Draft Preliminary Investigative Report for the East Fork Irrigation District Irrigation Modernization Project

Prepared by Farmers Conservation Alliance

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Acronyms

°F	degrees Fahrenheit
cfs	cubic feet per second
BOR	United States Bureau of Reclamation
CTWS	Confederated Tribes of the Warm Springs Reservation of Oregon
CWA	Clean Water Act
DVC	Dukes Valley Canal
EA	Environmental Assessment
EFID or District	East Fork Irrigation District
EFU	Exclusive Farm Use
ESA	Endangered Species Act
FCA	Farmers Conservation Alliance
HDPE	high-density polyethylene
HRSWCD	Hood River Soil and Water Conservation District
HUC	Hydrologic Unit Code
MHID	Mount Hood Irrigation District
mWh	megawatt hours
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
OAR	Oregon Administrative Rule
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OWRD	Oregon Water Resources Department
ODSL	Oregon Department of State Lands
O&M	operations and maintenance
PCE	Primary Constituent Element
PIR	Preliminary Investigative Report
PL 83-566	Watershed Protection and Flood Prevention Program, Public Law 83-566
PVC	polyvinyl chloride
RM	River Mile

SHPO	State Historic Preservation Office
TMDL	total maximum daily load
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
Plan-EA	Watershed Plan-Environmental Assessment

1 Introduction

Aging infrastructure, growing populations, shifting rural economies, and changing climate conditions have increased pressure on water resources across the western United States (U.S.). In parts of the Hood River basin, irrigated agriculture (the primary out-of-stream water use in the area) still relies on infrastructure that is over 100 years old to deliver water to farms and other users. The Hood River Valley is one of Oregon's leading fruit growing regions and produces one third of the U.S. winter pear crop for fresh consumption (Stampfli et al. 2012).

Although pipelines currently serve most irrigation water deliveries within the East Fork Irrigation District (herein referred to as EFID or the District), it is estimated that more than half of these pipelines are older and/or unpressurized. Additionally, three of the District's four major distribution canals and laterals still exist as open earthen ditches that are inefficient for water conveyance, pose a public safety risk, and require increased maintenance due to their age and other factors. Aging canals and inefficient water delivery systems contribute to water supply insecurity for out-of-stream users and limit streamflow, affecting aquatic habitat and water quality in the Hood River and its tributaries. To address these issues, the District must invest increasing amounts of funding in canal maintenance and infrastructure modernization.

A portion of the water diverted through EFID's open canal and laterals[1] is currently returned to surface waters as end spill (overflow) at the end of the laterals, seeps into the soil, or evaporates prior to reaching orchards and farms. As a result, the canals and laterals must carry more water than is required for irrigation so that water reaches all patrons throughout the District. Piping and pressurizing its distribution system would increase the District's operating efficiency and allow EFID to divert less water from the East Fork Hood River. Modernizing its irrigation infrastructure offers an opportunity to enhance habitat for fish and aquatic species, eliminate public safety risks posed by the canals and laterals, and support and maintain agricultural land use through improved water supply reliability.

EFID is the largest of five irrigation districts in the Hood River basin, currently serving 9,596 acres of irrigated cropland. The District operates and maintains 17.9 miles of open canals and laterals and 64.8 miles of mostly unpressurized pipeline. EFID proposes to modernize its infrastructure by converting its open canals to buried, gravity-pressurized pipelines; replacing 43.5 miles of older pipelines with high-density polyethylene (HDPE) piping; and by adding a settling basin to manage glacial sand and silt in its water supply. The District plans to keep 21.3 miles of its existing pipeline, and to replace piping that is at least 10 years old or more. Some of the piping to be replaced is not currently rated to withstand the expected water pressures in a pressurized delivery system. Converting its infrastructure to pressurized pipelines would result in a nearly 100-percent efficient conveyance system and provide financial and operational benefits to the District and its patrons. The District's proposed project is described further in Section 7.2.2 and is available in its System Improvement Plan (Farmers Conservation Alliance [FCA] 2018). Completion of the project is anticipated to take 10 years, depending on the availability of funding assistance.

EFID plans to apply for federal funding assistance for the proposed modernization project through the Watershed Protection and Flood Prevention Program, Public Law 83-566 (herein referred to as PL 83-566). Authorized by Congress in 1954, this program is managed by the U.S. Department of

[1] "Laterals" refer to canals that branch off from the main canal.

Agriculture's Natural Resources Conservation Service (NRCS) agency. Through this program, NRCS provides technical and financial assistance to eligible project sponsors to plan and implement authorized projects for watershed protection.

2 Consultation and Participation with Local Partners, Agencies and Tribes

This Preliminary Investigative Report (PIR) was prepared with assistance from the Hood River-based nonprofit organization FCA to introduce the EFID Irrigation Modernization Project (herein referred to as the "project" or the "proposed action"), present the project's goals and objectives, and provide the information necessary for all stakeholders to evaluate the project and guide development. This project development process is designed to work collaboratively with partners, agencies, tribes, and other stakeholders so that there is transparency, ownership, and cooperation towards a solution that fits within the framework of the purpose and need for action (Section 3). There are many organizations involved in water issues in the Hood River basin; therefore, during the development of the PIR, EFID and NRCS Oregon together with FCA conducted initial consultation with natural resource agencies and other stakeholders. EFID and its partners will conduct further comprehensive public scoping prior to the preparation of the Watershed Plan-Environmental Assessment (Plan-EA) as described in the Scope of the Environmental Assessment (Section 4). As noted in Section 1, EFID anticipates federal funding assistance for the project under PL 83-566.

2.1 Sponsors, Local Partners, Agencies and Tribal Participation

For the purpose of the project, sponsors are the agencies involved in scheduling, facilitating communication, project design and development, and document writing. The primary sponsor for the project is East Fork Irrigation District. The supporting sponsor for the project is NRCS.

Local entities that have land ownership or a shared resource within the District include:

- Hood River County
- Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS)

State and federal agencies that are or will be involved with the project include:

- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Water Resources Department (OWRD)
- State Historic Preservation Office (SHPO)
- Oregon Department of Environmental Quality (ODEQ)
- Oregon Department of State Lands (ODSL)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries
- Bonneville Power Administration (BPA)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Army Corps of Engineers (USACE)
- U.S. Bureau of Reclamation (Reclamation)

Tribes consulted regarding the project include:

- Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS)

Other stakeholders for this project are any interested parties. Currently identified stakeholders include:

- Hood River Watershed Group (HRWG)
- Hood River Soil and Water Conservation District (HRSWCD)
- Mt. Hood Irrigation District (MHID)
- U.S. Forest Service (USFS)
- Oregon State University Extension Office
- Interested public

2.2 Permits and Compliance

EFID anticipates that this project will invest federal funds through the NRCS PL 83-566. Therefore, the project will require a Plan-EA. The Plan-EA will include compliance with all relevant state and federal permits and regulations, including Section 106 of the National Historic Preservation Act (NHPA; managed by the Oregon SHPO), Section 7 of the Endangered Species Act (ESA; managed by NOAA Fisheries[2] and USFWS), and Sections 404 and 401 of the Clean Water Act (CWA; managed by ODSL and USACE).

2.3 Mitigation

Following consultation with SHPO and the public scoping process, there may be a requirement for mitigation for loss of historic irrigation canals or other cultural resources. Mitigation for any other potential impacts of the project will be outlined, designed, and completed following consultation with the corresponding agencies. It is expected that mitigation measures would be employed before, during, and after project construction as necessary to avoid or minimize the impacts of the project on community, environmental, or other resources.

3 Purpose and Need for Action

The project area is defined as the canals and pipelines to be modernized, as well as, associated easements on each side of these where construction activity would occur. The project area is located within four subwatersheds that cover a total of 77,780 acres (see Table 3-1) within the Middle Columbia-Hood watershed (Hydrologic Unit Code [HUC] 17070105)[3]. These four subwatersheds comprise the EFID Watershed Planning Area.

[2] Formerly known as National Marine Fisheries Service or NMFS

[3] A HUC identifies and delineates watersheds using a national standard hierarchical system based on surface water features, and was developed by the U.S. Geological Survey.

Table 3-1. East Fork Irrigation District Watershed Planning Area.

12-digit Hydrologic Unit Code	Name	Area (acres)
170701050701	Neal Creek	19,713
170701050702	Odell Creek-Hood River	20,905
170701050703	Indian Creek-Hood River	10,017
170701050706	Lower East Fork Hood River	27,145
	Total	77,780

The District currently provides irrigation water to approximately 9,600 acres using one diversion on the East Fork Hood River, which is a tributary to the Columbia River. EFID also diverts water for the MHID, which serves 1,110 acres. Irrigation water is diverted at River Mile (RM) 6.6 into EFID's open Main Canal and is conveyed 6.8 miles to the Distribution Center. At the Distribution Center, the system splits into two laterals: the open Dukes Valley Canal (DVC) and the Central Lateral Pipeline (CLP). The DVC conveys water to the southwestern extent of the District via five lateral pipelines. The CLP supplies water to 10 sublateral pipelines and discharges into the open Eastside Canal, which conveys water to the northeastern extent of the District (see Figure 2 in Section 5.2). All of EFID's pipelines, canals, and laterals are fed by gravity. Some patrons are required to pump the water to their individual farms from the District's turnouts. During peak irrigation season, the District's water rights allow for the diversion of 117.36 cubic feet per second (cfs) of live flow from the East Fork Hood River. The District does not have any water storage reservoirs.

The purposes of this project are to:

- Improve water conservation within the Hood River basin by reducing water losses from end spills (operational overflows) and canal seepage.
- Support and maintain existing agricultural uses through improved irrigation water management on 9,596 acres in the Hood River basin.
- Enhance aquatic habitat by reducing diversion rates from the East Fork Hood River and creating permanent instream water rights with a portion of the conserved water through Oregon's Allocation of Conserved Water Program.
- Reduce risks to public safety on almost 18 miles of open irrigation canal and laterals.
- Conserve energy by reducing the need for on-farm irrigation pumping.
- Increase water supply security and reliability for District patrons in the face of a changing climate.
- Improve financial stability and control long-term operating costs for the District.

Consistent with these purposes, the project would specifically address the following concerns:

- Water losses from end spill and seepage in the District's conveyance system;
- Water delivery and operational inefficiencies;
- Instream flow conditions for threatened fish species; and
- Drowning hazard along open canals.

3.1 Watershed Problems and Resource Concerns

3.1.1 Water Loss in District Conveyance Systems

Conserving water is a key objective of EFID. Several studies have been conducted over the last 13 years to quantify potential water losses throughout the delivery system. These investigations focused primarily on two sources of water loss: excess end spills and seepage (infiltration). Evaporation loss was estimated to be minor (Wharry 2016). End spills are excess water released into ditches or streams at the termination of an unpressurized canal or lateral. The District's existing infrastructure loses an estimated 18.3 percent of the water diverted annually to end spills that are maintained throughout the District. FCA estimated the average rate of end spills in the District during summer 2016 and 2017 at 16.6 cfs (FCA 2018). The District diverts this water to ensure a continual water supply for all patrons. End spills are considered losses in the system because the water is diverted from the river and never used directly to irrigate crops. FCA determined through a flow loss analysis and hydraulic modeling that the District could save this water if the EFID conveyance system was piped and pressurized. Another additional, unquantified amount of water loss occurs from seepage (infiltration) along the District's open earthen canals. Measurement of seepage losses within the District have been inconclusive due to the large number of turnouts along canals, associated measurement errors, and other uncertainties. Where seepage study results were considered valid, the limited canal locations studied meant that the measurements could not be extrapolated to the whole District. The details of the water loss analysis can be found in the District's System Improvement Plan (FCA 2018).

3.1.2 Water Delivery and Operation Inefficiencies

The District's canals and pipelines do not convey water as efficiently as a fully piped and pressurized system could. Conveyance of water in the District's open canals requires the use of end spills at 58 locations throughout the system so that a steady water supply can be delivered to all patrons. EFID staff monitor end spills and adjust the rate of diversion daily to limit the amount of water lost, but managing end spills can be difficult as patrons turn delivery gates on and off. Piping and pressurizing EFID's aging distribution system would eliminate these end spills, increase the District's operating efficiency, and allow EFID to divert less water from the East Fork Hood River. With a piped and pressurized system, patrons will be able to adjust their deliveries by opening or closing a valve on a pressurized pipe, similar to turning a faucet on and off. Rather than taking their full rate, 24 hours a day, 7 days a week, patrons can take only the water they need. A modern piped and pressurized system will automatically backwater and leave any unneeded water in the river, greatly reducing the need for staff to manually adjust diversion amounts at the District's diversion as well as at individual delivery gates throughout the system.

As the system ages, the District faces increasing operation and maintenance costs. A large proportion of its existing pipelines are polyvinyl chloride (PVC) and concrete pipes that are 10 or more years old. Some of the District's oldest pipelines are over 70 years old and include wooden pipes (Brian Nakamura, EFID Board, personal communication, September 24, 2018). It is anticipated that many of these pipelines will need replacement beginning in the next decade. Some of these older pipelines are not rated to withstand the expected water pressures that would occur in a pressurized system. District staff inspect, repair, and remove debris from the open canals and laterals as part of the District's maintenance work. Buried pipe requires very little maintenance because tree limbs, leaves, garbage, or other debris cannot enter and obstruct or damage the District's system. Modernization will change how EFID invests in operations and maintenance

(O&M). It will allow the District to focus on assisting its patrons and delivering precise amounts of water as needed rather than continually managing, maintaining, and repairing its aging canals and delivery system.

3.1.3 Future Watershed Yield

The District's water supply in summer months is fed by snow and glacial melt on Mount Hood, and spring sources. Since the 1920s, the amount of snowpack in the Hood River basin has decreased. Mount Hood's glaciers have been steadily receding since the mid-1900s or earlier. Glacial recession and decreased snowpack are expected to continue as a result of the warmer temperatures predicted with the changing climate (Reclamation 2015). The basin's natural runoff is projected to increase during the fall and winter months and decrease in the late spring and summer months when water uses are greater. Currently, between 50 and 70 percent of streamflow in the basin during the critical water use period is provided from glacial melt (Reclamation 2015). Once the Mount Hood glaciers fully recede, the basin will lose one of its largest water storage supplies. In the East Fork Hood River, the modeled future decline in average natural streamflows for the months of May through September approached 30 percent for the years 2030 to 2059 compared to the base period of 1980 to 2009 (Reclamation 2015). Currently, there is a lack of adequate streamflow in the basin during the summer months to meet the competing demands for water. This imbalance is expected to be exacerbated by climate change.

