Tumalo Irrigation District
Irrigation Modernization Project

Watershed Plan-Environmental Assessment

August, 2018

United States Department of Agriculture, Natural Resources Conservation Service – Lead Federal Agency in cooperation with the Deschutes Basin Board of Control and Tumalo Irrigation District

Prepared by Farmers Conservation Alliance

Watershed Plan-Environmental Assessment for the Tumalo Irrigation District - Irrigation Modernization Project

Lead Agency: United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Oregon

Sponsoring Local Organization (SLO): Deschutes Basin Board of Control (DBBC) (lead sponsor) and Tumalo Irrigation District (TID) (co-sponsor)

Authority: This Watershed Plan-Environmental Assessment (Plan-EA) has been prepared under the Authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566). The Plan-EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, Public Law 91-190, as amended (42 United States Code [U.S.C.] 43221 et seq.).

Abstract: This document is intended to fulfill requirements of the NEPA and to be considered for authorization of Public Law 83-566 funding of the Tumalo Irrigation District – Irrigation Modernization Project (Project). The Project seeks to improve water conservation, water delivery reliability, and public safety on up to 68.8 miles of canals and laterals in Oregon's Deschutes Basin. The Project would include converting 68.8 miles of TID's canals and laterals to a buried and pressurized pipeline. Total estimated Project costs are $43,326,000, of which $13,544,300 would be paid by the sponsors and other non-federal funding sources. The estimated amount to be paid through NRCS Public Law 83-566 funds is $29,781,700.

Watershed Agreement
between the
Deschutes Basin Board of Control
(Referred to herein as the lead sponsor)
and the
Tumalo Irrigation District
(Referred to herein as the co-sponsor)
and the
U.S. Department of Agriculture,
Natural Resources Conservation Service
(Referred to herein as NRCS)

Whereas, application has heretofore been made to the Secretary of Agriculture by the sponsors for assistance in preparing a plan for works of improvement for the Tumalo Irrigation District - Irrigation Modernization Project, State of Oregon, under the authority of the Watershed Protection and Flood Prevention Act, as amended (16 U.S.C. Sections 1001 to 1008, 1010, and 1012); and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, has been assigned by the Secretary of Agriculture to NRCS; and

Whereas, there has been developed through the cooperative efforts of the sponsors and NRCS a watershed project plan and environmental assessment for works of improvement for the Tumalo Irrigation District - Irrigation Modernization Project, State of Oregon, hereinafter referred to as the watershed project plan or plan, which plan is annexed to and made a part of this agreement.

Now, therefore, in view of the foregoing considerations, the Secretary of Agriculture, through NRCS, and the sponsors hereby agree on this watershed project plan and that the works of improvement for this project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this plan and including the following:

1. Term. The term of this agreement is for the installation period and evaluated life of the project (100 years) and does not commit NRCS to assistance of any kind beyond the end of the evaluated life.

2. Costs. The costs shown in this plan are preliminary estimates. Final costs to be borne by the parties hereto will be the actual costs incurred in the installation of works of improvement.

3. Real Property. The sponsors will acquire such real property as will be needed in connection with the works of improvement. The amounts and percentages of the real property acquisition costs to be borne by the sponsors and NRCS are as shown in the cost-share table in Section 5 hereof.

The sponsors agree that all land acquired for measures, other than land treatment practices, with financial or credit assistance under this agreement will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency that will continue to maintain and operate the development in accordance with the operation and maintenance (O&M) agreement.

4. Uniform Relocation Assistance and Real Property Acquisition Policies Act. The sponsors hereby agree to comply with all of the policies and procedures of the Uniform Relocation Assistance and Real Property Acquisition Policies Act (42 U.S.C. Section 4601 et seq. as further implemented through regulations in 49 Code of Federal Regulations [CFR] Part 24 and 7 CFR Part 21) when acquiring real property interests for this federally assisted project. If the sponsors are legally unable to comply with the real property acquisition requirements, it agrees that, before any federal financial assistance is furnished, it will provide a statement to that effect, supported by an opinion of the chief legal officer of the state containing a full discussion of the facts and law involved. This statement may be accepted as constituting compliance.

5. Cost-share for Watershed Project Plans. The following table will be used to show cost-share percentages and amounts for watershed project plan implementation.

Cost-share Table for Watershed Operation or Rehabilitation Projects					
	NRCS		Sponsors		Total
Works of Improvement	Percent	Cost	Percent	Cost	Cost
Cost-Sharable Items[1/]					
Agricultural Water Management	67%	$24,900,000	33%	$12,529,200	$37,429,200
Sponsors Engineering Costs	75%	$1,332,700	25%	$444,100	$1,776,800
Subtotal: Cost-Sharable Costs	67%	$26,232,700	33%	$12,973,300	$39,206,000
Non-Cost-Sharable Items[2/]					
NRCS Technical Assistance/Engineering	98%	$2,764,000	2%	$50,000	$2,814,000
Project Administration[3/]	67%	$785,000	33%	$392,100	$1,177,100
Permits	0%	$0	100%	$128,900	$128,900
Subtotal: Non-Cost-Share Costs	86%	$3,549,000	14%	$571,100	$4,120,000
Total:	**69%**	**$29,781,700**	**31%**	**$13,544,300**	**$43,326,000**

Installation costs explanatory notes:

1. The cost-share rate is the percentage of the average cost of installing the practice in the selected plan for the evaluation unit. During project implementation, the actual cost-share rate must not exceed the rate of assistance for similar practices and measures under existing national programs.
2. If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.
3. The sponsors and NRCS will each bear the costs of project administration that each incurs. Sponsors costs for project administration include relocation assistance advisory service.

6. Land Treatment Agreements. The sponsors will obtain agreements from owners of not less than 50 percent of the land above each multiple-purpose and floodwater-retarding structure. These agreements must provide that the owners will carry out farm or ranch conservation plans on their

land. The sponsors will ensure that 50 percent of the land upstream of any retention reservoir site is adequately protected before construction of the dam. The sponsors will provide assistance to landowners and operators to ensure the installation of the land treatment measures shown in the watershed project plan. The sponsors will encourage landowners and operators to continue to operate and maintain the land treatment measures after the long-term contracts expire, for the protection and improvement of the watershed.

7. Floodplain Management. Before construction of any project for flood prevention, the sponsors must agree to participate in and comply with applicable federal floodplain management and flood insurance programs. The sponsors are required to have development controls in place below low and significant hazard dams prior to NRCS or the sponsors entering into a construction contract.

8. Water and Mineral Rights. The sponsors will acquire or provide assurance that landowners or resource users have acquired such water, mineral, or other natural resources rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

9. Permits. The sponsors will obtain and bear the cost for all necessary federal, state, and local permits required by law, ordinance, or regulation for installation of the works of improvement.

10. Natural Resources Conservation Service Assistance. This agreement is not a fund-obligating document. Financial and other assistance to be furnished by NRCS in carrying out the plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

11. Additional Agreements. A separate agreement will be entered into between NRCS and the sponsors before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. Amendments. This plan may be amended or revised only by mutual agreement of the parties hereto, except that NRCS may deauthorize or terminate funding at any time it determines that the sponsors have failed to comply with the conditions of this agreement or when the program funding or authority expires. In this case, NRCS must promptly notify the sponsors in writing of the determination and the reasons for the deauthorization of project funding, together with the effective date. Payments made to the sponsors or recoveries by NRCS must be in accordance with the legal rights and liabilities of the parties when project funding has been deauthorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between NRCS and the sponsors having specific responsibilities for the measure involved.

13. Prohibitions. No member of or delegate to Congress, or resident commissioner, may be admitted to any share or part of this plan or to any benefit that may arise therefrom; but this provision may not be construed to extend to this agreement if made with a corporation for its general benefit.

14. Operation and Maintenance (O&M). The sponsors will be responsible for the operation, maintenance, and any needed replacement of the works of improvement by actually performing the work or arranging for such work, in accordance with an O&M agreement. An O&M agreement will be entered into before federal funds are obligated and will continue for the project life (100 years). Although the sponsors' responsibility to the Federal Government for O&M ends when the O&M agreement expires upon completion of the evaluated life of measures covered by the agreement, the sponsors acknowledge that continued liabilities and responsibilities associated with works of improvement may exist beyond the evaluated life.

15. Emergency Action Plan. Prior to construction, the sponsors must prepare an emergency action plan (EAP) for each dam or similar structure where failure may cause loss of life or as required by state and local regulations. The EAP must meet the minimum content specified in NRCS Title 180, National Operation and Maintenance Manual, Part 500, Subpart F, Section 500.52, and meet applicable State agency dam safety requirements. NRCS will determine that an EAP is prepared prior to the execution of fund obligating documents for construction of the structure. EAPs must be reviewed and updated by the sponsors annually.

16. Nondiscrimination Provisions. In accordance with federal civil rights law and USDA civil rights regulations and policies, the USDA, its agencies, offices, employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

By signing this agreement, the recipient assures the USDA that the program or activities provided for under this agreement will be conducted in compliance with all applicable federal civil rights laws, rules, regulations, and policies.

17. Certification Regarding Drug-Free Workplace Requirements (7 CFR Part 3021). By signing this Watershed Agreement, the sponsors are providing the certification set out below. If it is later determined that the sponsors knowingly rendered a false certification, or otherwise violated the requirements of the Drug-Free Workplace Act, NRCS, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

Controlled substance means a controlled substance in schedules I through V of the Controlled Substances Act (21 U.S.C. Section 812) and as further defined by regulation (21 CFR Sections 1308.11 through 1308.15);

Conviction means a finding of guilt (including a plea of *nolo contendere*) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the federal or state criminal drug statutes;

Criminal drug statute means a federal or non-federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including (i) all direct charge employees, (ii) all indirect charge employees unless their impact or involvement is insignificant to the performance of the grant, and (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement, consultants or independent contractors not on the grantees' payroll, or employees of subrecipients or subcontractors in covered workplaces).

Certification:

A. The sponsors certify that they will or will continue to provide a drug-free workplace by—

(1) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition.

(2) Establishing an ongoing drug-free awareness program to inform employees about—

(a) The danger of drug abuse in the workplace.

(b) The grantee's policy of maintaining a drug-free workplace.

(c) Any available drug counseling, rehabilitation, and employee assistance programs.

(d) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(3) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (1).

(4) Notifying the employee in the statement required by paragraph (1) that, as a condition of employment under the grant, the employee must—

(a) Abide by the terms of the statement; and

(b) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than 5 calendar days after such conviction.

(5) Notifying NRCS in writing, within 10 calendar days after receiving notice under paragraph (4)(b) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the federal agency has designated a central point for the receipt of such notices. Notice must include the identification numbers of each affected grant.

(6) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (4)(b), with respect to any employee who is so convicted—

(a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a federal, state, or local health, law enforcement, or other appropriate agency.

(7) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (1), (2), (3), (4), (5), and (6).

B. The sponsors may provide a list of the sites for the performance of work done in connection with a specific project or other agreement.

C. Agencies will keep the original of all disclosure reports in the official files of the agency.

18. Certification Regarding Lobbying (7 CFR Part 3018)

A. The sponsors certify to the best of their knowledge and belief, that—

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the sponsors, to any person for influencing or attempting to influence an officer or employee of an agency, Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any federal grant, the making of any federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this federal contract, grant, loan, or cooperative agreement, the undersigned must complete and submit Standard Form LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The sponsors must require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients must certify and disclose accordingly.

B. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. Section 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

19. Certification Regarding Debarment, Suspension, and Other Responsibility Matters—Primary Covered Transactions (7 CFR Part 3017).

A. The sponsors certify to the best of their knowledge and belief, that they and their principals—

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any federal department or agency;

(2) Have not within a 3-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (federal, state, or local) transaction or contract under a public transaction; violation of federal or state antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (federal, state, or local) with commission of any of the offenses enumerated in paragraph A(2) of this certification; and

(4) Have not within a 3-year period preceding this application/proposal had one or more public transactions (federal, state, or local) terminated for cause or default.

B. Where the primary sponsors are unable to certify to any of the statements in this certification, such prospective participant must attach an explanation to this agreement.

20. Clean Air and Water Certification.

(Applicable if this agreement exceeds $100,000, or a facility to be used has been subject of a conviction under the Clean Air Act (42 U.S.C. Section 7413(c)) or the Federal Water Pollution Control Act (33 U.S.C. Section 1319(c)) and is listed by EPA, or is not otherwise exempt.)

A. The project sponsoring organizations signatory to this agreement certify as follows:

(1) Any facility to be utilized in the performance of this proposed agreement is (____), is not (_x_) listed on the U.S. Environmental Protection Agency List of Violating Facilities.

(2) To promptly notify NRCS-State administrative officer prior to the signing of this agreement by NRCS, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which is proposed for use under this agreement is under consideration to be listed on the Environmental Protection Agency List of Violating Facilities.

(3) To include substantially this certification, including this subparagraph, in every nonexempt subagreement.

B. The project sponsoring organizations signatory to this agreement agree as follows:

(1) To comply with all the requirements of Section 114 of the Clean Air Act as amended (42 U.S.C. Section 7414) and Section 308 of the Federal Water Pollution Control Act (33 U.S.C. Section 1318), respectively, relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in Section 114 and Section 308 of the Air Act and the Water Act, issued there under before the signing of this agreement by NRCS.

(2) That no portion of the work required by this agreement will be performed in facilities listed on the USEPA List of Violating Facilities on the date when this agreement was signed by NRCS unless and until the EPA eliminates the name of such facility or facilities from such listing.

(3) To use their best efforts to comply with clean air standards and clean water standards at the facilities in which the agreement is being performed.

(4) To insert the substance of the provisions of this clause in any nonexempt subagreement.

C. The terms used in this clause have the following meanings:

(1) The term "Air Act" means the Clean Air Act, as amended (42 U.S.C. Section 7401 et seq.).

(2) The term "Water Act" means Federal Water Pollution Control Act, as amended (33 U.S.C. Section 1251 et seq.).

(3) The term "clean air standards" means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as described in Section 110 of the Air Act (42 U.S.C. Section 7414) or an approved implementation procedure under Section 112 of the Air Act (42 U.S.C. Section 7412).

(4) The term "clean water standards" means any enforceable limitation, control, condition, prohibition, standards, or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the Environmental Protection Agency or by a State under an approved program, as authorized by Section 402 of the Water Act (33 U.S.C. Section 1342), or by a local government to assure compliance with pretreatment regulations as required by Section 307 of the Water Act (33 U.S.C. Section 1317).

(5) The term "facility" means any building, plant, installation, structure, mine, vessel, or other floating craft, location or site of operations, owned, leased, or supervised by a sponsor, to be utilized in the performance of an agreement or subagreement. Where a location or site of operations contains or includes more than one building, plant, installation, or structure, the entire location will be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are collocated in one geographical area.

21. Assurances and Compliance.

As a condition of the grant or cooperative agreement, the sponsors assure and certify that it is in compliance with and will comply in the course of the agreement with all applicable laws, regulations, executive orders, and other generally applicable requirements, including those set out below which

are hereby incorporated in this agreement by reference, and such other statutory provisions as a specifically set forth herein.

State, Local, and Indian Tribal Governments: Office of Management and Budget (OMB) Circular Nos. A-87, A-102, A-129, and A-133; and 7 CFR Parts 3015, 3016, 3017, 3018, 3021, and 3052.

Nonprofit Organizations, Hospitals, Institutions of Higher Learning: OMB Circular Nos. A-110, A-122, A-129, and A-133; and 7 CFR Parts 3015, 3017, 3018, 3019, 3021 and 3052.

22. Examination of Records.

The sponsors must give NRCS or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to this agreement, and retain all records related to this agreement for a period of three years after completion of the terms of this agreement in accordance with the applicable OMB Circular.

23. Signatures

DESCHUTES BASIN BOARD OF CONTROL

The signing of this plan was authorized by a resolution by the DBBC governing body and adopted at an official meeting held on

August 15, 2018 at Madras, Oregon.

By: _____ Date: 8/15/18

Mike Britton, Chairman
Deschutes Basin Board of Control
c/o: DBBC Chair
2024 NW Beech Street
Madras, OR 97741

TUMALO IRRIGATION DISTRICT

The signing of this plan was authorized by a resolution by the TID governing body and adopted at an official meeting held on

8-15, 2018 at Tumalo, Oregon.

