Street and drains into Nancy's Ditch. According to a local landowner, drainage issues south of 44th Street began when a larger culvert that drained into Nancy's Ditch was replaced with the current, much smaller culvert. This has not been confirmed by ESA staff. A second culvert (DD17-Culvert 5) crosses northwest under 44th Street from the 44th Street South Ditch and drains into the 44th Street North Ditch. Very little flow was observed at the inlet of either of these culverts. In addition, a perched culvert (DD14-Culvert 10) was observed on top of DD17-Culvert 5 approximately 1.9 feet above the channel bed (Photo 11). Unlike DD17-Culvert 5, DD14-Culvert 10 is oriented east-west. The fact that the culvert is perched likely impedes the westerly flow of water in the 44th Street South Ditch east of this point when the water level is below the culvert. However, DD17-Culvert 5 is located at the bottom of the channel below DD14-Culvert 10, so even when the water level is low, drainage of the east portion of the 44th South Ditch to the 44th North Ditch could still potentially occur. During the wet season site visit, field investigators observed water close to or above the tops of culverts on the 44th Street South Ditch between DD14-Culvert 10 and DD14-Culvert 14.

Connecting Private Ditches. As previously mentioned, adjacent agricultural and soccer fields drain to the 44th Street South Ditch via private ditches. These ditches include Drainage Ditches 3, 4, 10, 13, and 18. Drainage Ditches 10, 13, and 18 are oriented north-south and connect to the 44th Street South Ditch. Drainage Ditch 3 is oriented east-west and drains to Drainage Ditch 4, which is oriented north-south toward the 44th Street South Ditch through private property. Drainage Ditch 4 is presumed to connect to 44th Street South, although this connection was not observed. Water and limited flow were observed in Drainage Ditches 3 and 4 during the dry season visits. A culvert (DD4-Culvert 1) was observed in Drainage Ditch 4 approximately 45 feet north of the intersection with Drainage Ditch 3. Field investigators did not observe the other end of the culvert, but it is likely, due to its orientation and location, that Drainage Ditch 4 drains to the 44th Street South Ditch.

Photo 9. 44th Street South Ditch adjacent to the soccer fields

Photo 10. 44th Street South Ditch and culvert, west of 50th Avenue East

Photo 11. Perched culvert in the 44th Street South Ditch. A second culvert that flows under the road and into the 44th Street North ditch is below it in the channel.

Photo 12. Water levels above the top of a culvert along the 44th Street South Ditch, observed during the wet season site visit.

5.5 South Ditch

Overview. South Ditch is a constructed watercourse originating at the southeast corner of the River Jam Field soccer complex and ending approximately 100 feet east of Clear Creek. South Ditch is oriented east to west, with its west end directly north of Chief Leschi School.

South Ditch historically flowed into Clear Creek, but it no longer connects. Due to sediment deposition in Clear Creek, the creek is now higher than the ditch, preventing gravity drainage to the creek. Subsequently, the ditch outlet was filled. Instead of flowing west into Clear Creek, South Ditch now drains north to Drainage Ditch 18, a private drainage ditch. This ditch carries flows from South Ditch northwards into the 44th Street South Ditch. Water then flows into Nancy's Ditch and eventually enters Clear Creek approximately 4,000 feet downstream of the original outlet of South Ditch.

Water Flow Observations. During the dry season site visits, water was not observed at the east end of South Ditch. Toward the west end of the channel, water was approximately 3 feet deep. Little to no water flow was observed in the channel. During the wet season site visit, less than 0.5 foot of standing water was observed at the east end of South Ditch.

South Ditch is drained via a private north-south oriented ditch into the 44th Street South ditch. Adjacent agricultural fields drain into South Ditch via two north-south oriented ditches (DD11 and DD12). In addition, there are several man-made ponds just north of South Ditch, one of which is fed by a private ditch.

Channel Condition. The condition of South Ditch varied. Some areas of the channel had stable banks, and other areas had steep, eroding banks. The majority of the channel had silty sediment along the bed, and channel width ranged between approximately 6 and 20 feet at the top of the bank. During the wet season site visit, increased turbidity was observed in the channel.

Vegetation. South Ditch appeared to be maintained at the east end, south of the soccer fields. No vegetation was observed in the channel, and both banks were mowed. Reed canarygrass was the dominant species west of the soccer fields and was observed growing in dense mats within the channel and along the banks. Duckweed covered much of the water surface (Photo 13). Black cottonwood, red alder, Pacific willow, Sitka willow, Oregon ash, and Himalayan blackberry were observed along the south bank and adjacent to the channel. During the wet season visit, no duckweed was observed on the water surface.

Culverts. Field investigators did not observe any culverts along South Ditch. However, there could potentially be a buried and/or obstructed culvert given the observed dense vegetation and sediment in the channel at its west end.