3.1.4 Instream Flow for Fish and Aquatic Habitat

The Hood River and its tributaries experience low streamflows every year due to the diversion of water for agricultural use. Resource agencies have identified streamflow as a primary concern in the Hood River Basin, with the lower East Fork Hood River downstream of the EFID diversion identified as the highest level of concern for water quantity and water quality in the entire basin (Shively 2006). In dry and drought years, EFID typically diverts an average of 73 percent and up to 85 percent of the available flow of the East Fork Hood River during the late summer[4].

The mainstem Hood River and its tributaries support threatened and sensitive species, including steelhead trout, bull trout, Chinook and coho salmon, Pacific lamprey and many other fish, bird, and wildlife species. Low streamflows associated with water diversions limit the amount and quality of habitat for many of these species, concentrate predators and prey together, increase competition for food and spawning sites, and contribute to warm water temperatures that are harmful to salmon and trout. Because streamflow is strongly correlated with critical physical and biological characteristics of a river, it influences the functions of associated riparian areas (National Research Council 2002).

3.1.5 Risks to Public Safety

Open canals pose a safety risk for the public and EFID employees. In the 1980s, two persons drowned in EFID canals in two separate incidents that included the drowning death of a child (J. Buckley, EFID Manager, personal communication, September 24, 2018). Water depths in EFID canal and laterals range between 2 to 4 feet during the irrigation season, with velocities up to 5 feet per second in places. These conditions make it difficult for a healthy, strong adult to stand in or

[4] Percentages based on 2001-2017 average August EFID diversion of 102 cfs (FCA 2018) and 80% exceedance streamflow (below Dog River) of 139 cfs (OWRD 2018a, and EFID 2015 diversion of 105 cfs from live flow of 125 cfs (Salminen et al. 2016).

climb out of a canal without assistance. A child or non-/weak-swimmer would have a higher risk of drowning in a canal with these attributes. If a person or animal falls into a canal, they could have serious difficulty gaining a hold on the banks to climb out due to the volume and speed of the moving water. Barriers or fences at the top banks of the canals are not currently installed. The public safety risks from open canals can be expected to increase along with increased rural residential development within the District and continued population growth in Hood River County. Piping the remaining open canals will allow the District to eliminate these risks.

3.1.6 Irrigation Water Quality

The East Fork Hood River's high glacial sand and silt content requires that sediment be separated from irrigation water near the point of diversion. EFID operates a sand trap within its Main Canal about 2,300 feet from the diversion headgate (the gate at the beginning of the canal). Wide areas in the canal upstream of the sand trap provide additional settling capacity. The District also employs small sedimentation ponds at various locations within its system to limit the sand content in the water delivered to patrons. Despite these efforts, the District's water quality is poor at certain times during the irrigation season. As a result, on-farm filter systems are necessary for irrigators using low flow sprinkler systems. The high sand and silt content in the EFID water supply increases patron's maintenance needs on-farm. In addition, it erodes sprinkler nozzles, clogs drip emitters, and limits the potential for widespread use of more efficient on-farm irrigation technology within the District.

3.2 Watershed and Resource Opportunities

The implementation of the project would benefit the following list of resources. Other sections of this report quantify or further describe these opportunities as appropriate.

- Improve irrigation water management and irrigation water delivery to EFID patrons by improving water conveyance efficiencies and pressurizing deliveries.
- Improve streamflows, water quality, and aquatic habitat availability within the lower East Fork Hood River (RM 0 to RM 6.6) and the Hood River (RM 0 to RM 14.7).[5]
- Improve water quality in Neal Creek (RM 0 to RM5.8), West Fork Neal Creek (RM 0 to RM 1.8), Odell Creek RM 0 to RM 2.3), Lenz Creek (RM 0 to RM 1.2), and Whiskey Creek (RM 0 to RM 1.3).[6]
- Minimize the potential for injury and loss of life associated with open EFID canals and laterals.
- Reduce O&M demands involved in delivering irrigation water to EFID patrons.
- Reduce energy costs by removing the need for individual on-farm irrigation pumps.
- Improve the quality of irrigation water delivered to patrons through enhanced sediment management.

[5] In this report, the river miles noted for the East Fork Hood River are measured from its confluence with the Middle Fork Hood River. This notation is from the Oregon Spatial Data Library. It differs from the U.S. Geological Survey (USGS) National Hydrography Dataset that identifies RM 0 of the East Fork Hood River to be at its confluence with the West Fork Hood River.

[6] River miles approximated based on where spill would enter each creek.

4 Scope of the Environmental Assessment

NRCS and EFID will conduct public scoping as the National Environmental Policy Act (NEPA) review process proceeds. Public scoping will seek to identify additional issues of economic, environmental, cultural, and social importance in the watershed. NRCS, EFID, and FCA will organize agency and public scoping meetings that will provide an opportunity to review and evaluate the project alternatives, express concerns, and gain further information. Following the scoping process, a Plan-EA will be drafted to determine if the proposed project meets the program criteria found in Title 390, National Watershed Program Manual, Part 500, Subpart A, Sections 500.3 and 500.4.

5 Affected Environment - Existing Conditions

5.1 Project Setting

The proposed project will occur within existing canal and lateral footprints within District easements and/or rights of way or other prescriptive locations. EFID is located in the Columbia River Gorge region of Oregon approximately 55 miles east of Portland, in an agricultural area known locally as the Hood River Valley. The District falls within Hood River County, which includes the City of Hood River and several unincorporated communities such as Odell and Parkdale (Figure 1). The county's population in 2017 was 25,145 and its growth rate from 2010 to 2016 ranked as Oregon's second fastest at 10.7 percent.

The entire District is approximately 15,150 acres in area, and it serves 9,596 irrigable acres used by approximately 990 patrons. The District falls within four 12th field HUC subwatersheds,[7] which have a total area of 77,780 acres (see Table 3-1). These four subwatersheds comprise the Watershed Planning Area (see Figure 1) for the project. The Watershed Planning Area is located within the larger Middle Columbia-Hood Watershed (4th field HUC 17070105) as shown in the inset box in Figure 1.

[7] A small portion of EFID (72 acres) at its northern boundary extends into the Rowena Creek-Columbia River subwatershed (12th field HUC 170701051106). This subwatershed was excluded from the planning area given that project effects will not occur in this area.

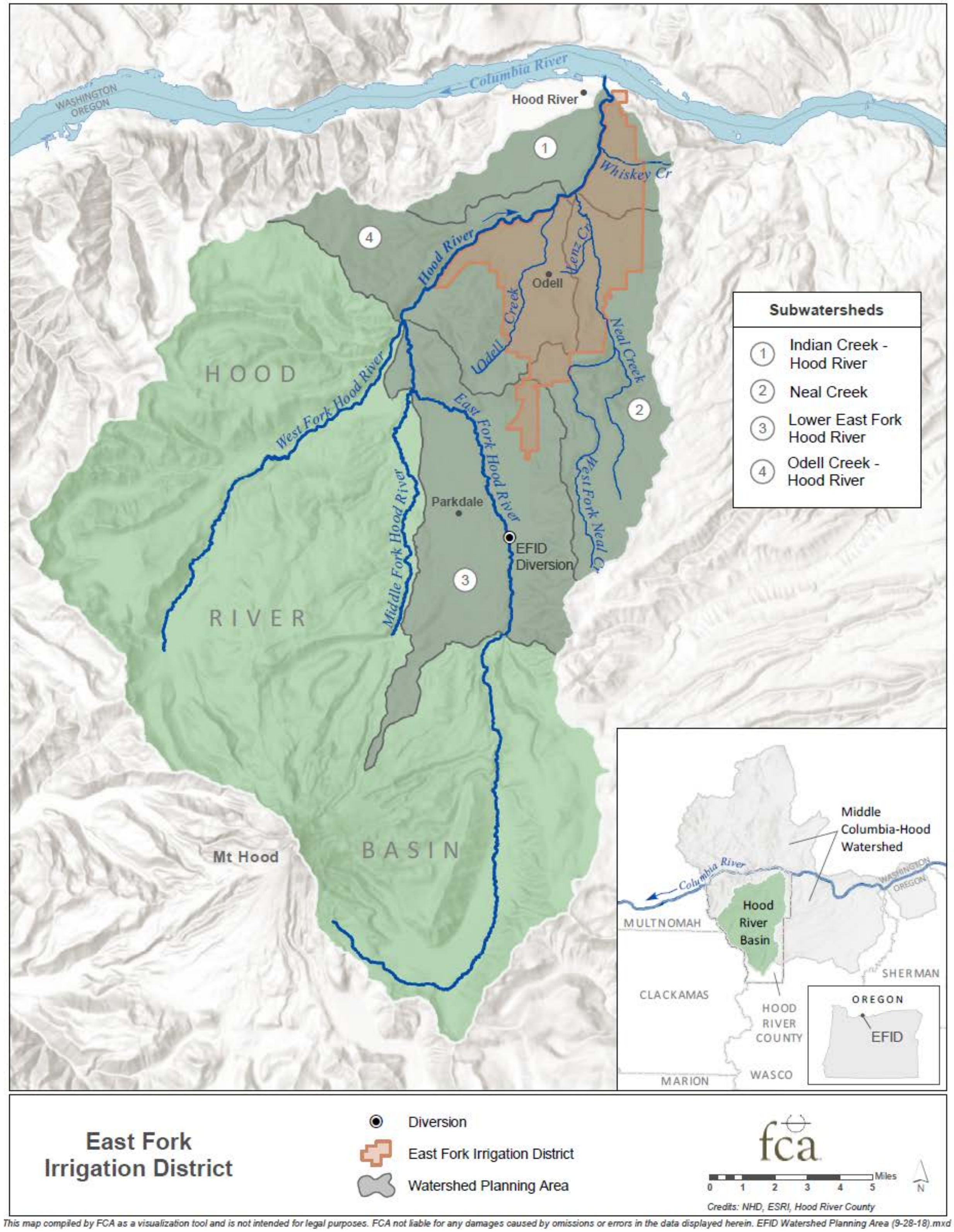

Figure 1. East Fork Irrigation District Watershed Planning Area.

5.2 Current Infrastructure

The District operates and maintains approximately 82.8 miles of canals and laterals, including 17.9 miles of open canals and 64.9 miles of existing piped segments. The District has a single point of diversion on the East Fork Hood River (RM 6.6). The diversion structure includes an Obermeyer weir, steel slide headgates, and a fish ladder.

EFID diverts water both for itself and for the smaller MHID located south of EFID that serves 1,110 acres. MHID does not operate its own diversion, and instead withdraws water under its own water rights from EFID's Main Canal at two locations. MHID is completely piped.

EFID operates a sand trap and fish screen facility within its Main Canal about 2,300 feet from the diversion. From the diversion, water is conveyed to the sand trap, which is a 90-foot long by 66-foot wide concrete structure designed to separate, retain, and eventually dispose of over 1,000 cubic yards of sand within an 8-hour period (Buell and Associates 2000). Wide areas in the canal upstream of the sand trap provide additional settling capacity; however, in some years these sediment management facilities are overwhelmed, and thousands of yards of material must be stockpiled along the access road or hauled offsite.

Fish screening is provided by Coanda-type fish screens that are installed in the downstream end of the sand trap. These screens are regarded as experimental technology by NOAA Fisheries. Limited testing of EFID's screens conducted in 1999 found no injuries or mortalities in juvenile steelhead and Chinook passing the fish screens (Buell and Associates 2000). The testing did not include the effects on fish from the diversion to the point of the bypass channel discharge to the river (CBFWA 2005). Compared to NOAA Fisheries criteria for horizontal fish screens (NMFS 2011), Coanda screens do not meet the current criteria for approach velocity and bypass flow depth. Other disadvantages include the need to adjust the bypass flow rate to prevent dewatering at the lower portion of the screen and/or a loss of bypass flow during low flow periods, which could result in fish injury or mortality (Reclamation 2006). Additionally, the self-cleaning functions of the screen are not always reliable (QW Consulting 2018).

After leaving the sand trap and fish screen facility, the water diverted for irrigation re-enters the open EFID Main Canal and is conveyed to a Distribution Center 6.8 miles to the north. From the Distribution Center, the system splits into two laterals: the open DVC the CLP. The DVC conveys water to the southwestern extent of the District via five lateral pipelines (see Figure 2). The CLP supplies water to 10 sub-lateral pipelines and to the open Eastside Canal. The Eastside Canal supplies water to seven piped laterals and transitions into the Whiskey Creek Pipeline and several piped laterals. The conveyance system is fed entirely by gravity.

Approximately 79 percent or 64.8 miles of the District's conveyance system has been piped. However, 43.5 miles of these existing pipes are at least 10 years old and will need to be replaced as they reach the end of their design life or will not meet current engineering standards. Some of the District's older piping is not currently rated to withstand the water pressures expected in a pressurized delivery system.

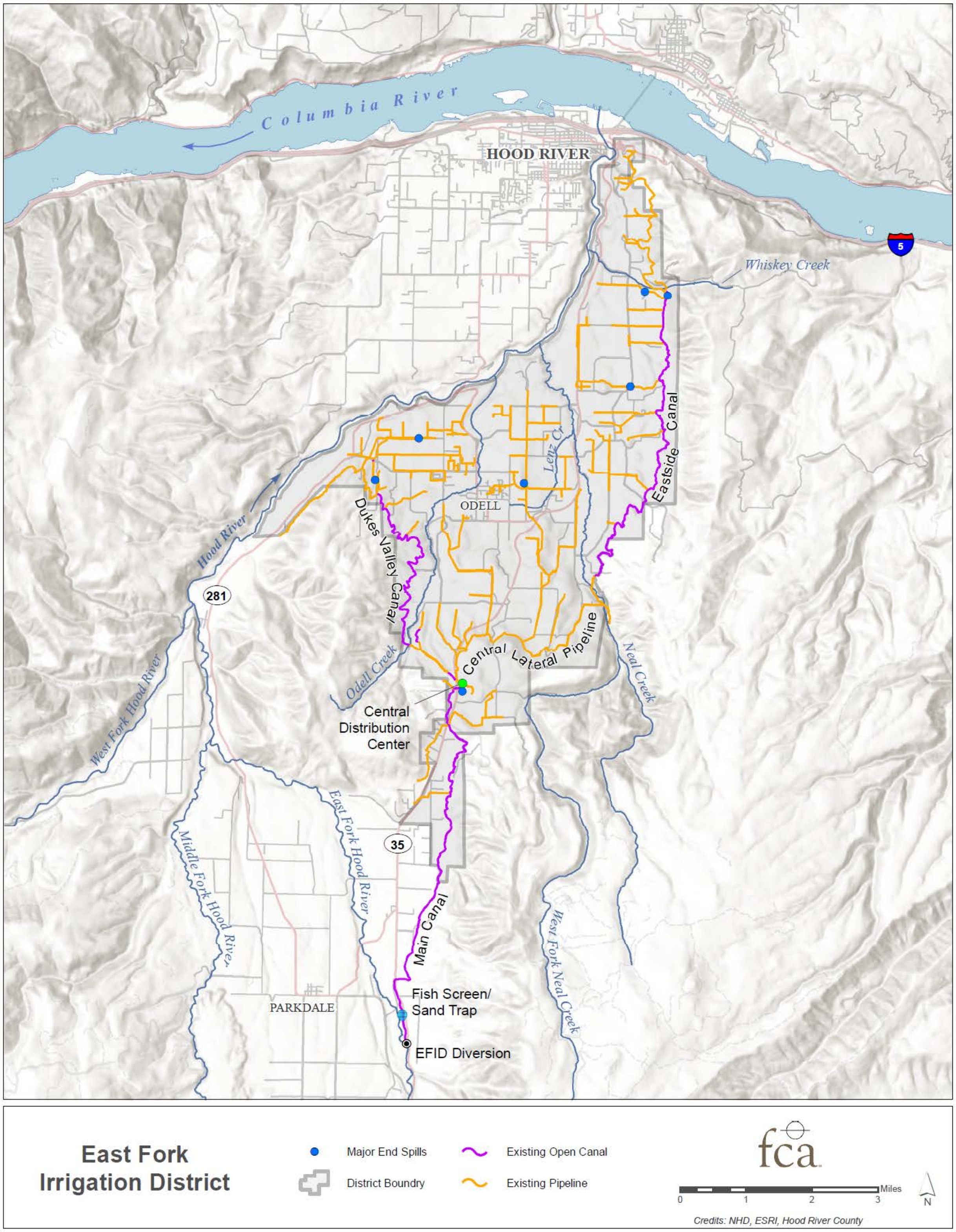

Figure 2. East Fork Irrigation District's current infrastructure.