By: _____ Date: 8-15

Kenneth B. Rieck, District Manager and Secretary to the Board
Tumalo Irrigation District
64697 Cook Avenue
Bend, OR 97703

USDA-NATURAL RESOURCES CONSERVATION SERVICE

Approved by: _____ Date: 08/16/18

Ron Alvarado, State Conservationist
Natural Resources Conservation Service
1201 NE Lloyd Blvd
Suite 900
Portland, OR 97232

Table of Contents

Table of Appendices

Table of Figures

Table of Tables

Office of Management and Budget (OMB) Fact Sheet

Summary Watershed Plan-Environmental Assessment Document For Tumalo Irrigation District – Irrigation Modernization Project Upper Deschutes Basin Subwatersheds: Buckhorn Canyon, Bull Creek, Lower Tumalo Creek, Laidlaw Butte-Deschutes River, Overturf Butte-Deschutes River, and Deep Canyon Dam-Deep Canyon Deschutes County, Oregon Oregon 2nd Congressional District	
Authorization	Public Law 83-566 Stat. 666 as amended (16 U.S.C. Section 1001 et. Seq.) 1954
Lead Sponsor	Deschutes Basin Board of Control and Tumalo Irrigation District (co-sponsor)
Proposed Action	The Tumalo Irrigation District (TID) – Irrigation Modernization Project is a large agricultural water conveyance efficiency project. The proposed action would modernize up to 1.9 miles of TID's irrigation canals and 66.9 miles of laterals.
Purpose and Need	The purpose of this project is to improve water conservation, water delivery reliability, and public safety on 68.8 miles of District-owned canals and laterals. Implementation of the proposed action would meet Public Law 83-566 Authorized Project Purpose (v), Agricultural Water Management, through irrigation water conservation, water quality improvement, and more reliable agricultural water supply. Federal action is needed to address the following watershed problems and resource concerns: water loss in District conveyance systems, water delivery and operations inefficiencies, instream flow for fish and aquatic habitat, and risks to public safety from open irrigation canals. Implementation of the proposed action would ensure agricultural production is maintained in an area undergoing rapid urbanization where public safety and environmental concerns necessitate federal action. The proposed action addresses seepage and evaporation loss and provides better-managed water diversions for farm use, increased agricultural production, improved streamflow for fish, aquatic, and riparian habitat, and increased public safety. These measures would serve to stretch the supply of water by increasing the reliability and efficiency of water delivered for irrigation while permanently reducing the amount of water diverted, and legally protecting saved water instream.
Description of the Preferred Alternative	Under the Preferred Alternative, 1.9 miles of canals and 66.9 miles of laterals in the TID system would be converted to high-density polyethylene (HDPE) gravity-pressurized buried pipe.
Project Measures	Under the Preferred Alternative, project sponsors would replace canals and laterals with HDPE pipe. Additionally, existing turnouts would be upgraded to pressurized delivery systems with additional turnouts added, and three pressure-reducing valves (PRV) would be installed to alleviate high pressures within the system. Construction of the Preferred Alternative would occur in seven project groups over the course of 11 years.

Resource Information			
Subwatersheds	**12-digit Hydrologic Unit Code**	**Latitude and Longitude**	**Subwatershed Size**
Buckhorn Canyon	170703010804	44.248873, -121.356289	13,809 acres
Bull Creek	170703010603	44.190339, -121.420120	32,153 acres
Lower Tumalo Creek	170703010502	44.065108, -121.415720	17,238 acres

Laidlaw Butte-Deschutes River	170703010802	44.151316, -121.329905	42,749 acres
Overturf Butte-Deschutes River	170703010406	44.027097, -121.367571	31,374 acres
Deep Canyon Dam-Deep Canyon	170703010604	44.235075, -121.452157	31,928 acres
Subwatershed Total Size	169,251 acres		
Tumalo Irrigation District Size	27,964 acres		
Climate and Topography	The Project is located in the rain shadow of the Cascade Mountain range. TID's annual average precipitation is 10-14 inches. The average high temperature for July is 82 degrees Fahrenheit, and the average low temperature for December is 23 degrees Fahrenheit. The land within TID is slightly undulating with an average elevation of 3,200 feet above mean sea level.		
Land Use Tumalo Irrigation District (total 27,964 acres)	Use		Acres
	Agriculture (irrigated acres)		7,417
	Developed		2,622
	Undeveloped		17,925
Land Ownership Tumalo Irrigation District (total 27,964 acres)	Owner		Percentage
	Private		77% (21,530 acres)
	State-Local		7% (1,923 acres)
	Federal		16% (4,511 acres)
Population and Demographics	The Preferred Alternative would occur within Deschutes County, Oregon. The population of Deschutes County was 166,622, or 56 people per square mile, in 2015. The population growth rate of the county between 2005 and 2015 was 14 percent. The population of the State of Oregon grew by about 8 percent in the same period.		
Population and Demographics		Deschutes County	Oregon
	Population 2015	166,622	3,939,233
	Unemployment Rate	4.1%	4.1%
	Median Household Income	$51,223	$51,243
Relevant Resource Concerns	Resource concerns identified through scoping are water conservation and quality, groundwater, aquatic and fish resources, soil and geologic resources, visual resources, cultural resources, recreation, socioeconomics, wetlands, terrestrial wildlife, and vegetation resources.		
Alternatives			
Alternatives Considered	Eleven alternatives were considered; nine were eliminated from full analysis due to inconsistency with the purpose and need for action or due to cost, logistics, existing		

	technology, social, or environmental reasons. The No Action Alternative, Canal Lining Alternative, and HDPE Pressurized Piping Alternative were analyzed in full.
No Action Alternative	Under the No Action Alternative, construction activities associated with the project would not occur and TID would continue to operate and maintain its existing canals and pipe system in their current condition. The need for the project would still exist; however, 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 under a project-by-project approach at the large scale necessary to modernize the District's infrastructure.
Proposed Action	Two action alternatives were considered. Under the Canal Lining Alternative, TID would line 65.1 miles of open canals and laterals with a geomembrane covered by shotcrete. Under the HDPE Pressurized Piping Alternative, TID would replace 1.9 miles of canals and 66.9 miles of laterals with gravity-pressurized HDPE buried pipe. The HDPE Pressurized Piping Alternative has been identified as the National Economic Development (NED) alternative and is also the Preferred Alternative.

Project Costs	**PL 83-566 Funds**		**Other Funds**		**Total**	
Construction	67%	$24,900,000	33%	$12,529,200	$37,429,200	86%
Engineering	75%	$1,332,700	25%	$444,100	$1,776,800	4%
SUBTOTAL COSTS	67%	$26,232,700	33%	$12,973,300	$39,206,000	90%
Technical Assistance	98%	$2,764,000	2%	$50,000	$2,814,000	6%
Relocation	Not Applicable					
Real Property Rights	Not Applicable					
Permitting	0%	$0	100%	$128,900	$128,900	0%
Project Administration	67%	$785,000	33%	$392,100	$1,177,100	3%
Annual Operation and Maintenance (O&M)	Not Applicable					
TOTAL COSTS	**69%**	**$29,781,700**	**31%**	**$13,544,300**	**$43,326,000**	**100%**

Mitigation, Minimization, and Avoidance Measures	Approximately 1,610 acres of land along open canals and laterals, which could provide seasonal wetland characteristics, would be converted to upland vegetation. Project canals and laterals are not considered jurisdictional wetlands by state or federal agencies. The wetland characteristics that could occur in the open canals and laterals have low function and the loss would be more than offset by gains in water quality and habitat function in the project area's natural riverine systems. The National Wetland Inventory (NWI) geographic information systems data (USFWS 2016) shows about 23 wetland features to sporadically occur adjacent to canals and laterals within the area of potential effect; however, these wetland features have not been field verified. Wetland determinations and/or delineations of areas adjacent to canals and laterals in areas where work would occur will be conducted prior to implementation of construction of each project group, and wetlands will be avoided to the extent practicable. Surveys for cultural resources have been completed for Project Group 1. In this portion of the project, archaeological resources have not been found and effects to aboveground resources have been addressed through completion of a Historic American Engineering Report. For Project Groups 2-7, cultural resource surveys and consultation between NRCS and the Oregon State Historic Preservation Office (SHPO) for compliance with Section 106 of the National Historic Preservation Act (NHPA) will be completed nearer to initiation of construction. Mitigation measures such as historical reports, brochures, interpretive signs,

	and content on the District's website will be identified prior to construction and completed concurrent with or after construction. For all project groups, ground disturbances would be limited to only those areas necessary and within rights-of-way to minimize effects on soil, vegetation, and land use. Construction activities would be confined to existing rights-of-way to avoid effects on agricultural lands. Where roads or access routes do not currently allow construction access, temporary access routes would be selected in a manner to minimize effects on vegetation and avoid the removal of trees and erosion. Stormwater best management practices would be employed during and after construction, and construction schedules would be determined to minimize disturbance to wildlife and the public. After construction, disturbed areas would be graded and replanted with a mix of native grasses and forbs to reduce the risk of erosion and spread of noxious weeds.
Project Benefits	
Project Benefits	Implementation of the Preferred Alternative would improve water delivery reliability for TID's patrons, conserve 48 cubic feet per second of water for instream uses, reduce TID's operation and maintenance costs, reduce electricity costs from pumping, and improve public safety.
Number of Direct Beneficiaries	TID serves 667 patrons, who would benefit from the project.
Other Beneficial Effects-Physical Terms	Implementation of the Preferred Alternative would have minor to moderate, long-term, beneficial effects on agricultural water availability, water quality, and fish and wildlife habitat.

Damage Reduction Benefits	**Project Group***						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Other - Reduced O&M	$5,000	$30,600	$9,300	$21,800	$19,300	$29,600	$11,000
Other - Power Cost Savings	$700	$49,500	$25,400	$58,400	$31,400	$133,100	$27,000
Other - Social Value of Carbon (Avoided Carbon Emissions)	$0	$19,200	$9,800	$23,900	$12,600	$53,600	$10,500
Water Conservation	$199,900	$170,000	$91,100	$101,000	$70,200	$279,500	$75,600
Total Quantified Benefits	$205,600	$269,300	$135,600	$205,100	$133,500	$495,800	$124,100
Benefit to Cost Ratio	1.00	1.34	1.28	1.69	1.36	1.41	2.67

*Project Group refers to groupings of canals and laterals that would undergo construction during the same period. Canals and laterals under each project group are as follows:
1. Tumalo Feed Canal, Kerns
2. Tumalo Res. Feed, Steele, Rock Springs, Highline, 2 Rivers, Parkhurst, Gill, Lacy
3. Allen, Allen Sublateral West, Allen Sublateral South, McGinnis Ditch
4. West Branch Columbia So. West, Beasley, Spaulding, N. Spaulding
5. Couch, West Couch, West Couch Sublateral East, Chambers (Lafores) Ditch, East Couch, Gainsforth
6. North Columbia So. West, Jewett, Conarn East, Putnam, West Branch Columbia So. East, Conarn, Phiffer, Hooker Creek, Hammond, North Hammond, Columbia Southern TFC to PRV, Columbia Southern PRV to Tail, North Columbia So. East
7. Hillburner, Gerking, Kickbush, West Branch Columbia So. South, Flannery Ditch, Tellin Ditch

Period of Analysis							
Project Group	1	2	3	4	5	6	7
Installation Period (years)	2	2	1	1	1	3	1

Project Life	100 years for each project group

Funding Schedule

Year—Project Group		PL 83-566	Other Funds	Total
2018, 2019	--1	$5,179,100	$1,756,800	$6,935,900
2020, 2021	--2	$5,505,300	$1,703,900	$7,209,200
2022	--3	$3,019,600	$943,600	$3,963,200
2023	--4	$3,559,400	$1,108,700	$4,668,100
2024	--5	$2,965,700	$927,200	$3,892,900
2025, 2026, 2027	--6	$9,287,200	$5,357,100	$14,644,300
2028	--7	$265,400	$1,747,000	$2,012,400

Environmental Effects

In portions of the project area where canals are considered historic features under Section 106 of the National Historic Preservation Act (NHPA), conversion of the canals would be mitigated through implementation of measures in consultation with the Oregon State Historic Preservation Office (SHPO). Consultation has been completed for Project Group 1. For Project Groups 2-7, cultural resource surveys and consultation between NRCS and SHPO for compliance with Section 106 of the NHPA will be completed nearer to initiation of construction in order to achieve no effects greater than moderate in intensity. Effects to below-ground archaeological resources are not anticipated for Project Groups 2-7, as surveys for Project Group 1 found no archaeological resources. Areas of potential ground disturbance for Project Groups 2-7 would be surveyed closer to construction and effects to archaeological resources will be avoided to the extent practicable in consultation with SHPO. As there would be no known effects to below-ground cultural resources, and changes to historic resources would not diminish resource integrity, effects to cultural resources would be negligible to moderate, for each project group.

Effects to aquatic species would result from the application of legal and permanent protection to conserved water seasonally released from Crescent Lake Dam that was previously volunteered by the District. Further, additional flows would be seasonally protected instream in Tumalo Creek. Three federally-listed species may occur in the area potentially affected by the project; bull trout, steelhead, and Oregon spotted frog. There would be no effect from the proposed action on bull trout or steelhead due to the timing of increased streamflow resulting from project actions and the location of bull trout and steelhead populations being at the very downstream end of where effects could be detectable. Any effects to Oregon spotted frog would be entirely beneficial. Overall, the presence (and legal protection) of conserved water from the proposed action would serve to benefit aquatic species and their habitat, thus the effects of the project on all aquatic species would be minor to moderate, and beneficial in the long term.

The proposed action will result in a total of approximately 200,000 cubic yards of soil disturbance during the 11-year construction period of the Preferred Alternative. Soil disturbances would be minor, as these effects would be short-term and localized to small portions of the larger project area over an 11-year construction period. Effects would be further minimized through implementation of soil stabilization measures, such as the preservation of vegetation when possible and re-vegetating disturbed areas after construction.

The Preferred Alternative would have a negligible effect on land use, as property ownership and existing use of land would not change. It is anticipated that the proposed action will encourage and promote agricultural sustainability in the watershed through improved irrigation water reliability.

As the proposed action would eliminate drowning risk from open canals, the project would have minor, and long-term effects on public safety; these effects would be entirely beneficial.

Effects to recreation from the proposed action would be minor in the short-term, as construction may temporarily preclude or limit dispersed and dedicated recreational opportunities during project construction. After construction, effects to both river- and land-based recreation would be negligible as the project would create visual and water level changes but would not change the quality of the recreational experience in a quantifiable way.

Of the 27,964 acres within the TID boundary, construction of the Preferred Alternative would temporarily disturb a total of approximately 167 acres of vegetation. Since the project would be completed over an 11-year construction period, only a portion of these effects would be evident at any one time. Long-term vegetation changes would occur over less than 1 percent of the District. Further, mitigation measures such as seeding all exposed areas with native grasses and forbs would be implemented. At project completion, about 44 acres of previously-open canals and laterals would be converted to upland vegetation over the buried pipes. Since effects to vegetation would be localized, would occur over a relatively small area, and all disturbed vegetated areas would be revegetated, effects to vegetation would be minor.

Overall, the visual change from canal to buried pipe would be expected to have a minor effect because there would be short-term visual changes during construction, and the long-term effects would be a vegetated corridor that would blend in with the natural landscape following revegetation.

Effects on surface water hydrology and water quality would vary in intensity depending on the stream reach, and none would be adverse. The following waterbodies would experience minor to moderate, long-term beneficial effects to hydrology and water quality: Crescent Creek, the Little Deschutes River, Tumalo Creek, and the Deschutes River downstream from the confluence with the Little Deschutes River (RM 192.5) to Lake Billy Chinook (RM 120). Because all effects to surface water resources would be beneficial, there would be no adverse effects to surface water resources. Since the reduction in seepage to groundwater realized from the piped canals would be reduced by increased groundwater recharge via improved streamflows upgradient from the proposed action, effects to groundwater would be negligible.

Effects to wetlands, floodplains, and riparian areas would be minor, as there are no wetland features in the canals or laterals, effects to any adjacent wetlands would be avoided or mitigated, and riparian and wetland areas downstream of the project would benefit from the protection and addition of instream flows.

Effects to terrestrial wildlife would be minor because there would be small, localized changes in wildlife populations and their habitats due to construction disturbance; however, these changes would be of little consequence to any populations or their habitats due to abundance of species and their habitat in the area. As project groups would be constructed sequentially over an 11-year period, terrestrial wildlife would have ample time to adjust and find new water sources and habitats as open canals are converted to buried pipe.

There would be no effects from the proposed action to designated Wild and Scenic rivers.

Major Conclusions	Implementation of the Preferred Alternative would improve water delivery reliability for farmers, reduce water loss to seepage and evaporation in District infrastructure, enhance fish and aquatic habitat through greater instream flows, and improve public safety while supporting agriculture and improving the environmental quality of rivers and tributaries in the area of potential effect.
Areas of Controversy	There have been no areas of controversy identified.
Issues to be Resolved	None
Evidence of Unusual Congressional or Local Interest	Comments on the Plan-EA and/or Preliminary Investigative Report were received from one state representative (Knute Buehler, District 54), one municipality (City of Bend), four state agencies through the Regional Solutions Program/Oregon Governor's Office (Oregon Department of Environmental Quality, Oregon Department of Transportation, Oregon Department of Fish and Wildlife, and Oregon Water Resources Department), two federal agencies (United States Fish and Wildlife Service and United States Forest Service-Deschutes National Forest), and local non-governmental organizations and individuals.

