Preliminary Investigative Report for the Central Oregon Irrigation District Irrigation Modernization Project

Prepared by Farmers Conservation Alliance

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Acronyms

AF	acre-feet
BLM	U.S. Bureau of Land Management
BOR	U.S. Bureau of Reclamation
cfs	cubic feet per second
CO_2	carbon dioxide
COID	Central Oregon Irrigation District
CTWS	Confederated Tribes of Warm Springs
EA	Environmental Assessment
ESA	Endangered Species Act
FCA	Farmers Conservation Alliance
HUC	Hydrologic Unit Code
kWh	kilowatt hour(s)
MW	megawatt
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration (NOAA) Fisheries
NRCS	Natural Resources Conservation Service
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODSL	Oregon Department of State Lands
OWRD	Oregon Water Resources Department
PIR	Preliminary Investigative Report
RM	River Mile
SHPO	State Historic Preservation Office
SIP	System Improvement Plan
UDWC	Upper Deschutes Watershed Council
U.S./US	United States
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

1 Introduction

Aging infrastructure, growing populations, shifting rural economies, and changing climate conditions have increased pressure on water resources across the western United States (US). Within the Deschutes Basin, irrigated agriculture (the primary out-of-stream water use in the area) relies on infrastructure that is over 100-years-old to divert, store, and deliver water to farms and ranches across the region. System water losses and the need to minimize those losses have been an ongoing concern of the Central Oregon Irrigation District (herein referred to as COID or the District). Starting in the mid-1990s, COID has consistently pursued a water conservation program to provide a permanent solution to system-wide water losses. Irrigation canals have become a public health safety risk due to urban encroachment and require additional maintenance due to the age of the system. This contributes to water supply insecurity for out-of-stream users and limits stream flow, affecting water quality and instream habitat in the Deschutes River and its tributaries. The aging infrastructure also affects the financial stability of the District as maintenance costs continue to increase.

A portion of the water diverted through COID's canals and laterals[1] currently seeps into the area's porous, volcanic soil prior to reaching farms. Less water would need to be diverted if the distribution system could be made more efficient. Improving aging irrigation infrastructure offers an opportunity to enhance aquatic species habitat, reduce public safety risks, support and maintain existing agricultural land use through enhanced water supply reliability, and provide financial stability to irrigation districts in the Deschutes Basin, including COID.

The District operates and maintains over 400 miles of canals and laterals, including some segments (approximately 4.8 miles) that are already piped. The District's proposed plan to modernize its infrastructure is to convert its 26-mile-long Pilot Butte Canal and associated 52 miles of laterals to buried pipe. This would result in pressurized water deliveries for about half of the District's existing system, help to alleviate local and watershed-scale water quality, instream flow, and habitat issues, and provide financial and operational benefits to the District and its patrons. This includes hydropower production, energy savings, irrigation efficiencies, and public safety.

Upgraded District infrastructure will allow for corresponding on-farm infrastructure improvements. Specific details regarding the District's proposed project are available in its System Improvement Plan (SIP; COID 2017), and are further described in Section 7.3.1.

2 Consultation and Participation with Local Partners, Agencies and Tribes

This Preliminary Investigative Report (PIR) was prepared to provide sponsors, local partners, and agencies with information to evaluate further planning, implement the goals and objectives, and aid in securing funding for the COID Irrigation Modernization Project (herein referred to as the "project"). This project development process is designed to work collaboratively with partners, agencies, tribes, and stakeholders so that there is transparency and cooperation towards a solution that fits within the framework of the purpose and need for action (Section 3). There are many involved organizations in the Deschutes Basin. During the development of the PIR, project sponsors conducted initial interviews with natural resource agencies and stakeholders. COID and its partners will conduct further comprehensive public scoping prior to the preparation of the

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

Watershed Plan-Environmental Assessment (Watershed Plan-EA) as described in the Scope of the Environmental Assessment (Section 4).

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:

- Deschutes Basin Board of Control

Supporting sponsors for the project are:

- Central Oregon Irrigation District (COID)
- National Resource and Conservation Service (NRCS)

Local partners are area entities that have land ownership or a shared resource within the District. Local partners for the project include:

- Deschutes County
- City of Bend
- City of Redmond
- Community of Terrebonne
- Bend Metro Parks and Recreation District
- Lone Pine Irrigation District
- North Unit Irrigation District

Agencies that are involved with the project include state and federal resource agencies:

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

Tribes that will be consulted regarding the COID Irrigation Modernization Project include:

- Confederated Tribes of Warm Springs (CTWS)

Other stakeholders for this project are any interested parties and the public. These include:

- Upper Deschutes Watershed Council (UDWC)
- Deschutes River Conservancy (DRC)
- Arnold Irrigation District
- Tumalo Irrigation District

- Swalley Irrigation District (SID)
- Deschutes Water Alliance (DWA)
- Energy Trust of Oregon
- Oregon Department of Energy
- Oregon Watershed Enhancement Board
- Portland General Electric
- Family Farm Alliance
- Central Oregon Land Watch
- WaterWatch of Oregon
- Trout Unlimited
- Coalition for the Deschutes
- Interested public

2.2 Permits and Compliance

It is anticipated that this project will utilize NRCS federal dollars for funding. Therefore, it will require a Watershed Plan-EA. This process will include compliance with all relevant state and federal permits and regulations, including Section 106 of the National Historic Preservation Act (managed by SHPO), Section 7 of the Endangered Species Act (managed by NOAA Fisheries and USFWS), and Sections 404 and 401 of the Clean Water Act (managed by ODSL and USACE).

2.3 Mitigation

The project would have a beneficial effect on water resources and fish and aquatic habitat in the Watershed Planning Area (see Section 3.0). No mitigation is proposed, as the project is anticipated to provide a net benefit to affected resources.

3 Purpose and Need for Action

The project area is defined as the canals and laterals to be piped and associated rights of way and/or easements. The project area is located in seven subwatersheds: Osborne Canyon-Crooked River, Deschutes Junction, North Unit Main Canal, Laidlaw Butte-Deschutes River, Odin Falls-Deschutes River, and Cline Falls-Deschutes River (Table 3-1), which cover a total of 249,512 acres as defined by Section 500.3 of the Watershed Planning Manual (NRCS 2014). These seven subwatersheds comprise the COID Watershed Planning Area and are located within the Upper Deschutes watershed (Hydrologic Unit Code [HUC] 17070301) and the Lower Crooked watershed (HUC 17070305).

Table 3-1. COID Watershed Planning Area.

12-digit Hydrologic Unit Code	Name	Area (acres)
170703051101	Osborne Canyon-Crooked River	42,387
170703010801	Deschutes Junction	47,337
170703051005	North Unit Main Canal	11,451
170703010802	Laidlaw Butte-Deschutes River	42,749
170703010805	Odin Falls-Deschutes River	66,353
170703051006	McAllister Slough-Crooked River	27,371
170703010803	Cline Falls-Deschutes River	11,864
	Total	249,512

The District's Pilot Butte Canal and associated infrastructure currently provides irrigation water to approximately 17,336 acres using one primary diversion from the Deschutes River, a tributary to the Columbia River. During peak irrigation season, the District may divert up to 516 cfs for the Pilot Butte Canal diversion. The District also conveys up to approximately 29 cfs of Deschutes River live-flow plus additional storage when needed through the Pilot Butte Canal to the weir for Lone Pine Irrigation District located on the north side of the Crooked River, east of Terrebonne, Oregon. The Pilot Butte Canal system also connects to North Unit Irrigation District's canal system.

The purposes of this project are to:

- Enhance habitat for aquatic species by creating water rights through Oregon's Allocation of Conserved Water Program and increasing year-round stream flows in the Deschutes River
- Reduce North Unit Irrigation District reliance on Wickiup Reservoir storage by replacing it with Deschutes River live flow senior water rights, facilitating enhanced habitat for aquatic species and supporting and maintaining existing agricultural uses
- Reduce risks to public safety from open irrigation canals
- Support and maintain existing agricultural uses through enhanced water supply reliability and improved water management
- Provide financial stability to COID through reduced operation and maintenance cost and through increased energy generation associated with the installation of qualified conduit hydropower facilities
- Conserve energy and reduce on-farm expenses by reducing the need for on-farm pumping

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

- Improved habitat conditions for aquatic species
- Reduced risks to public health and safety
- New opportunities for farmers to modernize irrigation infrastructure
- Increased agricultural water supply reliability
- Increased financial security

3.1 Watershed Problems and Resource Concerns

3.1.1 Habitat Conditions

The Deschutes River is listed as an impaired waterway under Section 303(d) of the Clean Water Act because it does not meet the State of Oregon's water quality standards for salmon and trout. Water management along the Deschutes River and its tributaries contributes to these impairments. Additionally, reduced habitat associated with stream flow alteration increases competition between fish populations. This competition often favors non-native brown trout (*Salmo trutta*) over native redband trout (*Oncorhynchus mykiss*). Reduced habitat availability can concentrate fish populations and increase susceptibility to predators and disease.

The Deschutes River and its tributaries support sensitive species including Oregon spotted frog, steelhead trout (*Oncorhynchus mykiss*), redband trout, Chinook salmon (*Oncorhynchus tshawytscha*), as well as many other fish, bird, and wildlife species. Stream flow in the Deschutes River limits habitat for many of these species year-round. Returning water to the Deschutes River would benefit the ecosystem by increasing the quantity and value of aquatic habitat, potentially reducing water temperatures, and improving water quality. This project would provide an opportunity to measurably improve habitat along 119 miles of the Deschutes River from Crane Prairie Reservoir (RM 239) to Lake Billy Chinook (RM 120) and in Crane Prairie Reservoir and/or Wickiup Reservoirs.