5.3 Topography

The District is located in the Hood River Valley, where the topography of the irrigated lands can vary from relatively flat to moderately sloping terrain. The EFID diversion is located at 1,721 feet elevation, while the lowest delivery point in the District is at approximately 300 feet elevation. The Main Canal drops approximately 280 feet in elevation from the EFID diversion to the Distribution Center. The DVC drops 400 feet and the CLP drops 600 feet from the Distribution Center to the Eastside Canal. The terminal end of the Eastside Canal is 796 feet lower in elevation than the EFID diversion.

5.4 Climate

The Hood River basin is set along the eastern flanks of the Cascade Mountains, within the transition zone between the moist maritime climate to the west and the drier continental climate to the east. Moist air from the Pacific Ocean lifts as it encounters the high elevations along the western and southern boundaries of the basin, resulting in more precipitation in these regions. As the air descends and warms, it re-absorbs moisture from the land surface, leading to more arid conditions along the eastern and northern regions of the basin (Reclamation 2014). Precipitation within EFID's more arid northeastern basin averages 31 inches per year (McMahan 2011), and most arrives in the winter months, making irrigation essential to crop production. The average high temperature in summer is 81 degrees Fahrenheit (°F) and the average low in January is 28°F. The growing season ranges from approximately 143 to 183 days depending on elevation (CGFG 2018).

Recent yet consistent changes in climate show signs of future increased temperatures and changes in precipitation patterns. The probable response to changes in precipitation patterns and increased temperatures is a transition from snow to rain at intermediate and low elevations in the Cascade Range, causing earlier runoff and reduction in the pulse of runoff and groundwater recharge associated with spring snowmelt (Waibel 2010). Winter (October through March) warming is predicted to stimulate greater winter stream flow immediately. Increased spring and summer (April through September) warming is estimated to increase the rate of spring snowmelt, subsequently decreasing late summer stream flows in response to the reduction of summer snow reserves (Das et al. 2011).

5.5 Cultural and Historic Properties

Section 106 of the NHPA of 1966 requires federal agencies to take into account the potential effects of a project on historic properties listed in or eligible for listing in the National Register of Historic Places. Implementation of the NHPA in Oregon is overseen by the Oregon Parks and Recreation Department and the SHPO. Recommendations of eligibility for the National Register require consultation with SHPO, and the consulting parties must agree on a determination of effects. A finding that historic properties could be adversely affected requires that the consulting parties enter into a Memorandum of Agreement with stipulations for certain actions and timelines that mitigate the adverse effect and are acceptable to all of the consulting parties.

The District's canal and laterals that are involved in this project have not been surveyed for cultural and historic resources to date, and the District does not have any features listed or pending for listing on the National Register. Consultation with SHPO prior to project implementation will be necessary to determine the potential effects on cultural and historic resources, if any, from the project.

5.6 Fish & Aquatic Species

Fish species do not occur in EFID's irrigation infrastructure except for the upper 2,300 feet of the Main Canal between the District's diversion and its fish screens. Aquatic species other than fish such as amphibians and aquatic insects or other macroinvertebrates do occur in the District's open canals, both upstream and downstream of the fish screens. The fish screens were constructed in 1996 to separate the water diverted for irrigation from the water left instream. These screens prevent fish from entering the District's irrigation conveyance system; therefore, no resident or anadromous fish or threatened and endangered aquatic species are present in any of the EFID canals or pipelines downstream of the fish screens. Waterbodies affected by District diversions that support fish and other aquatic species include the East Fork Hood River and the mainstem Hood River. In addition, several smaller streams that support fish and other aquatic species are affected through larger end spills that are maintained by the District. These include West Fork Neal Creek, Neal Creek, Lenz Creek, Odell Creek, and Whiskey Creek (see Table 5-1). While approximately 50 other smaller end spills occur throughout EFID and may enter surface waters, their pathways are not easily identified. An unknown proportion of these smaller end spills may penetrate soils or be absorbed by plants along roadside ditches before reaching a stream.

Table 5-1. Waterbodies Associated with District Operations.

Name	Reach	Tributary To	Relationship to Project
East Fork Hood River	EF Hood River from the EFID diversion at RM 6.6 to Middle Fork Hood River confluence at RM 0	Hood River	Diversion of up to 117.36 cfs affects streamflows, fish passage, and water quality. EFID operates a fish screen and currently maintains at least 15 cfs in the river immediately below the diversion. The canal between the diversion and the fish screen is occupied by juvenile fish, presenting a stranding hazard when the canal is dewatered[8] at the end of the irrigation season.
Hood River	Mainstem Hood River from Middle Fork Hood River (RM 14.7) to mouth	Columbia River	Diversion of up to 117.36 cfs affects streamflows in this reach.
West Fork Neal Creek	West Fork Neal Creek from RM 1.8 to confluence with Neal Creek	Neal Creek	End spill affects streamflows and water quality in this reach.
Neal Creek	Neal Creek from West Fork Neal Creek confluence (RM 5.8) to mouth	Hood River	End spill affects streamflows and water quality in this reach.
Odell Creek	Odell Creek from RM 2.3 to mouth	Hood River	End spill affects streamflows and may affect water quality in this reach.
Whiskey Creek	Whiskey Creek from RM 1.3 to mouth	Hood River	End spill affects streamflows and may affect water quality in this reach.
Lenz Creek	Lenz Creek from RM 1.2 to mouth	Neal Creek	End spill affects streamflows and may affect water quality in this reach.

[8] "Dewatered" means that the source of the irrigation water is turned off or diverted from the irrigation ditch. A ditch that is dewatered outside of the irrigation season may be used for temporary flows associated with stormwater collection, stock water runs, or fire suppression.

There are 18 species of fish known to occur in reaches of the Hood River associated with District operations (see Table 5-2).

Table 5-2. Fish Species within the Waterbodies Associated with District Operations.

Fish Species	Scientific Name	Origin
Bridgelip sucker	*Catastomus columbianus*	Indigenous
Bull trout	*Salvelinus confluentus*	Indigenous
Brown bullhead	*Ameiurus nebulosus*	Introduced
Chinook salmon	*Oncorhynchus tshawyscha*	Indigenous
Brown trout	*Salmo trutta*	Introduced
Chiselmouth	*Acrocheilus alutaceus*	Indigenous
Coastal cutthroat trout	*Oncorhynchus clarkii*	Indigenous
Coho salmon	*Oncorhynchus kistutch*	Indigenous
Dace species	*Rhinichthys* spp.	Indigenous
Largescale sucker	*Catastomus macrocheilus*	Indigenous
Mountain whitefish	*Prosopium williamsoni*	Indigenous
Northern pike minnow	*Ptychocheilus oregonensis*	Indigenous
Pacific lamprey	*Lampetra tridentata*	Indigenous
Rainbow trout	*Oncorhynchus mykiss irideus*	Indigenous
Sculpin species	*Cottus* spp.	Indigenous
Steelhead	*Oncorhynchus mykiss*	Indigenous
Three-spined stickleback	*Gasterosteus aculeatus*	Indigenous
White sturgeon	*Acipenser transmontanus*	Indigenous

Source: BPA 1996; Coccoli 1999; R. Gerstenberger, CTWS, personal communication, July 30, 2018

The Hood River basin is part of the 10 million acres of lands ceded to the United States by the CTWS. Under rights reserved by treaty, tribal members harvest salmon and steelhead from the Hood River. Tribal fishing opportunity has become severely restricted because of low fish abundance and the need to protect weak or threatened stocks (Salminen et al. 2016). Hood River anadromous fish populations are co-managed by CTWS and ODFW.

Since the development of agriculture in the late 1800s, the diversion of water, construction of reservoirs, fish passage barriers, drainage, and other agricultural activities have affected the aquatic environment and fish populations in the Hood River basin. Low streamflows and water quality impairments are recognized as key limiting factors for fish populations in the basin (Shively 2006). Steelhead, bull trout, coho, and Chinook in the Hood River are listed as threatened under the federal ESA and, with the possible exception of bull trout, are all present in the East Fork Hood River. The East Fork Hood River below the District's diversion is regarded as having the best potential spawning and rearing habitat for salmon and steelhead within the entire mainstem East Fork Hood River based on its gentle gradient, abundant gravel, and broad floodplain (R. French, ODFW, personal communication, August 8, 2018). Streamflows are lowest in the one half-mile bypass reach between the EFID diversion (RM 6.6) and the point where a portion of the diverted water returns to the river from the EFID fish screen facility (RM 6.1). Low streamflows and shallow water in this bypass reach affects fish passage conditions for adult salmon and steelhead attempting to migrate into the upper East Fork Hood River.

Elevated water temperatures in response to natural and human-caused factors, including reduced summer streamflows, negatively affect the growth and survival of salmonids (Recsetar et al. 2012). Water temperatures that are out of the normal range for a given fish species can increase physiologic stress, increase susceptibility to disease and predators, and influence feeding, metabolism, and development.

In addition to fish, other aquatic species may be found within the project area or along waterbodies that are associated with District operations. These other aquatic or semi-aquatic species likely include water shrew, water vole, and salamander species, including Pacific giant salamander, and they may also include Pacific treefrog and Cascades frog. These species are all native to Oregon and may be present in open irrigation canals and adjacent banks where there is suitable vegetation (C. Fiedler, USFS, personal communication, July 25, 2018). The bull frog is an invasive, non-native species that may also be present in areas along irrigation canals at lower elevations.

5.6.1 Federally Listed Fish and Aquatic Species

The ESA (16 United States Code [USC] 1531 et seq), as amended in 1988, establishes a national program for the conservation of species listed as threatened and endangered, and the preservation of habitats on which they depend. The ESA defines procedures for listing species, designating critical habitat for listed species, and preparing recovery plans. Section 7 of the ESA, as amended, requires organizations to consult with NOAA Fisheries and/or the USFWS if listed species or designated Critical Habitat may be affected by a proposed project. If adverse impacts could occur, the ESA requires federal agencies to evaluate the likely effects of the proposed project and ensure that it neither risks the continued existence of federally listed ESA species nor results in the destruction or adverse modification of designated Critical Habitat.

A list of aquatic species protected under the ESA that are known or expected to occur in seven waterbodies associated with District operations was obtained from *Federal Register* (FR) notices and from the USFWS Information for Planning and Consultation website. Fish species listed as threatened under the ESA occurring within the Hood River basin include Lower Columbia River coho salmon (70 FR 37160, June 28, 2005), Lower Columbia River Chinook salmon (64 FR 14308, March 24,1999), and Lower Columbia River steelhead trout (71 FR 84, January 5, 2006; and the Columbia River population segment of bull trout (63 FR 31647, Jun 10, 1998). All of these species are known to occur or may occur in the Hood River and the East Fork Hood River, and one or more of these species do or may occur within other waterbodies affected by the project. These waterbodies include Neal, West Fork Neal, Odell, Lenz, and Whiskey creeks. One or more of these species occur in the project area within the canal between the District's diversion and its fish screen and sand trap facility, as well as within the sand trap itself and the fish screen return channel. No federally listed or other fish species occur elsewhere within EFID's irrigation infrastructure.

Critical habitat for coho, Chinook, and steelhead has been designated in each of the waterbodies affected by the project with the exception of Odell Creek. NOAA Fisheries has identified Primary Constituent Elements (PCEs) for critical habitat that represent the essential biological and physical features for the conservation of a species and describe habitat components that support one or more life stages of the species (70 FR 52630, September 2, 2005). The PCEs for coho, Chinook, and steelhead describe habitat with water quantity and quality conditions supporting spawning, egg incubation, larval development, and migration; water quantity and floodplain connectivity supporting juvenile growth and mobility; shade; complex habitat structure and cover such as submerged and overhanging large wood, aquatic vegetation, and boulders; and a sufficient food base supporting growth and maturation.

Critical habitat for bull trout has been designated in the Hood River mainstem from its confluence with the Middle Fork Hood River downstream to the Columbia River (RM 0 to RM 14.7).[9] USFWS has identified PCEs for bull trout critical habitat that describe habitat that has aquatic connectivity, complex habitat structure, water temperatures no greater than 59°F, natural variability in streamflow, a sufficient food base, and the absence of non-native predatory and competing fish (70 FR 56211, October 26, 2005).

With the exception of winter-run steelhead, the current extinction risks of salmon and steelhead populations within the Hood River basin are very high (ODFW 2010). State and federal agencies along with tribal governments have identified low streamflows as a primary limiting factor to the recovery of listed salmon and steelhead in the basin (NMFS 2013).

5.6.2 State Listed Fish and Aquatic Species

ODFW maintains a list of native fish and wildlife species in Oregon that have been determined to be either "threatened" or "endangered" according to criteria set forth by Oregon Administrative Rule (OAR 635-100-0105; ODFW 2018). Lower Columbia River coho salmon are listed as endangered and are present in waterbodies associated with EFID operations. There are no other Oregon-listed threatened, endangered, or candidate fish or aquatic species known to occur within the waterbodies associated with EFID operations or in the irrigation canals and laterals within the project area.