A concrete footbridge crosses South Ditch at the west end of the soccer fields (Photo 13). The bridge is approximately 4 feet wide and positioned 1 foot above the channel bed, and could be an obstruction at higher flows.

Connecting Private Ditches. As mentioned above, South Ditch connects to the 44th Street South Ditch via Drainage Ditch 18, a private, north-south oriented ditch. Drainage Ditches 11 and 12

originate at mid-points of adjacent agricultural fields and connect to South Ditch via narrow channels overgrown with reed canarygrass. Very little water flow was observed in these channels.

5.6 50th Avenue East Ditch

Overview. The 50th Avenue East Ditch (Drainage Ditch 16) is a roadside drainage ditch (constructed watercourse) oriented north-south on the east side of 50th Avenue. Field investigators collected data only on the portion of this ditch from East 40th Street to 44th Street East. Another ditch is located on the west side of 50th Avenue but was not inventoried. No connection was observed from the 50th Avenue West Ditch to 50th Avenue East Ditch.

Water Flow Observations. No water was observed in the ditch until just north of 44th Street East. At this point, field investigators observed very shallow standing water with no visible flow.

Photo 13. South Ditch between Drainage Ditches 11 and 12. Dense reed canarygrass dominates both banks. Duckweed is dense in the channel. Red alder overhangs the channel.

Photo 14. South Ditch is maintained south of the soccer fields.

Channel Condition. The banks of the channel appeared to be stable with no signs of erosion. However, the overall condition of the channel was difficult to assess due to dense reed canarygrass throughout the channel. The channel width remained relatively consistent, ranging between approximately 8 and 10 feet at the top of the bank.

Vegetation. The entire length of the channel was dominated by reed canarygrass, and no shrubs or trees were present (Photo 15).

Culverts. The 50th Avenue East Ditch flows through two culverts: one under a driveway along 50th Avenue (DD16-Culvert 1) and one at the corner of 44th Street East and 50th Avenue (DD16-Culvert 2). Both culverts had sediment and reed canarygrass partially obstructing their inlets and outlets. These obstructions prevented field investigators from measuring the culverts. DD16-Culvert 2 appeared to be directed east of 50th Avenue to connect the 50th Avenue East Ditch with the 44th Street North Ditch; however, the other end of the culvert was not found by field investigators.

Photo 15. 50th Avenue East ditch facing south toward 44th Street

5.7 52nd Street East Ditches (North and South)

Overview. Drainage ditches (constructed watercourses) were observed on both sides of 52nd Street East (52nd North Ditch and 52nd South Ditch). These ditches drain directly to Clear Creek at their western ends. Both the 52nd North Ditch and 52nd South Ditch are oriented east-west and end near a railroad crossing to the west. The 52nd South Ditch extends farther east than 52nd North Ditch, nearly to 66th Avenue East. The 52nd North Ditch ends at the intersection with 62nd Avenue East. GPS data points were only collected at the west ends of the ditches, but the general condition of the ditches was observed along their lengths.

Water Flow Observations. No water was observed at the east ends of the two channels. At the west end of the 52nd South Ditch, water was 1.5 feet deep with little flow. In the 52nd North Ditch, water was 2.5 feet deep with very low flow in the direction of Clear Creek.

Channel Condition. No signs of erosion were observed at the west ends of the channels but may have been obscured by the dense vegetation in the channel. The 52nd South Ditch was 18 feet wide at the top of the bank, and the 52nd North Ditch was 25 feet wide at the top of the bank. Both channels had a layer of silty sediment along the bed.

Vegetation. Dense reed canarygrass was observed growing on the banks as well as in the channel of the 52nd South Ditch (Photos 16 and 17). In open water areas without reed canarygrass, there was dense duckweed. East of the intersection of the ditch with Clear Creek, field investigators observed a patch of cattails. Other vegetation on the banks included blackberry, red alder, and black cottonwood. Farther east, some vegetation was observed in the channel but little to no reed canarygrass.

Similar to the 52nd South Ditch, the 52nd North Ditch had dense reed canarygrass on the banks and in the channel. Water pennywort was also observed growing in a dense mat across the channel at the west end. A dense patch of cattails was also observed to the east of where the 52nd North Ditch connects to Clear Creek.

Culverts. No data were collected for culverts on the 52nd Street East ditches.

Photo 16. 52nd North Ditch near Clear Creek, facing east

Photo 17. 52nd South ditch near Clear Creek, facing east

6.0 Findings

The following sections summarize the major findings drawn from the field investigations described in Chapter 6. The findings include general observations about conditions in the drainage system, maintenance needs, as well as observations about longer term needs.