3.1.2 Risks to Human Health and Safety

Piping of COID's Pilot Butte Canal and laterals would be a notable safety enhancement for the central Oregon community. Central Oregon and the lands within COID, particularly the urban and suburban areas around Bend, Redmond, and Terrebonne, have been subjected to rapid urbanization in the last 10 years, such that people now live and generally spend more time in close proximity to the dangerous open canals. There have been two recent drowning deaths in canals in the Deschutes basin. Deschutes County was the fastest growing county in Oregon in 2015 based on the Oregon Population Report (PSU 2015); these public safety risks will continue to grow as urbanization expands into previously-rural areas such as COID's service area.

3.1.3 Water Supply Reliability

Although conserving water is a key goal of the District, its antiquated canal infrastructure loses water to seepage and other conveyance inefficiencies. The District's open canals and laterals do not pass water as efficiently as a fully-piped system would, especially at the reduced rates allowed early and late in the irrigation season. When the District diverts through the project canal and laterals, the canal and laterals lose an estimated 156 cfs through seepage. Details of water losses and demands can be found in the District's System Improvement Plan (SIP) [COID 2017; Appendix].

Water losses due to the open channel delivery system influence how the district delivers water over the course of the season. During low-water and drought years, the District has curtailed deliveries due to a lack of supply, and COID's patrons do not always receive the full rate and duty associated with the water right. Now, with the restrictions on releases from Crane Prairie Reservoir for the Oregon spotted frog, the District may struggle to deliver patrons their full allocations, especially in the shoulder seasons, even in wet years.

The Deschutes River and its tributaries also experience shortages every year. Reservoir operations lead to low winter stream flows and high summer stream flows in the Deschutes River upstream from COID's two diversions on the Deschutes River (Figure 3-2). The combined diversions of the

six irrigation districts and the cities that divert water in or near the City of Bend lead to low spring, summer, and fall stream flows in the Deschutes River downstream from COID's diversion. In order to protect habitat in the Deschutes Basin, the irrigation districts are jointly developing a multi-species Habitat Conservation Plan (HCP) under the federal ESA that will be used to establish seasonal stream flow targets in areas of the Upper Deschutes watershed with endangered species.

3.1.4 District Financial Security

The development of smaller parcel sizes served with the original canal systems greatly increases the time and effort expended by COID to manage its water supply system. This results in increasing operation and maintenance costs. Urbanization also demands substantial infrastructure upgrades and related costs. Another consideration relative to irrigation of smaller parcels is water use efficiency by the end user, which COID desires to improve through providing a pressurized system.

3.2 Watershed and Resource Opportunities

The following is a list of resource opportunities that would be realized through the implementation of the project. Quantification of these opportunities is provided in other sections of this PIR, or in the Watershed Plan-EA or its supporting documents, as appropriate.

- Improve stream flows and water quality within the Deschutes River from Crane Prairie Reservoir (RM 239) to Lake Billy Chinook (RM 120)
- Improve water availability in Crane Prairie Reservoir
- Minimize the potential for injury and loss of life associated with the open COID canals
- Provide a more reliable source of irrigation water to COID patrons
- Reduce the maintenance involved in delivering irrigation water to COID patrons
- Maintain or reduce COID operating costs
- Reduce energy costs by removing the need for individual on-farm pumps
- Potential for 7 qualified conduit hydroelectric opportunities with a combined capacity of 6.42 MW

Stream flow benefits would be realized by allocating saved water instream through Oregon's Allocation of Conserved Water Program.

4 Scope of the Environmental Assessment

NRCS and COID will conduct public scoping as the NEPA review process proceeds. Public scoping will seek additional issues of economic, environmental, cultural, and social importance in the watershed. NRCS and COID will organize agency and public scoping meetings, which will provide an opportunity to review and evaluate the project alternatives, express concerns, and gain further information. Following the scoping process, a Watershed 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 is located in central Oregon, in Deschutes and Crook Counties. It is situated northeast of the city of Bend and east of the Deschutes River, and it falls within seven

subwatersheds that have a total area of 249,512 acres (Figure 5-1, Table 3-1). These seven watershed form the Watershed Planning Area. COID's Pilot Butte Canal area includes portions of the cities of Bend and Redmond and the community of Terrebonne. The Pilot Butte Canal area of the District currently serves 17,336 acres of irrigated land. COID's Pilot Butte Canal infrastructure also conveys water to the Lone Pine Irrigation District located on the north side of the Crooked River, east of the community of Terrebonne (Figure 5-2). The District operates and maintains over 400 miles of main and lateral canals in total, 78 miles of which are within the project area.

The Watershed Planning Area is located within the Upper Deschutes (4th field HUC: 17070301) and Lower Crooked (4th field HUC: 17070305) watersheds. Within the Upper Deschutes watershed, portions of the Deschutes River are referenced as the upper Deschutes River (from RM 226 to RM 165) and the middle Deschutes River (from RM 165 to RM 120). This reference point divides the river based on its hydrograph, which is driven by reservoir operations (Figure 5-3). Current reservoir management in the upper Deschutes River leads to low winter flows and high summer flows. When the high summer flows reach the North Canal Dam, they are diverted for use by several irrigation districts.

There are two segments of the Deschutes River within or adjacent to the Watershed Planning Area that are designated as a National Wild and Scenic River. The approximately 56 mile segment from Wickiup Reservoir (RM 227) to Central Oregon Irrigation District's Central Oregon Diversion (RM 171) and a 20-mile segment from Odin Falls (RM 140) to the upper end of Lake Billy Chinook (RM 120) (USDA USFS 1996) are designated as Wild and Scenic River. Downstream of the Project area, the 35-mile segment of the Deschutes River from Twin Bridges (RM 155) to the head of Lake Billy Chinook (RM 120) is a state scenic waterway under the Oregon Scenic Waterways Program.

COID Pilot Butte Canal patrons' lands are located adjacent to the middle Deschutes River. COID stores water in Crane Prairie Reservoir, located in the upper reaches of the Upper Deschutes watershed. After the water is stored in Crane Prairie Reservoir, it is conveyed through Wickiup Reservoir (where North Unit Irrigation District has stored water rights) and down the Deschutes River. This water is then diverted at two separate locations on the Deschutes River, the Central Oregon Canal diversion (RM 171) and the Pilot Butte Canal diversion at North Canal Dam (RM 165).

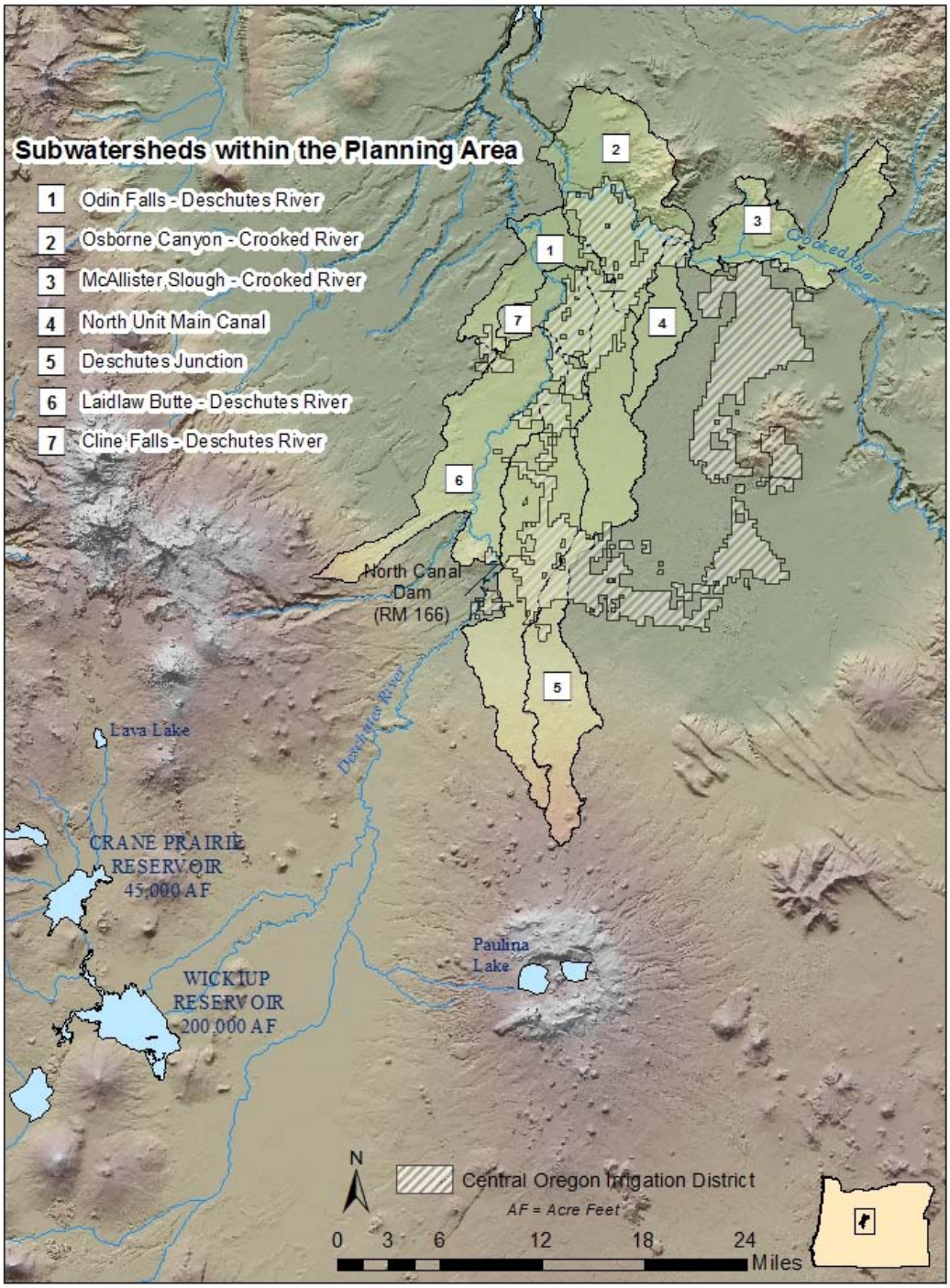

Figure 5-1. Central Oregon Irrigation District Pilot Butte Watershed Planning Area.