5.7 Geology and Soils

5.7.1 Geology

Within the Hood River basin, the Hood River Valley is dominated by Mt. Hood (11,235 feet), a stratovolcano formed by lava and pyroclastic flow deposits. The area is widely underlain by the Columbia River Basalt Group, an extensive basaltic lava that covers more than 64,595 square miles in the Pacific Northwest (Tolan et al. 1989; McClaughry et al. 2012). The Columbia River basalt formation is made up of individual lava flows ranging from tens to hundreds of feet thick. Pleistocene-era glaciers and Holocene floods have shaped the landscape into steep narrow valleys, and terraces of clay, silt, sand, gravel and boulders (PacifiCorp 1998). Basaltic andesite and Missoula flood deposits are the most common geologic units within the District, accounting for 44 percent of the total area.

The Hood River Valley is separated into an upper and lower valley by Middle Mountain (2,643 feet). The majority of EFID lies within the lower valley, which is a broad north-sloping bench through which the Hood River cuts deeply forming a steep canyon. The Hood River's major tributaries, including the East Fork Hood River, originate on Mt. Hood and are fed by glacial sources that transport large amounts of sediment. Natural landslides, debris flows, and glacial outburst floods originating on the moraines and slopes of Mt. Hood frequently impact downstream channels.

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[9] The 2.4-mile reach of the Hood River between the West Fork and Middle Fork confluences is sometimes also identified as part of the East Fork Hood River, for example, in the USGS National Hydrography data set and topography maps, although the USGS river mile notations for the East Fork Hood River begin at its confluence with the Middle Fork Hood River.

5.7.2 Soils

The predominant soils in the project area are Hood loam, 0 to 8 percent slopes; Oak Grove loam, 0 to 12 percent slopes; and Wyeast silt loam, 0 to 8 percent slopes (NRCS 2018). The Hood series of soils are well drained and formed in very deep silty lacustrine deposits. The Oak Grove series formed in deep clayey mudflows and alluvial materials and are well drained. The Wyeast series are somewhat poorly drained and formed in deep silty lacustrine deposits (U.S. Department of Agriculture [USDA] 1981). Approximately 50 percent of soils in EFID are classified by NRCS as Prime Farmland, and 45 percent are classified as Farmland of Statewide Importance.

5.8 Land Use, Zoning, and Ownership

5.8.1 Land Ownership

The project area traverses through privately owned land with the exception of approximately 3.5 miles that border or cross public land. The District maintains easement agreements with landowners along existing canals, laterals, and pipelines that secure the District's right of access to operate and maintain their irrigation infrastructure. The vast majority of the work associated with the project will likely occur within these existing easement agreements. However, the District would work with landowners to obtain any new easements or right of way agreements as needed for any infrastructure realignments or land requirements that may be proposed (J. Buckley, EFID, personal communication, 2018).

5.8.2 Land Use

The District is located within rural Hood River County with land parcels that are typically 20 to 40 acres, but can be as large as 145 acres. Of the 15,500 acres that fall within EFID's boundary, approximately 9,600 acres are currently served by the District. Most of the lands served by the District are used for commercial agriculture consisting of pear, cherry, and apple orchards. The average farm size within the county is 47 acres (USDA 2012). The vast majority of the land within EFID is zoned by Hood River County as Exclusive Farm Use (EFU). Counties are required to inventory and protect farm lands under Statewide Goal 3, Agricultural Land, Oregon Revised Statute 215 and OAR 660-033. The EFU designation serves to accomplish Statewide Goal 3. The purpose of EFU zoned land is to preserve and maintain Oregon's agricultural lands and the benefits they provide. Undeveloped land within the District that is not served by the District primarily consists of hillslopes with Ponderosa pine, oak, Douglas fir, shrub species, or grasslands, and stream corridors or ravines. Developed, non-agricultural land use within the District mainly consists of rural residences, transportation, and commercial or industrial properties.

5.9 Public Safety

The District has 17.9 miles of open canals and laterals. Although most of these canals and laterals are on private land, they remain accessible to local residents, farmworkers, and in some areas to the public. Approximately 3.5 miles of the open canal segments border county-owned forest land that is open to the public for hunting and other outdoor recreation. Open canals and laterals pose a risk to public safety when they carry water. Water depths in EFID canal and laterals range between 2 to 4 feet during the irrigation season, with velocities up to 5 feet per second in places. These conditions make it difficult for a healthy, strong adult to stand in or climb out of a canal without assistance. A child or non-/weak-swimmer would have a higher risk of drowning in a canal with these attributes. If a person or animal falls into a canal, they could have serious difficulty gaining a hold on the banks to climb out to safety. Swift water flowing through the canals can easily result in tragic outcomes. Two drownings occurred in EFID canals in the 1980s in two separate incidents involving the death of a child and an adult (J. Buckley, EFID Manager, personal communication, September 24, 2018). Barriers or fences at the top banks of the canals are not currently installed.

5.10 Recreation

The vast majority of EFID's canals, laterals, and pipelines cross private land where there are no public recreational opportunities. Approximately 3.5 miles of the District's 82.8 miles of canals laterals, and pipelines border or cross County-owned forest lands that are used for hunting, off-highway vehicles, and other types of outdoor recreation. Recreational use of maintenance roads and canals is not sanctioned by the District although some local residents walk or hike alongside the canals on maintenance roads.

Recreation in the Hood River and the East Fork Hood River downstream from the EFID diversion would be indirectly affected by the proposed project due to increased streamflows. Two county-owned parks and other river access sites are found along these river reaches. The Toll Bridge County Park and campground is located on the East Fork Hood River one half mile downstream of the diversion, and Tucker Park and campground is located on the mainstem Hood River approximately 15 miles downstream of the diversion. Fishing is one of the primary recreational activities along these rivers. The Hood River is popular among kayakers and provides other types of recreation including swimming, trails, photography, and picnicking.

5.11 Socioeconomics

The project area falls within Hood River County. Nearby unincorporated communities or cities include Mt. Hood, Parkdale, Odell, and Hood River. Generally, the area has seen stable growth over the past 7 years (2010 to 2017; see Table 5-3). The Oregon Office of Economic Analysis estimates that by 2040, Hood River County will reach a population of 33,530 (OEA 2013).

Table 5-3. Population Characteristics by City, County, and State.

Area	Year 2010 Population (number of people)	Year 2017 Population (number of people)	Population Growth Rate 2010 to 2017	Year 2017 Population per Square Mile (number of people)
Cities and Towns				
City of Hood River	7,113	7,686	8.1%	3,014
County				
Hood River County	22,346	23,377	4.6%	45
State				
Oregon	3,831,072	4,142,776	8.1%	43

Source: U.S. Census Bureau 2017

5.11.1 Area Employment and Income

The economy within the area associated with the project is described by employment numbers, employment by industry, and agricultural activity. Table 5-4 summarizes employment by industry classification. Agriculture, healthcare and social assistance, retail trade, manufacturing and accommodation, and food service provide the highest number of employment positions throughout the area. The median household income in Hood River County was $56,581 for the years 2012 through 2016 (U.S. Census Bureau 2018).

Table 5-4. Employment by Industry and Percent Employment Rates in the State of Oregon and Hood River County, 2016.

Employment Sectors	Oregon		Hood River County	
	Number of People	Percent of Oregon Employment	Number of People	Percent of County Employment
Agriculture, forestry, fishing and hunting, and mining	60,693	3.3%	1,608	14.6%
Arts, entertainment, recreation, accommodation, and food services	182,571	10.0%	1,002	9.1%
Construction	208,442	5.7%	696	6.3%
Educational services, health care, and social assistance	421,502	23.0%	2,311	21.0%
Finance and insurance, real estate, rental, and leasing	103,341	5.7%	349	3.2%
Information	34,090	1.9%	204	1.9%
Manufacturing	208,442	11.4%	1,008	9.2%
Other services (except public administration)	88,784	4.8%	545	5.0%
Professional, scientific, management, and administrative and waste management services	196,635	10.7%	931	8.5%
Public administration	82,094	4.5%	302	2.7%
Retail trade	219,299	12.0%	1,112	10.1%
Transportation, warehousing, and utilities	76,661	4.2%	466	4.2%
Wholesale trade	53,736	2.9%	460	4.2%
Total Employed- all sectors	1,832,620	100%	10,994	100%

Source: U.S. Census Bureau 2016

Table 5-5 demonstrates the labor force characteristics for Hood River County and the State of Oregon in 2017.

Table 5-5. Labor Force Characteristics in the State of Oregon and Hood River County 2017

Indicator	Hood River County	Oregon (State)
Labor Force	14,359	2,089,234
Employed	13,841	2,012,100
Unemployed	518	77,134
Unemployment Rate	3.6%	3.7%

Source: USBLS 2018; Oregon data from May 2017

5.11.2 Agricultural Statistics

The 2012 USDA Census of Agriculture provides the most recent agricultural data for Hood River County. In 2012, total agricultural product sales in Hood River County were $77,117,000. Tree fruit including pears, apples, and cherries represented 94 percent of the total market value of products sold. The top crop item produced by acreage (9,967 acres) was pears. The average farm size was 47 acres. Table 5-6 presents agricultural information for the lands served by the District.

Table 5-6. Crops Grown in the East Fork Irrigation District.

Crop	Total Acreage
Pears	5,200
Cherries	980
Apples	880
Blueberries	83
Grapes	21
Grass, Pasture. Hay	1,450
Other	348
Total	**8,962**

Source: Christensen and Salminen 2013

5.12 Vegetation

The greatest proportion of land cover in the Hood River basin is evergreen forest, and its location in the transitional Eastern Cascades Slopes and Foothills ecoregion results in a high diversity of vegetation types. EFID lies within the Cascade Mountains, Eastern Slope-Oak-Conifer Eastern Cascades-Columbia Foothills ecoregion at the eastern edge of the Columbia River Gorge. This unit is characterized by vegetation of Oregon white oak, ponderosa pine, and Douglas fir. Over the past century, land use has changed much of the native vegetation within the District and surrounding areas. Roads, orchards, and other irrigated agriculture, forest management, and livestock grazing are the primary causes of changes to the plant community. The dominant vegetation in the District today consists of orchards of pear, cherry, and apple trees. Smaller areas of pasture also occur. A mix of shrublands, grasslands, ponderosa pine, Oregon white oak, and Douglas fir woodlands are common in undeveloped areas surrounding the orchards and along District borders. Pine-oak woodlands are common, especially to the east and on south-facing slopes. Common vegetation found within the project area along the canals and laterals includes native deciduous and conifer trees and shrubs, including vine maple, big leaf maple, Ponderosa pine, Douglas fir, Oregon grape, snowberry, and non-native plants including reed canary grass, knapweed, and blackberry (C. Mead, USFS, personal communication, July 26, 2018).

Based on USFWS (2018) and Portland State University (Oregon Biodiversity Information Center 2016) sources, no federally or state listed plant species that are endangered, threatened, or species of concern or their designated critical habitats are identified within the project area.

5.13 Visual Resources

The District's open canals and laterals are generally flat against the landscape or are a few feet lower than the landscape level, and the canal and lateral banks are part of the landscape. Within the project area, vegetation growing adjacent to canals and laterals can obscure the view of the water flowing in the canals and laterals. Throughout agricultural lands, the visual characteristics of the existing canal and lateral alignments can vary. In most areas, the canal features are obscured by vegetation, hidden by sloping terrain or located at the back of larger agricultural tracts or residential properties. Most of the District's open canals are visible to the public only at road crossings or sporadically alongside minor roadways. In one area, an open canal segment is a visible water feature adjacent to the outdoor seating area of a restaurant.

Viewers' experiences of open canals and laterals differ throughout the year. The District's irrigation season is typically from mid-April through September, although water is diverted for frost control and spray purposes in the months of March and October. During these months, the District's canals and laterals carry water. From November through February, the canals and laterals do not carry water, and except during large storms are usually dry with occasional puddles in low-lying areas. Although the canals are not naturally formed waterways, the presence of open channels with flowing water could be considered an amenity by some residents as it provides a unique water feature on or near their property.

The District's pipelines are buried and the associated pipeline corridors are generally indistinguishable from adjacent landscape features. The vast majority of the proposed project would occur on private lands where the District operates under easements granted for purposes that include irrigation system operation and maintenance.

5.14 Water Resources

5.14.1 Water Supply

The District's water supply depends on streamflow from snow and glacial meltwater on Mt. Hood, and spring sources. All of the water used by the District comes from live flow of the East Fork Hood River. The District does not have any water storage reservoirs. The eight water rights held by the District include a total of 117.36 cfs for irrigation (see Table 5-7). The District's largest single water right has a priority date of November 25, 1895, for 104.5 cfs. This water right is the most senior on the East Fork Hood River; therefore downstream water users are unable to make a priority call for this water during a drought event.

The District diverts an average annual volume of 28,829 acre-feet of water for irrigation for use within EFID. An estimated 5,287 acre-feet or 18.3 percent of the diverted water is lost to end spills that are maintained throughout the District (FCA 2018). As noted previously, MHID does not operate its own diversion but instead obtains water diverted by EFID from two locations along EFID's Main Canal. Under its own water rights, MHID uses an average volume of approximately 2,043 acre-feet of water annually (Christensen and Salminen 2013). Roughly half of MHID's water use is counted in the EFID water use reports to OWRD. This is because one of the two MHID withdrawal points is located downstream of the EFID gauging station (Christensen and Salminen 2013).

The irrigation season extends from April 15 to September 30, with peak irrigation demand occurring in the months of July and August. The District also diverts water in March and October for frost control and spray purposes.

Drought conditions have limited irrigation water supply in three of the last 17 years and led to curtailment in the District. Curtailments of water deliveries by 25 percent have begun as early as mid-July during the peak irrigation demand season. Curtailment can negatively affect crop yields and the size of fruit grown in the District, and it can lead to disease or loss of orchard trees in subsequent years. Had both EFID and the MHID fully exercised their water rights during the droughts of 2005 and 2015, the full flow of the East Fork Hood River would have been diverted.

The primary demands placed on the basin's surface water supplies include irrigation needs; potable water; hydropower; protection of aquatic species, in particular ESA-listed fish; recreation; and scenic value. These demands are expected to increase as climate change and population growth impact water resources in the region (Reclamation 2015). In addition to domestic wells, potable water supply is provided from spring sources in the basin. Suppliers include the City of Hood River, Crystal Springs Water District, Odell Water Company, City of The Dalles, Mt. Hood Meadows, Ice Fountain Water District, Odell Water Company, and the Parkdale Water Company. Project effects on potable water supplies are not anticipated but would be confirmed by OWRD in the event that a Conserved Water application is made by EFID. As part of the Conserved Water application approval process, ORWD is required to evaluate any potential impacts on all other water right holders in the basin.