6.1 Reliance on Clear Creek for Drainage

Currently, all agricultural drainage from the Clear Creek area flows into Clear Creek before eventually draining to the Puyallup River. Relying on Clear Creek to drain agricultural fields creates several problems for agriculture in the Clear Creek area. Clear Creek is a salmon-bearing stream, which leads to higher regulatory barriers and permitting requirements for drainage maintenance. Clear Creek receives substantial sediment and stormwater inputs from its four major tributaries. During wet-season conditions, stormwater volumes from the tributaries raise the water level in Clear Creek, reducing the capacity of the channel to drain agricultural ditches. Because of aggradation in Clear Creek, South Ditch no longer flows directly into the stream. Regulatory barriers to removing sediment from the Clear Creek channel make it difficult to correct drainage issues like those affecting South Ditch. Downstream of agricultural drainage areas, Clear Creek flows through two Port of Tacoma wetland mitigation sites which are not maintained for the purpose of drainage. Clear Creek drains into the Puyallup River through two tide gates that are not controlled by Drainage District 10 or other agricultural interests in the area. A major constraint on the agricultural drainage system is that it relies on a stream which is affected by many factors not controlled by Drainage District 10 and others interested in agricultural drainage.

6.2 Overall Drainage Conditions and Maintenance Problems

The overall conclusion about drainage conditions in the Clear Creek area is that ditch maintenance is needed. There are thick growths of reed canarygrass and other vegetation in the ditches, and there is evidence of sediment deposition in most ditches. Both the vegetation growth and sediment deposits restrict drainage in the area.

Ditches generally have stable banks, but there are some small areas of localized erosion. A general lack of native trees and shrubs on the banks of ditches limits shading, which is a factor in vegetation grown in the channels. The lack of bank vegetation may also increase sediment runoff into ditches. Bankside vegetation could trap and filter sediment in runoff from adjacent farmland.

Some trash debris was observed, including a television and car parts in the Clear Creek channel just upstream of the culvert under Gay Road. Trash was also observed in the Clear Creek channel downstream of the historic intersection with South Ditch.

Because Drainage District 10 was inactive in recent years, most drainage ditch maintenance for the large collector ditches was deferred. The Drainage District has recently been reactivated and is beginning to address deferred maintenance. Many of these problems could be remedied through regular maintenance implemented under a drainage management plan.

6.3 Noxious Vegetation

Invasive plants, including reed canarygrass, elodea, duckweed, and Himalayan blackberry, are a maintenance issue for the agricultural drainage system in the Clear Creek area. Most of the weeds identified in the Clear Creek area drainage ditches are listed by the state or Pierce County as noxious weeds, including elodea, reed canarygrass, bindweed, and Himalayan blackberry (Pierce County Noxious Weed Control Board, 2017; Washington State Noxious Weed Control Board, 2017). Removal of reed canarygrass, in particular, is the primary unaddressed maintenance need in the drainage system. Reed canarygrass encroaches on ditch channels, traps sediment in the channel, and impedes water flow. Reed canarygrass was also observed in floating mats in the channel of several ditches in the Clear Creek area. In summer 2016, a Washington Conservation Corps (WCC) field crew removed reed canarygrass from the Clear Creek channel, which improved drainage. However, these actions need to be repeated on a regular basis to be effective.

Reed canarygrass was observed in the channel at every data point surveyed on Clear Creek, although in most instances it was sparse. The drainage inventory field work was conducted approximately one month after WCC field crews removed reed canarygrass from the channel, which explains why only sparse reed canarygrass was observed. High density of reed canarygrass was observed in the channel between the outlet of upper Clear Creek and the intersection of Nancy's Ditch. In this reach, mats of reed canarygrass were observed, and field investigators noted that reed canarygrass was choking out the channel.

Duckweed and reed canarygrass were observed throughout the channel of Nancy's Ditch. At some points, duckweed was observed covering the entire surface of the channel. In some portions of the ditch, high density mats of reed canarygrass were observed to be choking the channel. Duckweed and reed canarygrass were also observed throughout the channel of South Ditch. Dense reed canarygrass was also observed in every roadside ditch inventoried, along with other vegetation (such as epilobium and equisetum) in the channel.

As noted above in Section 6.2, lack of shade on ditches is one factor contributing to growth of noxious vegetation. Water quality issues, such as nutrient pollution, could also be contributing to growth of noxious vegetation. This drainage inventory did not assess water quality.

6.4 Sediment

Accumulated sediment is an issue for agricultural drainage because it reduces the carrying capacity of ditches and stream channels. Accumulated sediment was observed in ditches throughout the Clear Creek area. Specific locations where sediment was observed are described below.

Sediment depths in Clear Creek ranged from approximately 0.1 foot to 3.6 feet. The highest depth (3.6 feet) was observed at the intersection of Clear Creek with Nancy's Ditch. Approximately 100 feet upstream of the intersection with Nancy's Ditch, sediment was 1.7 feet deep. Most points surveyed on Clear Creek between the outlets of Canyon Creek and upper Clear Creek had over 1

foot of accumulated sediment. Culverts along this reach of Clear Creek had up to 1 foot of accumulated sediment at the bottom of the culvert.