Compliance	Is this report in compliance with executive orders, public laws, and other statues governing the formulation of water resource projects? Yes _X_ No____

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.). Within the Deschutes Basin, irrigated agriculture is the primary out-of-stream water use and relies on up to 100-year-old infrastructure to divert, store, and deliver water to farms and ranches across the region. The need to minimize system water losses is an ongoing concern of the Tumalo Irrigation District (herein referred to as TID or the District).

In recent years, water resources have been a community focus within the Deschutes Basin. In response, TID has been pursuing a water conservation program to provide a permanent solution to system-wide water losses since the mid-1990s. Although some improvements have been made, aging and outdated infrastructure continues to contribute to water delivery insecurity for out-of-stream users and limit streamflow, affecting water quality and aquatic habitat along the Deschutes River and its tributaries. Irrigation canals and laterals in the District have become a public safety risk and require increasing maintenance. Aging infrastructure also affects the financial stability of TID and its patrons, as the District must find new approaches to fund growing maintenance needs.

Approximately 30 percent of the water diverted through TID's canals and laterals[1] currently seeps into the area's porous, volcanic soil, or evaporates, prior to reaching farms. The District has a higher diversion rate than their on-farm delivery rate to account for the losses in the distribution system. If the distribution system were more efficient, the District would divert less water and leave more water instream in the Deschutes River and its tributaries. Patrons would continue receiving their water rights, supporting local agriculture and the local economy. Improving irrigation infrastructure offers an opportunity to improve water conservation, increase water delivery reliability to farms, reduce O&M costs for farmers and the District, enhance streamflow and habitat conditions for fish and aquatic species in the Deschutes Basin, and reduce risks to public safety from open irrigation canals.

The Deschutes Basin Board of Control (DBBC) is the lead sponsor for the TID Irrigation Modernization Project (herein referred to as the project or proposed action), which is intended to improve water conservation, water delivery reliability, and public safety for District-owned canals and laterals. The District operates and maintains over 77 miles of main canals and laterals; of these, approximately 8.2 miles are piped and the rest are unlined, open channels dug into volcanic soils and rock (Figure 1-1). The proposed action would modernize up to 68.8 miles of canals and laterals in order to conserve up to 48 cubic feet per second (cfs) of water, equivalent to 15,115 acre-feet of water throughout the entire irrigation season. Modernization would allow the District to provide more reliable water deliveries to patrons; enhance instream flow, water quality, and aquatic habitat; provide financial and operational benefits to the District and its patrons; and improve public safety. Specific details regarding the District's proposed action are further described in this document and in the System Improvement Plan (SIP) (TID 2017).

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

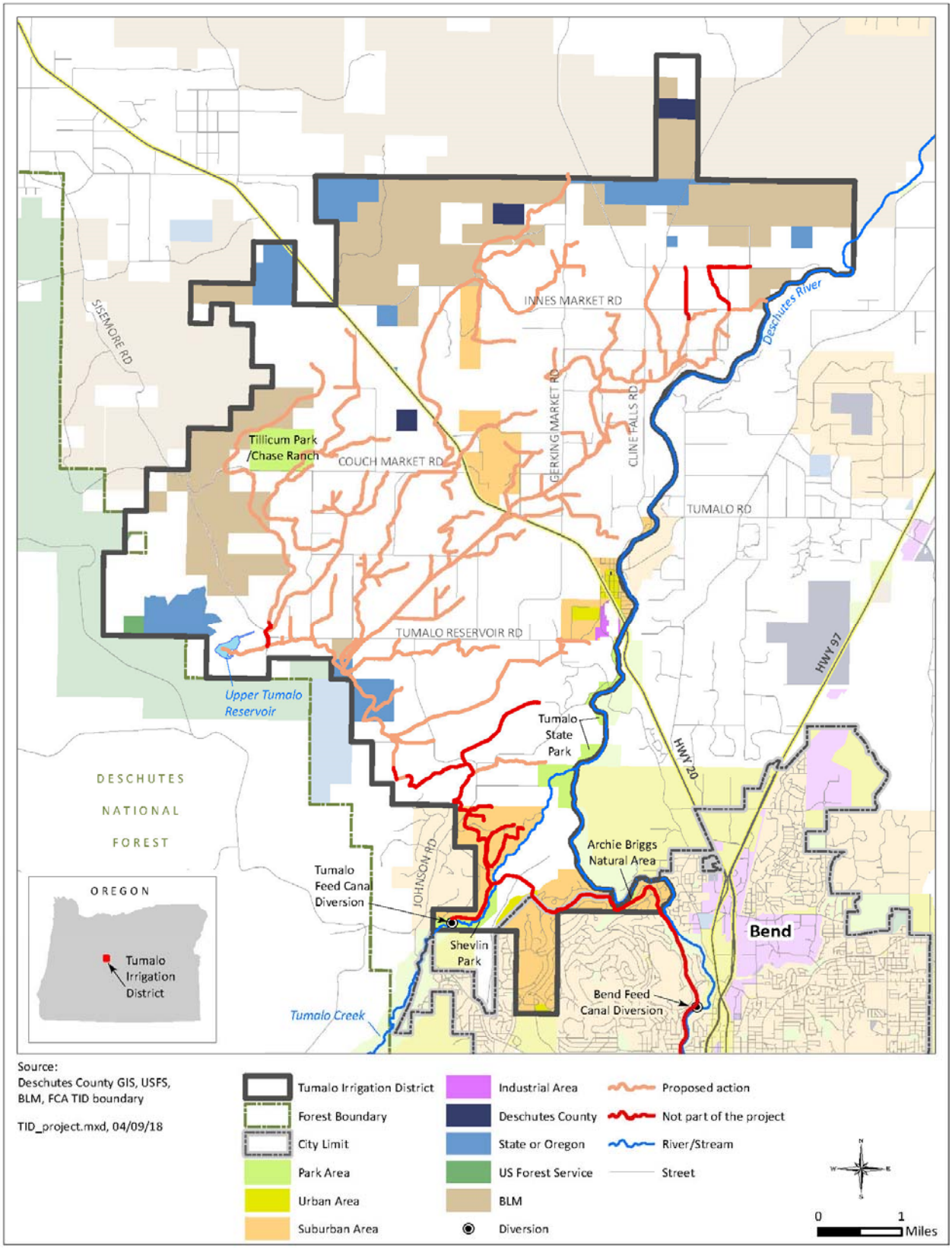


Figure 1-1. Location of the Tumalo Irrigation District – Irrigation Modernization Project.

1.1 General Setting

The District is located in Central Oregon, in the northern half of Deschutes County. The District is situated northwest of the City of Bend, west of the Deschutes River, and falls within six subwatersheds that comprise the TID Watershed Planning Area (Figure 1-2; Table 1-1). The entire District is approximately 28,000 acres; within that, there are 7,417 acres currently irrigated by 667 patrons. Of these 7,417 acres, 7,002 irrigated acres would be served by infrastructure included in the proposed action (TID 2017). The District is about 15 miles long (north to south) and 8 miles wide (east to west).

The Watershed Planning Area is 169,251 acres and is located within the Upper Deschutes watershed (4th field Hydrologic Unit Code [HUC]: 17070301) and within Deschutes County. Within the Upper Deschutes watershed, portions of the Deschutes River are referenced as the upper Deschutes River (from River Mile [RM] 226 to RM 164.8) and the middle Deschutes River (from RM 164.8 to RM 120). This reference point divides the river based on its hydrograph, which is influenced by reservoir operations and irrigation diversions. Current reservoir management in the upper Deschutes watershed leads to low winter flows and high summer flows in the upper Deschutes River. Six irrigation districts divert water from the Deschutes River at the City of Bend during the spring, summer, and fall, leading to lower flows in the middle Deschutes River.

There are several designated National Wild and Scenic Rivers (Public Law 90-542; 16 U.S.C. 1271 et seq.) in the general area. These include the Deschutes River from Wickiup Reservoir (RM 226.8) to the Bend Urban Growth Boundary (approximately RM 172) and from Cline Falls (RM 140) to the upper end of Lake Billy Chinook (RM 120). The 10-mile segment of Crescent Creek downstream from Crescent Lake (RM 30) is also designated as a National Wild and Scenic River. In addition, there are about 61.7 miles of waterways in the general area that are designated through the Oregon Wild and Scenic Rivers Act (Oregon Revised Statute [ORS] 390.826) as Oregon Scenic Waterways.

1.2 Current Infrastructure

The District has two primary points of diversion. The District's primary water right is on Tumalo Creek, a tributary of the Deschutes River that is fed by snowmelt and precipitation. The District diverts water at the Tumalo Diversion Dam, located on Tumalo Creek at RM 2.5, approximately 0.5 mile downstream from Shevlin Park.

The District also maintains supplemental storage rights in Crescent Lake, as Tumalo Creek flows are insufficient to meet the District's water rights throughout the irrigation season. Water flows from Crescent Lake via Crescent Creek to the Little Deschutes River, which then flows to the Deschutes River. The District diverts this water from the Deschutes River at Steidl Dam (RM 166) in Bend, Oregon (TID 2017). Steidl Dam was built in 1922 and was rehabilitated in 1975. The District is the only irrigation district that withdraws water from this location. Both of TID's diversions have powered head gates, fish passage, and agency-compliant fish screens to protect upstream and downstream migrating fish.

District infrastructure includes approximately 8.2 miles of pipe and 68.8 miles of canals, laterals, and ditches. Water at the Tumalo Diversion Dam enters the Tumalo Feed Canal (TFC), a dual-pipe

conveyance system, and is transported approximately 4,000 feet to the convergence with the Bend Feed Canal (BFC), which transports water from the Steidl Dam diversion on the Deschutes River. The BFC is fully piped for 5 miles. It consists of a combination of 72-inch-diameter reinforced concrete pipe that was installed in the 1970s and 84-inch-diameter high-density polyethylene (HDPE) pipe that was installed by the District over the last 15 years (TID 2017).

From the convergence of the BFC and the TFC, the water is conveyed in a combination of pipes and canals until it reaches the Tumalo Reservoir. The TFC is approximately 60 percent piped, consisting predominantly of HDPE pipe except for steel pipe at siphon locations; reinforced, dual-barrel concrete pipes from the intake for approximately 2,967 linear feet downstream of the TFC diversion; and a segment of steel-reinforced polyethylene pipe (TID 2017).

Below the piped section of the TFC, the water continues into an unlined canal for approximately 2.5 miles to a junction known as the Division. Here, the open, unlined Columbia Southern Lateral carries water into the District in a northeasterly direction. The Tumalo Reservoir Feed continues to Tumalo Reservoir, which feeds the Couch Lateral. The District stores and releases water from Tumalo Reservoir to meet changes in demand further down in the system. Numerous open laterals stem from the TFC and the Columbia Southern Lateral (Figure 1-1).

Elevations in the District fall approximately 370 feet between the diversions and the northern limit of the District. Patron turnouts from District canals and laterals are gate-regulated and weir-measured by TID field staff; approximately 10 patrons are currently being served by the existing pressurized pipelines.

The District's distribution system does not discharge to any natural waterbodies. Due to the age of the District's distribution system and porous nature of the underlying soils, the District's system loses approximately 48 cfs of water through seepage and evaporation. The District must divert more water than needed by farms in order to account for the loss in the distribution system. Water loss associated with specific canals and laterals is detailed in the SIP (Appendix D).

1.3 Watershed Planning Area

The District's service area and the TID Irrigation Modernization Project are located in six subwatersheds: Buckhorn Canyon, Bull Creek, Lower Tumalo Creek, Laidlaw Butte-Deschutes River, Overturf Butte-Deschutes River, and Deep Canyon Dam-Deep Canyon (Table 1-1; Figure 1-2), which cover a total of 169,251 acres. These six subwatersheds comprise the TID Watershed Planning Area. They are located within the Upper Deschutes watershed (HUC 17070301).

Table 1-1. Tumalo Irrigation District Watershed Planning Area.

12-Digit Hydrologic Unit Code	Name	Area (acres)
170703010804	Buckhorn Canyon	13,809
170703010603	Bull Creek	32,153
170703010502	Lower Tumalo Creek	17,238
170703010802	Laidlaw Butte-Deschutes River	42,749
170703010406	Overturf Butte-Deschutes River	31,374
170703010604	Deep Canyon Dam-Deep Canyon	31,928
	Total	**169,251**

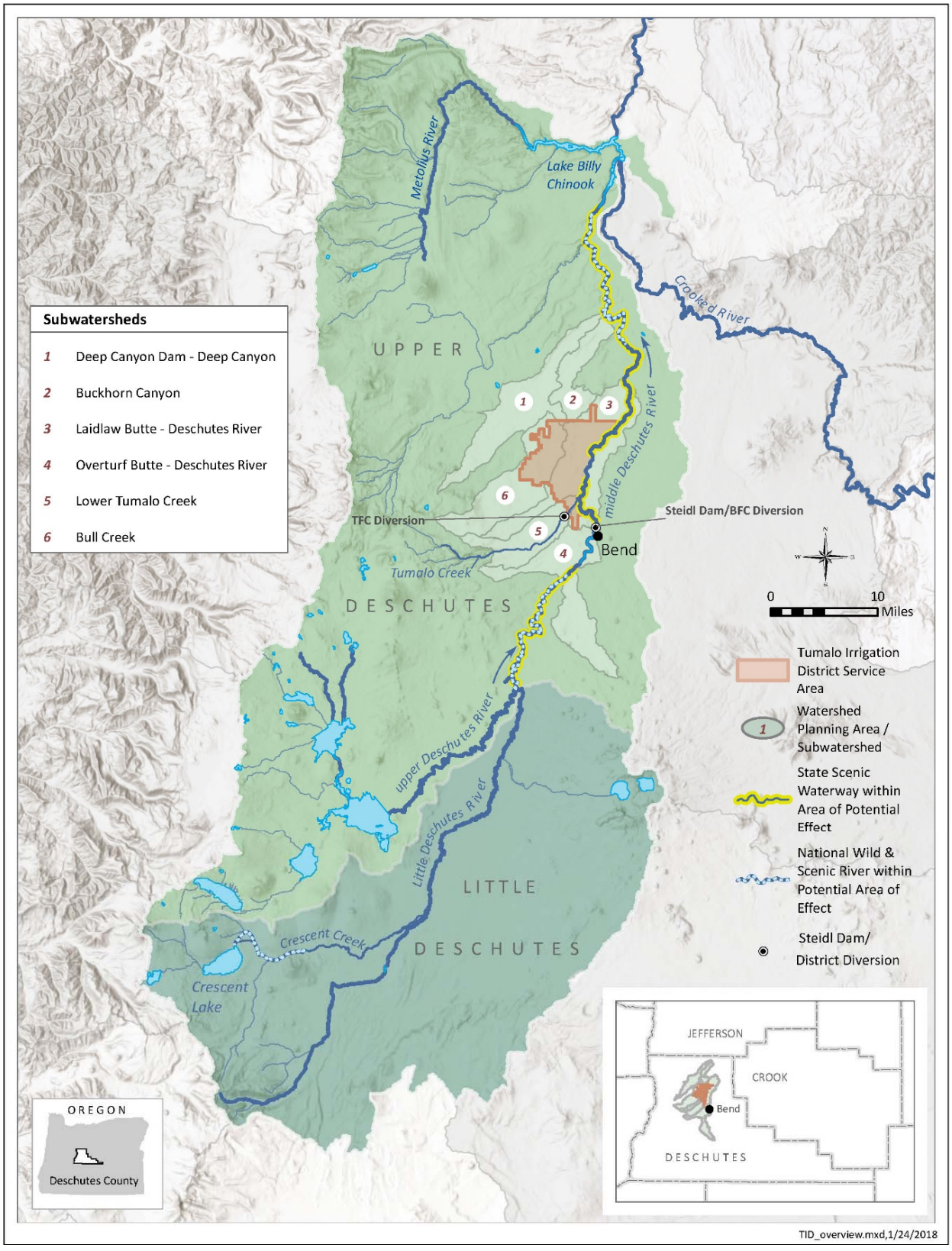


Figure 1-2. The Six Subwatersheds Comprising the Tumalo Irrigation District Watershed Planning Area.

1.4 Project Area

The "project area" for the TID Irrigation Modernization Project is the area where construction activities would occur to modernize up to 68.8 miles of the District's canals and laterals. All construction activities would occur entirely within the District's existing rights-of-way (ROW), which were granted under the Carey Desert Land Act of 1894 (Carey Act). The District's ROW under the Carey Act extends 50 feet on each side of the canal from the toe of the bank for a total easement width of 100 feet plus the width of the canal.

The "area of potential effect" for the TID Irrigation Modernization Project is the area that would be affected by implementation of the proposed action. Unlike the project area, the area of potential effect is not a single defined boundary; it varies depending on the resource affected. For example, the area of potential effect on water resources would include waterbodies upstream and downstream of the District's diversions that are several miles away from any construction. Conversely, the area of potential effect on public safety would be identical to the boundaries of the project area.