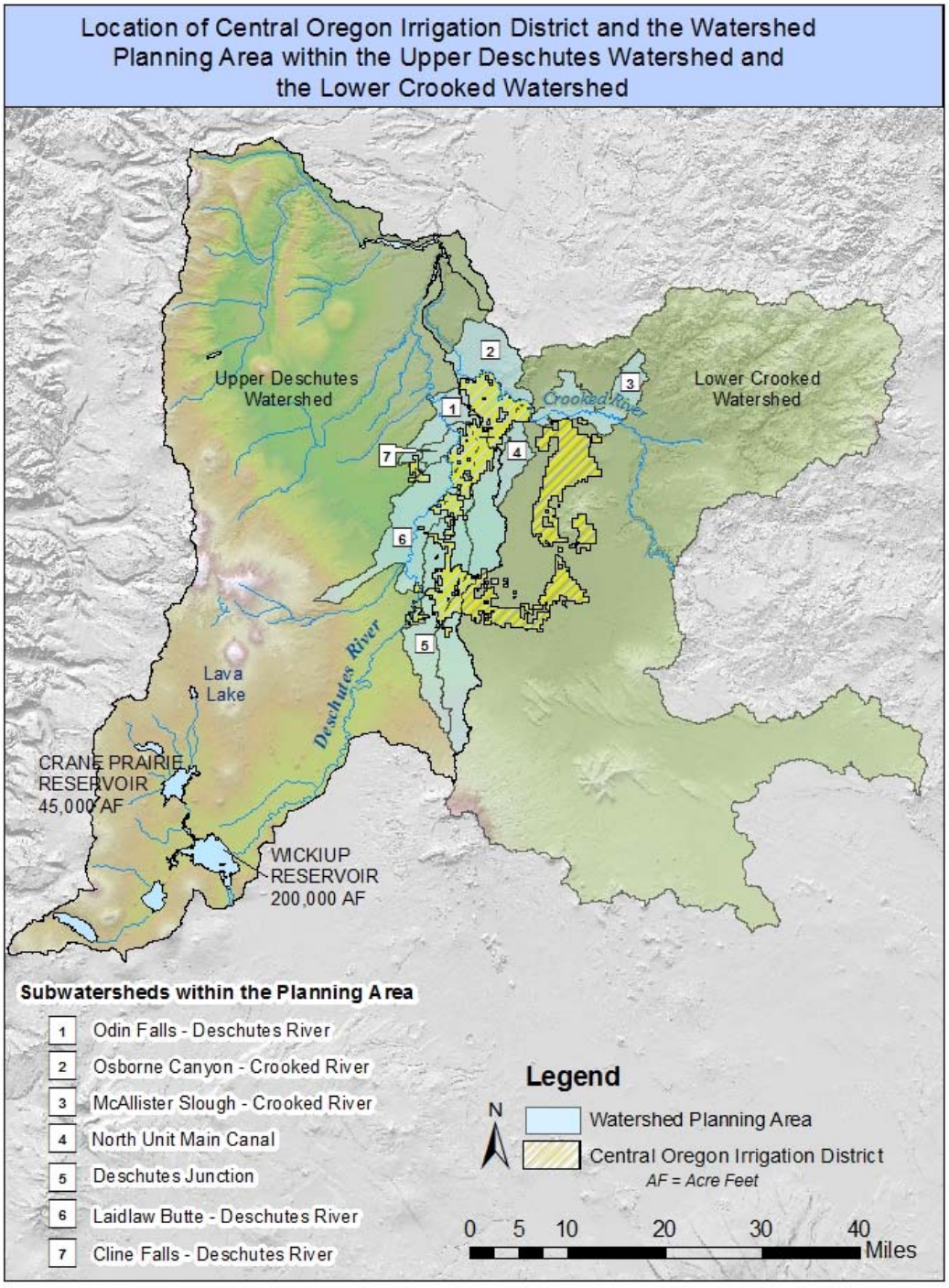

Figure 5-2. Location of Central Oregon Irrigation District and Pilot Butte Canal Watershed Planning Area within the Upper Deschutes watershed.

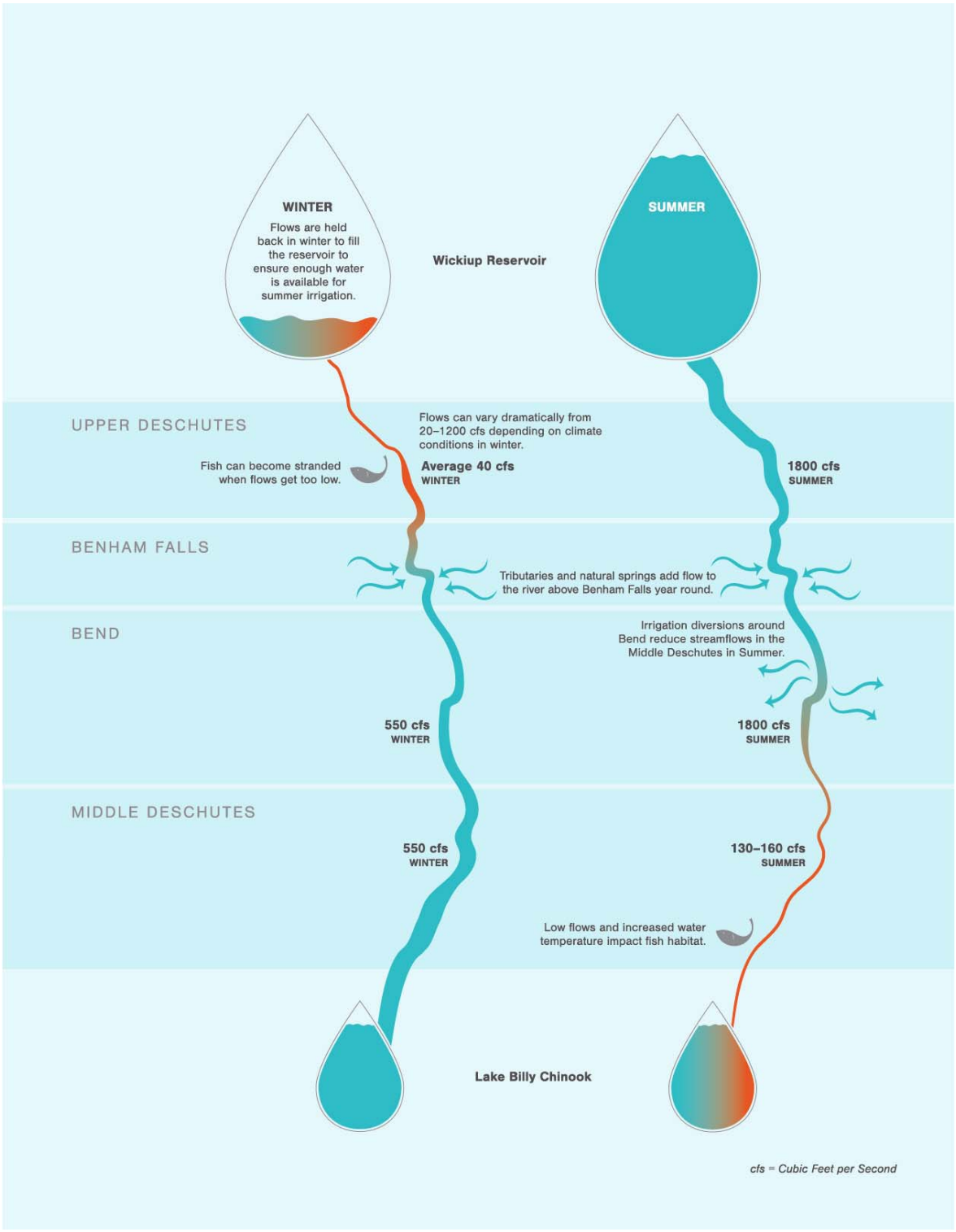

Figure 5-3. Deschutes River Seasonal Flow Management.

Source: Central Oregon Irrigation District

5.2 Current Infrastructure

COID's Pilot Butte Canal Diversion at RM 165 on the Deschutes River has powered head gates, fish passage, and an agency-compliant fish screen to protect both upstream and downstream migrating fish. The District has 26,000 AF of stored water rights in Crane Prairie Reservoir, which also stores water for other irrigation districts and to support the Oregon spotted frog. Water from Crane Prairie is released throughout the irrigation season and conveyed through the Deschutes River to the Pilot Butte Canal diversion or its other diversion (Central Oregon Canal).

Crane Prairie Reservoir dam is jointly owned by BOR and COID, and operated by COID, with maintenance of the dam shared amongst Lone Pine Irrigation District (21 percent), Arnold Irrigation District (27 percent), and COID (52 percent).

The Pilot Butte Canal is approximately 26 miles long and, from the point of diversion at North Canal Dam (RM 165) and it conveys water into the District in a northerly direction (Figure 5-4). The entire canal system is open channel except for a few piped segments within Redmond, Oregon and a 2.5 mile section just north of Bend, Oregon. This section was piped in 2010 to conserve water and to install the 3.3 MW Juniper Ridge Hydropower Project. Power generated at this facility is sold to Pacific Power to subsidize COID operations. Approximately 52 miles of laterals (over 5 cfs) are associated with the Pilot Butte Canal, serving a total 17,336 acres throughout Bend, Redmond, and Terrebonne. In addition to serving COID's patrons, this canal system also carries and delivers water to Lone Pine Irrigation District. This canal system also connects to and can pass water to North Unit Irrigation District's canal system.

The Pilot Butte Canal serves 1,855 patrons, and the water diverted into the Pilot Butte Canal falls approximately 647 feet in elevation as it travels from its diversions to the northern limit of the District. Patron turnouts from District canals and laterals are gate-regulated and weir-measured via COID field staff. Seven patrons are currently being served from individual diversions off the Deschutes River.