Most roadside ditches had no or little (up to 0.1 foot) accumulated sediment at the bottom of the ditch when inventoried in the dry season. The ditch on the north side of 52nd Street had 0.8 foot of accumulated sediment in the channel. The roadside ditch on the south side of 44th Street had 1.1 feet of accumulated sediment at the culvert conveying water from the roadside ditch to Nancy's Ditch. Accumulated sediment levels in the channel of Nancy's Ditch were high, ranging from 1.1 to 2.5 feet. Sediment levels in South Ditch were lower, ranging from 0 to 0.6 foot.

During the wet season field visit, at the culverts where upper Clear Creek and Squally Creek enter Clear Creek, field investigators observed that water entering from the tributaries was significantly less turbid than the water in Clear Creek (Photo 18).

Photo 18. Culverts conveying upper Clear Creek into Clear Creek on January 19, 2017. Water from upper Clear Creek was substantially less turbid than water in Clear Creek.

Addressing the accumulation of sediment would improve the agricultural drainage system. More information on sources of sediment and approaches to address sediment are included in the *Sediment Conditions in the Puyallup River and Clear Creek* Technical Memorandum (ESA, 2016b).

6.5 Culverts

The Clear Creek agricultural drainage system includes numerous culverts. Much of the system relies on roadside ditches, which flow through relatively small culverts under roadways. All agricultural drainage from areas north of Clear Creek and 52nd Street eventually flows into Nancy's Ditch, which flows through four relatively small culverts before entering Clear Creek. During the field investigation, culverts were generally observed to be in good condition, although vegetation and sediment partially obstructed many culvert inlets. During the wet season site visit, water was observed near or above the tops of several culverts. This could indicate downstream drainage problems and undersized culverts.

In the wet season field visit, water was observed at the top of the culverts conveying Clear Creek under Gay Road. In the dry season, a large rock was partially blocking the entrance to one of the culverts, and large woody debris was observed at the entrance to the other culvert. Several culverts conveying Clear Creek under driveways or access roads were partially obstructed by sediment.

Nancy's Ditch flows through four small culverts directly adjacent to each other before entering Clear Creek. Each culvert is 2.4 feet in diameter. During the dry season field visits, sediment was observed in the culverts. During the wet season field visit, the culverts had some debris at their inlets. While water was flowing through the culverts, water flow was faster on the outlet side of the culverts, suggesting that the culverts may be constricting water flow. Water was observed near the top of the culverts (approximately 0.3 inch from the top) but not overtopping the culverts. Water in Nancy's Ditch upstream of the culverts was at bankfull height (Photo 19).

Photo 19. Nancy's Ditch flowing through four culverts before entering Clear Creek on January 19, 2017

A culvert (DD14 Culvert 7) crosses under 44th Street, carrying water from the roadside ditch on the south side of 44th Street to Nancy's Ditch. The culvert is only 1.1 feet in diameter. When observed in the dry season, it was partially blocked by silty sediment. The culvert was submerged during the wet season field visit. No flow was visible from the south side of 44th Street into the culvert. Based on the small diameter of the culvert and the fact that it was submerged, this culvert is likely undersized.

There are eight culverts on the 44th Street South roadside ditch west of the intersection with 50th Avenue. Two of the culverts are 2 feet in diameter; the rest are 1 foot in diameter. Some of the culverts were partially obstructed by reed canarygrass, bindweed, or large cobbles. In the wet season field visit, these culverts were either submerged or nearly submerged. Based on the small size of the culverts and the fact that they were at or near overtopping, these culverts are likely undersized.

There are 15 culverts on the 44th Street South roadside ditch east of 50th Avenue. The majority are 1 foot in diameter, although some are up to 2.9 feet in diameter and two are only 8 inches in diameter. Two plastic culverts were cracked. Erosion was observed on the downstream end of one culvert. Many of the culverts were partially obstructed by reed canarygrass, sediment, gravel, cobbles, leaves, dense epilobium, trash, or debris.

Eight culverts were observed on the 44th Street North roadside ditch east of 50th Avenue. The culverts ranged from 1 to 2 feet in diameter. Sediment was observed in the culverts, in some cases leaving as little as 0.4 foot of culvert open above the top of the sediment. Culverts on both sides of 50th Avenue East were partially or mostly blocked with sediment and dense reed canarygrass, to the point that the culverts could not be fully investigated.

As described in this section, many of the culverts in the Clear Creek area appear to be undersized based on field observations. In order to determine whether an individual culvert is indeed undersized, a culvert backwater analysis could be conducted. The culvert backwater analysis

would require additional information on the physical conditions of the culvert (such as the exact size and slope of the culvert, the elevation of the culvert inlet, the shape of the ditch, the elevation of the bottom of the ditch, and the slope of the ditch). This information could be obtained through a survey. Ideally, a backwater analysis would also be based on information from logging water elevations on both sides of the culvert. However, if that information was not available, rainfall data from USGS could be used. Because the culvert and ditch system is so interconnected, however, it would be preferable to analyze the system as a whole to determine which culverts are undersized instead of analyzing culverts individually. Ideally, this would be done through a Drainage Maintenance Plan.