1.5 Decision Framework

This Draft Watershed Plan-Environmental Assessment (Plan-EA) has been prepared to assess and disclose the potential effects of the proposed actions. The Plan-EA is required to apply for federal funding through the Watershed Protection and Flood Prevention Program, Public Law 83-566, authorized by Congress in 1954 (herein referred to as PL 83-566). This program is managed by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). Through this program, NRCS provides technical and financial assistance to states, local governments, and Tribes (project sponsors) to plan and implement authorized watershed project plans for the purpose of watershed protection; flood mitigation; water quality improvements; soil erosion reduction; rural, municipal, and industrial water supply; irrigation; water management; sediment control; fish and wildlife enhancement; and hydropower. NRCS is the lead federal agency for this Plan-EA and is responsible for review and issuance of a decision in accordance with the National Environmental Policy Act (NEPA).

NEPA requires that Environmental Impact Statements (EISs) are completed for projects utilizing federal funds and that significantly affect the quality of the human environment. When a proposed project is not likely to result in significant impacts requiring an EIS, but the activity has not been categorically excluded from NEPA, an agency can prepare an EA to assist them in determining whether there is a need for an EIS (See 40 Code of Federal Regulations [CFR] 1501.4, 1508.9; 7 CFR 650.8.).

For purposes of NEPA compliance, the intent of this Plan-EA is to provide a programmatic platform for the implementation of the proposed action. The DBBC and TID are partnered with NRCS to implement the Irrigation Modernization Project within the TID Watershed Planning Area under the watershed authority of the PL 83-566 program. This approach provides a programmatic analysis to which those site-specific actions may tier, reducing the regulatory burden of acquiring approval for each individual project in a streamlined fashion that is responsive to the NEPA framework.

Tiering is a staged approach to NEPA as described in the Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 – 1508). Broad programs and issues are described in initial analyses, while site-specific proposals and impacts are described in subsequent site-specific studies. The tiered process permits the lead agency to focus on issues that are ripe for decision, and exclude from consideration issues already decided or not yet ripe. Tiering eliminates repetitive discussions of the same issues through incorporating by reference the general discussions.

NRCS has determined the need for a Plan-EA to implement the proposed action under PL 83-566 watershed authority. Due to the broad spatial scale of this analysis, and the multi-year project group approach, this Plan-EA does not identify the specific details associated with the engineering design and construction activities that would be required to implement the proposed action. Instead, this document intends to present an analysis in sufficient detail to allow implementation of a proposed action within the designated project area with minimal additional NEPA analysis.

The proposed action is planned to be completed in seven project groups[2]. Consistent with the tiering process as described above, prior to the implementation of each project group, an onsite Environmental Evaluation (EE) review would occur utilizing the Form NRCS-CPA-52, "Environmental Evaluation Worksheet." The EE process would determine if that particular project group meets applicable project specifications, and whether the site-specific environmental effects are consistent with those as described and developed in this Plan-EA. This process provides information for the Responsible Federal Official (RFO) to determine if the proposed action has been adequately analyzed, and if the conditions and environmental effects described in the Plan-EA are still valid. Where the impacts of the narrower project specific action are identified and analyzed in the broader NEPA document, no further analysis would occur and the Plan-EA would be used for purposes of the pending action.

If it is determined that the Plan-EA is not sufficiently comprehensive, not adequate to support further decisions, or if resource concerns or effects have not been adequately evaluated through the programmatic approach, a separate site-specific supplemental EA would be prepared. Furthermore, as part of the tiering process, agency consultation (e.g., Section 404 of the Clean Water Act [CWA] and Section 106 of the National Historic Preservation Act [NHPA]) would be completed for each individual project group before implementation of the project group, as appropriate.

This Plan-EA has been prepared in accordance with applicable CEQ regulations for implementing NEPA (40 CFR 1500–1508), USDA's NEPA regulations (7 CFR Part 650), NRCS Title 190 General Manual Part 410, and NRCS National Environmental Compliance Handbook Title 190 Part 610 (May 2016). The Plan-EA also meets the guidelines of the 2015 NRCS National Watershed Program Manual (NWPM) and the 2014 NRCS National Watershed Program Handbook (NWPH). This Plan-EA serves to fulfill the NEPA and NRCS environmental review requirements of the proposed action.

[2] Project Group refers to groupings of canals and laterals that would undergo construction during the same period. The project groups identified in the SIP are not identical to the project groups identified in the Plan-EA.

2 Purpose and Need for Action

The purpose of this project is to improve water conservation, water delivery reliability, and public safety on up to 68.8 miles of District-owned canals and laterals.

Federal action is needed to accelerate and provide certainty to address the following watershed problems and resource concerns: water loss in District conveyance systems, water delivery and operations inefficiencies, instream flow for fish and aquatic habitat, and risks to public safety from open irrigation canals. The District has begun to address these concerns over the past two decades as funding opportunities have allowed. These funding opportunities are not reasonably certain to occur if the District continues to follow their current approach. Federal action would enable the District to follow a strategic, comprehensive approach to securing additional funding and addressing these issues, which are discussed below in more depth.

2.1 Watershed Problems and Resource Concerns

2.1.1 Water Loss in District Conveyance Systems

Conserving water is a key goal of the District; it has already invested in multiple large piping projects and used the State of Oregon's Allocation of Conserved Water Program to protect the water conserved instream. Currently, the District's remaining antiquated canal infrastructure loses approximately 48 cfs (approximately 15,115 acre-feet annually) of water to seepage through the porous underlying soils, evaporation, and other conveyance inefficiencies. During past drought conditions, the District has had to curtail deliveries by up to 75 percent due to a lack of water. If the District's distribution system did not lose so much water to seepage and evaporation, less would need to be diverted and more water could stay instream. Details of water losses and demands can be found in the District's SIP [TID 2017; Appendix D].

2.1.2 Water Delivery and Operations Inefficiencies

In addition to seepage and evaporation losses, it can take days to recharge[3] open canals and laterals after the District reduces its diversions, further affecting the reliability of water deliveries for patrons. When the District increases its diversion rate again to increase the water level in the canal, the ends of the District's laterals remain dry as the system recharges. During these periods, the District cannot always fully meet its obligations to deliver water to its patrons due to conveyance inefficiencies. The District's canals and laterals do not transport and deliver water as precisely, accurately, or efficiently as a modernized system would.

The District's antiquated canal and laterals make it difficult to deliver the correct amount of water to patrons at the correct time, particularly early and late in the irrigation season. During these periods, the District's water rights require it to divert water at a reduced rate. At these reduced flow rates, the canals and laterals are more sensitive to small changes in streamflows at the diversion or deliveries at

[3] After the winter season when the canals are dry, it takes the District a few days at the beginning of the irrigation season to wet the perimeter of the canals, which allows for the swelling of clays, a decrease in the permeability of the canal soil, and therefore a more efficient system to send water flows to patron turnouts. This process is referred to by the District as recharging the canals.

each point-of-delivery. The reduced flow rates in the open canal and laterals make it much more challenging for the District to deliver the amount of water that patrons need when they need it. For example, a point-of-delivery near the end of a lateral may receive no water in the morning and excess water in the evening. The District also has to pass excess water, known as carry water, to ensure that the appropriate amount of water reaches all points-of-delivery based on patrons' needs and water rights. When patrons' demands subside, this excess water is spilled onto non-productive lands at the ends of the conveyance system; the water does not return to any waterways. This excess water is another example of the inefficiencies in the current conveyance system.

Operating and maintaining the District's open canals and laterals requires staff to clean ditches and canals, clean debris from trash racks, and adjust flows to patrons. The District's current operations budget is approximately $946,000 annually (see Figure 5-2), or over $12,000 per mile of the system. The District now serves small-sized parcels through a canal and lateral system originally designed for larger parcels. Approximately 54 percent of TID's accounts are now 5-acre or smaller parcels. These accounts represent only 15 percent of the irrigated area of the District (TID 2017). District staff invest proportionally more time to manage water delivery for these smaller-sized parcels than they would for larger parcels; smaller deliveries on an unpressurized canal and lateral system are more sensitive to fluctuations in system operations due to changes in streamflows, diversion amounts, or other patrons' deliveries.

2.1.3 Instream Flow for Fish and Aquatic Habitat

The Deschutes River and its tributaries experience low streamflows every year due to the storage and diversion of water for agricultural use. Resource agencies have identified streamflow as a primary concern in Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River (UDWC 2014). Reservoir operations lead to low winter streamflows and high summer streamflows in Crescent Creek, the Little Deschutes River, and the Deschutes River upstream from TID's BFC diversion. The combined diversions of the seven major irrigation districts and the cities that divert water in or near the City of Bend lead to low spring, summer, and fall streamflows in the Deschutes River downstream from TID's BFC diversion and in Tumalo Creek downstream from TID's TFC diversion.

The Deschutes River and its tributaries support many fish, bird, and wildlife species. Among these include several sensitive species such as steelhead trout, redband trout, and Chinook salmon, as well as the Oregon spotted frog and bull trout listed as 'threatened' under the Endangered Species Act. Low streamflows in the Deschutes River and its tributaries limit habitat for many of these species. Reduced habitat associated with low streamflows increases competition between populations, which often favors non-native brown trout over native redband trout, and can concentrate fish populations and increase susceptibility to predators and disease.

Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River are listed as impaired waterways under Section 303(d) of the CWA (the "Clean Water Act" became the common name with the 1972 amendments to the Federal Water Pollution Control Act of 1948) because they do not meet one or more of the State of Oregon's water quality standards for salmon and trout, as well as other beneficial uses. Water management along the entire length of the Deschutes River

affects temperature, dissolved oxygen, pH, and other water quality parameters, which in turn affects habitat conditions.

Low streamflows in late fall, winter, and early spring associated with upstream reservoir storage limits riparian vegetation in Crescent Creek and the Deschutes River (RDG 2005). Low streamflows along these reaches can expose the channel bed and river banks, facilitating increased erosion and fine sediment delivery following freeze-thaw processes and increased spring streamflow (RDG 2005). The opposite is seen in Tumalo Creek as winter flows are maintained in their near-natural state but summer flows are severely limited downstream from the TFC diversion. 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).

As riparian areas become hydrologically disconnected from their adjacent stream due to consistently low streamflows, they lose many of their ecological functions. 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).

2.1.4 Risks to Public Safety

Open canals pose a risk to public safety during the irrigation season. In addition to multiple instances of injury, several drowning deaths have occurred in adjacent districts' canals in 1996, 1997, and 2004 (Flowers 2004). The District's location in a partly urbanized area heightens the potential for an accident, as the canals pass through urban areas, rural residences, private lands, and irrigated fields.

During the summer, water depths in the District's canals range between 2 to 6 feet, 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 an even higher risk of drowning in a canal with these attributes. If a person or animal falls into a District canal, they could have serious difficulty gaining hold on the banks in order 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.

Deschutes County was the second fastest growing county in Oregon in 2015 based on the Oregon Population Report (PSU 2015). Public safety risks associated with open canals will continue to grow as urbanization expands into previously rural areas such as TID's service area.

2.2 Watershed and Resource Opportunities

The following list of resource opportunities would be realized through the implementation of the project. Quantification of these opportunities is provided in other sections of this Plan-EA.

- Provide a more reliable source of irrigation water to TID patrons by enabling TID to better deliver the amount of water that patrons need when they need it. Piping open canals and

laterals eliminates the need for carry water[4] so that more water is available for patrons and further reduces the need to spill excess water as the system becomes on demand. Either piping or lining open canals would improve operational efficiencies to ensure that patrons receive the water they need at the time that they need it. A modern conveyance system would reduce the District's diversion rate while fulfilling patron water rights.

- Improve streamflows, water quality, and habitat availability in Tumalo Creek downstream from the TFC Diversion, Crescent Creek downstream from Crescent Lake, the Little Deschutes River downstream from Crescent Creek, and the Deschutes River downstream from the Little Deschutes River by legally protecting conserved water instream under the State of Oregon's Allocation of Conserved Water Program (described below).

- Reduce the operations and maintenance costs involved in delivering irrigation water to TID patrons.

- Minimize the potential for injury and loss of life associated with the open TID canals.

- Reduce energy costs by removing the need for most patrons' individual pumps. Currently, TID patrons use individual pumps to pressurize water from their private ditch or pond. Cumulatively, these individual pumps serving farms across the District use approximately 6 million kilowatt hours per year with electricity costs of approximately $584,000 per year.

2.2.1 Using the State of Oregon's Allocation of Conserved Water Program

The District has determined that implementation of the proposed action could conserve up to 48 cfs that is currently lost through seepage and evaporation (TID 2017). The District would use the State of Oregon's Allocation of Conserved Water Program (Oregon Revised Statute [ORS] 537.470) to legally protect the water conserved by the project as instream flow. The Conserved Water Program allows water users to create new water rights for water saved as the result of an efficiency project (see OWRD 2017 and Appendix E for more information about the Conserved Water Program). New instream water rights created through the program are permanently protected instream and unavailable for other uses. The District anticipates that 100 percent of the project would be funded through PL 83-566 and other public or public-interest funding sources. With this anticipated funding, the District would allocate 100 percent of the conserved water instream.[5]

Through the Conserved Water Program, the Oregon Water Resources Department (OWRD) would issue a new water right certificate to the District with the original priority date reflecting the reduced quantity of water being used with the improved technology. An additional certificate would then be issued to the State of Oregon for the instream water right. The water allocated instream through the

[4] Lining canals would still require the District to utilize carry water.

[5] The District would potentially invest up to 5% of the cost of any project group from its own funds to facilitate project implementation, only if needed, due to unforeseen circumstances. For example, the District would invest its own funds in materials if public funds were not yet available and doing so would ensure that project construction could occur on schedule. If the District were to invest its own funds in a project group, the District would apply for an amount of conserved water created through that project group in proportion to the amount of public and public-interest funding invested in that project group (i.e. between 95% and 100% of the water saved by that project group). The District would not apply to create new water rights for out-of-stream uses through any project group.

program would be legally protected against any out-of-stream use; the District would no longer be able to divert the water.

The water allocated for instream use would be shared between Crescent Creek and Tumalo Creek. Water allocated to instream water rights in Crescent Creek would be released outside of the irrigation season from Crescent Lake Dam. Water allocated to instream water rights in Tumalo Creek would bypass the TFC diversion and remain instream. Streamflow and habitat conditions along Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek would benefit from increased streamflows. OWRD would continue to measure streamflows in each of these water bodies at existing permanent stream gauging stations and diversions into TID's system to ensure that the water conserved by the project remains instream.

Section 6.10 and its subsections describe a volume of water to be conserved and allocated instream following the completion of the proposed action. These sections also describe the rates, timing, and sources for this allocation. These rates, timing, and sources are estimates based on prior conserved water applications that were associated with similar projects in TID and that have already completed the State of Oregon's administrative process for the allocation of conserved water (see Oregon Administrative Rules 690-018-0050). The State of Oregon's administrative process will determine the final volumes, rates, timing, and sources of water allocated instream for each conserved water application.

3 Scope of the Plan-EA

The scoping process followed the general procedures consistent with NRCS guidance and PL 83-566 requirements. Both NRCS procedures and NEPA regulations (40 CFR 1500–1508) require that NRCS use scoping early in the planning process to identify issues, concerns, and potential effects that require detailed analysis.

Using input obtained during scoping, NRCS refined the TID Irrigation Modernization Project to focus on relevant resource concerns and issues, as well as eliminated those that are not relevant from further detailed study. Relevant resource concerns are carried forward for further study and discussion.

3.1 Agency, Tribal and Public Outreach

Federal, state, and local agencies and representatives, as well as non-governmental organizations (NGOs), received an invitation to the scoping period of the Plan-EA. Advertisements announcing the scoping period and the associated scoping meeting were placed in two local and regional newspapers in addition to multiple online locations including NRCS website, the District's website, and DBBC's website. In addition, the scoping meetings were featured by KTVZ Channel 21 and KBND News.

Tribal consultation was conducted in accordance with the NHPA of 1966 and Executive Order (EO) 13175, *Consultation and Coordination with Indian Tribal Governments*, to maintain NRCS' government-to-government relationship between Native villages and tribes. NRCS sent a letter to the Confederated Tribes of Warm Springs (CTWS) requesting input and notifying them of the

scoping process. Confederated Tribes of Warm Springs responded and requested that they be consulted during the planning phase of the TID Irrigation Modernization Project.

3.2 Scoping Meeting

A scoping meeting was held on Thursday, July 6, 2017 at the Tumalo Community Church Meeting Room, 64671 Bruce Avenue in Bend, Oregon. Presenters at the meeting included Tom Makowski, NRCS; Kenneth B. Rieck, Manager of TID; Margi Hoffmann, Farmers Conservation Alliance (FCA); and Bridget Moran, U.S. Fish and Wildlife Service (USFWS). The presentations covered the financial assistance available through PL 83-566, the purpose and need of the project, the Watershed Plan-EA process, and how the public could get involved. After the presentations, attendees asked questions and provided comments for the public record. The meeting was attended by 76 people, excluding staff from TID, NRCS, USFWS, and FCA.