Currently, there is already a lack of adequate streamflow in the basin during the summer months to meet both instream flows for fish and irrigation demands for water. This imbalance is expected to be exacerbated by climate change. The basin's natural runoff is projected to increase during the fall and winter months and decrease during the spring and summer months when water uses are greater. The District' relies heavily on snowmelt at the beginning of summer and Mount Hood glacial melt during August and September of each year. Warming temperatures in future years will increase the speed of snowpack and glacial melting. Also, glaciers and snowpack are projected to continue to decrease in size and volume. Currently, between 50 and 70 percent of flow during the critical water use period is provided from glacial melt (Reclamation 2015).

While most diversion occurs during the summer peak irrigation season, the District also diverts water in the spring for orchardists to use for spray and frost control; however, only a fraction of this water is used. The water that is diverted and not used is spilled out the ends of the system. Piping and pressurizing the system would eliminate this loss and reduce the need for diversion as in the springtime (Salminen et al. 2016).

Table 5-7. Water Rights held by East Fork Irrigation District.

Permit or Certificate	Priority	Source	Acres	Rate (cfs)	Duty (acre-feet per acre)	Use
92000	11/25/1895	E. Fork Hood River	8,521.99	104.20	3	Irrigation
			9.78 inchoate	0.12		Irrigation
			15	0.18		Industrial
88094	11/25/1895	E. Fork Hood River	8.8	0.11	N/A	Irrigation
80929	3/13/1964	E. Fork Hood River	478.80	5.99	3	Irrigation
80928	8/13/1965	E. Fork Hood River	89.00	1.10	3	Irrigation
80927	10/26/1966	E. Fork Hood River	57.00	0.71	3	Irrigation
80926	6/14/1967	E. Fork Hood River	25.00	0.31	3	Irrigation
S-43393	2/23/1977 8/15/1978	E. Fork Hood River	N/A	10.00	N/A	Spray
				27.00		Frost
				0.10		Fire
84803	8/8/1977	E. Fork Hood River	405.00	4.45	3	Irrigation
	8/3/1978			0.61		
84802	2/3/1982	E. Fork Hood River	10.00	0.125	3	Irrigation

Source: FCA 2018

5.14.2 Surface Water Hydrology

The hydrology of the Hood River basin is characterized by highly variable streamflow and rapid runoff. The primary sources for surface water and groundwater springs are snowpack and glacial melt on Mt. Hood. Snowmelt typically begins in April, and glacial melt contributing to streamflow generally occurs between July and October. Streamflow to the mainstem Hood River is contributed from three major forks: West Fork Hood River, Middle Fork Hood River, and East Fork Hood River. The West Fork subbasin contributes greater than 40 percent of natural flow of the Hood River. The Middle Fork and East Fork combined contribute approximately 45 percent of the natural flow of the mainstem Hood River (Salminen et al. 2016). Downstream of the three forks, the remainder of the basin contributes 15 percent of the flow of the Hood River.

The East Fork Hood River originates on the Newton-Clark glacier on Mt. Hood and is 27.4 miles long as measured to its confluence with the Middle Fork Hood River. The river has no long-term stream gaging, and therefore historical streamflow data is limited. Little historical streamflow data is available because the East Fork Hood River has no long-term stream gaging. Simulated historic natural monthly average streamflow (i.e., without water diversions) in the East Fork Hood River above the Middle Fork confluence for the water years 1980 through 2009 ranged from 145 cfs in

September to 383 cfs in March (Reclamation 2014). Annual peak simulated flows ranged from approximately 400 cfs to 2,700 cfs during this period (Normandeau and Associates, Inc. 2014).

Mt. Hood's glaciers have been receding since the mid-1900s or earlier. An analysis of the aerial extent of snowpack on April 1 each year from 1920 through 2009 found that snowpack has decreased by approximately 5 percent every 30 years (Reclamation 2015). Glacial recession and declining snowpack are expected to continue as a result of the warmer temperatures predicted with the changing climate (Phillippe 2008; Reclamation 2015). The basin's natural runoff is projected to increase during the fall and winter months and decrease in the late spring and summer months. In the East Fork Hood River, the modeled future decline in average natural streamflows for the months of May through September approached 30 percent for the years 2030 to 2059 compared to the base period of 1980 to 2009 (Reclamation 2015).

The construction and operation of reservoirs, dams, and diversions on the river and its tributaries have changed hydrologic conditions in the Hood River basin. The District's irrigation canals can affect surface water hydrology by intercepting and redirecting storm runoff. Areas where this occurs include portions along the Eastside Lateral Canal and the DVC. In these areas, the open canals help to prevent local flooding on orchards or rural residential properties.

The management of surface water for irrigation use results in lower flows downstream from reservoirs during the storage season (i.e., late fall, winter, and early spring) and downstream from irrigation diversions during the irrigation season. EFID's irrigation operations affect streamflows in the East Fork Hood River from its diversion to its confluence with the Middle Fork Hood River (RM 6.6 to RM 0) and in the Hood River from the Middle Fork to the Columbia River (RM 14.7 to RM 0). Return flows associated with major EFID overflows or end spills affect streamflows in the West Fork Neal Creek (RM 1.8 to RM 0); Neal Creek (RM 5.8 to RM 0); Lenz Creek (RM 1.3 to RM 0) Odell Creek (RM 2.3 to RM 0) and Whiskey Creek (RM 1.3 to RM 0)[10]. As noted in earlier in Section 3.1.4, in dry and drought years EFID typically diverts approximately 73 percent or as much as 85 percent of the available flow of the East Fork Hood River during the late summer months.

Since the replacement of its headworks facilities in 2013, EFID has maintained a minimum flow of 15 cfs below its diversion for fish ladder operations. A study to determine a permanent minimum instream flow to benefit fish migration in the bypass reach below the diversion is expected to be completed in Fall 2018. This multi-year study was conducted by the CTWS.

Instream water rights have been established in the basin for the maintenance and enhancement of aquatic and fish life, wildlife, and other public values, and they are held in trust by OWRD. These instream water rights are junior in priority and therefore have no effect on senior water rights in the basin, including those held by EFID for irrigation. There are four major instream water rights in the waterbodies affected by District operations (OWRD 2018; Christensen and Salminen 2013):

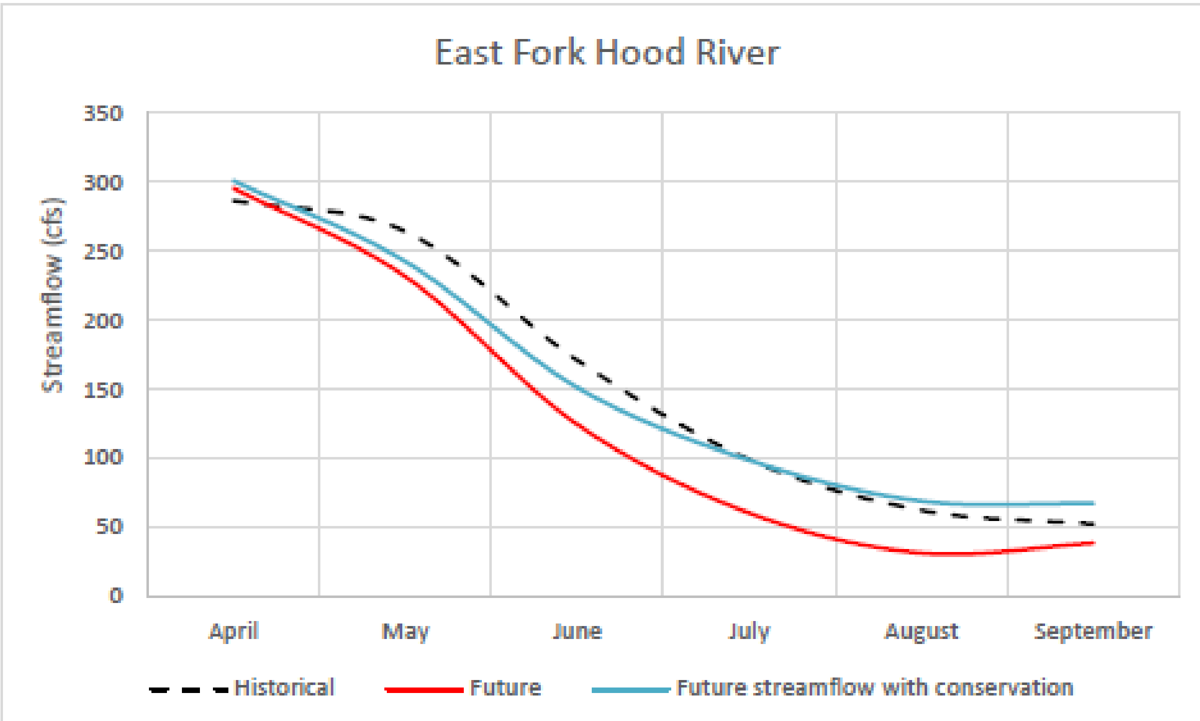
- Monthly flows of 100 to 150 cfs with a November 3, 1983, priority date for the East Fork Hood River at the point above its confluence with the Middle Fork Hood River (RM 0) (Certificate #68457)
- Monthly flows of 100 to 270 cfs with a November 3, 1983 priority date for the Hood River between RM 4 and RM 0 (certificate #59679)
- Monthly flows of 220 to 250 cfs for May through October with an October 8, 1998 priority date for the Hood River between RM 4 and RM 0 (certificate #76155)

[10] Stream reaches affected by end spills are approximated.

- Monthly flows of 5 to 20 cfs with a November 3, 1983 priority date for Neal Creek at the mouth (RM 0) (certificate #59681)

Additional instream water rights for monthly flows of 150 cfs to 210 cfs have been applied for in the East Fork Hood River by ODFW (application # IS 88322) with priority date of December 1, 2016.

Monthly average summer streamflow in the lower East Fork Hood River under current and future conditions are shown below in Figure 3. Projected future streamflow is based on the median climate change scenario developed by Reclamation (Reclamation 2015) and is shown with and without likely conservation actions.



Source: Salminen et al. 2016

Figure 3. Historical and projected future summer flows in the lower East Fork Hood River based on climate simulations. Future streamflow is shown with and without likely conservation actions.

5.14.3 Water Quality

The ODEQ maintains a list of all surface waters in the state that are considered impaired because they do not meet water quality standards under Section 303(d) of the CWA (33 USC 1251 et seq.). ODEQ is required to develop total maximum daily loads (TMDLs) for these 303(d)-listed rivers and streams describing limits on a pollutant that would be needed to meet water quality standards. Four of the waterbodies associated with EFID operations are included on Oregon's current 2012 303(d) list for not meeting water quality standards for one or more of the following parameters: copper, iron, silver, arsenic, and thallium, Guthion, chlorpyrifos, biological criteria, and dissolved oxygen (see Table 5-8). Several of these waterbodies are also identified as water quality limited for temperature, although these temperature listings were removed from the 303(d) list following the approval of ODEQ's 2001 Western Hood TMDL by the U.S. Environmental Protection Agency (USEPA).

Water diversion and storage in the Hood River basin has decreased seasonal streamflows below natural levels. Low streamflows can affect water quality by exacerbating temperature and dissolved oxygen problems, and potentially by increasing the concentration of some pollutants. EFID's irrigation diversion decreases streamflows in the East Fork Hood River and in the mainstem Hood River but increases streamflows in several creek or stream reaches as a result of end spill. Despite such streamflow increases through end spill, end spill discharges to streams by the EFID conveyance system can negatively affect water quality in the receiving streams through the transfer of heat and glacial turbidity or suspended solids. End spill is also a potential source of contaminants given the exposure of the District's open canals to fertilizer, pesticides, and other substances. The following sections describe existing 303(d)-listings and temperature impairments in the waterbodies associated with District operations. These impairments may extend upstream or downstream of the reaches included in Table 5-8.

Table 5-8. Impaired Waterbodies Associated with District Operations.

Waterbody Name	Area Associated with District Operations	Parameters Included on Oregon's 303(d) List	Identified as Water Quality Limited for Temperature
East Fork Hood River	From Diversion (RM 6.6) to mouth	Biological criteria Copper Iron Thallium	Yes
Hood River	RM 14.7 to mouth	Biological criteria Copper Iron Lead Thallium	Yes
Lenz Creek	RM 1.2 to mouth	Biological Criteria Chlorpyrifos Guthion pH	No
Neal Creek	RM 5.8 to mouth	Arsenic Biological Criteria Chlorpyrifos Dissolved oxygen Guthion Iron Silver	Yes
West Fork Neal Creek	RM 1.8 to mouth	Dissolved oxygen	No
Whiskey Creek	RM 1.3 to mouth	N/A	Yes

Sources: ODEQ 2012; ODEQ 2017

5.14.3.1 Temperature

The East Fork Hood River, the Hood River, Neal Creek, and Whiskey Creek do not meet stream temperature criteria within the area associated with District operations (see Table 5-8). The current applicable temperature criteria for the East Fork Hood River, Whiskey Creek, and Neal Creek is 64.4º F year-round for the protection of salmonid fish rearing and 60.8°F in the Hood River (ODEQ 2017). The 64.4º F criterion is typically exceeded in the East Fork Hood River during the summer with 7-day average daily maximum temperatures reaching 68º F upstream of the Middle Fork Hood River confluence (ODEQ 2017). Irrigation diversions have greatly reduced streamflows in this reach, contributing to the warm temperatures. Modeling simulations conducted by ODEQ to illustrate the response of stream temperatures to water diversion in the Hood River basin indicated that without EFID's diversion, the East Fork Hood River would be cooler by approximately 3.5º F above the confluence with the Middle Fork Hood River, and the Hood River mainstem at the mouth would be cooler by 2ºF (ODEQ 2001).

End spill discharges by the District into West Fork Neal Creek can contribute to the water temperature impairment in Neal Creek because the East Fork Hood River water source is an average of 5ºF warmer than the creek immediately upstream of the discharge as indicated from measurements collected during the 2009 to 2011 irrigation seasons (Stampfli et al. 2012). This end spill also transfers glacial silt from the East Fork Hood River into this naturally clear tributary.

In addition to low flows, other factors such as reduced streamside vegetation and widened channels can all contribute to elevated stream temperatures. Temperatures above the water quality criteria are considered sub-lethal and can be stressful for cold water fish species, such as salmon and trout. Fish mortality related to sub-lethal temperature effects are commonly attributed to interaction of decreased metabolic energy for feeding, growth, or reproduction; increased exposure to pathogens (viruses, bacteria, and fungus), decreased food supply (impaired macroinvertebrate populations), and increased competition from warm water tolerant species (ODEQ 2001).