6.6 South Ditch Problems

A local landowner informed the ESA field crew that South Ditch no longer flows directly into Clear Creek, and the crew confirmed this during the field visit. Due to sediment deposits in Clear Creek, the creek is now higher than the ditch, preventing the ditch from draining into the creek. Subsequently, the ditch outlet to Clear Creek has been filled in. It is unclear how this occurred, though the ESA field crew was informed it was done to block backflow from Clear Creek into South Ditch during high flows and floods.

Instead of flowing west into Clear Creek, South Ditch now drains to several narrow private drainage ditches (Figure 4). These ditches carry flows from South Ditch north to the roadside drainage ditch on the south side of 44th Street. From there, water flows into Nancy's Ditch, where it flows north then west, entering Clear Creek approximately 4,000 feet downstream of the original outlet of South Ditch. The inability of South Ditch to drain directly into Clear Creek is a major impediment to agricultural drainage in the Clear Creek area.

During the wet season field visit, water was flowing faster at the west end of South Ditch than it was during the dry season. However, little to no flow was observed east from this point, likely due to reed canarygrass growth within the channel.

6.7 44th Street and 50th Avenue Flow Problems

During the wet season field visit, water was present but not moving in the roadside ditch on the west side of 50th Avenue. No water flow was observed in the roadside ditch on the east side of the 50th Avenue. A high density of reed canarygrass was observed, and approximately 3 inches of standing water was observed on the adjacent field. It was not clear where the roadside ditches on either side of 50th Avenue drained to.

The 44th Street North Ditch is long and has the potential to collect significant amounts of runoff from neighboring farms. During the wet season field visit, the 44th Street North Ditch east of the 50th Street intersection was completely overtopped with water, and no water flow was observed in the ditch. It was not clear where this roadside ditch drained to.

Landowners reported drainage issues along the south side of 44th Street to the ESA field crew. Drainage problems could be caused by the undersized culvert connection between the 44th Street

South Ditch and Nancy's Ditch. It is also likely that rerouting flows from South Ditch into Nancy's Ditch has contributed to the problem.

Additional investigation is needed to understand the drainage problems in these three roadside ditches. Confirming how water is routed would be an important step in assessing drainage in this portion of the Clear Creek area. The size of these ditches and culverts should also be checked for adequacy based on their drainage areas.

7.0 Recommendations

Based on the observations and findings described in this report, ESA developed the following recommendations for improving agricultural drainage in the Clear Creek area drainage system. The primary recommendation is to separate the agricultural drainage system from the stream system. This would improve the long-term viability of agriculture in the area. Other recommendations are included to address more immediate drainage problems, as well as longer term recommendation to address drainage problems at South Ditch and along 44th Street and 50th Avenue.

The recommendations in this section vary in the degree of difficulty of implementation. Some of the recommendations, particularly the recommendation to separate the agricultural drainage system from the stream system and Recommendations 5 through 7, would require extensive study, permitting, and funding. However, these recommendations could be pursued as collaborative multiple-benefit projects where they would improve habitat or minimize flood risk as well as improve agricultural drainage, or where they could be included as a component of a larger multiple-benefit capital project like the Clear Creek Floodplain Reconnection Project. The Puyallup Watershed Floodplains for the Future initiative and the upcoming master planning process for the Clear Creek Floodplain Reconnection Project are opportunities to pursue these recommendations.

Recommendation for Long-term Agricultural Viability in the Clear Creek Area

Because relying on Clear Creek for drainage poses several problems for farms in the Clear Creek area as described in Section 6 (Findings), ESA recommends separating the agricultural drainage system from the stream system. If the agricultural drainage system in the Clear Creek area had a separate outlet to the Puyallup River, possibly with fish screens installed, it would be easier to permit maintenance activities because most if not all of the ditches would likely be considered non-fish-bearing. Drainage District 10 and individual farmers would have more control over the drainage system. There would be less input flow into the system that the agricultural drainage relies upon. Separating the drainage system from Clear Creek would also allow options for restoring the stream to more natural conditions.