3.3 Scoping Comments

Scoping comments were accepted from June 16, 2017, to July 24, 2017. Comments were submitted via the following methods:

- At the public meeting on July 6, 2017
- Email, wsp@tumalo.org or margi.hoffman@fcasolutions.org
- Mail, Farmers Conservation Alliance, Attention Watershed Plan-EA, 11 3rd Street Suite #101, Hood River, OR 97031
- Phone, Farmers Conservation Alliance, 541-716-6085

Comments generally supported the TID Irrigation Modernization Project. Comments included these items:

- Importance of instream flows for the health of the Deschutes River, its tributaries, and the associated fish, aquatic species, and general wildlife
- Request to permanently commit 100 percent of water conserved through the project instream
- Amount of water conserved by the project, mechanism by which water would be conserved, and how the conserved water would be distributed in the area of potential effect
- Whether conserved water would be used for groundwater mitigation credits
- Request to include an analysis of the efficient use of dollars, quantifying the public cost per cfs of water conserved
- Request to work with farmers to adopt on-farm water conservation measures as a result of pressurized delivery
- Importance of preparing for the potential effects of climate change
- Concern for wildlife along the canals and laterals

- Concern for private ponds and associated wildlife
- Concern for groundwater, aquifer recharge, and water availability for private wells
- Concern for vegetation along the canals and laterals, especially mature trees
- Removal cost of and responsibility for trees that do not survive the project
- Concern for property values of the adjacent landowners
- Request to avoid any new irrigation on previously unirrigated land
- Cost effectiveness and engineering considerations of a top-down versus bottom-up piping design
- Effect of water meters and measuring water use
- Effect of the project cost on District water rates
- Effect on maintenance and access roads along canals
- Recreation possibilities and potential trail network
- Trail development and proximity to private homes
- Effect on patron deliveries including amount of water and timing
- Ability of patrons to lease their water to other users or for other purposes
- Relation of the project to hydroelectric development
- Effect on Tumalo Reservoir management and infrastructure
- Relation of the project to the floodplain

Federal, state, Tribal, and local agency consultation and other public participation activities are further described in Section 7 of the Plan-EA.

3.4 Identification of Resource Concerns

Resource concerns identified through scoping comments include water resources (water conservation, water quality, groundwater, and wild and scenic rivers), aquatic and fish resources, soil and geologic resources, visual resources, cultural resources, recreation, socioeconomics, wetlands, terrestrial wildlife, and vegetation resources. Table 3-1 provides a summary of resource concerns and their relevancy to the proposed action. Resource items determined not relevant have been eliminated from detailed study, and those resources determined relevant have been carried forward for analysis.

Table 3-1. Summary of Resource Concerns for the Tumalo Irrigation District – Irrigation Modernization Project.

Resource	Relevant to the Proposed Action?		Justification
	Yes	No	
Air			
Air Quality		X	Review of Oregon Department of Environmental Quality air quality data indicates that the entire project area is in attainment for all criteria pollutants. Emissions from equipment associated with implementation of proposed action activities would occur; however, such emissions are considered negligible when compared to background levels and the application of best management practices.
Geology and Soils			
Erosion	X		Soil disturbance during construction could contribute to erosion.
Landslides	X		There are some areas of low to moderate landslide risk within the project area.
Prime Farmlands	X		Prime farmlands occur in the project area and could be affected by the project.
Human Environment			
Archaeological Resources	X		Archaeological resources have not been found in the portions of the project area that have been surveyed to date. Additional archaeological surveys would be completed for the remaining portions of the project area.
Environmental Justice		X	The proposed action would not disproportionally affect any racial, socioeconomic, or environmental justice groups, and would comply with Executive Order 12898.
Historical Resources	X		Historical resources are known to occur in the project area. Consultation with the State Historic Preservation Office is required for compliance with Section 106.
Land Use	X		While no effects on property ownership would occur, construction activities would temporarily affect traffic and agricultural land use would be indirectly affected.
National Parks and Monuments		X	No National Parks or Monuments occur in the project area.

Resource	Relevant to the Proposed Action?		Justification
	Yes	No	
Noise		X	The project is located in agricultural areas where heavy equipment use is commonplace. Therefore, noise in the project area is anticipated to be consistent with existing background levels. Effects associated with noise were considered, but eliminated from detailed analysis because the potential for any additional noise-related effects is low.
Parklands	X		Construction activities would temporarily affect recreation activities in the southeast corner of Tillicum Park.
Public Safety	X		Implementation of the proposed action would affect the risk of drowning in open canals depending upon the alternative selected.
Recreation Trails	X		Construction activities would temporarily affect recreational use of Twin Bridges Scenic Bikeway and Tillicum Park.
Visual Resources	X		Visual resources of the project area would be affected by project construction where open canals would be altered.
Socioeconomics			
Local and Regional Economy	X		The proposed action involves an expenditure of public funds, which could affect the local and regional economy. An evaluation of the effects of providing NRCS funding is included.
National Economic Development (NED)	X		A NED analysis has been completed as required by the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.
Vegetation			
Invasive Species/Noxious Weeds	X		Construction activities could spread noxious weeds and/or create conditions for them to establish.
Mature Trees	X		Direct and indirect effects to mature trees could occur.
Special Status/Threatened or Endangered Species	X		The project area has rights-of-way through BLM land that is an Area of Critical Environmental Concern for Peck's milkvetch, a Federal Species of Concern; however, the species has not been observed in the project area to date.
Water			
Coastal Zones		X	No coastal zones occur within or near the project area.

Resource	Relevant to the Proposed Action?		Justification
	Yes	No	
Coral Reefs		X	No coral reefs occur within or near the project area.
Conserved Water	X		Water conserved by the proposed action would not be diverted and would remain in Tumalo Creek or Crescent Creek and would be allocated to instream uses.
Floodplain Management		X	The proposed action does not occur in the 100-year floodplain as represented by the Federal Emergency Management Agency's Flood Insurance Rate Maps (FEMA 2013), and the proposed action would not directly or indirectly support floodplain development; as such, effects on the floodplain are not further considered or addressed.
Groundwater Mitigation Credits		X	The proposed action would not create groundwater mitigation credits.
Groundwater Quality		X	Groundwater quality would not be affected by the proposed action.
Groundwater Quantity, Aquifer Recharge	X		Reduced seepage from canals and increased instream flows could affect groundwater quantity and aquifer recharge.
Hydroelectric Development		X	The proposed action does not consider developing hydroelectric facilities and cannot use the existing authorization of PL 83-566 funding for such development.
Hydrology	X		Reduced seepage could affect hydrology. The proposed action would allocate conserved water instream.
Private Water Features and Ponds		X	The proposed action would not remove or modify private water features and ponds.
Public Water Supply		X	The proposed action would not affect public water supply.
Regional Water Resources Plans	X		Implementation of the proposed action would allocate more water instream and reduce District diversion flow rates. Changes to District operations and management plans of the District's water resources would likely occur.
Surface Water Quality	X		Implementation of the proposed action could result in long-term effects by increasing river flows.
Tumalo Reservoir		X	Implementation of the proposed action does not change Tumalo Reservoir operations and maintenance activities; as such, they are not further considered or addressed.
Water Leasing	X		Implementation of the proposed action would remove leasing limitations for patrons.

Resource	Relevant to the Proposed Action?		Justification
	Yes	No	
Water Rights	X		Transfers of water rights would occur under the Allocation of Conserved Water Program.
Wild and Scenic Rivers	X		Stretches of the Deschutes River upstream and downstream from TID's diversion, as well as a stretch of Crescent Creek, are a designated Wild and Scenic River and would be indirectly affected by the proposed action.
Wetlands and Riparian Areas			
Wetlands and Riparian Areas	X		Wetlands and riparian areas could be indirectly affected.
Fish and Wildlife			
Bald and Golden Eagle Protection Act	X		Habitat for bald eagles could occur in the project area. Two golden eagle nests are known to occur near project area.
Endangered Species	X		The proposed action would not affect the yellow-billed cuckoo, northern spotted owl, endangered gray wolf, or their designated critical habitat due to species habitat preferences and ranges. These species would not be carried forward for consideration and analysis in this Plan-EA. Oregon spotted frog and bull trout or their habitats are known to occur in waterways that could be affected by the project.
Essential Fish Habitat		X	The Magnuson-Stevens Act established requirements for including Essential Fish Habitat (EFH) descriptions in federal fishery management plans, and requires federal agencies to consult with National Marine Fisheries Service (NMFS) on activities that may adversely affect EFH (Pub. L. No. 104-297). EFH can include all streams, lakes, ponds, wetlands, and other viable waterbodies, and most of the habitat historically accessible to salmon necessary for spawning, breeding, feeding, or growth to maturity. As the project would not affect EFH, consultation under the Magnuson Stevens Act is not required.
Fish and Fish Habitat	X		The proposed action could affect fish habitat within the area of potential effect.
General Wildlife and Wildlife Habitat	X		Construction and operation of project components could affect wildlife within the area of potential effect.
Migratory Bird Treaty Act species	X		Construction and operation of project components could affect migratory birds.

4 Affected Environment

The following sections describe the existing ecological, physical, biological, economic, and social environment of areas that would be affected by the proposed action. The project area is defined in Section 1.4 and is a single, defined boundary. The area of potential effect varies for each resource based on the relevant expected effects of the proposed action.

4.1 Cultural Resources

Cultural resources are defined as physical or other expressions of human activity or occupation. Historic properties are defined as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register of Historic Places. The term "historic properties" includes traditional cultural properties and archaeological sites. Section 106 of the NHPA requires federal agencies to take into account the potential effects of a project on historic properties. The area of potential effect for cultural resources is identical to the project area.

4.1.1 Irrigation Development in Central Oregon

At the turn of the twentieth century, Central Oregon, known then as the Deschutes country, was one of the most remote regions in the nation. Settlers were enticed with opportunities to capitalize on the Deschutes River, promising lands for agriculture, and immense pine forests. Two major factors contributed to the settlement and agricultural development of Central Oregon: the arrival in 1900 of the Columbia Southern railroad, and the State of Oregon's acceptance in 1901 of the 1894 federal Carey Act that encouraged states to pursue development of arid lands (NPS 2015). In exchange for up to 1 million acres of federal land, states made up to 160 acres available to settlers who agreed to improve and cultivate the land. The Carey Act enabled states to issue irrigation contracts to private developers who were expected to design and build irrigation projects, as well as recruit settlers to farm the new areas. The State would issue a water right to the private developer for a particular project, but the State would not be responsible for financing or construction. If an irrigation project failed, the State reassigned the contract to another development company. While limited irrigation in Central Oregon had begun before these changes, the Carey Act helped spur the creation of more irrigation companies and investment in large-scale irrigation projects (NPS 2017).

4.1.2 Archaeological Resources

Archaeological surveys were conducted for the District's Highline/Couch laterals in 2006 (parts of Project Group 2 and 5) and the TFC in 2017 (Project Group 1). The canal and laterals were empty at the time of the surveys, allowing an examination of the canal banks and the full length and width of the ROW. No archaeological resources were found (Stuemke 2006 and 2017). Archaeological surveys for areas affected by other project groups (Project Groups 2 through 7) would be completed closer to their implementation date. An overview of Central Oregon's prehistoric cultural history and Euro-American history can be found in Appendix E.

4.1.3 Historical Resources

Construction of the TID system began in 1900, with other substantial building phases occurring in 1903, 1913-1914, and 1922-1923. Originally known as the Tumalo Project, the irrigation system has encouraged and accompanied settlement and agricultural development in the upper Deschutes

Basin. Over time, the District made improvements to failing structures, installed required fish screens, and piped critical segments of canal for public safety and water conservation. Portions of the original system are still in use today.

Based on its significance as one of the earliest Carey Act irrigation enterprises in Oregon's upper Deschutes Basin, the State Historic Preservation Office (SHPO) concurred with the U.S. Bureau of Reclamation (Reclamation) in 1997 that TID is considered eligible for listing in the National Register of Historic Places (Reclamation 2010). Eight features of the system were evaluated for the National Register as contributing or potentially contributing features. These features include the Tumalo Diversion Dam, TFC, Columbia Southern Canal, Bend Diversion Dam, BFC, Tumalo Reservoir, Tumalo Dam and Control House, and Bull Creek Dam and Bridge. These features of the District are documented in Historic American Engineering Record No. OR-151 (HAER) (Luttrell and Pfaff 2006).

Two features that would be affected by the proposed action, the TFC (Project Group 1) and the Columbia Southern Canal (Project Group 6), are described below in more detail with information from the HAER (Luttrell and Pfaff 2006).

4.1.3.1 Tumalo Feed Canal

The TFC was constructed from 1913 to 1914. As originally built, the canal extended 7.2 miles overland from Tumalo Creek, running northwesterly along the southwestern edge of TID to the reservoir on Bull Flat. The canal consisted of a 14-foot-wide open ditch with a water depth of 4 feet. It had three state-of-the-art metal flumes collectively totaling 6,381 feet in length, each 10 feet wide by five feet deep, elevated on wooden trestles set on concrete piers. All structures appurtenant to the TFC, such as drops, canal crossings, and turnouts were constructed of concrete.

Beginning with a rehabilitation program in 1974, substantial changes have occurred to the canal structures to correct conveyance losses or replace aged components. The TFC was rehabilitated in 1974 with 2,755 feet of 54-inch diameter concrete-pipe siphon. In 1998, 3,000 feet of new pipeline were installed in the canal. The Klippel and Weber flumes, two original wooden trestle flumes, were replaced with siphons in 2000. Flume replacement features included concrete inlet and outlet structures and buried steel pipeline. Likewise, the adjacent twin flumes downstream from the Klippel Siphon have also been removed. The Pauly Lateral Canal is presently served by a newer concrete delivery.

4.1.3.2 Columbia Southern Canal

The construction of the Columbia Southern Canal was initiated by the Three Sisters Irrigation Company in 1900. Starting eight miles upstream of Shevlin Park, the unlined and open canal diverted water from Tumalo Creek for 8.5 miles to the intersection with the TFC and an associated settling pond. The Columbia Southern Canal south of the pond is no longer used by the District. The pond also directly supplies water into the Tumalo Reservoir Feed Canal and the Lacey Lateral Canal. After leaving the pond, the Columbia Southern Canal continues northward to its diversion into the West Branch Columbia Southern Canal. Both the West Branch Drop and the Gerking Flume are situated along the West Branch Columbia Southern Canal. Although an original feature of the canal, the Gerking Flume has been periodically rehabilitated during its lifetime.

The HAER found that as the oldest project feature, the Columbia Southern Canal represents a contributing element if it retains sufficient physical integrity. To date, the Columbia Southern Canal has not been thoroughly surveyed (Luttrell and Pfaff 2006).

4.2 Fish and Aquatic Resources

The area of potential effect for fish and aquatic resources includes waterbodies that could be affected by the project (Table 4-1). These waterbodies include Crescent Lake, Crescent Creek (RM 30 - 0), the Little Deschutes River (RM 57 - 0), the Deschutes River (RM 192.5 - 120), and Tumalo Creek (RM 2.5 - 0). These waterbodies are included in the area of potential effect because the increased water in these sections of stream following completion of the project, would indirectly affect fish and aquatic resources.

Table 4-1. Waterbodies Included in the Area of Potential Effect for Fish and Aquatic Resources.

Waterbody No.	Name	Reach	Size	Tributary To
1	Crescent Lake	N/A	86,900 acre-feet	N/A
2	Crescent Creek	Crescent Lake Dam (RM 30) to the mouth (RM 0)	30 miles	Little Deschutes River
3	Little Deschutes River	Crescent Creek (RM 57) to the mouth (RM 0)	57 miles	Deschutes River
4	Deschutes River	Little Deschutes River (RM 192.5) to the Bend Feed Canal diversion at Steidl Dam (RM 166)	26.5 miles	Columbia River
5	Deschutes River	Bend Feed Canal diversion at Steidl Dam (RM 166) to Lake Billy Chinook (RM 120)	46 miles	Columbia River
6	Tumalo Creek	Tumalo Feed Canal diversion (RM 2.5) to its confluence with the Deschutes River (RM 0)	2.5 miles	Deschutes River

Notes:
N/A: Not Applicable

4.2.1 General Fish and Aquatic Species

The District's canals do not support game fish, salmonids, or threatened and endangered aquatic species. Fish screens compliant with Oregon Department of Fish and Wildlife (ODFW) standards were installed on the BFC diversion in 2004 and on the TFC diversion in 2006. These fish screens separate water diverted for consumptive use from water left instream. They prevent any fish from entering the District's irrigation conveyance system.

There are 18 species of fish documented in the area of potential effect (Table 4-2). All 18 of these fish species are potentially present in the Deschutes River from Steelhead Falls (RM 128) to Lake Billy Chinook (RM 120). The summer steelhead, Chinook salmon, and sockeye salmon in this reach are part of a re-introduction effort that began in 2009 to mitigate for blockage of fish passage around the Pelton Round Butte Dam Complex (ODFW and CTWS 2008). Chinook and sockeye salmon are unable to navigate Steelhead Falls at RM 128, which creates the uppermost distribution limit for salmon in the Deschutes River. Summer steelhead are able to pass upstream of Steelhead Falls but are unable to navigate upstream of Big Falls at RM 132. Big Falls is considered the uppermost limit of anadromous fish distribution (ODFW 1996).