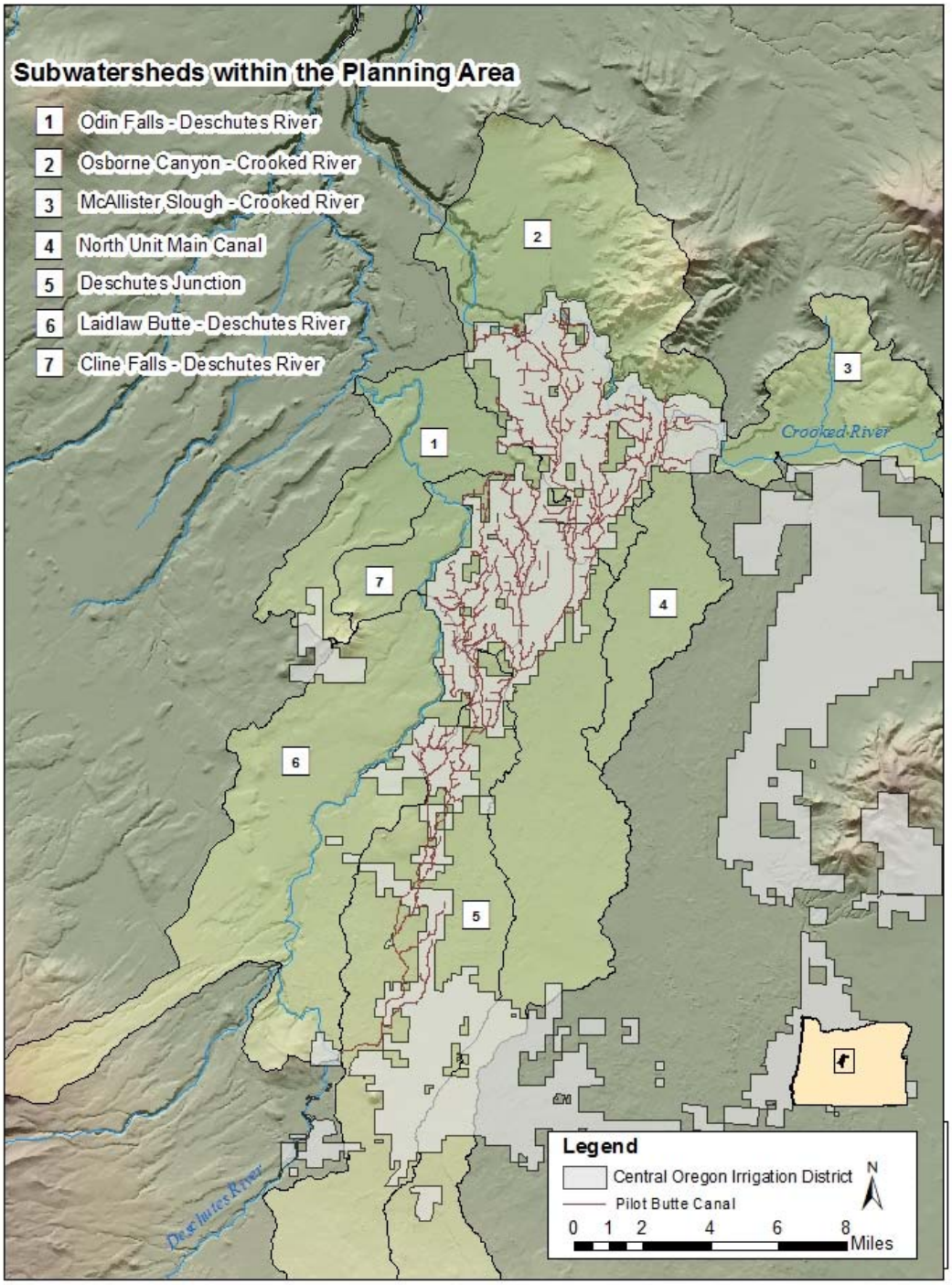

Figure 5-4. Central Oregon Irrigation District, Pilot Butte Canal system (COID 2017).

5.3 Topography

The Watershed Planning Area is located generally to the north of the City of Bend, Oregon and serves properties surrounding Bend and Redmond. The Watershed Planning Area is generally confined by the Deschutes and Crooked Rivers. The land within the Watershed Planning Area is slightly undulating. The Pilot Butte Canal diversion on the Deschutes River is at 3,504 feet above sea level. There is approximately 647 feet of elevation loss between the canal diversion on the Deschutes River and the bottom end of the District infrastructure.

5.4 Climate

The COID Watershed Planning Area is located in the rain shadow of the Cascade Mountain range. Orographic processes result in large amount of precipitation in the Cascades Mountain Range with levels exceeding 200 inches per year, mostly as snow. Precipitation rates diminish rapidly moving from west to east across the basin, with less than 10 inches per year received in the central part of the basin. The annual average precipitation in the COID Watershed Planning Area is 10 to 14 inches, thus irrigation is essential to crop production, and COID irrigators rely on the Deschutes River in order to receive adequate water supplies for their crops. The average high temperature for the month of July is 82 degrees Fahrenheit and average winter low temperature for the month of December is 23 degrees Fahrenheit. The average annual growing season is 120 days.

Recent yet consistent changes in climate show signs of future increased temperatures and changes in precipitation patterns, which will result in fundamental changes in the seasonal distribution of stream flow in the area and may have serious implications for natural resource managers and local farmers (Vano et al. 2015). Variable Infiltration Capacity simulations show a substantial decrease in annual stream flow in response to increasing summer (April through September) warming where winter (October through March) warming stimulates greater stream flow immediately, which partly compensates for a subsequent decrease in summer stream flow that happens because less water is available (Das et al. 2011). The probable result of climate changes 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).

5.5 Geology and Soils

5.5.1 Geology

The COID Watershed Planning Area is located within the Deschutes-Columbia Plateau, which is part of the larger Columbia Plateau. The Deschutes-Columbia Plateau was formed by periodic fissure eruptions of lava during the Miocene epoch, which filled a subsiding basin. The COID Watershed Planning Area consists of volcanic features, most of which are the result of relatively young eruptions causing the Deschutes Formation (late Miocene/early Pliocene epoch) which is found throughout the northern half of the District and the younger Newberry Volcano Formation (Pleistocene/Holocene epoch) which is found throughout the southern half of the District as well as sections in the northwestern corner. The valleys between the mountains, buttes, and hills in the Deschutes Columbia plateau including the COID Watershed Planning Area are in general, level floored owing in part to the deposition of alluvium and fragmented material blown out of volcanoes in the condition of gravel and dust in addition to large, thick lava sheets that are found throughout these areas.

The COID Watershed Planning Area is located in the High Lava Plains physiographic province (Orr et al. 1992). The High Cascades were primarily formed 2 to 4 million years ago during the Pliocene and Pleistocene Epochs and they changed the landscape of the Deschutes Basin. This volcanic

activity resulted in complex assemblages of vents, lava flows, pyroclastic deposits, and volcanically derived sedimentary deposits. Peaks in the High Cascades that lie to the west of COID are: Jefferson, Three Fingered Jack, Washington, the Three Sisters, Broken Top, and Bachelor. Over the last 2 to 4 million years, erosion, sedimentation, and volcanic activity deposited more layers of alluvium, ash, and andesite over areas of the COID Watershed Planning Area. The geologic units found in the study area include basaltic to andesitic lava from the Cenozoic Era (OGDC, 2014).

In areas with coarse-gained, unconsolidated sediments, vesicular rock, and brecciated lava flows that contain holes and cracks, water is able to move through easily (Lite and Gannet 2012). This influences hydrology because many stream reaches lose water to the underlying aquifers, or gain water through springs, both of which are created by these layers of volcanic rock. In addition, there are some areas throughout the COID Watershed Planning Area where the underlying rock formation consists of fine-grained sedimentary deposits, dense lava flows, and pyroclastic flows the ability of water to penetrate the layer is low (Sherrod et at. 2004).

5.5.1 Soils

Soils in the Watershed Planning Area are extensively influenced by the volcanic activity along the Cascade Range. The underlying material of the COID Watershed Planning Area is generally basalt and andesite. Soil surface layers mainly consist of sandy loam (USDA National Resources Conservation Service 2002). Much of the sandy loam and soil complexes occur in areas between mounds and ridges of rock outcrops, which are characteristic of the upland plains east of the Cascades. Found throughout the northern portion of the Watershed Planning Area, Deschutes sandy loam has a slightly developed profile, meaning the subsoil is slightly finer in texture and more compact than the surface soil and has a weakly developed structural aggregate. They are very loose and are sensitive to lateral soil movement and erosion. Soil displacement of topsoil layers can adversely affect soil fertility and productivity. Deskamp sandy loam is found mainly in the southern portion of the Watershed Planning Area. The sandy loam soils are moderately deep and are well-drained. This type of soil has high seepage rates for canal conveyed water and for ponds. The low available water capacity and high permeability requires the careful management of sprinkler irrigation to avoid deep percolation losses while providing adequate soil moisture for crop use. These soils are also subject to wind erosion without adequate cover.

Almost all of the bedrock materials beneath soils are extrusive volcanic rocks (USDA 1990). Litter and duff on the soil surface is also found in variable depths throughout the District, primarily as a function of the aspect and plant association on which a given soil profile is located. Surface litter and duff is a primary component of the productivity of the soils present within the area. Underlying glacial or volcanic materials within the District affect the subsurface flow of water, but can also influence the availability and content of nutrients within the soil profile.

5.6 Water Resources

5.6.1 Water Supply and Stream Flow

Pilot Butte Canal obtains water from the Upper Deschutes watershed. Crane Prairie Reservoir (RM 238) is located several miles downstream from the headwaters of the Deschutes River and is primarily fed by annual snow melt, precipitation, and Little Lava Lake. Crane Prairie Reservoir is relatively shallow and holds 55,300 acre-feet at full capacity. The reservoir was built in 1922 by local irrigation districts and rehabilitated by BOR in 1940. COID is the primary name on water right certificate #76685, confirming the right to store the waters of the Deschutes River in Crane Prairie Reservoir. Crane Prairie is federally-authorized for irrigation only, but the State of Oregon

authorized Crane Prairie for multiple purposes, including instream flows for fish and wildlife, in 2000. Certificate #76685 entitles the right to store 50,000 acre-feet in accordance with the inter-district agreement dated January 4, 1938 between Lone Pine Irrigation District, (formerly Crook County Improvement District No. 1), Arnold Irrigation District, and COID.