5.14.3.2 Dissolved Oxygen

Oregon's water quality standards for dissolved oxygen include different criteria for freshwaters supporting several types of aquatic life, including sensitive fish species and life stages. The criteria apply at different time periods throughout the year. Within the area affected by District operations, West Fork Neal Creek and Neal Creek do not meet Oregon's standards for dissolved oxygen (see Table 5-8). Dissolved oxygen levels in Neal Creek (RM 0 to RM 6.4) are not high enough to meet the applicable criteria[11] during the salmon and steelhead spawning season from October 15 to May 15 (ODEQ 2012). In the entire West Fork Neal Creek, the dissolved oxygen levels are not high enough to meet the criteria for salmonid spawning from October 15 to June 15 (ODEQ 2012). Low dissolved oxygen levels can affect aquatic life by reducing habitat quality and quantity, changing behavior, or reducing growth rates. Elevated stream temperatures, excess nutrients, associated algae growth and die-off, and in some cases naturally low oxygen-content groundwater inflow can all contribute to lower dissolved oxygen levels.

5.14.3.3 Biological Criteria

Under Oregon's water quality standards, waters of the state must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities. Using data from reference sites, water quality impairment for biological criteria is based on the number and types of

[11] Not less than 11 milligrams per liter or 95 percent saturation.

macroinvertebrates that are expected to be in a waterbody under least disturbed conditions. This standard is not met year-round in East Fork Hood River (RM 0 to RM 27.4), Neal Creek (RM 0 to RM 6), and in the Hood River (RM 0 to RM 1.4) (ODEQ 2012). Toxic substances, sedimentation, excess nutrient inputs, associated algae growth and die-off, and elevated stream temperatures can result in detrimental changes in aquatic insects, crustaceans, worms, and other macroinvertebrates living in the stream environment that support the food chain for many fish and wildlife species.

5.14.3.4 Guthion and Chlorpyrifos

Neal Creek from RM 5.6 to RM 0 does not meet the year-round criteria for the toxic substances Guthion and chlorpyrifos. Guthion, also called azinphos-methyl, is a pesticide that was used on many crops, especially apples, pears, cherries, peaches, almonds, and cotton. Many of its former uses have been cancelled by the EPA, and its few remaining uses are being phased out. A coordinated voluntary Pesticide Stewardship Program is ongoing in the basin among growers and partners including the Oregon State University Extension Office, CTWS, HRSWCD, and ODEQ that includes water quality monitoring, education, and other measures to improve pesticide application practices. Monitoring since the early 2000s has shown a significant reduction in most pesticide levels in Hood River tributaries. In the past four years, very few benchmark or criteria exceedances of any pesticide were observed in the basin (ODEQ 2018).

5.14.3.5 Arsenic, Lead, Silver, Thallium, Iron, Copper

Four of the seven waterbodies associated with District operations are listed for one or more of the heavy metals arsenic, lead, silver, thallium, iron, and copper. Reported sources of heavy metals in the global environment include natural geologic processes as well as industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources. Many of these metals can be an essential nutrient at trace levels, but are toxic to aquatic organisms, as well as humans and wildlife, at higher concentrations.

5.15 Groundwater

Groundwater has not been extensively developed in the Hood River basin so data that are critical to understanding this resource are limited. The Hood River Valley is underlain by the Columbia River basalt formation at depths ranging from the ground surface to hundreds of feet below ground surface (Grady 1983). Groundwater in this basalt generally occurs in the broken contact zone between individual lava flows. Wells in the Hood River Valley that draw from the Columbia River basalts are generally very productive, yielding from 70 to 400 gallons per minute (Keller 2011). Approximately 514 water supply wells in Hood River County were registered with OWRD through August 13, 2018. Of these wells, 412 were for domestic use, 22 were for irrigation, and 22 were for industrial use. The remainder were for community, thermal, or unstated uses. Of all wells registered, 35 were noted as abandoned (ORWD 2018c). Between 2008 and 2018, five more wells have been tapped for irrigation use. Surface water quality and quantity concerns could cause more irrigators to turn to groundwater in the future. Adjacent watersheds have observed significant groundwater declines due to over appropriation and the slow recharge of the Columbia River Basalt aquifers. An increase in wells tapped for irrigation could conceivably affect existing domestic wells in addition to surface water flows (Reclamation 2014).

Open irrigation canals can contribute to groundwater through seepage or infiltration, and seepage rates can vary widely depending on the permeability of soils within the canal. Studies of seepage losses in EFID have been limited to date, and as noted earlier in Section 3.3.1,study results were inconclusive and could not be extrapolated to estimate total seepage losses throughout the District (Melchiorsen 2018).

5.16 Wetland and Riparian Areas

Wetlands perform a number of valuable functions including water storage, water filtration, and biological productivity. They can also support complex food chains that provide sources of nutrients to plants and animals and specialized habitat for many aquatic and terrestrial species. Wetlands associated with the proposed action may be subject to federal or state regulations depending on their characteristics. In Oregon, wetlands are managed under two laws, the federal CWA, and the Oregon Removal-Fill Law. The USACE administers Section 404 of the CWA with the oversight of the USEPA. This law regulates the dredge or fill of wetlands over which the USACE has jurisdiction (or "jurisdictional wetlands").

Section 404 of the CWA defines wetlands as "those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (USACE 1986). The ODSL implements the Removal-Fill Law (Oregon Revised Statute 196.800-990) which regulates the removal or fill of material in wetlands or waterways, requiring any person who plans to "remove or fill" material within "waters of the state" to obtain a permit from ODSL. Per the Oregon Removal-Fill statute OR 141-085-0515(9), an irrigation ditch is not jurisdictional under Oregon Removal-Fill permitting if it meets both of the following (ODSL 2013):

- The ditch is operated and maintained for the primary purpose of irrigation; and
- The ditch is dewatered outside of the irrigation season except for isolated puddles in low areas.

The 1986 Final Rule for Regulatory Programs of the Corps of Engineers (1986 Final Rule) indicated that irrigation ditches are generally not considered Waters of the United States for the purpose of determining CWA Section 404(f)(1)(C) applicability. However, USEPA reserved the "right to determine on a case-by-case basis if any of these waters are "Waters of the United States…" including, "…irrigation ditches excavated on dry land…" (USACE 1986). In 2006, a "significant nexus" jurisdiction standard[12] from Rapanos v. United States (547 U.S. 715 2006) was established, which has been used to determine if identified waters are Waters of the United States. In 2015, the Clean Water Rule: Definition of "Waters of the United States" (2015 Final Rule) (USEPA 2015) was published and provided clear exclusions for certain types of ditches. However, on October 9, 2015, the U.S. Court of Appeals for the Sixth Circuit stayed the 2015 Final Rule nationwide pending further action of the court (In re EPA, 803 F.3d 804 [6th Cir. 2015]). This reinstated the "significant nexus" jurisdiction standard from Rapanos v. United States.

Wetlands, including riverine and palustrine types, are found within and sporadically adjacent to the waterbodies associated with District operations. The National Wetland Inventory geographic information systems data (USFWS 2016) will be used to identify any jurisdictional wetland resources within the project area. Water typically flows through the canals and laterals in the project area from March through October. Water may also flow through these canals during the winter months due to storm runoff or be present as standing water following rain or snow events. Although some canals and laterals may have hydrology and vegetation indicative of a wetland, they do not meet the functional criteria of wetlands and are not regulated as wetlands by ODSL or USACE. These canals

[12] In general, this standard involves determining whether the water in question alone or together with other similarly situated waters significantly affects the chemical, physical, or biological integrity of a downstream navigable or interstate waterway.

and laterals meet exemptions under the Oregon Removal-Fill Law for specific agricultural activities in wetlands and other waters of the state.

Riparian areas are transition zones between waterbodies and adjacent upland areas that support hydrophytic vegetation that is dependent upon the hydrology of the waterbody. Riparian areas as defined by Section 404 of the CWA are "areas next to or substantially influenced by water. These may include areas adjacent to rivers, lakes, or estuaries" (USEPA 2015). Riparian areas of varying size and quality occur adjacent to natural waterbodies associated with District operations. Low summer and early fall streamflows associated with irrigation withdrawals may limit riparian vegetation along the East Fork Hood River downstream of EFID's diversion. Because streamflow is strongly correlated with critical physical and biological characteristics of the river, it influences the functions of associated riparian areas (National Research Council 2002). Reestablishing a more natural hydrologic regime in these reaches allows the river channel to supply water to riparian areas via infiltration through channel banks, thus enhancing riparian function by facilitating processes such as hyporheic exchange, physical and chemical transformations, and supporting riparian plant communities and aquatic habitat (National Research Council 2002).

5.17 Wildlife

Generally, wildlife present within EFID's agricultural lands consists of habitat generalists or edge species with the ability to adapt to or exploit the agricultural environment. These species are generally tolerant to disturbance and include species such as deer, elk, coyote, skunk, grey squirrel, raccoon, and red-tailed hawk (Blair 1996; Ditchkoff et al. 2006; McKinney 2002).

Wildlife within the project area may use the open canals as a water source and dispersal corridor. Additionally, where not cleared, vegetation along canals and laterals can provide food, cover, and breeding sites for many wildlife species throughout the year.

5.17.1 MBTA/BGEPA Species

There are multiple bird species with potential to occur within the EFID project area, some of which are protected under the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act. Although migratory birds are known to occur in the project area and its vicinity, limited habitat is provided within much of the project area due to agricultural land use and EFID canal maintenance activities that remove vegetation on an annual basis. Consultation with a USFWS biologist will occur during the development of the Plan-EA.

5.17.2 Federally Protected Species

A review of available USFWS Information for Planning and Consultation data showed no federal threatened, or endangered wildlife species, designated critical habitat, or federal species of concern occur within the project area. Consultation with a USFWS biologist will occur during the development of the Plan-EA.

5.17.3 State Listed Species

ODFW maintains a list of native wildlife species in Oregon that have been determined to be either threatened or endangered according to criteria set forth by rule (OAR 635-100-0105) (ODFW 2017). In addition, a "sensitive" species classification was created under Oregon's Sensitive Species Rule (OAR 635-100-0040), which focuses fish and wildlife conservation, management, and research and monitoring activities on species that need conservation attention. The state list together with information from the Oregon Explorer Natural Resources Digital Library shows there are no state-listed terrestrial species known to occur within the project area where construction associated with the proposed action would occur (Oregon State University 2018).

5.18 Wild and Scenic Rivers

There are no federally designated Wild and Scenic Rivers (Public Law 90-542; 16 USC 1271 et seq.) associated with District operations.

5.19 Ecosystem Services

Ecosystem services are defined as the benefits people obtain from ecosystems, and can be categorized as supporting, provisioning, regulating, and cultural services (Millennium Ecosystem Assessment 2005). Examples include such benefits and services as food, water, pollination, medicinal resources, waste decomposition, nutrient recycling, water purification, soil formation, as well as recreation, spiritual. and educational experiences. Modernizing EFID's irrigation infrastructure through piping and pressurizing open canals, replacing aging pipelines with HDPE piping, improving fish screening and enhancing sediment management all have the potential to strengthen ecosystem services by restoring streamflows, improving water quality, reducing carbon emissions, and improving habitat conditions for threatened fish species.

6 Technical Evaluations

A number of studies and technical evaluations pertaining to modernization of EFID were used to provide technical background for this PIR, and will be further utilized as a Plan-EA is developed for this District. Relevant documents are as follows:

- **East Fork Irrigation District System Improvement Plan.** Completed by KPFF Consulting Engineers in January 2016, this document describes the existing irrigation delivery system and conditions, and lists potential modernization projects including main canal piping, additional sediment facilities, bypass upgrades, storage, and telemetry monitoring and controls together with preliminary planning-level cost estimates for these improvements.
- **East Fork Irrigation District System Improvement Plan.** Completed by FCA in July 2018, the specific objectives of this plan were to determine water conservation potential; hydroelectric power generation potential; energy conservation; improvements to diversion water quality, fish screening and fish passage; and a mitigation strategy for system water losses. This document describes the specific infrastructure requirements for modernization of EFID's distribution system. This document is integral to the formulation of the proposed action.
- **Hood River Basin Study.** A collaborative effort between Reclamation, OWRD, and the local Hood River Basin Study Work Group to assess water supply and demand for current and future conditions in the Hood River basin to identify a range of potential strategies to address any projected imbalances. Key focuses of the study are water demands in the basin; potential effects of climate change on water supply; and the ability of water conservation, groundwater use, or additional surface water storage to mitigate for any negative impacts from supply or demand changes in the future. A final summary report of this work was completed in November 2015. Several assessments, technical reports, and models were developed for the study, and those most relied upon in the EFID PIR are listed below.

- **Hood River Basin Water Use Assessment.** Completed in June 2013 by Watershed Professionals Network L.L.C., this study describes water use in the Hood River basin and in EFID, potential effects from climate change on water supply, and the ability of water conservation, groundwater use, or additional water storage to mitigate any negative impacts from supply or demand changes in the future.
- **Hood River Water Conservation Assessment.** Completed in August 2013 by Watershed Professionals Network, L.L.C., this study presented potential water conservation opportunities in the Hood River Basin and estimated potential water savings and cost estimates to serve as a stand-alone report and to inform the Hood River Basin Study.

7 Alternatives

7.1 Formulation Process

In order to determine the most viable alternatives to meet the project's purpose and need, NRCS and EFID have considered the needs of water users; goals for conservation and restoration; resources and funding available to both the District and the water users; and the current status of the District's previous improvements. Alternatives considered during project development but proposed for elimination from detailed study were evaluated based on the criteria in USDA's Guidance for Conducting Analysis Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water and Resource Investments (USDA 2017). Pursuant to this guidance, alternatives that become "unreasonable due to cost, logistics, existing technology, social or environmental reasons," or general inability to address the purpose and need for action, may be removed from consideration.

The No Action Alternative is described in Section 7.2.1, and the Piping and Pressurization Alternative (the District's preferred alternative) is described in Section 7.2.2. Alternatives considered by EFID during project development but proposed for elimination are discussed in Section 7.3.

7.2 Description of Alternatives Considered

7.2.1 No Action Alternative (Future Without Federal Investment)

Under the No Action Alternative, the District would continue to operate and maintain its existing canals and pipeline system in its current condition. This alternative assumes that modernization of the District's system to meet the purposes and needs of the project would not be reasonably certain to occur. Under this alternative, the District would only modernize its infrastructure on a project-by-project basis as public and public interest funding became available. This funding is not reasonably certain to be available with a project-by-project approach at the large scale necessary to modernize the District's infrastructure.