Table 4-2. Fish Species within the Area of Potential Effect for the Tumalo Irrigation District – Irrigation Modernization Project.

Fish Species	Scientific Name	Origin
Bridgelip sucker	*Catastomus columbianus*	indigenous
Brook trout	*Salvelinus fontinalis*	introduced
Brown bullhead catfish	*Ictalurus nebulosus*	introduced
Brown trout	*Salmo trutta*	introduced
Bull trout	*Salvelinus confluentus*	indigenous
Chinook salmon	*Oncorhynchus tshawyscha*	indigenous
Chiselmouth	*Acrocheilus alutaceus*	indigenous
Largescale sucker	*Catastomus macrocheilus*	indigenous
Longnose dace	*Rhinichthys cataractae*	indigenous
Mountain whitefish	*Prosopium williamsoni*	indigenous
Northern pike minnow	*Ptychocheilus oregonensis*	indigenous
Rainbow trout	*Oncorhynchus mykiss*	introduced
Redband trout	*Oncorhynchus mykiss*	indigenous
Sculpin spp.	*Cottus* spp.	indigenous
Sockeye salmon/Kokanee	*Oncorhynchus nerka*	indigenous
Summer Steelhead	*Oncorhynchus mykiss*	indigenous
Three-spined stickleback	*Gasterosteus aculeatus*	introduced
Tui chub	*Gila (Siphateles) bicolor*	introduced

Notes:
Adapted from Starcevich 2016

Redband trout and mountain whitefish are indigenous species that are found in the entire area of potential effect including Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek. Brown trout, eastern brook, and tui chub trout are introduced species that are also found throughout the area of potential effect. Brown trout were introduced to the Deschutes Basin by state and federal agencies in the early 1900s. In Tumalo Creek, redband trout, brown trout, and eastern brook trout are the most abundant species (Starcevich 2016). Brown bullhead catfish and three-spined stickleback are distributed in the Deschutes River and the Little Deschutes River. Sculpin spp. has also been found within the area of potential effect (Starcevich 2016). Longnose dace, chiselmouth, largescale sucker, bridgelip sucker, and northern pike minnow are found in the Deschutes River between Lake Billy Chinook and Big Falls. All of these species are indigenous to the Deschutes River.

Rainbow trout is a managed species that has been stocked in the Deschutes River and its lakes and tributaries for over 100 years. In the 1990s, ODFW adopted the Wild Fish Policy and stopped stocking rivers with hatchery rainbow trout to protect populations of native redband trout (ODFW 1996). Rainbow trout are still found in areas of the Deschutes River and within the area of potential effect.

Between 2012 and 2014, Carrasco and Moberly found fish assemblages in the middle Deschutes River (RM 164.8 - 120) to include mountain whitefish, redband trout, brown bullhead, mottled sculpin, brown trout, tui chub, and bridgelip sucker. Mountain whitefish, redband trout, and brown trout were found to be the dominant species (Carrasco and Moberly 2014). This species assemblage is similar to the species that ODFW found in an electrofishing occupancy study (Starcevich 2016).

Historically, the Deschutes River had relatively consistent streamflows seasonally and annually (see Section 4.10.2). The steady streamflows created fish habitat with cold, clear water, and consistent hydrology. Since the late 1800s, changes to Deschutes River surface water flows, construction of fish passage barriers, and water management has created a very different aquatic environment with resulting changes to the fish species assemblages.

Elevated water temperatures in the middle Deschutes River negatively affect salmonid growth and survival (Recsetar et al. 2012). Availability of cold-water refugia 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. Water temperature changes to the area of potential effect are provided in Section 4.10.3.1.

Other aquatic species potentially found in the project area include Oregon spotted frog (see Section 4.2.2), bullfrog, western toad, Pacific treefrog, and long-toed salamander. The western toad, Pacific treefrog, and long-toed salamander are native to Oregon and may be present in open irrigation canals and adjacent banks where there is suitable vegetation (S. Wray, personal communication, November 17, 2017). The bullfrog is considered an invasive species that was introduced to Oregon in the early 1900s. Bullfrogs are voracious predators that eat any animal they can swallow. With the exception of the Oregon spotted frog listed as vulnerable, all of these amphibians are listed as species of least concern by the International Union for Conservation of Nature (IUCN 2017).

4.2.2 Federally Listed Fish and Aquatic Species

A list of species protected under the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.), as amended in 1988, that have the potential to occur within the area of potential effect was obtained using the USFWS Environmental Conservation Online System Information for Planning and Conservation. Federally listed fish and aquatic species that are known to occur in the area of potential effect are Oregon spotted frog, steelhead, and bull trout (USFWS 2017).

USFWS lists Oregon spotted frog as threatened under the ESA. The Oregon spotted frog and its designated critical habitat occurs upstream of the BFC within the area of potential effect for aquatic resources, primarily in the area of Crescent Creek and the Little Deschutes River (Figure 4-1). USFWS has identified primary constituent elements (PCEs) for Oregon spotted frog critical habitat (81 *Federal Register* 29335, 2016). PCEs represent biological and physical features that are essential to the conservation of a species, and they describe habitat components that support one or more life stages of the species. PCEs for Oregon spotted frog generally describe areas that have appropriate water depths and refuge from predators, aquatic connectivity, and absence of non-native predators. A detailed list of Oregon spotted frog Critical Habitat PCEs is provided in Appendix E.2.

USFWS also lists bull trout as threatened under the ESA, and critical habitat is designated. The PCEs for bull trout describe habitat that has aquatic connectivity, complex habitat structure, water temperatures ranging from 2 degrees Celsius (°C) to 15 °C, natural variability in streamflows, a sufficient food base, absence of non-native predatory and competing fish (70 *Federal Register* 56211, 2005). A detailed list of Critical Habitat PCEs for bull trout is provided in Appendix E.2. Although critical habitat for threatened bull trout has been designated downstream of the TFC diversion and within the area of potential effects to aquatic resources in the Deschutes River from Big Falls (RM 132) to Lake Billy Chinook (RM 120) (Figure 4-2), recent electrofishing for an occupancy study did not find evidence of bull trout in this section of the Deschutes River (Starcevich 2016).

Steelhead populations are listed as threatened under ESA and are present within the area affected by the project (see Section 4.2.1). However, the population in the Deschutes River (Middle Columbia River steelhead) is classified as a non-essential experimental population (NEP) under section 10(j) of ESA and critical habitat is not designated (76 *Federal Register* 28715, 2011). Because of this classification, and because the NEP is located outside of a National Wildlife Refuge System and a National Park System, the population is treated as "proposed for listing" under ESA section 7 (76 *Federal Register* 28715, 2011; 81 *Federal Register* 33416, 2016).

4.2.3 State Listed Species

The 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 Oregon Administrative Rule [OAR] 635-100-0105 (ODFW 2017a). There are no threatened, endangered, or candidate aquatic species known to occur within the irrigation canals or any other areas where work associated with the proposed action would occur.

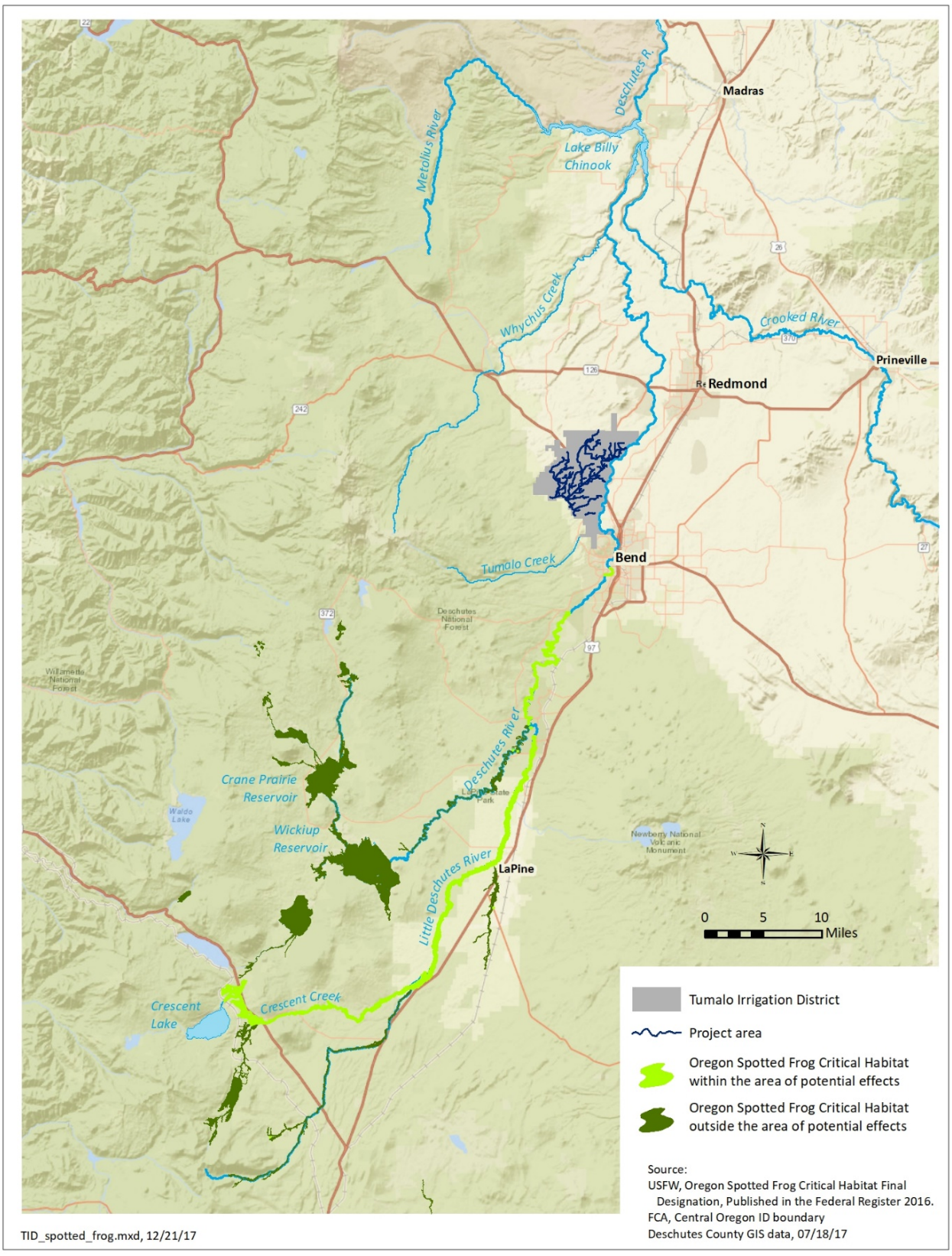


Figure 4-1. Oregon Spotted Frog Critical Habitat near the Tumalo Irrigation District.

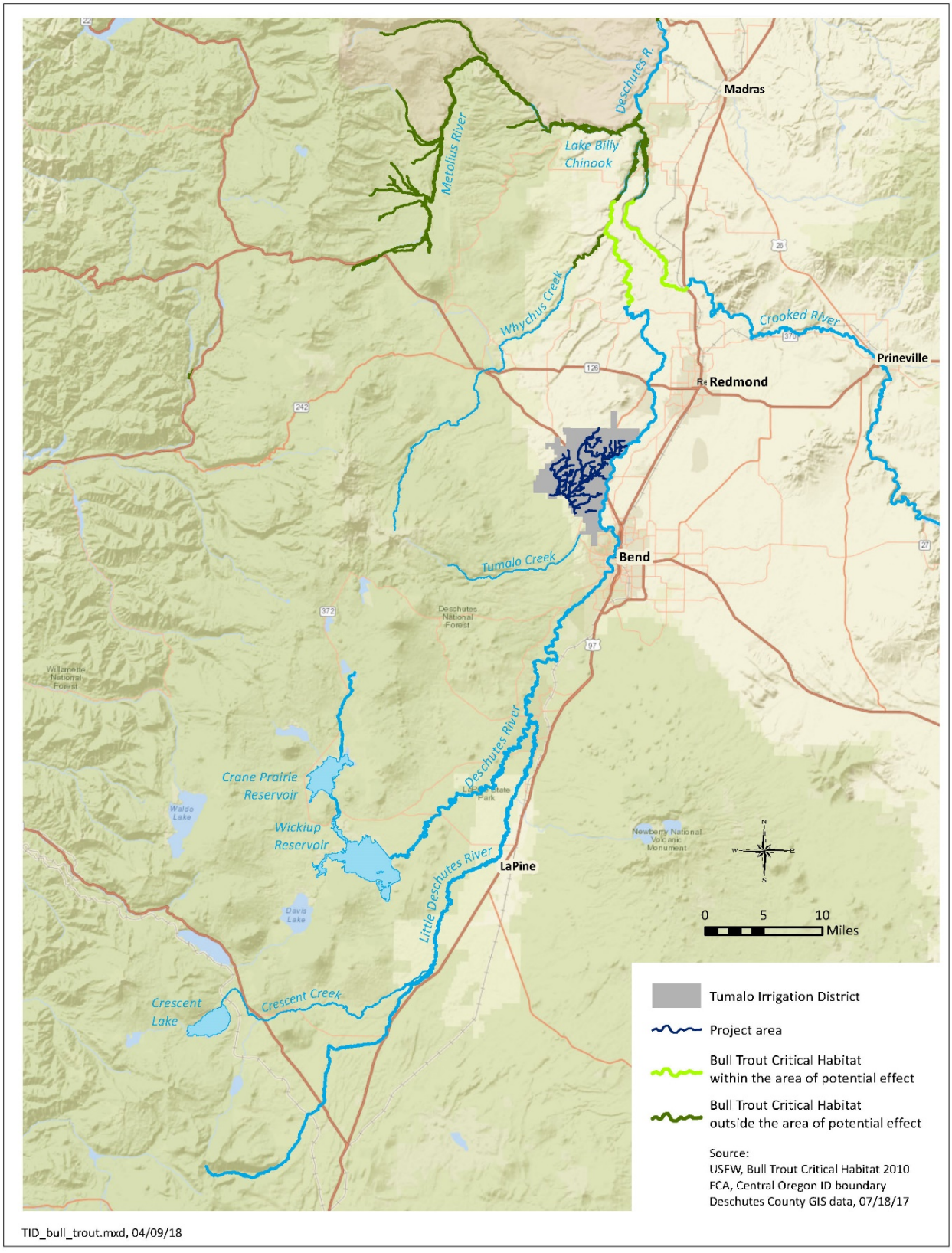


Figure 4-2. Bull Trout Critical Habitat near the Tumalo Irrigation District.

4.3 Geology and Soils

Effects on geology and soil resources as a result of the proposed action are not expected to extend beyond the project area; therefore, the area of potential effect is bound by the limits of the project area.

4.3.1 Geology

The project 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 Deschutes Formation is a result of these basalt flows that erupted from vents and fissures (Lite and Gannett 2012). The permeability of the Deschutes Formation is variable within the Deschutes Basin. In areas 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. 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 Gannett 2012). These layers of volcanic rock influence 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.

The project area is located at the interface of the Cascade Range and High Lava Plains physiographic provinces (Orr et al. 1992) and more specifically, just east of the High Cascade subprovince. 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. The peaks in the High Cascades that lie to the west of TID are Jefferson, Three Fingered Jack, Washington, the Three Sisters, Broken Top, Mt. Mazama, 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 Deschutes Formation. The geologic units found in the area of potential effect include basaltic to andesitic lava from the Pliocene and Miocene epochs, areas of sand and gravel deposits, as well as alluvium from the Pleistocene and some small areas of tuff deposits (Sherrod et al. 2004).

Geologic formations along TID's two primary diversion canals, the BFC and TFC, include basalt, volcanic ash tuff, cinder deposits, and sand and gravel deposits. Geology along the Columbia Southern Canal and its laterals are primarily sand and gravel deposits and basalt. The Highline and Couch Laterals and their sub-laterals overtop either basalt or sand and gravel deposits. Figure 4-3 presents a general geologic map of the District.