The storage water may be released for use by the district (per separate water right certificate) and is conveyed east through Wickiup Reservoir and then north through the Deschutes River to one of the District's two primary diversions, the Central Oregon Canal diversion (RM 171) and the Pilot Butte Canal diversion (RM 165). Excess water in the Pilot Butte Canal spills to the North Unit Irrigation District system. In addition to stored water conveyance and diversion, the District also retains 1,370 cfs of live flow water rights in the Deschutes River that are subject to diversion.

COID is a senior water right holder on the Deschutes River. Water right certificate #83571 is COID's primary water right, confirming the right to use the waters of the Deschutes River, with 1900 and 1907 priority dates. Per court decree, this certificate allows COID to divert a maximum rate of 1370 cfs during the irrigation season between the Central Oregon Canal and Pilot Butte Canal to meet seasonal demand. Water right certificate #76714, issued to COID, confirms the right to use the water stored in Crane Prairie Reservoir for multiple uses during the irrigation season in accordance with the 1938 inter-district agreement. COID uses its allotment to supplement certificate #83571 when Deschutes River live-flow is deficient. Certificate #86026 allows the water being diverted at the District's Pilot Butte Canal diversion located at North Canal Dam to be used for hydroelectric power generation at the Juniper Ridge facility.

Under the water right certificates, the beneficial uses for the District are irrigation, dust abatement, municipal, quasi-municipal, industrial, mining, livestock, and pond maintenance. COID has completed conserved water projects resulting in allocations of conserved water transferred instream, and has also filed permanent instream transfers, both resulting in increased stream flows. OWRD has modified COID certificates accordingly.

5.6.2 Ground Water

As discussed above, groundwater plays an important role in the hydrograph of the entire Deschutes watershed; groundwater in the upper watershed provides more than three quarters of the total stream flow for the entire watershed. At upper elevations, most (approximately 70 percent) precipitation becomes groundwater, whereas precipitation at low elevations is largely lost to evapotranspiration, with only 5 percent infiltrating to the groundwater system (Manga 1997 and Gannett et al. 2003). Due to the porous geology of the area, groundwater levels and stream discharge are tied to the frequent movement of water between surface and groundwater sytems.

Irrigation canals in the Deschutes watershed, and the COID Watershed Planning Area in particular, often show seepage losses indicative of the area's permeable geology, as discussed in Section 5.6.1.

5.6.3 Water Quality

Impacts of changes to the Deschutes River and its tributaries' hydrographs due to flow discussed in Section 5.6.1 include diminished water and habitat quality throughout the Deschutes River, as low flows can exacerbate temperature and dissolved oxygen (DO) problems, which can then lead to other water quality issues. The Oregon Department of Environmental Quality (ODEQ) periodically prepares a list of all surface waters in the state considered impaired because they do not meet water quality standards under Section 303(d) of the Clean Water Act (33 USC 1251 et seq.). The Deschutes River is included on the most current list for temperature, DO, pH, sedimentation, turbidity, aquatic weeds, E. Coli, and/or Chlorophyll a. Segments are also considered water quality

limited, but not included on the 303(d) list, for flow modification that impairs fish habitat (ODEQ 2012).

5.6.3.1 Temperature

Elevated stream temperature in the Deschutes River affects native fish by exacerbating conditions that cause stress and disease, raise their metabolism, and reduce growth rates. Non-native fish often thrive in warmer waters, allowing them to outcompete and prey on native fish (Recsetar et al. 2012; Shea and Peterson 2007). Higher water temperatures also reduce the DO potential. Oregon's temperature standard in the Deschutes River is 64 degrees Fahrenheit to protect salmon and trout rearing and migration life stages. This standard is frequently exceeded in the portion of the Deschutes River that would be affected by the project (ODEQ 2012).

5.6.3.2 Dissolved Oxygen

Sufficient DO concentration is an important characteristic of habitat suitability for aquatic organisms. Portions of the Deschutes River are included on the State 303(d) list for not meeting DO criteria in the study area and are listed year-round for not meeting the non-spawning DO criterion of not less than 8.0 mg/l or 90 percent of saturation. The Deschutes River is also listed for not meeting the salmonid spawning DO criterion of not less than 11.0 mg/L or 95 percent of saturation from January 1 to May 15 (ODEQ 2012).

5.6.3.3 pH

pH values in surface waters are generally determined by DO and temperature levels, as both reduced DO availability and higher temperatures increase pH. pH violations can affect the solubility of nutrients, thereby changing the amount of nutrients available for plant growth. When pH is high, too many nutrients are available, plants grow at a higher than normal rate, resulting in increased organic matter decomposing in the stream, which further reduces DO. The pH standard in rivers associated with the Watershed Planning Area is 6.5 to 8.5, this standard is frequently exceeded with higher, or more alkaline, pH values. The Deschutes River is included on the State 303(d) list for not meeting this criterion (ODEQ 2012).

5.6.3.4 Sedimentation

The Deschutes River is listed as not meeting the State's criterion for sedimentation through a portion of the study area (RM 168.2 to RM 189.4; ODEQ 2012). This criterion is set for resident fish and aquatic life and salmonid fish spawning and rearing in the river. Sedimentation affects resident fish by, among other impacts, directly decreasing habitat availability. Stream flow alterations have decreased bank stability and increased sediment transport and deposition rates in the Deschutes River. Upstream reservoir operations in the Deschutes River, adjacent to the Watershed Planning Area, may contribute to this impairment.

5.6.3.5 Turbidity

The Deschutes River is listed as not meeting the State's criterion for turbidity, a 10% increase in Nephelometric Turbidity Units, adjacent to the Watershed Planning Area (RM 168.2 – RM 222.2) during the spring and summer (ODEQ 2012). This standard is set to protect aesthetics, resident fish and aquatic life, and water supply in the river. Increased turbidity can be caused by increased sediment, algae, or other microscopic organisms in the water column. It can impair fish populations by reducing growth rates, impairing spawning and egg development, reducing food supplies, or

other impacts. Upstream reservoir operations and urbanization have altered channel morphology and may contribute to this impairment.

5.6.3.6 Aquatic Weeds

Crane Prairie and Wickiup Reservoirs are listed as not meeting the State's criterion for aquatic weeds. This standard encompasses the development of fungi and other plant growth that may have a deleterious effect on stream substrates. Aquatic weeds can affect fish, aquatic life, human health, recreation, and industry.

5.6.3.7 Chlorophyll a

A portion of the Deschutes River adjacent to the Watershed Planning Area (RM 168.2 – 189.4) is included on the State's 303(d) list for not meeting the State's criterion for Chlorophyll a, 0.015 mg/l, during the summer (ODEQ 2012). This standard is set to protect multiple uses, including resident fish and aquatic life, in the river. Chlorophyll a indicates excess algal growth, and excess algae often contributes to low dissolved oxygen concentrations (see Section 5.6.4.2).

5.7 Fish & Aquatic Species

COID's Pilot Butte canal, laterals, and hydroelectric facility do not provide habitat for game fish, salmonids, or threatened and endangered aquatic species. Fish screens compliant with ODFW standards were installed on the Pilot Butte Canal Diversion at North Canal Dam (RM 165) in 2004. These screens separate water diverted for consumptive use from fish and water left instream. This prevents any fish from entering the irrigation conveyance system and the hydroelectric facilities.

As discussed in Section 5.2.1, historically, the Deschutes River had very consistent stream flows seasonally and annually. This created fish habitat with cold, clear, water and consistent hydrology. Since the late 1800s, changes to Deschutes River stream flows, construction of fish passage barriers, and water management has created a very different aquatic environment with resulting changes to the fish species assemblages.

The species currently present in the middle Deschutes River are a reflection of the available habitat conditions. The ODFW, Oregon Watershed Enhancement Board, and the Upper Deschutes Watershed Council (UDWC) have been working to describe fish populations in the middle Deschutes River and interpret how fish are using aquatic habitat in relation to temperature and stream flow conditions (UDWC 2014). The data collected as part of this study have improving the understanding of the native and non-native fish assemblages in the middle Deschutes and how they respond to changes in flow and water temperatures. Between 2012 and 2014, Carrasco and Moberly found fish assemblages in the middle Deschutes River to include: mountain whitefish (*Prosopium williamsoni*), redband trout, brown bullhead (*Ameiurus nebulosus*), sculpin spp. (*Cottus spp.*), brown trout, tui chub (*Gila bicolor*), and bridgelip sucker (*Catostomus columbianus*). Mountain whitefish, redband trout, and brown trout were found to be the dominant species (Carrasco and Moberly 2014). Mountain whitefish and redband trout are native to the middle Deschutes River. Brown trout were introduced to the Deschutes Basin by state and federal agencies in the early 1900s.

An isolated population of bull trout (*Salvelinus confluentus*) exists in the Metolius River and Lake Billy Chinook (ODFW 1996). The Metolius River is one of the three rivers that feed Lake Billy Chinook. Bull trout may utilize the Deschutes River downstream from Big Falls (RM 132).

Historically, Chinook salmon and summer steelhead were also distributed in the Deschutes River up to the natural barriers of Steelhead Falls (RM 127.75) and Big Falls (RM 132), respectively. The

construction of the Pelton Round Butte Dam complex on the Deschutes River eliminated anadromous populations upstream from the dams. Fisheries managers initiated efforts to reintroduce Chinook salmon and steelhead trout upstream from the Pelton Round Butte Project as part of a hydropower relicensing agreement in 2005.

Elevated water temperatures in the middle Deschutes River (Section 5.6.4.1) negatively impact salmonid growth and survival (Recsetar et al. 2012). Availability of cold refuge for temperature-sensitive fish species is of key importance when water temperatures in the main streams rise above acceptable standards. Water temperatures out of the normal range for fish can increase physiologic stress, increase susceptibility to predators, and influence growth rates, feeding, metabolism, and development. Further data collection and temperature modeling efforts will aid in managing the additional habitat gained by increased stream flows.