The No Action Alternative is a near-term continuation of the District's current O&M. Streamflow provided by the District for instream uses would remain the same. Energy consumption for individual on-farm pumps within EFID would continue to require an estimated 1.4 megawatt hours (mWh) per year. Irrigated agriculture in EFID would continue to be susceptible to water supply shortages due to projected declines in snowpack and summer streamflow levels, and increased operational and system maintenance costs over time.

The No Action Alternative does not contribute to the purpose and need as follows:

- Improve water conservation: This alternative continues the ongoing water loss from end spill and canal seepage in the District's system of 16.6 cfs or 5,287 acre-feet over the entire irrigation season.
- Improve water delivery and operational inefficiencies: This alternative maintains existing outdated infrastructure and inefficient operations that would improve only if the District secures additional funding sources. The vulnerability of irrigated agriculture to drought and to the effects of a changing climate on water supply would remain unchanged. The high sediment and silt load in the diverted water will continue to create operational challenges for the District and for irrigators.
- Reduce or control O&M costs: This alternative would maintain conditions where O&M costs for the District are expected to rise over time. The costs to maintain canals would remain the same as EFID personnel continue system maintenance that includes the removal of debris and repairs to the banks of open canals, while facing additional and increasing costs to replace existing pipelines over time as these reach the end of their expected life cycle. Some of these pipelines are over 70 years old.
- Improve streamflow and habitat conditions for threatened fish and other aquatic species: The District may allocate conserved water instream incrementally as projects are completed if additional sources of funding become available over time; however, these projects are not reasonably certain to occur. Should this happen, this alternative would only enhance streamflow and habitat conditions along the East Fork Hood River and Hood River if and when projects are completed.
- Improve public safety: This alternative would not reduce the drowning risks associated with open canals.
- Conserve energy: This alternative maintains unpressurized deliveries and therefore does not reduce the need for on-farm irrigation pumping and associated pumping costs for patrons. The use of individual patron pumps requires 1.4 mWh of energy per year across the District at a cost of approximately $112,000 per year.

7.2.2 Piping and Pressurization Alternative (Future with Federal Investment)

The Piping and Pressurization Alternative is EFID's preferred alternative (see Figure 4). Two approaches for piping and pressurization were evaluated in the District's 2018 System Improvement Plan (FCA 2018), one for an entirely piped and pressurized system, and another for almost-entirely piped and pressurized system with enhanced sediment management capacity. The District selected the latter approach, and has determined through engineering analysis that this alternative is feasible and addresses the project's purpose and need. HDPE solid wall pipe (PE4710 resin), conforming to the American Society for Testing and Materials D3350 standard, is proposed as the primary pipe material for piping EFID. PVC pressure pipe may be more cost effective and equally as available as HDPE, but HDPE is far more flexible and ductile than PVC and is considered to have a significantly longer design life, greater abrasion resistance, and has been shown to have superior seismic resilience (Eidinger and Davis 2012; Rubeiz 2009). Most importantly, the flexibility of the HDPE material allows pipes made from it to bend into place to follow the curves in the existing open canal alignments. Under this alternative, the District would:

- Pipe 17.5 miles of remaining open canals and laterals with HDPE pipeline. A 2,300-foot long section of the upper Main Canal would remain open from the point of diversion to the existing sand trap and fish screen facility. This section would be widened, and check dams would be installed to slow the water flow and promote the settling of glacial sand and silt.
- Pipe the Main Canal with a dual 48- and 54-inch HDPE pipeline. The dual pipeline is more cost-efficient than a single large diameter HDPE pipe.
- Replace 43.5 miles of older existing PVC and concrete pipeline with HDPE pipe (or 100 pounds per square inch rated PVC piping for the smallest pipelines) within current alignments to reduce long-term replacement costs, reduce long-term repair costs, and provide pipe that can withstand the system's new pressure ratings.
- Install pressure reducing valves as required and replace delivery gates or turnouts for fully pressurized water deliveries (40 to 100 pounds per square inch) on 7,350 acres or 77 percent of the District. Most remaining irrigated land within the District would receive partial pressurization, with the Main Canal service area having limited pressurization as a result of the upper half mile segment remaining open.
- Install a 30,000 square foot sedimentation basin immediately downstream of the sand trap. The existing sand trap would be retained for use as a secondary sedimentation facility as necessary, as well as for fish acclimation[13] purposes.
- Install a horizontal, flat-plate fish and debris screen in the upper Main Canal close to the diversion to improve upon the District's current fish screening operations and ensure they are compliant with NOAA Fisheries criteria.

The main construction tasks associated with this alternative include excavating trenches, installing pipe, fusing pipe joints, installing pressure reducing valves and new turnouts, and backfill of the trenches. A full description of this alternative, including detailed pipe sizing, pipe materials, project alignment, water loss assessment, and hydraulic modeling of the system can be found in the EFID System Improvement Plan (FCA 2018).

This alternative would contribute to the project's objectives as follows:

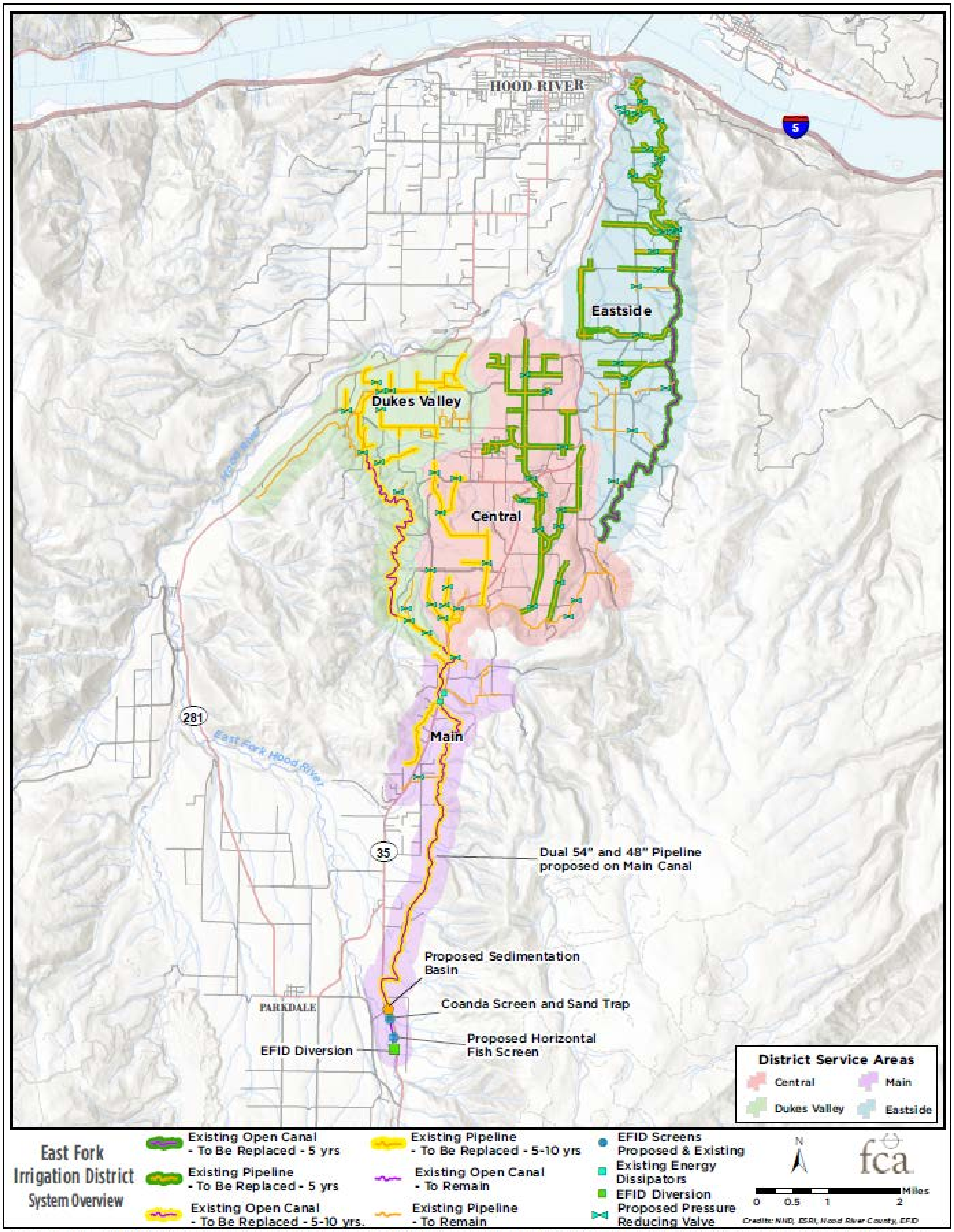
- <u>Improve water conservation</u>: This alternative would eliminate all of the existing water losses from end spill and nearly all water losses from canal seepage,[14] saving an estimated 16.6 cfs over the entire irrigation season. This would be accomplished by replacing nearly all of the District's open canals with pressurized HDPE pipe and replacing 43.5 miles of existing pipeline together with installation of pressure reducing elements and new patron turnouts for pressurization.
- <u>Support and maintain existing agricultural uses</u>: Modernizing the system would improve irrigation water delivery reliability for 9,596 acres of irrigated land. This alternative would improve operational efficiencies to ensure that patrons receive the water they need at the time that they need it. A piped and pressurized system greatly increases conveyance

[13] For two weeks each spring, CTWS uses part of the sand trap to hold juvenile, native-stock hatchery steelhead prior to their release to the river as part of the tribal-state Hood River Production Program for fisheries.

[14] Another additional, unquantified amount of water loss occurs from seepage (infiltration) along the District's open earthen canals. Measurement of seepage losses within the District have been inconclusive due to the large number of turnouts along canals, associated measurement errors, and other uncertainties.

efficiency, reducing the need to spill excess water and potentially making a portion of the conserved water available to patrons in the future. This alternative is also expected to reduce silt levels and improve the quality of irrigation water delivered to patrons.

- Reduce O&M costs: This alternative would be cost-efficient over time for the District and its patrons because many of the existing PVC and concrete cylinder pipelines are over 20 years old, and, by the time the project will begin, many will need to be replaced as they approach the end of their estimated design life of 33 years. While PVC piping is available at a lower cost, the planned HDPE pipes are easy to install, require no maintenance, are bendable, abrasion-resistant, retain their properties between -220°F and 180°F, and have a design life of 100 years. They are water-hammer and earthquake resistant and have high tensile strength. During installation HDPE pipes are welded together, minimizing the need for expensive fittings and thrust blocks. In addition, a pressurized pipeline allows for the reduction of individual pumps serving farms across the District and allow patrons to conserve approximately 1.4 mWh per year. It would reduce patron pumping costs and decrease carbon dioxide emissions. Sediment management improvements are expected to reduce the labor and equipment costs currently needed to remove sediment from the sand trap and other locations.
- Enhance streamflow and habitat conditions for fish and aquatic species: This alternative would enhance streamflow and habitat conditions for fish and aquatic species by creating instream water rights of up to 12.4 cfs through the State of Oregon's Allocation of Conserved Water Program and through the District's own Conserved Water Policy. Under this program, a fully publicly funded project would be required to permanently allocate at least 75% of any conserved water to instream use. As part of the Conserved Water Program's application approval process, ORWD would evaluate any potential impacts of this action on other water right holders in the basin. The District would allocate the conserved water instream incrementally following completion of each project group and after verification of actual water savings realized. Streamflow and habitat conditions along the Hood River would therefore also benefit incrementally.
- Improve public safety: Converting open canals and laterals to buried pipe would eliminate the risk of drowning.



Source: FCA 2018

Figure 4. East Fork Irrigation District's Piping and Pressurization Alternative. Map is adapted from the District's System Improvement Plan (FCA 2018).

7.3 Alternatives Proposed for Elimination from Detailed Study

7.3.1 Exclusive Use of Groundwater for Irrigation

Exclusive use of groundwater for irrigation would leave more surface water in streams and rivers. The exclusive use of groundwater for irrigation would cause irrigators to forgo surface water diversions that currently average 28,829 acre-feet per year[15] to exclusively pump groundwater to meet irrigation needs in the District.

The use of groundwater for irrigation would have logistical and legal constraints. The District would need the authority from each patron to switch surface rights to groundwater rights. There would be no guarantee of gaining this approval from patrons. Switching from surface water rights to groundwater rights would also affect the seniority and therefore reliability of the District's water rights. The District currently has very senior surface water rights, however, new groundwater rights would be more junior and would be subject to curtailment. This would not meet the purpose and need of the project to improve water delivery reliability for patrons.

As described in Section 5.15, the collection of hydrogeological data necessary to understand groundwater resources in the Hood River basin has been limited. This alternative would require multiple wells, each with a pump to draw water from the ground, which would have high electricity and installation costs. Based on cost estimates for irrigation districts elsewhere in the state, the cost across a 100-year lifespan of such a project would be substantially higher. The exclusive use of a conversion from surface water rights to groundwater for irrigation alternative is proposed to be eliminated from consideration due to the exorbitant annual costs of installing and operating individual or District-owned wells and pumps and the logistical and legal constraints and uncertainty associated with obtaining groundwater rights.

7.3.2 Fallowing of Farm Fields

Fallowing of farm fields would mean permanently transferring or temporarily leasing water rights from irrigated lands or not using water rights appurtenant to irrigated lands. Fallowing farm fields would not require irrigation water and therefore allow more water to remain instream. Fallowing of farm fields does not meet the purpose and need for the project and would be unreasonable due to social effects and logistics. This alternative was eliminated from consideration because relatively few acres of pasture or other annual crops suitable for fallowing occur in the District; the majority of irrigated acres consist of fruit trees. This alternative would not improve water delivery reliability and public safety for District-owned canal and lateral infrastructure. Fallowing orchards would have a negative social effect as it would be contrary to the interests and economic contribution of fruit growers and others in the District, and to public policy land use goals that support maintaining existing agricultural land uses.

7.3.3 On-Farm Efficiency Upgrades

On-farm efficiency refers to EFID patrons improving privately owned on-farm infrastructure (e.g., installing soil moisture sensors, or converting from impact sprinklers to micro sprinklers or drip irrigation. EFID is responsible for delivering water to the traditional high point (or delivery point) of the land. The District's responsibility of moving water ends at this delivery point. Private, on-farm infrastructure begins at this delivery point, and the District neither owns nor holds easements to the private infrastructure and lands associated with on-farm irrigation conveyances.