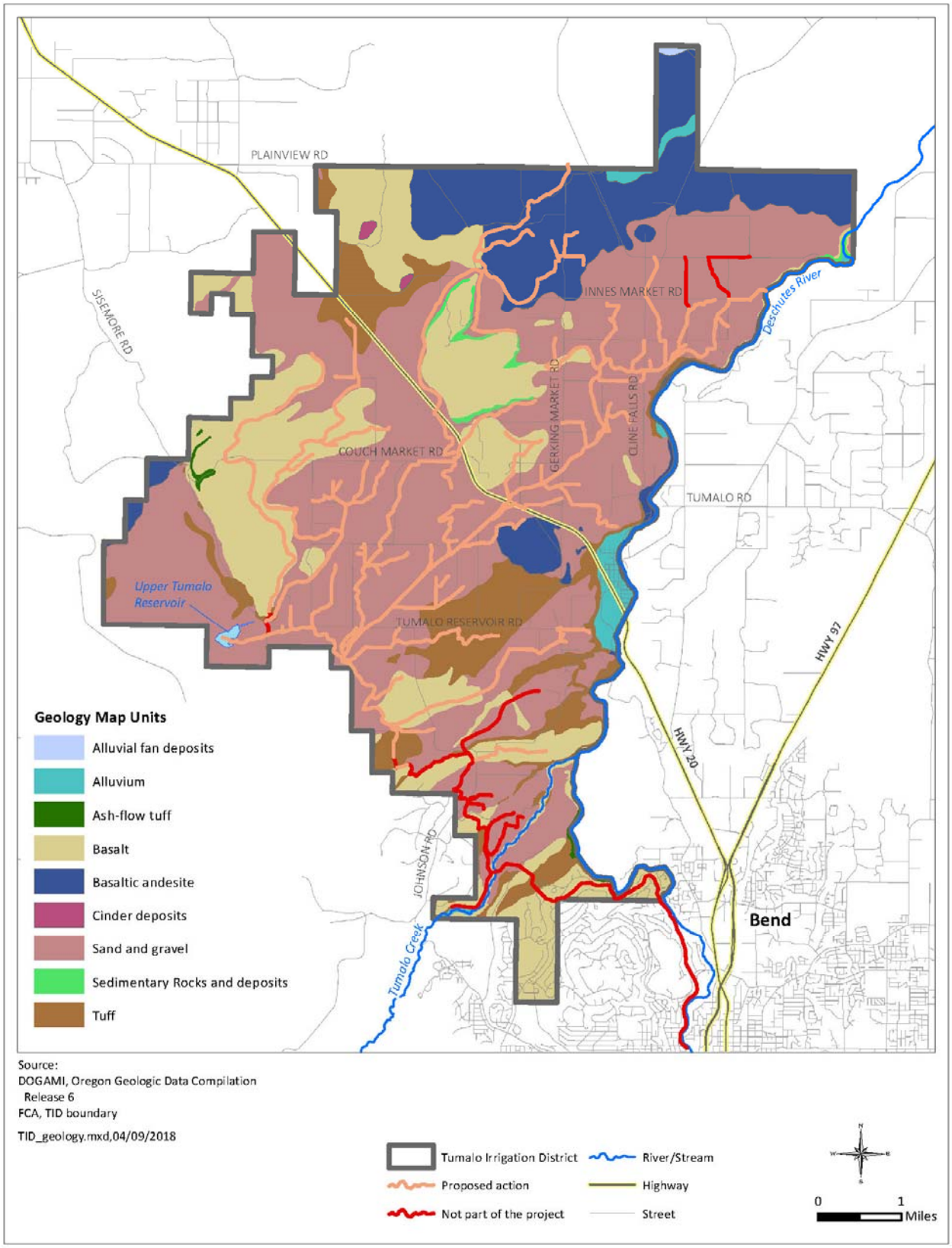


Figure 4-3. Geologic Formations in the Tumalo Irrigation District.

Geologic hazards in the project area include the potential liquefaction of soil that may occur during an earthquake. Areas that are susceptible to liquefaction include wet or low-lying areas or unconsolidated sediments. In portions of the project area with basalt formations, liquefaction susceptibility is generally low. Areas of the project area primarily overlain with gravel and sand deposits are more susceptible to liquefaction. There are some mapped areas with a low to moderate landslide risk within the project area (Burns et al. 2016). Areas with moderate landslide risk within the project area include Highline Canal, Lacy and Parkhurst Laterals off the TFC, the West Branch Canal, the Beasely Lateral of the West Branch, and the Hillburner Lateral of the Columbia Southern Canal (Burns et al. 2016). Additionally, there are areas of high landslide risk; these areas are primarily along the eastern border of the District paralleling the Deschutes River and are not crossed by the project area.

4.3.2 Soils

The underlying material of District lands is generally basalt and andesite, with areas of alluvium and volcanic ash deposits. Soil surface layers consisting of sandy loam and Tumalo sandy loam is the most common soil in the District (NRCS 2015b). Much of the Tumalo sandy loam occurs in areas between mounds and ridges of outcropping lava, which are characteristic of the upland plains east of the Cascades. Tumalo 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. The sandy loam soils are moderately deep and 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.

The parent materials for Tumalo sandy loam soils are primarily derived from ash and pumice deposited from past volcanic eruptions. Pumice and ash tephras were expelled during eruptions like that of Mt. Mazama and the other High Cascade mountains. The ash and pumice deposits fell on previously developed soils. Almost all of the bedrock materials beneath the soils are extrusive volcanic rocks (NRCS 2015). 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 and influence the availability and content of nutrients within the soil profile. Hydric soil materials line the open canals and laterals in some areas of the District. NRCS defines hydric soils as soils permanently or seasonally saturated by water to develop anaerobic conditions. Hydric soils were added to reduce seepage and do not reflect the natural profile of soils surrounding the project area. Figure 4-4 and Figure 4-5 present existing soil types within the District.

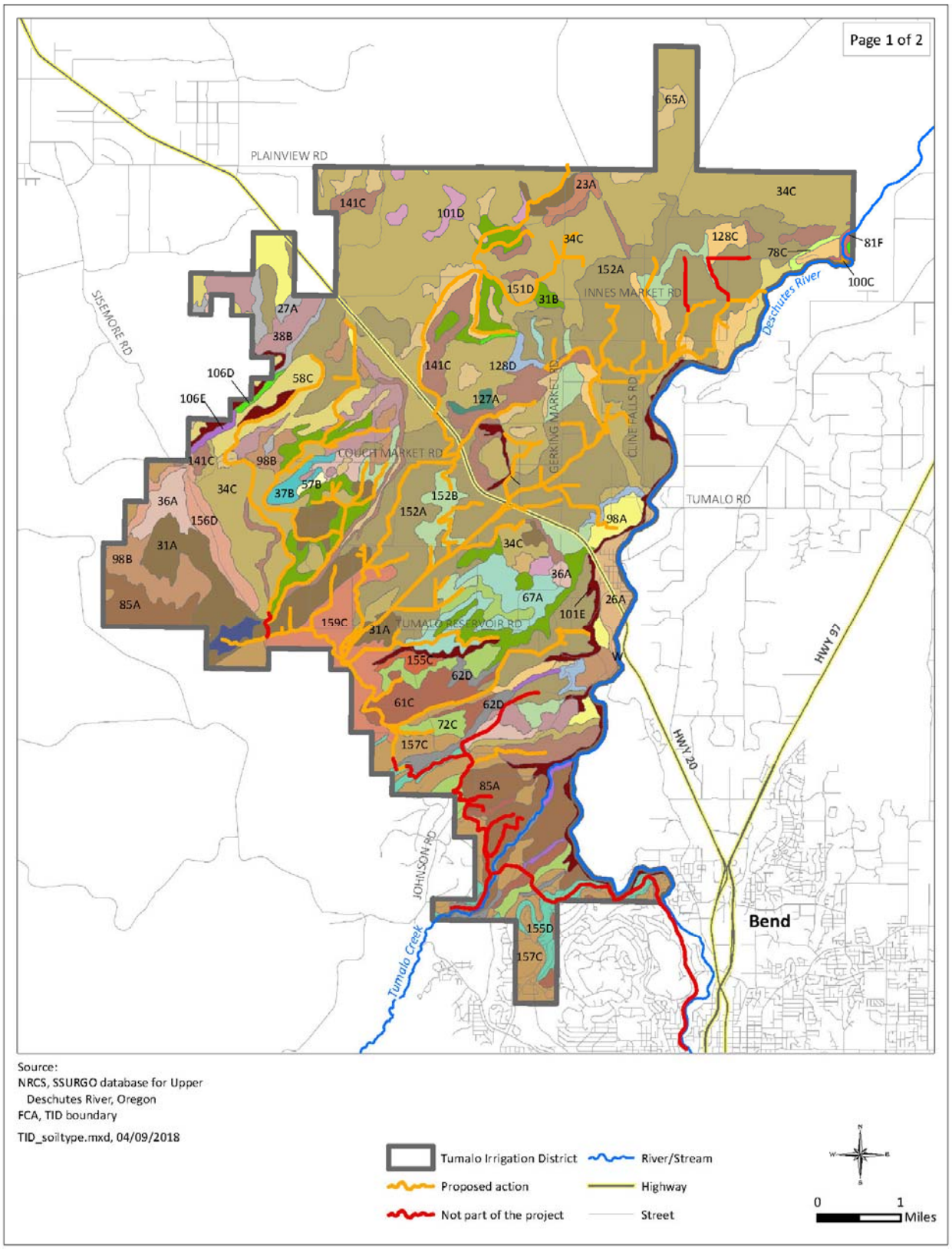


Figure 4-4. General Soil Types in Tumalo Irrigation District.

NRCS Map Unit Descriptions

Map Unit Symbol	Map Unit Name
23A	Buckbert sandy loam, 0 to 3 percent slopes
26A	Clinefalls sandy loam, 0 to 3 percent slopes
27A	Clovkamp loamy sand, 0 to 3 percent slopes
31A	Deschutes sandy loam, 0 to 3 percent slopes
31B	Deschutes sandy loam, 3 to 8 percent slopes
34C	Deschutes-Stukel complex, 0 to 15 percent slopes
36A	Deskamp loamy sand, 0 to 3 percent slopes
37B	Deskamp sandy loam, 3 to 8 percent slopes
38B	Deskamp-Gosney complex, 0 to 8 percent slopes
57B	Gosney stony loamy sand, 3 to 8 percent slopes
58C	Gosney-Rock outcrop-Deskamp complex, 0 to 15 percent slopes
61C	Henkle-Fryrear-Lava flow s complex, 0 to 15 percent slopes
62D	Henkle-Lava flow s-Fryrear complex, 15 to 50 percent slopes
65A	Houstake sandy loam, 0 to 3 percent slopes
67A	Houstake sandy loam, very gravelly substratum, 0 to 3 percent slopes
72C	Laidlaw sandy loam, 0 to 15 percent slopes
78C	Lickskillet-Deschutes complex, 0 to 15 percent slopes
81F	Lickskillet-Rock outcrop complex, 45 to 80 percent slopes
85A	Lundgren sandy loam, 0 to 3 percent slopes
98A	Plainview sandy loam, 0 to 3 percent slopes
98B	Plainview sandy loam, 3 to 8 percent slopes
100C	Redcliff-Lickskillet complex, 0 to 15 percent slopes
101D	Redcliff-Lickskillet-Rock outcrop complex, 15 to 30 percent south slopes
101E	Redcliff-Lickskillet-Rock outcrop complex, 30 to 50 percent south slopes
106D	Redslide-Lickskillet complex, 15 to 30 percent north slopes
106E	Redslide-Lickskillet complex, 30 to 50 percent north slopes
127A	Statz sandy loam, 0 to 3 percent slopes
128C	Statz-Deschutes complex, 0 to 15 percent slopes
128D	Statz-Deschutes complex, 15 to 30 percent slopes
141C	Stukel-Deschutes-Rock outcrop complex, 0 to 15 percent slopes
151D	Tetherow -Clovkamp complex, 8 to 50 percent slopes
152A	Tumalo sandy loam, 0 to 3 percent slopes
152B	Tumalo sandy loam, 3 to 8 percent slopes
155C	Wanoga sandy loam, 0 to 15 percent slopes
155D	Wanoga sandy loam, 15 to 30 percent slopes
156D	Wanoga-Fremkle-Henkle complex, 15 to 30 percent slopes
157C	Wanoga-Fremkle-Rock outcrop complex, 0 to 15 percent slopes
159C	Wilt sandy loam, 0 to 15 percent slopes
W	Water

Source:
NRCS, SSURGO database for Upper Deschutes River, Oregon

TID_soiltypelegend.mxd, 08/09/17

Figure 4-5. Legend for General Soil Types in Tumalo Irrigation District.

4.3.2.1 Farmland Classification

NRCS developed technical soil groups related to any environmental concerns that are associated with a particular soil type and a soil's rating for agricultural commodity production (NRCS 2015b). Using the NRCS soil mapping tool, the following soil groupings within TID were identified: prime farmland, farmland of statewide importance, and non-prime farmland.

Prime Farmland: Land designated with a prime farmland soil group has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. NRCS has developed further classifications under prime farmland as follows:

- Prime farmland if irrigated
- Prime farmland if irrigated and drained
- Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated and the product of soil erodibility (I) times (x) the climate factor (C) does not exceed 60

Farmland of Statewide Importance: Land that does not meet the criteria for prime farmland is considered "farmland of statewide importance." This land has characteristics that nearly meet prime farmland requirements and, when managed appropriately, can produce economically high crop yields.

Over 84 percent of the District is considered either farmland of statewide importance or prime farmland if irrigated. Table 4-3 presents the area and fraction of the District that are classified under each respective soil grouping. Figure 4-6 presents these soil groupings in map form.

Table 4-3. NRCS Classification of Farmlands within the Tumalo Irrigation District.

Farm Class	Area (acres)	Area (%)
Farmland of Statewide Importance	14,238	51
Non-Prime Farmland	1,694	6
Prime Farmland If Irrigated	12,032	43
Grand Total	**27,964**	**100**

4.3.2.2 Erosion Susceptibility

Erosion hazards include areas covered by soils with a high susceptibility to erosion as classified by NRCS. NRCS determines the erosion hazard class of an area by considering slope and select soil properties that may include cohesion, drainage, and the organic content of the soil. Within TID, approximately 84 percent of the soils are classified with a high erosion potential. Figure 4-7 presents the areas within TID with a high erosion potential.

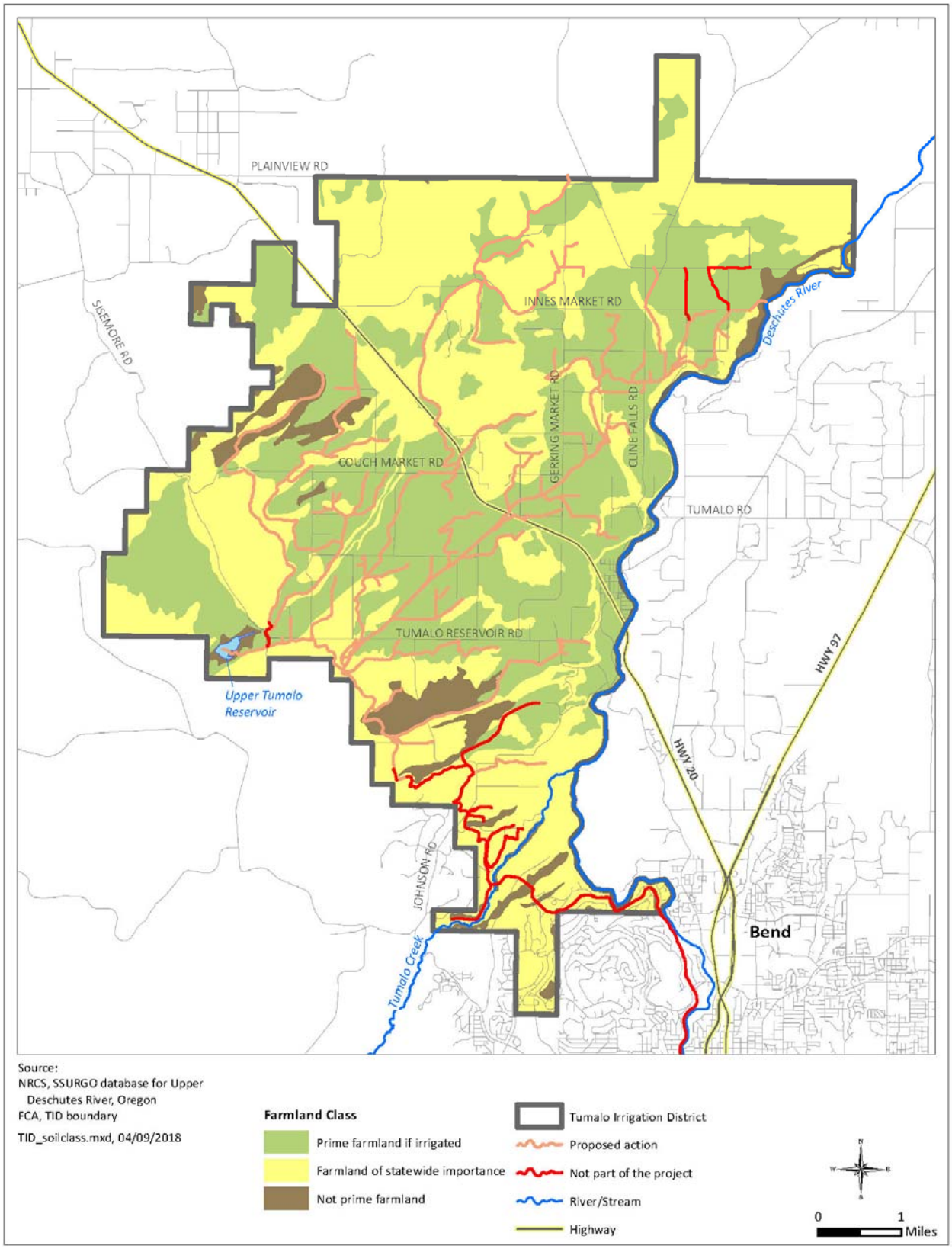


Figure 4-6. NRCS Classification of Farmlands within the Tumalo Irrigation District.