The Deschutes River upstream of North Canal Dam (RM 165) to Wickiup Reservoir (RM 227) has similar fish species to the river downstream of North Canal Dam (USFS 1996). The fish habitat has been affected in the last one hundred years by dam construction, regulation of stream flow, introduction of non-native species, removal of large woody material and habitat structure, and human development. All of these pressures affect water and habitat quantity and quality. Accordingly, many of the same pressures have affected the fish assemblages upstream of North Canal Dam and has resulted in similar species assemblages. Current fish species present in the upper Deschutes River include: mountain whitefish, redband trout, brown trout, sculpin spp. (*Cottus spp.*), tui chub, and three-spined stickleback (*Gasterosteus acukeatus*). The ratio of brown trout, redband trout, and mountain whitefish changes along the length of the Deschutes River, but these species are generally the most common current species of interest due to the present fishery interest.

The Oregon spotted frog, discussed further in Section 5.11, also occurs in and in the vicinity of the Watershed Planning Area. Although Oregon spotted frog does not occur in project irrigation canals, they are known to occur in the upper Deschutes River, Crane Prairie Reservoir, and Wickiup Reservoir. Oregon spotted frog typically occur in areas with shallow water and emergent vegetation, such as river margins. Water management that alters water levels has reduced habitat suitability for this frog in the river and its reservoirs and tributaries.

5.8 Wildlife

Wildlife and their habitat within the District's lands and irrigation canals within the Watershed Planning Area is relatively limited. Urbanization, commercial businesses, and transportation corridors have created fragmented, disturbed habitat, typically frequented by wildlife more tolerant of urban and agricultural land uses.

Typical mammals in the Watershed Planning Area may include: mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), beaver (*Castor canadensis*), cottontail rabbits (*Sylvilagus* spp.), jack rabbits (*Lepus* spp.), pygmy rabbits (*Brachylagus idahoensis*), gray squirrels (*Sciurus griseus*), golden-mantled ground squirrels (*Spermophilus lateralis*), least chipmunks (*Tamias minimus*), opossum (*Brachylagus idahoensis*), raccoon (*Procyon lotor*), and bats. Reptiles potentially present in the Watershed Planning Area include Western fence lizards (*Sceloporus occidentalis*), horned lizards (*Phrynosoma spp*), sagebrush lizards (*Sceloporus graciosus*), and gopher snakes (*Pituophus catenifer*). A wide variety of birds including osprey (*Pandion haliaetus*), turkey vulture (*Cathartes aura*), Canada goose (*Branta Canadensis*), bald eagle (*Haliaeetus leucocephalus*), red-tailed hawks (*Buteo jamaicensis*), Stellar's jay (*Cyanocitta stelleri*), spotted towhee (*Pipilo maculatus*), northern flicker (*Colaptes auratus*), rufous hummingbird (*Selasphorus rufus*), winter wren (*Troglodytes hiemalis*), red-breasted nuthatch (*Sitta canadensis*), and many others may occur in the Watershed Planning Area.

5.9 Vegetation

COID's Pilot Butte lands are predominantly within the Deschutes River Valley EPA level 4 ecoregion of the Blue Mountains level 3 ecoregion. The Deschutes River Valley ecoregion is a broad, intermountain sagebrush-grassland. The climate in this ecoregion has a marine influence and is not as arid as in the botanically-similar High Lava Plains level 4 ecoregion to the southeast. Because of the proximity of the High Cascade Mountains to the west, stream density and water availability are high. As a result, human population density is much higher than in some nearby ecoregions (Thorsen, et al. 2003).

Some lands in the southwest corner of the Pilot Butte area of the District are within the Ponderosa Pine/Bitterbrush Woodlands level 4 ecoregion of the Eastern Cascades Slopes and Foothills level 3 ecoregion. These lands are characterized by undulating volcanic plateaus and canyons with well-drained frigid soils that are often derived from ash. Ponderosa pine (*Pinus ponderosa*) is common; lodgepole pine (*Pinus contorta)* is largely absent.

Native vegetation in the Pilot Butte area of the District is typically represented by three communities as described by Johnson and O'Neil (2001): Ponderosa Pine Forest and Woodlands, Western Juniper and Mountain Mahogany Woodlands, and Shrub-Steppe. Typical vegetation assemblages in these communities are as follows.

- **Ponderosa Pine Forest and Woodlands** are widespread in the pumice zine of south-central Oregon between Bend and Crater Lake east of the Cascade Crest. They are dominated by Ponderosa pine and Douglas-fir (*Pseudotsuga menziesii*). Western larch (*Larix occidentalis*) can be co-dominant, and grand fir (*Abies grandis*) may also occur. Common understory species are mallowleaf ninebark (*Physocarpus malvaceus*) or common snowberry (*Symphoricarpos albus*).
- **Western Juniper and Mountain Mahogany Woodlands** are widespread and variable throughout it range, and occurs in basins and canyons, slopes and valleys, and benches and foothills. Western juniper (*Juniperus occidentalisi)* dominates, with curl-leaf mountain mahogany *(Cercocarpus ledifolius*) occurring as the only dominant tall shrub or small tree (or as a co-dominant). Common shrubs include big sagebrush (*Artemisia tridentate* spp. *tridentata, A. t.* spp. *wyomingensis*, and *A. t.* spp *vaseyana*) and/or antelope bitterbrush (*Purshia tridentat*). Mountain snowberry (*Symphoricarpos oreophilus*) or creeping Oregongrape *(Mahonia repens*) can be dominant in the understory.
- **Shrub Steppe** usually occurs below Ponderosa Pine Forest and Woodland, and Western Juniper and Mountain Mahogany Woodland Habitats. Typical dominant species include big sagebrush, antelope bitterbrush, silver sagebrush (*A. cana),* and/or three-tip sagebrush (*A. tripartia*).

Over the past 100 years, land use has changed much of the vegetation within the Pilot Butte area of the District. Urban development, roads, irrigated agriculture, land management, and livestock grazing are the primary causes of changes to the plant community. The introduction of cheat grass has also threatened the survival and diversity of native perennial grasses and forbs, while increasing the risk of severe hot wild fire in the project area. Due to the exclusion of fire, dense stands of small diameter juniper, sage, and bitterbrush cover vast areas of a land base once dominated by large diameter juniper and grasses.

A fringe of hydrophytic (water-loving) plants has formed along the margins of the top of the COID canal bank in some areas. This community is only a few feet wide in scattered locations and does not

function as a riparian zone or as a habitat type. Dominant plants in these locations are primarily bulrush (*Scirpus* spp.), black cottonwood (*Populus balsamifera*), and willow (*Salix* spp.). The COID infrastructure is maintained during the off-season by grading and clearing, and no vegetation is allowed to develop within the canals.

5.10 Wetlands

Wetlands are defined as "areas that are inundated or saturated by surface or ground water 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" (ACOE 1987). Wetlands have the following general environmental characteristics (ACOE 1987):

- Vegetation that consists of macrophytes, typically adapted to grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions.
- Soils that have been classified as hydric, or they possess characteristics that are associated with reducing soil conditions.
- Hydrological effects that inundates the area with permanently or periodically at mean water depths ≤6.6 ft, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

Wetlands in Oregon are managed under two laws: Section 404 of the Clean Water Act, which regulates dredge or fill of wetlands over which the Army Corps of Engineers has jurisdiction (or "jurisdictional wetlands") and the Oregon Removal-Fill Law. Jurisdictional wetlands are not known to occur in the project area. National Wetland Inventory geographic information systems (GIS) data (USFWS 2016), does not describe wetland resources within the project area.

Wetland plants are sometimes found along the banks of open irrigation canals, as the hydrology provided by the canals can create conditions where they can grow. Although canals may have hydrology and vegetation indicative of a wetland, the Oregon Removal-Fill Law provides several exemptions for specific agricultural activities in wetlands and other waters of the state. Per the Oregon Removal-Fill statue OR 141-085-0515(9), regardless of whether it was created in wetlands or uplands, an irrigation ditch is not jurisdictional under Oregon Removal-Fill permitting if it meets both of the following (Oregon Dept of State Lands 2013):

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

"Dewatered" means that the source of the irrigation water is turned off or diverted from the irrigation ditch. A ditch that is dewatered during non-irrigation season may be used for temporary flows associated with stormwater collection, stock water runs, or fire suppression. No wetlands under the jurisdiction of ODSL or USACE are anticipated to occur in the project area where work would occur.

5.11 Threatened and Endangered Species

The Endangered Species Act (ESA; 16 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 the USFWS if listed species or designated Critical Habitat may be affected by a proposed project. If adverse impacts would occur, the ESA requires federal agencies to evaluate the likely effects of the proposed project, and ensure that it neither risked the continued

existence of federally-listed ESA species, nor results in the destruction or adverse modification of designated Critical Habitat.

The USFWS maintains a list of wildlife species protected under the ESA that may occur in Deschutes County (USFWS 2017). Federal species of concern are identified by the USFWS but do not receive protection under the ESA. These species have potentially declining populations and could require additional management or protection in the future. Although a number of listed species are known by USFWS to occur in Deschutes County: threatened yellow-billed cuckoo (*Coccyzus americanus*), northern spotted owl (*Strix occidentalis caurina*), Oregon spotted frog (*Rana pretiosa*), and bull trout; endangered gray wolf (*Canis lupus*); and candidate whitebark pine (*Pinus albicaulis*); only the bull trout and Oregon spotted frog is known or likely to occur in areas that would be directly or indirectly affected by the project (USFWS 2017).

No threatened, endangered, or candidate species occur in irrigation canals or any other areas where project works would occur. Oregon spotted frog does not occur in project irrigation canals, they are known to occur in the upper Deschutes River as well as Crane Prairie Reservoir, which are waterbodies that would be indirectly affected by project activities. Designated critical habitat for the Oregon spotted frog includes the majority of the Deschutes River downstream from Crane Prairie Reservoir until the COID diversion (as well as other areas in the Deschutes drainage that are outside of the study area such as Crescent Creek and the Little Deschutes River).