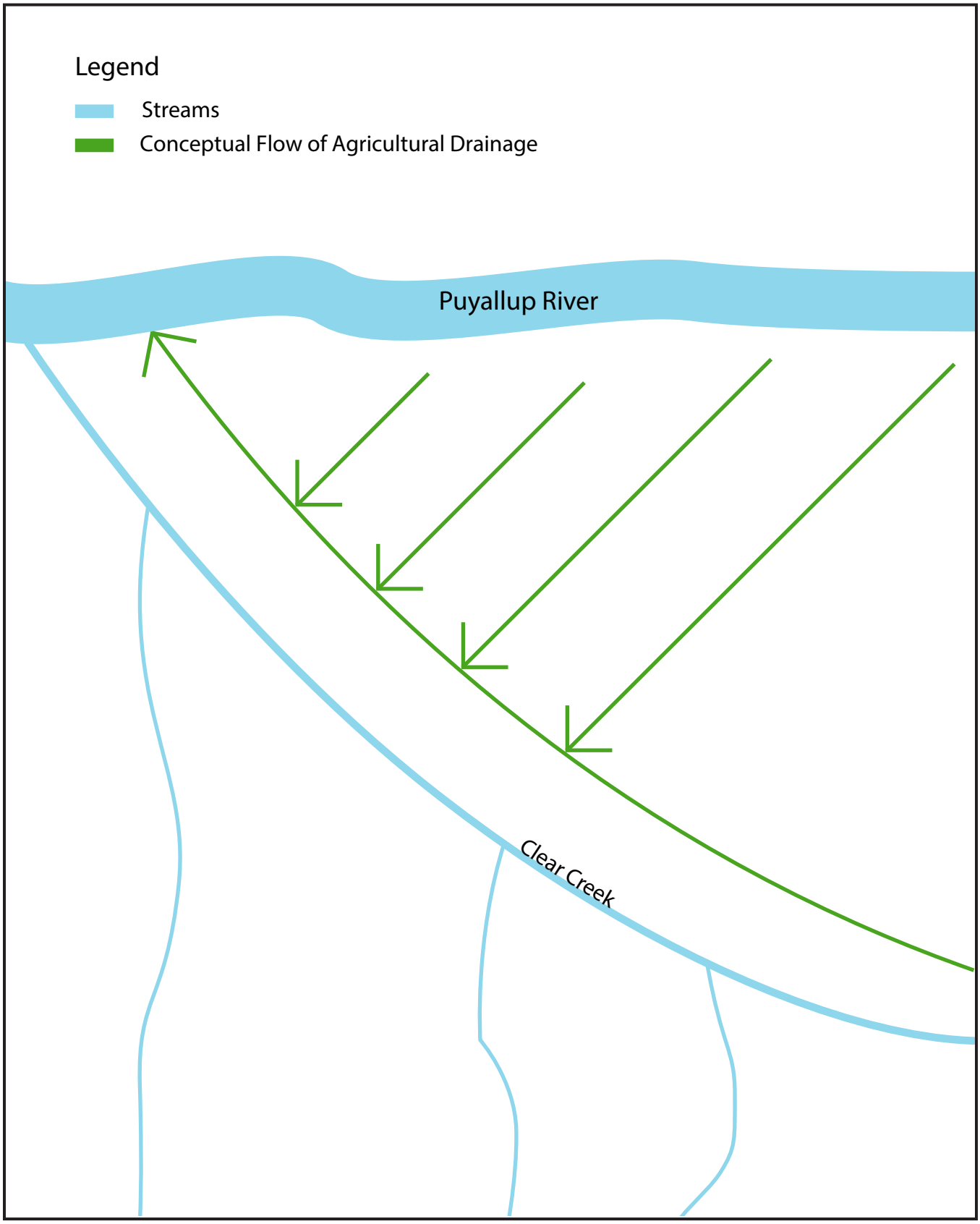
Separating the agricultural drainage system from Clear Creek would be a large capital project requiring new infrastructure. Because of topography, the new river outlet would ideally be located as far downstream as possible to maximize gravity drainage. The drainage channel leading to the new outlet would need to be excavated as far as feasible toward the outlet, but may need to be piped as the elevation of the ground rises.

Pursuing this recommendation would present several challenges:

- Studies would be required, including a survey of the entire area, hydrologic and hydraulic modeling, and wetland delineation.
- Permitting would be complex, including an HPA, an NPDES permit, Corps permits, Endangered Species Act consultation, State Environmental Policy Act compliance, and local permits (such as critical areas, grading, and stormwater permits). Wetland mitigation could potentially be required as well. A new outlet to the Puyallup River would difficult to permit, and additional information on anticipated discharges and potential water quality impacts would be needed.
- A complex set of agreements with landowners (including Pierce County SWM, the Port of Tacoma, and WSDOT) would be required.
- A new ditch system would need to be constructed.
- The new outlet to the Puyallup River would require piping or a pumping system to route water through the River Road Levee. Pumping would require a power source and funding to pay power costs.
- A new culvert under River Road with tide gates would be required for the new outlet.

Figure 6 shows a conceptual diagram of this recommendation.

This scale of project is currently beyond the ability of Drainage District 10 to pursue. However, the feasibility study and design could be included as part of other projects proposed for the area, such as the Clear Creek Floodplain Reconnection Project.