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[15] EFIS average diverted volume 2001 through 2017

This alternative of focusing on on-farm efficiencies would meet the objective of conserving water; however, the alternative is proposed to be eliminated because it would not eliminate water losses in the District's delivery infrastructure, increase operational efficiency; reduce EFID maintenance costs over time, nor improve public safety issues for District-owned open canals. Additionally, project sponsors must have the legal authority and resources to carry out, operate, and maintain works of improvement when using the federal funding assistance sought for the project (Public Law 83-566 Section 2 and Section 4(3)). Because PL 83-566 is a public law, rather than a policy, this consideration is a legal requirement and cannot be arbitrarily applied. Because EFID lacks the statutory authority or responsibility to carry out, operate and maintain on-farm infrastructure owned by EFID patrons, on-farm efficiency upgrades are not within the scope of actions that EFID can pursue as the Project Sponsor. Improving on-farm efficiency is, therefore, not consistent with PL 83-566 authorities under which this plan is being prepared as either a standalone alternative or as an additional measure added to an alternative under consideration. As a matter of practice however, the District will continue to support ongoing efforts by the HRSWCD to assist interested patrons with on-farm water use efficiency improvements.

7.3.4 Canal Lining

Canal lining would involve the installation of an impervious system to cover the 17.9 miles of open canals and laterals; existing piping in the system would not be replaced with lined canals. Materials typically employed include geomembranes, rubber liners, shotcrete and/or similar materials. Implementation of this alternative would require the reshaping of the current canals to a trapezoidal form, sub-grade preparation, installation of the liner, and applying a shotcrete coating for protection. Canal lining increases canal capacity, improves command (velocity), stabilizes the canal section, prevents bank erosion and breaches, assures economical water distribution, and reduces maintenance costs. Canal lining has a varying lifespan as short as 40 years and can require extensive maintenance to continue operating at high efficiency (Reclamation 2002). Lined canals are vulnerable to tears or cracks in the lining substrate; when torn or cracked, leakage from lined canals is similar to that from unlined canals. Over a 50-year life cycle, canal lining may be less expensive to implement in its first installation cycle than piping, however, canal lining requires significant maintenance and replacement cycles that ultimately cause it to exceed the cost of piping over time.

Lining would increase water velocity in the canal and laterals because the shotcrete cover is a smoother surface than the existing underlying rock. This makes the sides of the canal and laterals slippery and more difficult for people in the water to grasp onto and climb out of. Fences would need to be installed along the length of the canal and laterals to prevent public access to the channels in order to increase public safety and reduce District liability. Canal lining reduces water loss due to seepage and would meet the objective of conserving water. However, the conservation objective would be met only to a modest degree; canal lining would not eliminate the 58 spills at the end of canals and pipelines that are required to supply water to all patrons in an open, unpressurized system. Lining the canals would also not prevent the growth of nuisance algae and prevent pine needles, leaves, branches from entering the irrigation system that currently create a substantial maintenance workload by the District and many patrons.

This alternative is proposed for elimination because it does not meet the District's objectives to improve public safety, provide pressurized water deliveries, improve the system's operational efficiency, eliminate end spill losses, and would have higher annual costs over its lifetime compared to a piped system.

7.4 Economics

The 2013 Principles Requirements for Federal Investments in Water Resources states that Federal investments should "strive to maximize public benefits, with appropriate consideration of costs." A National Economic Efficiency analysis will be completed for the project during the Plan-EA process following the identification of problems and opportunities and NEPA scoping process. The National Economic Efficiency will analyze benefits and costs resulting from the proposed project.

8 References

Blair, R.B. (1996). *Land Use and Avian Species Diversity along an Urban Gradient. Ecological Applications*, 6(2), 506-519.

Bonneville Power Administration (BPA). (1996). *Hood River Fisheries Project Draft/Final Environmental Impact Statement* DOE/EIS-0241. July 1996. Portland, OR.

Buell and Associates, Inc. (2000). *Biological Performance Tests of East Fork Irrigation District's Sand Trap and Fish Screen Facility Phase 1-1999 conducted for East Fork Irrigation District.* January 2000. Portland, OR.

Coccoli, H. 1999. *Hood River Watershed Assessment.* Hood River Soil and Water Conservation District. December 1999. Hood River, OR.

Columbia Basin Fish and Wildlife Authority (CBFWA). (2005). *Notes by Pat Schille (WDFW) and Bryan Nordlund (NOAA) for the September 20, 2005 Fish Screening Criteria Workshop in Nampa, Idaho.* Retrieved from: http://fishscreensoc.com/wp-content/uploads/2016/10/ActionNotes092005DraftVer1.pdf

Columbia Gorge Fruit Growers (CGFG). (2018). *Crops information.* Retrieved from: http://www.cgfg.org/information/crops-information. Accessed August 7, 2018.

Christensen, N. and E. Salminen. 2013. *Hood River Basin Water Use Assessment.* Prepared for Hood River County. Watershed Professionals Network. Hood River OR. Retrieved from https://www.co.hood-river.or.us/vertical/sites/%7B4BB5BFDA-3709-449E-9B16-B62A0A0DD6E4%7D/uploads/Hood_River_Basin_Water_Use_Assessment.pdf. Accessed August 9, 2018.

Das, T., D.W. Pierce, D.R. Cayan, J.A. Vano, and D.P. Lettenmaier. (2011). *The importance of warm season warming to western U.S. streamflow changes*. Geophysical Research Letters, Vol. 38, L23403.

Ditchkoff, S.S., Saalfeld, P.S., & Gibson, C.J. (2006). *Animal Behavior in Urban Ecosystems: Modifications Due to Human-Induced Stress*. Urban Ecosystems, 9, 5-12.

Eidinger, J., and C.A. Davis. (2012). *Recent Earthquakes: Implications for U.S. Water Utilities*. Water Research Foundation. Denver, CO.

Farmers Conservation Alliance (FCA). (2018). *East Fork Irrigation District System Improvement Plan*. August 2, 2018. Hood River, OR.

Grady, S. (1983). *Ground-water resources in the Hood basin Oregon.* U.S. Department of the Interior Geological Survey Water Resources Investigations report 81-1108.

Keller, J. (2011). *Groundwater Hydrology of Hood River County, draft summary*. Prepared for the Hood River County Water Planning Group. April 26, 2011. Retrieved from: https://www.co.hood-river.or.us/vertical/sites/%7B4BB5BFDA-3709-449E-9B16-B62A0A0DD6E4%7D/uploads/HR_Groundwater_Resources_Summary_by_Jason.pdf. Accessed August 8, 2018

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being*. Washington, D.C: Island Press.

McClaughry, J.D., Thomas J. Wiley, Richard M. Conrey, Cullen B. Jones, and Kenneth E. Lite, Jr. (2012). *Digital geologic map of the Hood River Valley, Hood River and Wasco Counties, Oregon*. Open-File Report O-12-03.

McKinney, M. L. (2002). *Urbanization, Biodiversity, and Conservation. Biosciences,* 52, 88-890.

McMahan, H. (2011). *Climate and Precipitation of Hood River County*. Prepared for the Hood River County Water Planning Group. February 23, 2011. Retrieved from:https://www.co.hood-river.or.us/vertical/sites/%7B4BB5BFDA-3709-449E-9B16-B62A0A0DD6E4%7D/uploads/HRC_Climate__Precipitation.pdf. Accessed August 8, 2018.

Melchiorsen, M. (2018). *East Fork Irrigation District (EFID) Water Loss Study*. Prepared for Farmers Conservation Alliance. May 2018.

Natural Resources Conservation Service (NRCS). 2018. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/. Accessed July 19, 2018.

National Marine Fisheries Service (NMFS). (2011). *Anadromous Salmonid Passage Facility Design*. NMFS Northwest Region, Portland, OR.

National Marine Fisheries Service (NMFS). (2013). *ESA Recovery Plan for Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and Lower Columbia River Steelhead*. June 2013. Northwest Region.

National Research Council. (2002). *Riparian Areas: Functions and Strategies for Management*. Washington, DC: The National Academies Press.

Normandeau and Associates, Inc. (2014). *Hood River Tributaries Instream Flow Study*. Presented to Hood River County. June 13, 2014. Arcata, CA.

Oregon Biodiversity Information Center. (2016). *Threatened and Endangered Species of Oregon*. Institute for Natural Resources, Portland State University, Portland, Oregon. 130.pp

Oregon Department of Environmental Quality. (ODEQ). (2001). *Western Hood Subbasin Total Maximum Daily Load (TMDL)*. December 2001. Portland, OR.

Oregon Department of Environmental Quality. (ODEQ). (2012). Water Quality Assessment - Oregon's 2012 Integrated Report Assessment Database and 303(d) List. Retrieved from: https://www.deq.state.or.us/wq/assessment/rpt2012/results.asp. Accessed September 10, 2018.

Oregon Department of Environmental Quality. (ODEQ). (2017). *Revision to 2001 Western Hood Subbasin TMDL*. Portland, OR. April 2017. Portland, OR.

Oregon Department of Environmental Quality. (ODEQ). (2018). *2017 Oregon Nonpoint Source Pollution Program Annual Report*. July 2018. Portland, OR.

Oregon Department of Fish and Wildlife. (ODFW). (2010). *Lower Columbia River Conservation & Recovery Plan for Oregon Populations of Salmon & Steelhead*. Oregon Department of Fish and Wildlife. Salem, Oregon. 372 pages with appendices.

Oregon Department of Fish and Wildlife. (ODFW). (2018) *Threatened, Endangered, and Candidate Fish and Wildlife Species in Oregon*. Revised June 11, 2018. Available on https://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp. Accessed June 16, 2018.

Oregon Office of Economic Analysis. (OEA). (2013). Forecasts of Oregon's County Populations and Components of Change, 2010-2050. Department of Administrative Services: Salem, Oregon. Retrieved from: http://www.oregon.gov/das/OEA/Pages/forecastdemographic.aspx.

Oregon State University. (2018). Oregon Explorer Natural Resources Digital Library: OSU Libraries and Press and Institute for Natural Resources. Species list by watersheds available on http://oe.oregonexplorer.info/wildlife/wildlifeviewer/. Accessed August 16, 2018.

Oregon Water Resources Department. (OWRD). (2018). OWRD Water Rights Information System. Data retrieved August 10, 2018.

Oregon Water Resources Department. (OWRD). (2018a). OWRD Water Availability Analysis. Retrieved from https://apps.wrd.state.or.us/apps/wars/wars_display_wa_tables/display_wa_complete_report.aspx?ws_id=30410509&exlevel=80&scenario_id=1. Accessed October 9, 2018.

PacifiCorp. (1998). *Powerdale Hydroelectric Project, FERC Project No. 2659*. Application for new license for major project-existing dam. Vol. III, Exhibit E- environmental reports. February 1998. Portland, OR.

Phillippe, J. (2008). *Present-day and future contributions of glacier melt to the upper Middle Fork Hood River: implications for water management*. M.S.Thesis, Oregon State University. June 6, 2008. Corvallis, OR.

QW Consulting, LLC. (2018). Fish Screening Oversight Committee. http://fishscreensoc.com/screen-types/ Accessed: March 8, 2018.

Recsetar, R.S., M.P. Zeigler, D.L. Ward, S.A. Bonar, C.A. Caldwell. (2012). *Relationship Between Fish Size and Thermal Tolerance*. Transaction of the America Fisheries Society 141:1433-1438

Rubeiz, C. (2009). *Performance of Pipes during Earthquakes*. In Pipelines 2009, edited by J.J. Galleher and M.K. Kenny, 1205-1215.

Salminen, E., N. Chritensen, J. Keller, and C. Thieman. (2016). Hood River Basin Water Conservation Strategy. March 22, 2016. Watershed Professionals Network. Hood River, OR.

Shively, D. (2006). Hood River Basin Aquatic Habitat Restoration Strategy. November 2006. Mt. Hood National Forest, Hood River Ranger District. Mt. Hood-Parkdale, OR.

Stampfli, S., M. Saunders, B. Eineichner, and D. Pilz. (2012). *EFID Central Canal Pipeline Project - Stream Flow, Water Quality, and Fish Passage Final Report*. December 19, 2012. Prepared for East Fork Irrigation District of Odell, Oregon.

Tolan, T.L., Reidel, S.P., Beeson, M.H., Anderson, J.L., Fecht, K.R., and Swanson, D.A. (1989). Revisions to the estimates of the areal extent and volume of the Columbia River Basalt Group, in Reidel, S. P., and Hooper, P. R., eds., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 1–20.

U.S. Bureau of Reclamation (Reclamation). (2002). *Canal Lining Demonstration Project 10 Year Final Report. R-02-03*. Boise, ID: Bureau of Reclamation. 292 pp.

U.S. Bureau of Reclamation (Reclamation). (2006). *Fish Protection at Water Diversions: A Guide for Planning and Designing Fish Exclusion Facilities*. Water Resources Technical Publication, April 2006. US Bureau of Reclamation. Denver CO.

U.S. Bureau of Reclamation (Reclamation). (2014) Hood River Basin Study: *Distributed Hydrology Soil and Vegetation Model Technical Memorandum.* April 2014. Pacific Northwest Region Boise, Idaho.

U.S. Bureau of Reclamation (Reclamation). (2015). *Hood River Basin Study*. Pacific Northwest Region Boise, Idaho.

U.S. Census Bureau. (2016). *Selected Economic Characteristics*. Washington DC: U.S. Census Bureau. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk Accessed August 8, 2018.

U.S. Census Bureau. (2018). Quick Facts. Retrieved from: https://www.census.gov/quickfacts/fact/table/hoodrivercountyoregon,US/INC110216U.S August 17, 2018.

U.S. Department of Agriculture (USDA). (1981). Soil Survey of Hood River County, Oregon.

U.S. Department of Agriculture (USDA). (2012). 2012 Census of Agriculture County Profile, Hood River County Oregon. National Agricultural Statistics Service.

U.S. Department of Agriculture (USDA). (2017). *Guidance for Conducting Analysis Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water and Resource Investments* (DM 9500-013). Washington, DC: USDA.

U.S. Environmental Protection Agency (USEPA). (2015). Clean Water Rule: Definition of Waters of the United States"; Final Rule. *Federal Register, 80*(124), 37054–37127. June 29, 2015.

U.S. Fish and Wildlife Service (USFWS). (2016). *National Wetlands Inventory Mapping*. Retrieved from: https://www.fws.gov/wetlands/Data/Mapper.html. Accessed April 2018.

U.S. Fish and Wildlife Service (USFWS). (2018). *IPaC ECOS* (Environmental Conservation Online System). Retrieved from: https://ecos.fws.gov/ipac/location/index. Accessed May 2018.

Waibel, M.S. (2010). *Model Analysis of the Hydrologic Response to Climate Change in the Upper Deschutes Basin, Central Oregon.* Portland: US Geological Survey.

Wharry, M. (2016). *East Fork Irrigation District System Improvement Plan.* Final Report. January 2016. KPFF Project #314222.