The District is collaborating with state and federal agencies, local municipalities, and environmental groups to develop and implement specific recovery actions for Oregon spotted frog, including a multi-species Habitat Conservation Plan lead by the USFWS anticipated to be completed in 2018. Implementation of the proposed project would further these efforts by increasing flows in Oregon spotted frog habitat in the Deschutes River, Crane Prairie Reservoir, and Wickiup Reservoir. The project's interaction with Oregon spotted frog habitat will be further analyzed in the project's Watershed Plan-EA and through coordination with USFWS.

Fisheries managers have reintroduced summer steelhead, listed as threated under the ESA, to the Deschutes River and its tributaries upstream from the Pelton Round Butte Project. These reintroduced summer steelhead are considered to be a non-essential, experimental population under Section 10(j) the ESA.

5.12 Land Use, Zoning, and Ownership

The dominant land use in the Watershed Planning Area is agriculture followed by urban and suburban uses, fallow ground, and instream leases. The crops grown in the agricultural areas include pasture grass, hay, vegetables, fruit, and nursery plants. Farmers typically get two to three cuttings per year on hay and pasture grass. COID also delivers water to 1,025 tax lots smaller than five acres located in rural subdivisions as well as urban areas of Bend and Redmond.

Crops currently grown within the Watershed Planning Area are alfalfa, pasture, grains, and specialty crops. At the time of this study, a climate change assessment was in process with the United States BOR. At the conclusion of that study, the District plans to evaluate anticipated effects of climate change and will include these in the next Water Conservation Plan update, as applicable. It is anticipated that storage will be an important factor if climate change assessments call for warmer and wetter weather. Additionally, the annual pattern and quantity of water necessary to irrigate crops may also change.

The urbanization of District lands within the Bend and Redmond Urban Growth Boundaries (UGB) as well as the Urban Area Reserve (UAR) continue. Within these areas, approximately 5,635 acres of

water rights are allotted. About 4.9 percent of the District's total water rights use are within Bend's UGB and UAR whereas 8.3 percent of the District's total water rights are used within Redmond's UGB and UAR. Much of the water rights located within the urbanized areas are comprised of small parcels utilizing the water for lawn irrigation and small hobby farms.

5.13 Cultural and Historic Properties

The term "historic property" is defined in the National Historic Preservation Act as "any prehistoric or historic district, site, building, structure or object included in, or eligible for inclusion on the National Register." The term "historic properties" includes traditional cultural properties. Historic properties are also sometimes referred to as "cultural resources."

The District's irrigation system was determined to be eligible for the National Register of Historic Places as a contributing feature by Reclamation. The SHPO concurred with this determination on April 16, 1997. BOR, SHPO, and the District have a memorandum of agreement in place (no. R14MA13733) that satisfies Section 106 consultation for addressing the effects of the undertaking on historic properties. The MOA states that it is the intention of the District to pipe the conveyance infrastructure and provides a set of stipulations to mitigate for effects to historical property. A Programmatic Agreement is currently being drafted. Following the Programmatic Agreement, the District is responsible for historic documentation of the infrastructure. This consists of a multiple property document which inventories all the historic properties, facilities and infrastructure in COID. The multiple property document was completed October 2016. It will be used by COID to select segments of the conveyance system that will be listed on the National Register of Historic Places. These sites will be transformed into samples and used as historical interpretive sites. Upon completion of the Programmatic Agreement, multiple property document, and the construction of the interpretive site(s) all adverse effects resulting from piping will be considered fully mitigated. All piping actions can proceed without consultation with BOR or SHPO.

5.14 Recreation

COID's Pilot Butte Canal and laterals do not contain fish due to functioning fish screens at the diversion on the Deschutes River. Use of the canals to fish, swim, float, or any other activities by the public within the canal is prohibited. A federal Right of Way on the canal and easement along the laterals allow COID to access and maintain the system as it traverses private property but does not grant access to the public except as described in specific easements and trail agreements.

Areas that would be indirectly affected by the project due to changes in stream flows include the Deschutes River from the Crane Prairie Reservoir to Lake Billy Chinook, Crane Prairie, and/or Wickiup Reservoir. Part of this section of the Deschutes River is designated as a Wild and Scenic River. There are parks and campgrounds adjacent to the river and the reservoirs. The river and associated trails provide many types of recreation including: rafting, kayaking, floating, stand up paddle boarding, fishing, hiking, biking, and cross country skiing.

5.15 Aesthetics

As a region, Central Oregon has grown, and neighborhoods have been established along irrigation canals. Although canals are often viewed as water features, the sole purpose is to provide reliable water delivery to patrons. COID is actively exploring opportunities to develop trails over the top of piped canals.

5.16 Socioeconomics

Socioeconomics in the Watershed Planning Area are discussed below using data from Deschutes County and Crook County. Major towns or cities with reported socioeconomic data in or near the Watershed Planning Area are the communities of Bend, Redmond, and Prineville.

5.16.1 Population

Generally, the area has seen stable growth (8%) over the past 10 years (2005 to 2015). Although Crook County has a decrease in population by 3 percent between 2005 and 2015, Deschutes County has grown by 19 percent between 2005 and 2015, while the state had a moderate growth rate of 8 percent during the same period of time. Table 5.2 shows population estimates for Crook County and Deschutes County; the nearby communities of Redmond, Bend, and Prineville; and the state of Oregon. The Oregon Office of Economic Analysis (OEA) estimates that Deschutes County could reach a population of 241,223 by 2040 and that Crook County could reach a population of 26,117 by 2040.

Table 5.2. Population Characteristics for the Project Area and Vicinity, 2005 and 2015.

Area	Year 2005 Population (number of people)[1]	Year 2015 Population (number of people)[2]	Population Growth Rate 2005 to 2015	Year 2015 Population per Square Mile (number of people)
County				
Crook County	21,670	20,956	-3%	7
Deschutes County	143,490	170,740	19%	56
Cities and Towns				
Redmond	20,010	27,450	37%	1,635
Bend	70,330	87,017	24%	2615
Prineville	9549	9266	-3%	848
State				
Oregon	3,631,440	3,939,233	8%	40

Source: [1] U.S. Census Bureau 2005; [2] U.S. Census Bureau 2015b

5.16.2 Area Employment, Income, and Agriculture

The economy within the project area is described by employment/unemployment numbers, employment by industry, income, and agricultural activity. There is a strong level of employment in the project area according to the U.S Census Bureau data for 2015. The unemployment rate for Deschutes County was 9.4 percent in 2015, which was just slightly higher than the state unemployment rate of 9.3 percent in 2015 (US Department of Labor 2016). The unemployment rate for Crook County was 13.5%, which was moderately higher than the state unemployment rate. As of 2015, there were approximately 74,599 paid employees in Deschutes County and 8,014 paid employees in Crook County (U.S. Census Bureau 2015). Educational services, health care and social assistance provides the highest number of employment positions throughout both counties (Table 5-3).

Table 5-3. Employment by industry and unemployment rates in the project area and vicinity, 2015.

Employment Sectors	Oregon		Deschutes County		Crook County	
	Number of People	Percent of Oregon Employment	Number of People	Percent of County Employment	Number of People	Percent of County Employment
Agriculture, forestry, fishing and hunting, and mining	60,424	3.4%	2,330	3.1%	487	6%
Construction	99,157	5.5%	5,306	7.1%	498	6%
Manufacturing	204,094	11.4%	6,403	8.6%	1,085	14%
Wholesale trade	51,908	2.9%	1,358	1.8%	268	3%
Retail Trade	215,805	12.1%	9,619	12.9%	1,121	14%
Transportation, warehousing, and utilities	73,724	4.1%	2,013	2.7%	244	3%
Information	33,058	1.8%	2,159	2.9%	128	2%
Finance and insurance, real estate, rental, and leasing	102,145	5.7%	4,327	5.8%	243	3%
Professional, scientific, management, and administrative and waste management services	190,080	10.6%	8,554	11.5%	531	7%
Educational services, health care, and social assistance	413,562	23.1%	15,472	20.7%	1,550	19%
Arts, entertainment, recreation, accommodation, and food services	176,909	9.9%	10,046	13.5%	924	12%
Other services (except public administration)	88,177	4.9%	4,450	6.0%	360	4%
Public administration	80,653	4.5%	2,562	3.4%	575	7%
Total Employed- all sectors	1,789,696		74,599		8,014	
Unemployment rate		9.3%		9.4%		13.5%

Source: U.S. Census Bureau 2015.

6 Technical Evaluations

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

- **Central Oregon Irrigation District System Improvement Plan (for Canals of 5 cfs or Greater)**. Completed by COID in September 2016, this document describes the specific infrastructure requirements for modernization of COID's distribution system. This

document is integral to the formulation of the proposed action, and is attached to this PIR as an appendix.

- **Deschutes Basin Multi-Species Habitat Conservation Plan.** The USFWS is currently working to complete a Habitat Conservation Plan regarding potential effects to bull trout, middle Columbia River steelhead, Oregon spotted frog, and sockeye salmon, Chinook salmon in Crook, Deschutes, Jefferson, Klamath, Sherman, and Wasco counties, Oregon.
- **Upper Deschutes Basin Study.** A collaborative effort between the Bureau of Reclamation (BOR) and the Deschutes Basin Study Work Group to develop a comprehensive analysis of water supply and demand for current and future conditions in the Upper Deschutes Basin. This work is currently underway and is expected to be finished in 2018.
- **Central Oregon Irrigation District Water Management Conservation Plan (2013).** This Water Management Conservation Plan (WMCP) was written to satisfy rules found in Oregon Administrative Rules Chapter 690, Division 86 (OAR 690-086), which are administered by the OWRD. The WMCP addresses development of a strategy for managing water supplies in the most efficient manner possible and for meeting their existing and future demands.