SOURCE: ESA, 2016

PCCFT Farming in the Floodplain

Figure 6
Conceptual Sketch of Separation of Drainage Systems From Stream System

ESA

Recommendations for Ongoing Maintenance and Long-term Drainage Improvements

The following recommendations would address the maintenance and major drainage problems in the Clear Creek area. The near-term actions are described first, followed by the longer term actions.

Recommendation #1: Develop a Drainage Management Plan

Drainage District 10 should develop a Drainage Management Plan to guide maintenance activities in the Clear Creek area. A Drainage Management Plan would provide the foundation for maintaining drainage infrastructure. Having a Drainage Management Plan would help the District with budgeting and with permitting.

A Drainage Management Plan typically includes an inventory of the drainage system that identifies existing problems and thresholds for triggering maintenance actions in the future. The information in this agricultural drainage inventory analysis could be used as a starting point for developing a Drainage Management Plan. Additional information, such as survey data and documented water levels over time, should be gathered. The inventoried drainage features, along with district easements, roads, parcels, and other available information should be compiled in a base map that can be used as the basis for discussions within the District and with permitting agencies and other stakeholders.

The Whatcom Conservation District has developed a Drainage Management Guide that, while tailored to Whatcom County, includes resources that could help Drainage District 10 develop a Drainage Management Plan (Whatcom Conservation District, 2009). A number of the steps recommended in the guide are inventory processes such as:

- Map and classify the watercourses, including identifying constructed watercourses, modified natural watercourses, and natural watercourses.
- Inventory and map other infrastructure, including bridges and culverts, sediment traps, floodgates, tide gates, and other unique drainage infrastructure.
- Map significant natural features, including fish distribution and wetlands.

The majority of these inventory steps are included in this agricultural drainage inventory analysis. The mapping data are available electronically and can be provided to Drainage District 10. Other information may be available from other existing sources. For example, a GIS data layer on Chinook presence is available on the Pierce County Open GeoSpatial Data Portal (http://gisdata-piercecowa.opendata.arcgis.com/). Additional information is needed to understand flow conditions at the 44th Street and 50th Avenue ditches as identified in Section 6.7.

Other steps involved in developing a Drainage Management Plan relate specifically to implementing maintenance activities, including:

- Divide the watercourses into reaches.
- Schedule drainage maintenance work by reach.

- Adopt BMPs.
- Adopt monitoring, reporting, and adaptive management plans.

Adopting BMPs for maintenance activities will facilitate the issuance of permits. Examples are available in the guide and through other sources. Monitoring and adaptive management plans will guide the overall maintenance activities and help the District respond to unforeseen events.

There are other issues that Drainage District 10 needs to pursue outside the scope of this agricultural drainage inventory. The District should consider these issues prior to developing the Drainage Management Plan. These include:

- Consider if the Drainage District boundary should be expanded.
- Find existing drainage easement documents and/or apply new drainage easements for ditches that the District desires to maintain.
- Develop interlocal agreements with the Port of Tacoma and Pierce County regarding drainage responsibilities.

Recommendation #2: Address Acute Maintenance Issues

This agricultural drainage inventory identified several significant drainage problems in the Clear Creek area. These should be addressed soon and can be implemented prior to finalizing the Drainage Management Plan. These include:

- Remove reed canarygrass from drainage ditches and Clear Creek where it interferes with drainage. Dense mats of reed canarygrass were observed on most drainages and impede flows in many places. The reed canarygrass removal conducted by WCC field crews in Clear Creek in summer 2016 appears to have been successful in improving drainage conditions; however, this removal is not a permanent solution. Reed canarygrass should continue to be removed from the Clear Creek channel on a regular basis. Similar removal efforts should be undertaken for Nancy's Ditch, South Ditch, and key roadside ditches.
- Remove sediment deposits where feasible. Sediment removal in Clear Creek would be difficult to permit, and is unlikely to be feasible in the short term. Short-term efforts to remove sediment deposits should focus on Nancy's Ditch; the roadside ditch on the south side of 44th Street adjacent to the culvert conveying water in the ditch to Nancy's Ditch; the four culverts where Nancy's Ditch enters Clear Creek; the culvert conveying water from the 44th Street South Ditch to Nancy's Ditch; and culverts on the roadside ditches alongside 44th Street and 50th Avenue.
- Remove debris that is trapped at obstructions, including at the following locations:
    - Clear Creek channel upstream of the Gay Road culvert.
    - Inlets of the Gay Road East culverts.
    - Culverts on Nancy's Ditch.
    - Culverts on the 44th Street South Ditch.

- Culverts should be cleared of sediment, vegetation, or debris where appropriate. Culverts should be tall enough to provide a free water surface to avoid racking up floating debris. Priority should be given to fixing the culvert problems at Gay Road, Nancy's Ditch, and 44th Street South.