7 Alternatives

7.1 Formulation Process

In order to determine the most viable alternatives to meet the Project's purpose and need, NRCS and COID considered the needs of the water users, goals for conservation and restoration, resources and funding available for both the District and the water users, and the current status of the District's current infrastructure. Alternatives considered during project development but proposed for elimination from detailed study due to lack of feasibility or lack of consistency with the project's purpose and need are discussed in Section 7.2. The Proposed Action Alternative is described in Section 7.3.1 and the No-Action Alternative is described in Section 7.3.2.

7.2 Alternatives Proposed for Elimination from Detailed Study

The following alternatives are suggested for elimination from the analysis due to not meeting all aspects of the purpose and need.

7.2.1 Exclusive Use of Groundwater for Irrigation

Exclusive use of groundwater has been considered in order to leave more surface water available in streams and rivers for habitat values. The exclusive use of groundwater would involve forgoing COID's surface water rights and exclusively pumping groundwater to meet irrigation needs in the project area. This alternative would likely require hundreds of wells that would each need a pump to draw water from the ground. The exclusive use of groundwater for irrigation is not a viable option for the following reason:

- This option would not increase the financial security and reduce operation and maintenance costs. The power costs to the District to pump irrigation water from groundwater would be exacerbated due to the depths to groundwater ranging from 6 to 900 feet throughout the District. This cost makes groundwater pumping economically infeasible compared to the annual costs (amortized construction plus operation and maintenance) of either piping or lining the existing canals and laterals.

7.2.2 Fallowing of Farm Fields

Fallowing of farm fields includes permanently or temporarily transferring water rights off of irrigated lands or not using water rights appurtenant to irrigated lands. Fallowing of farm fields would allow for less use of irrigation water and would therefore allow more water to be kept instream for habitat uses. Fallowing of farm fields is not a viable option for the following reason:

- This option would not increase water supply reliability or financial stability for the District, nor would it improve public safety.

7.2.3 On-Farm Efficiencies Only

The on-farm efficiencies only alternative includes only improving on-farm infrastructure (e.g. converting to center pivot irrigation or installing soil moisture sensors) and farm management practices (e.g. deficit irrigation). COID 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. On-farm efficiencies only are not a viable option for the following reasons:

- The District is not able to implement on-farm efficiency upgrades because the on-farm infrastructure is owned by the individual land owner and therefore a responsibility of the patron.
- The human health and safety risk would remain unchanged and drownings due to canals would remain a risk.
- This alternative would not increase the financial security and reduce operation and maintenance costs for the District.

7.2.4 Canal Lining

Canal lining involves the installation of an impervious system to cover the canal bottom and banks. Materials typically employed include geomembranes, rubber liners, shotcrete and/or similar materials. Canal lining increases canal capacity, improves command (velocity), makes the canal section stable, prevents bank erosion and breaches, assures economical water distribution, and reduces maintenance costs. Canal lining has a varying lifespan as short as 10 years and can require extensive maintenance to continue operating at high efficiency (Bureau of 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.

This alternative would require the reshaping of the current canals to a trapezoidal form, sub-grade preparation, installation of the liner, and applying a coating for protection. Canal lining is not a viable option for the following reasons:

- Canal lining does not contribute to health and safety. Canal lining leaves canals open and potentially accessible to the public. Lining the canal may increase the risk; the smooth sides of a lined canal would increase the velocity of water flows, make the sides slippery, and make it and more difficult for people in the water to climb out of the canal.
- Canal lining does not contribute to the District's financial stability.
    - The District has found that the aggressive environment in Central Oregon, including temperature changes, frost heaving, and animal movements, accelerate the deterioration of membrane and shotcrete liners. These liners fall short economically

and in terms of labor intensity when compared to a life-cycle analysis of pipe. The District has already experienced a canal failure in a segment of lined canal wherein the liner tore and caused leakage.
    - Canal lining does not provide for pressurization, so it would not provide patrons the option to improve private, on-farm irrigation practices by eliminating expensive pumps and electricity use.
    - Additionally, canal lining has a shorter life span than pipe and requires maintenance and relatively frequent replacement, ultimately causing it to exceed the cost of piping over time.

7.3 Description of Alternatives Considered

7.3.1 Piping and Pressurization Alternative

The Piping and Pressurization Alternative is COID's Proposed Action, as the District has determined through engineering analysis described in the District's SIP, that this alternative is feasible and addresses the project's purpose and need. Under the Piping and Pressurization Alternative, COID would replace approximately 75 miles of canals and laterals[2] in its system with gravity pressurized buried pipe. Pipe diameters would range from 120 inches on portions of the Pilot Butte Canals to 4 inches on the F Lateral.

The main construction tasks associated with this alternative include excavating trenches, pipe welding and placement, and backfill of the trenches. A full description including detailed pipe sizing, pipe materials, project alignment, water loss assessment, and hydraulic modeling of the system can be found in the COID SIP (COID 2016).

This alternative would provide for the identified project purpose and need as follows:

1. Enhance habitat for aquatic species through increased stream flows in the Deschutes River. By increasing flows, habitat quality could increase and the water temperatures could decrease.
    - This alternative would improve stream flows and instream habitat. A piped and pressurized system would eliminate evaporation losses and seepage losses of up to 156 cfs during the irrigation season and an average of up to 29 percent from unlined canals and laterals. It would reduce District water needs and provide opportunities for instream flow restoration, helping to insure the viability of aquatic species.
    - This alternative could restore up to 156 cfs to up to 107 miles of the Deschutes River through Oregon's Allocation of Conserved Water Program.
    - This alternative could reduce turbidity, sedimentation, chlorophyll a, temperature, pH, and/or dissolved oxygen water quality limitations to benefit aquatic species along up to 107 miles of the Deschutes River.
    - This alternative could improve habitat conditions for the federally-listed Oregon spotted frog in Crane Prairie Reservoir, Wickiup Reservoir, and/or the Deschutes River.
2. Reduce risks to public safety from the irrigation canals. Putting the diverted irrigation water into a pipe would ensure that the risk of drowning in the canals is eliminated.
    - This alternative would reduce risks to downstream life and property along 75 miles of currently open canal and laterals. Open, unlined canals and laterals have the

[2] Only laterals delivering approximately 5 cfs or greater are included in this alternative.

potential to fail, causing flooding and risking downstream life and property. Even without canal failure, there is an ongoing risk of drowning. Piping canals and laterals eliminates these risks.

3. Support and maintain existing agricultural land uses through enhanced water supply reliability. The alternative would improve water supplies, facilitate the provision of pressurized water, and return water instream.
    - This alternative would improve irrigation water supply reliability for up to 17,336 acres of irrigated land. Eliminating seepage and evaporative losses through a piped and pressurized system greatly increases conveyance efficiency. It allows the District's patrons to receive the water that they need when they need it by providing pressurized water, ensuring the sustainability of the District's agricultural water supply and other beneficial uses.
    - Providing farmers with pressurized water will facilitate on-farm infrastructure improvements, encouraging small farms to modernize irrigation systems to take advantage of the lower operating costs
4. Provide financial stability to COID through reduced operation and maintenance costs, conserved energy through the reduction of irrigation pumping, and energy generation through in-conduit hydropower.
    - This alternative would reduce operation and maintenance costs associated with maintaining open canals and laterals.
    - This alternative would reduce energy use and associated costs. A pressurized pipeline allows for the elimination of individual pumps serving farms across the District and the conservation of approximately 13,316 MWh/year. It would reduce patron pumping costs by approximately $1.15 million/year and CO_2 emissions by 6,325 tons/year. In addition, it would facilitate future energy conservation at-scale that could be achieved by piping and pressurizing laterals with flow rates of less than 5 cfs.
    - This alternative would allow for the development of up to 6.42 megawatts of in-conduit hydropower. When built, these facilities would produce up to 28,000 MWh/year of renewable energy using only water already diverted for irrigation and reduce CO_2 emissions by 13,300 tons/year.

7.3.2 No Action Alternative (Future without Project)

Under the No Action Alternative, COID would not install piping on its remaining open canals and laterals. Construction activities associated with the project would not occur, and the District would continue to operate and maintain its existing canals and pipe system in its current condition. The need for the project would still exist, and the District would continue replacing open canals with buried pipes on a project-by-project basis as funding becomes available.

After over 20 years of conservation efforts, the District has completed several water conservation and pressurized pipe projects. These projects replaced 4.80 miles of open canal, less than 1% of the district's system, with buried pipe.

Under this alternative, there would be no water savings from irrigation improvements. Instream flows would not be enhanced for fish. Energy use and cost would remain high. Without pressurized water, the current individual pumps would continue to require an estimated 14,794 MWh/year. Agriculture in the area would decline due to continued inconsistent water supply and to increased

production costs. Increased competition for water resources, regulation, and litigation would continue and hinder agricultural production within the District.

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

- Enhanced habitat for aquatic species: This alternative would not improve instream flows and instream habitat.
- Reduce risks to public safety from open irrigation canals: This alternative would not reduce risks to downstream life and property. Unlined canals would still have the potential to fail, causing flooding and risking downstream life and property. The No Action Alternative does not address safety and drowning risks associated with canals.
- Support and maintain existing agricultural uses through enhanced water supply reliability: This alternative maintains existing operations and infrastructure and would not improve irrigation water supply reliability. Future regulatory demands on the water have the potential to force farmers to allow fields to go fallow, or discontinue irrigated agriculture.
- Provide financial security to COID through reduced operation and maintenance costs, conserved energy through the reduction of irrigation pumping, and energy generation through in-conduit hydropower production. This alternative would continue existing energy use and associated costs. The use of individual pumps would continue to require an energy use of 14,794 mWh/year across the District at a cost of up to $1.28 million/year. This energy use emits 7,027 tons/year of CO_2.

7.4 Economics

A National Economic Development analysis will be completed for the project during the NEPA review process. The alternative that maximizes the net economic benefit will be the preferred alternative.

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9 Appendices

Central Oregon Irrigation District System Improvement Plan