Addressing these problems are short-term actions. Long-term approaches to these issues should be included in the Drainage Management Plan.

Recommendation #3 Develop Plan for Weed Control

The District should develop a plan for controlling weeds in and along the drainage ditches. The Pierce County Noxious Weed Control Board offers information on appropriate weed control methods. Many of these methods will require permits, especially those that involve chemical applications. Water quality in ditches should be assessed to determine whether water quality issues, such as nutrient pollution, are contributing to growth of noxious vegetation. If so, addressing water quality issues could help with weed control.

Ongoing plans for weed removal and prevention should be included in the Drainage Management Plan.

Recommendation #4: Plant Desirable Vegetation along Drainage Ditches

Shade from shrubs and trees can effectively reduce some noxious weeds including reed canarygrass and elodea. In addition, vegetation strips can reduce sediment and pollutants entering ditches from adjacent land. PCC Farmland Trust and the Pierce Conservation District are currently developing a planting project for Nancy's Ditch. This could serve as a pilot project for planting along other drainage ditches in the Clear Creek area. Plantings could be undertaken by Drainage District 10 as part of its Drainage Management Plan or could be implemented by individual landowners or other entities.

Some considerations for planting projects include:

- Selecting native vegetation species.
- Avoiding planting any species on the Washington State or Pierce County noxious weed list.
- Maintaining access to the ditches for future maintenance activities.
- Designing plantings so that they do not interfere with the stability of the ditches.
- Selecting plants with strong roots that add to bank stability.
- Not selecting aggressive plants that would encroach on channels, such as Hooker's willow.

Recommendation #5: Manage Sediment Sources

Accumulated sediment, in some places 3 feet deep, is reducing the drainage capacity of agricultural ditches in the Clear Creek area. The *Sediment Conditions in the Puyallup River and*

Clear Creek Technical Memorandum describes a range of studies and actions that could be undertaken to manage sediment sources in the Clear Creek Subbasin (ESA, 2016b). These would focus on the tributaries to Clear Creek and include stormwater detention to control peak flows; control of direct discharges to the creeks; bank stabilization; installation of log jams to store sediment in the creeks and reduce down-cutting; and sediment loading evaluations for Squally Creek, Clear Creek, and Canyon Creek. Adoption of BMPs for soil management on agricultural fields could also reduce inputs of fine sediment to ditches in the area. Reduction of sediment inputs to the system would reduce long-term maintenance needs for the drainage system. Generally, the priority for sediment management should be to:

- Provide upland sediment source control.
- Create sediment traps or ponds at grade breaks where sediment-bearing tributaries enter the Clear Creek area.
- Remove accumulated sediment in the drainage network when the performance of the system is impacted.

Managing sediment sources should be included in the Drainage Management Plan. The plan should include steps for ongoing maintenance to control sediment, and BMPs that landowners should adopt to reduce sediment. It should also include plans to identify sources of funding for the studies needed to address the larger scale projects, such as the sediment loading evaluations for the tributaries.

Recommendation #6: Improve Drainage at 44th Street and 50th Avenue

As described in Section 6.7, the drainage patterns of the roadside ditches along 44th Street and 50th Avenue are unclear. The ESA field crew was not able to resolve how flows from the east portion of the roadside ditch on the north side of 44th Street and the roadside ditches along 50th Avenue are routed to Clear Creek. Additional study is needed to determine how these ditches connect, and to develop appropriate plans to address the problems. Addressing the problem is a long-term action requiring additional study, engineering, and funding. In the long term, it would be preferable if the agricultural drainage system did not rely on roadside ditches as collectors.

Recommendation #7: Improve Drainage from South Ditch

As described in Section 6.6, South Ditch no longer flows directly into Clear Creek. The inability of South Ditch to drain directly into Clear Creek is a major impediment to agricultural drainage in the Clear Creek area. One solution to the problem would be to dredge Clear Creek so that South Ditch is able to flow directly into the stream. Because Clear Creek is a salmon-bearing stream, it would be difficult to permit this action. Even if dredging could be permitted, it would not be a permanent solution because Clear Creek would likely continue to aggrade and block the outlet.

If South Ditch is not directly reconnected to Clear Creek, alternatives need to be developed to provide an appropriate outlet for South Ditch. Routing South Ditch through Nancy's Ditch adds to the drainage area of Nancy's Ditch, and therefore the amount of water flowing into Nancy's Ditch. Private ditches, roadside ditches, and road culverts are all part of the conveyance system for routing South Ditch flows to Nancy's Ditch. Alternatives to dredging would generally include

modifying the ditches and culverts that convey water from South Ditch to Clear Creek. A new connector ditch alignment should also be considered that would provide an outlet for South Ditch without tying into the roadside ditches or crossing under 44th Street.

Addressing this problem is a long-term action requiring additional study, engineering, and funding.

8.0 References

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