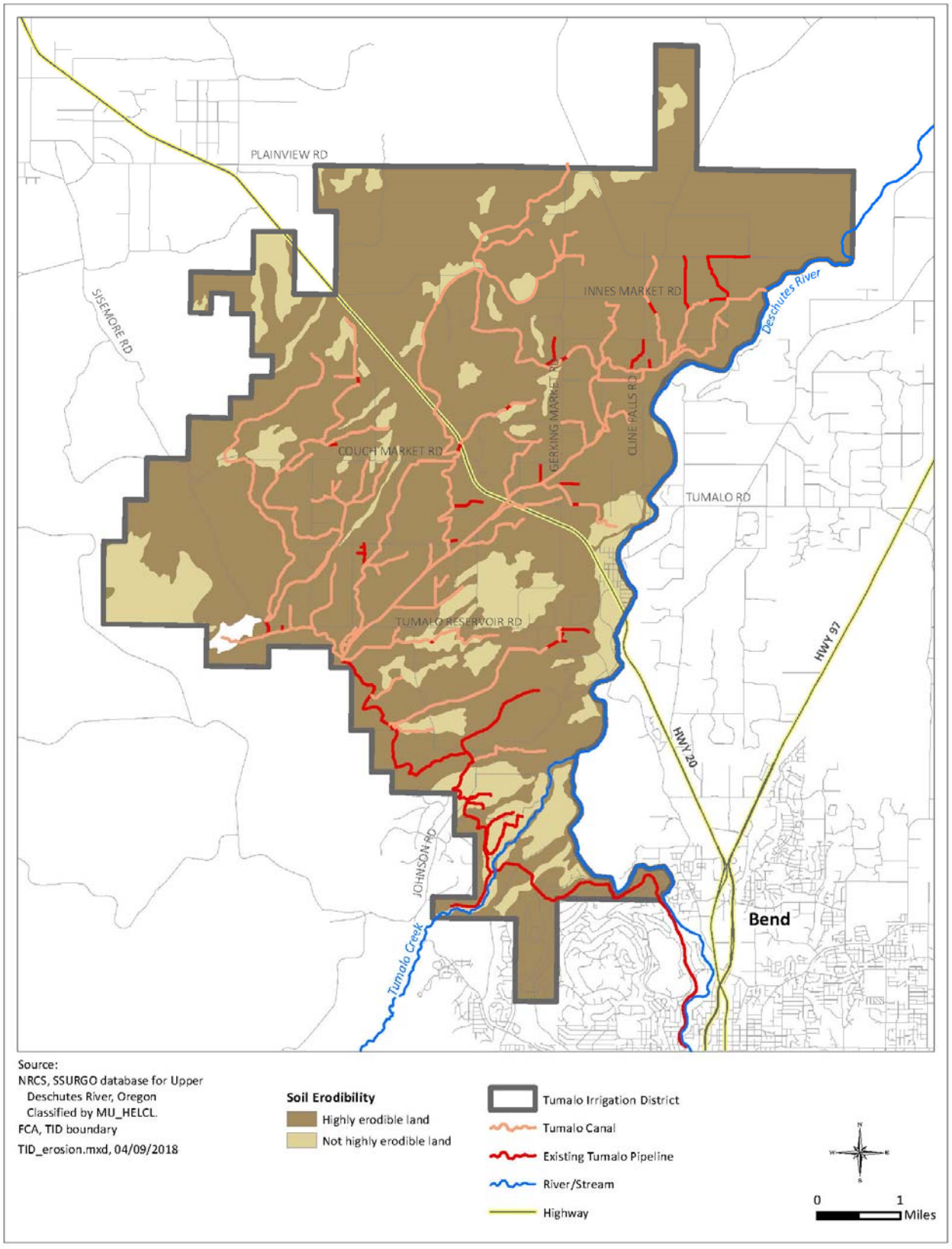


Figure 4-7. Erosion Potential of Soils in the Tumalo Irrigation District.

4.4 Land Use

Effects on land use are expected to extend beyond the project area to include all land served by the District.

4.4.1 ROW Land Use

Land use within the ROW consists of the conveyance of irrigation water as well as O&M of the irrigation system. However, in certain areas throughout the District there is informal and formal use of the ROW for recreation (see Section 4.6).

4.4.2 District Land Use

Land uses adjacent to TID's ROW are primarily irrigated land and land left undeveloped. Data from TID's SIP and the National Land Cover Dataset and corresponding land cover classes were used to indicate the land use. Table 4-4 shows the percentages of land uses within the District and that the project area crosses. Land use is also represented in land cover data shown in Figure 4-8.

Table 4-4. Land Use within Tumalo Irrigation District and Crossed by the Project Area.

Land Use Type	Area within TID (acres)	Percent Area of TID	Percentage of Total Proposed Action Length Crossing the Area[5]
Agriculture[1] (irrigated acres)[2]	7,417	27%	31%
Developed[3]	2,622	9%	11%
Undeveloped[4]	17,925	64%	58%
Total	**27,964**	**100%**	**100%**

Notes:
1. The NLCD data classified 5,983 acres as agriculture. Because more precise and current data on irrigated acres were available through the District, 7,417 acres was used to more accurately portray agricultural land use. The difference between these two numbers was taken out of the acres shown as Undeveloped Land.
2. Irrigated acres in the Tumalo Irrigation District (TID 2017). The proposed action would only affect 7,002 of the total irrigated acres.
3. Developed open space, high, medium, and low intensity development within TID; the project area only runs adjacent to low intensity and developed open space.
4. Shrub/scrub, barren land, evergreen forest, herbaceous, open water, woody wetlands
5. These numbers are approximate; in multiple areas, lengths of proposed action are simultaneously adjacent to both undeveloped land and agricultural land, but only one land use category could be considered in the calculations.

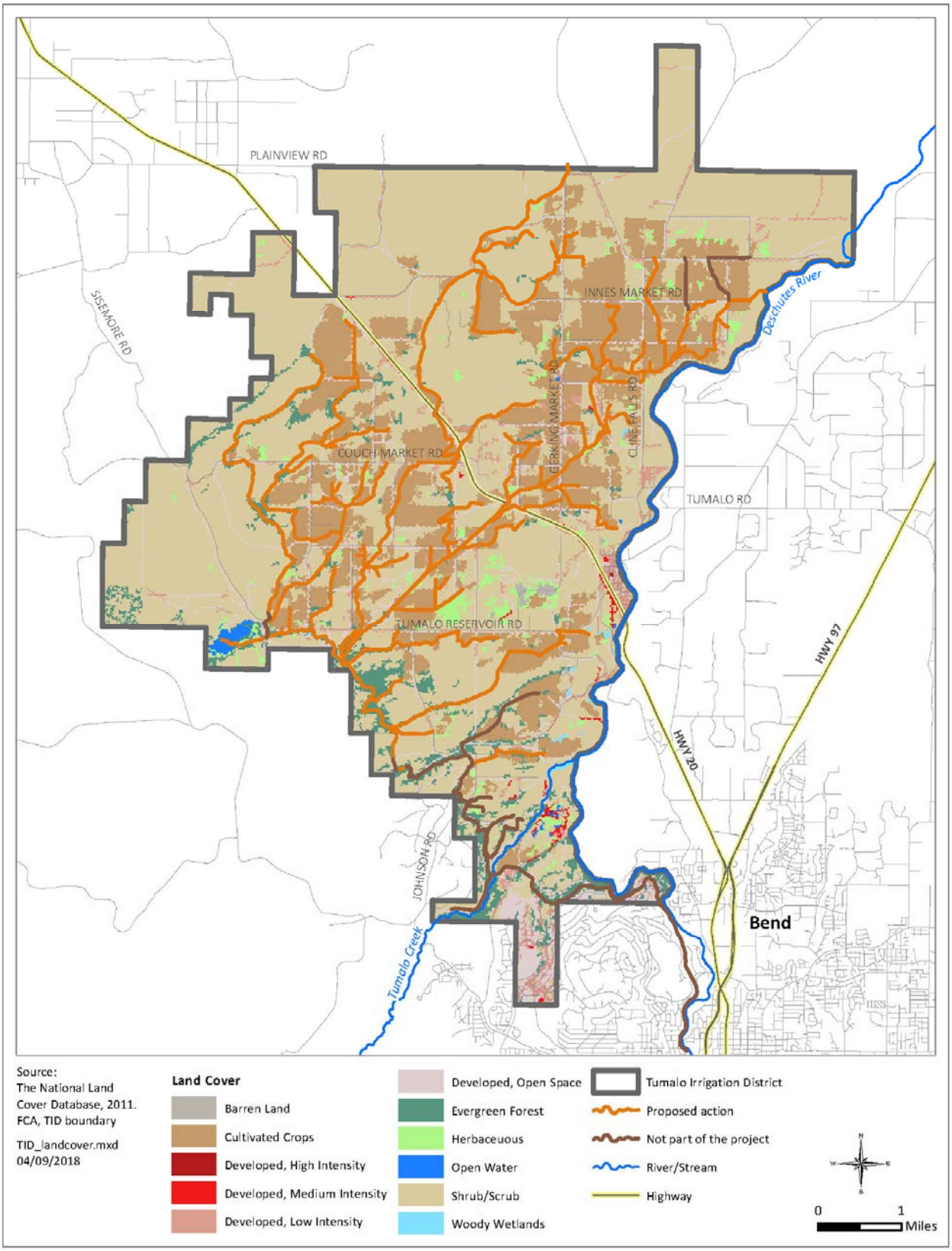


Figure 4-8. Land Cover in the Tumalo Irrigation District.

The primary crops grown on agricultural land within TID are hay, alfalfa, pasture, grains, and specialty crops. The majority of TID patrons irrigate parcels smaller than five acres. Farmers typically get two to three cuttings per year of hay and pasture grass (TID 2017). The agricultural land is primarily zoned as Exclusive Farm Use (EFU). The EFU designation is meant to maintain the agricultural economy of the state as well as assure the adequate provision of healthy food. The county is required to inventory and protect farmlands under Statewide Goal 3, Agricultural Land, ORS 215, and OAR 660-033. The EFU designation serves to accomplish Statewide Goal 3 and the Deschutes County Comprehensive Plan Goal 1. In 1992, Deschutes County identified seven EFU subzones based on the average number of acres irrigated. The District includes lands within both the Sisters/Cloverdale Subzone and Tumalo/Bend/Redmond Subzone. Parcels within the subzones must retain at minimum a specific number of irrigated acres per the type of farmland (Deschutes County 2010). As Bend, Redmond, and other towns in the region have grown and farmers have faced rising challenges of water shortages and drought, there has been increasing pressure on the conversion of agricultural lands.

4.4.3 District Land Ownership

The District's ROW is primarily adjacent to privately owned land (Table 4-5 and Figure 4-9). A small number of canals and laterals cross public land that is managed by the State of Oregon, Bureau of Land Management (BLM), and Bend Parks and Recreation District. Project activities would not occur on or affect lands owned by the U.S. Forest Service, National Park Service (NPS), Oregon Department of Parks and Recreation, Deschutes County, or other entities. Therefore, these lands are not discussed further.

Table 4-5. Land Ownership within the Tumalo Irrigation District.

Land Owner	Area within TID (acres)	Percentage of TID	Percentage of Total Proposed Action Length Crossing the Area
Private	21,530	77%	89%
U.S. Forest Service	45	.2%	0%
State of Oregon	1,219	4.4%	3%
U.S. Department of the Interior Bureau of Land Management	4,466	16%	7%
Oregon Department of Parks and Recreation	178	.6%	0%
Bend Parks and Recreation District	345	1.2%	1%
Deschutes County	181	.6%	0%
Total	**27,964**	**100%**	**100%**

The project area crosses the BLM's Peck's milkvetch Area of Critical Environmental Concern (ACEC), land that has been left undeveloped and is managed to not impair Peck's milkvetch habitat and populations (BLM 2005). Additionally, the project area crosses BLM land with an informal trail running alongside the Tumalo Reservoir Feed lateral. Land falling within the BLM Peck's milkvetch

ACEC and additional BLM parcels crossed by TID's system are managed according to the BLM, Upper Deschutes Record of Decision and Resource Management Plan (BLM 2005). The project area also crosses Tillicum Regional Park/Chase Ranch, which is owned and managed by Bend Parks and Recreation District. An additional parcel crossed by the project is owned by the State of Oregon but not under any current management plan.

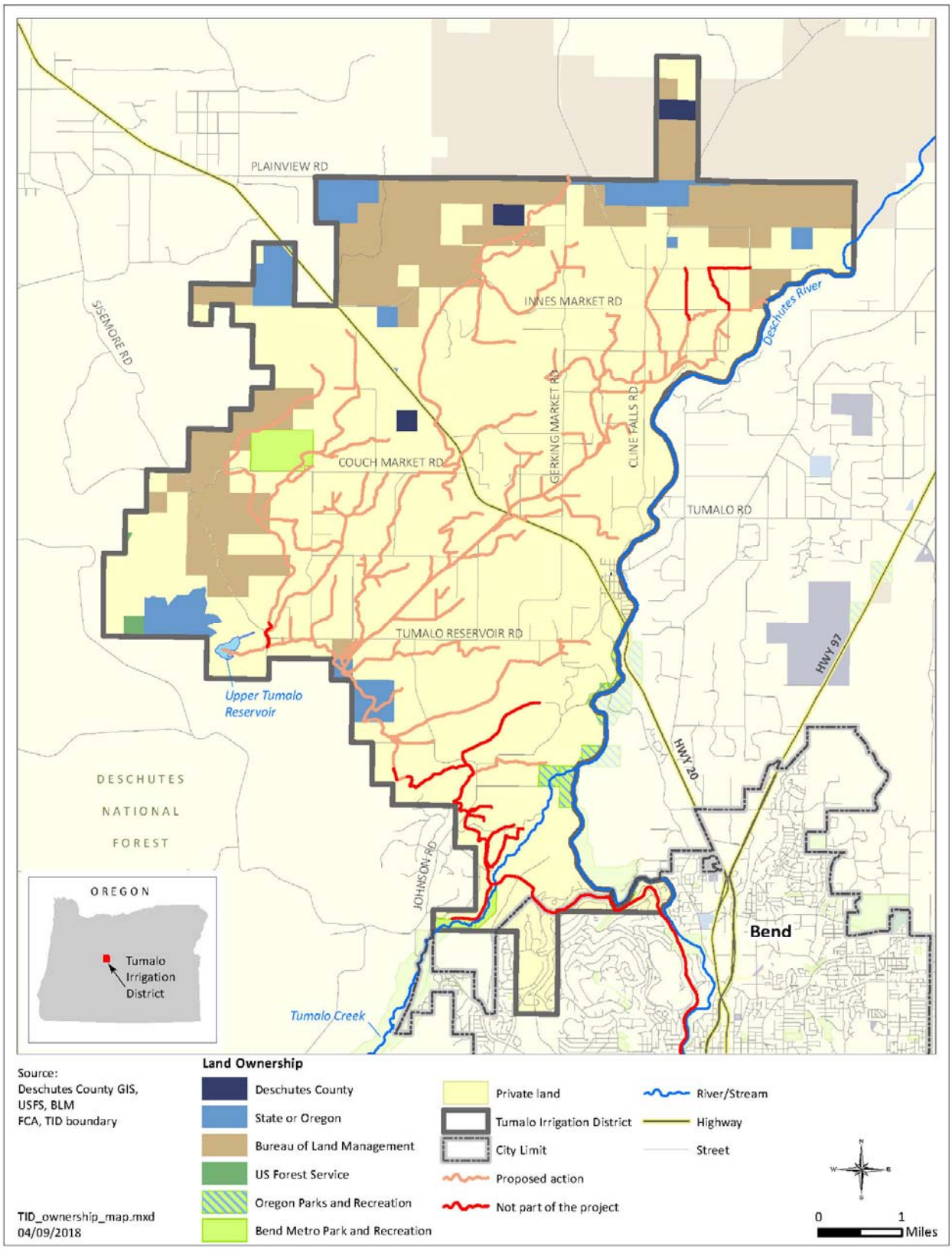


Figure 4-9. Land Ownership within Tumalo Irrigation District.

4.5 Public Safety

Effects to public safety are not expected to extend beyond the limits of the project area; therefore, the area of potential effect and project area are identical.

The District has approximately 65.1 miles of open canals that are accessible to the public. These canals pose a risk to public safety when they carry water. During the summer months when irrigation water is flowing at peak volume in the canals, water depths range between 2 to 6 feet and velocities range up to 5 feet per second. These conditions result in areas of deep, swift water that can make it difficult for a child or non-swimmer to get to safety and can result in tragic outcomes. In addition to multiple instances of injury, several drowning deaths have occurred in neighboring districts' canals in 1996, 1997, and 2004 (Flowers 2004). The District canals' route through urban areas, rural residential areas, and private lands heightens the potential for accidents.

4.6 Recreation

The area of potential effect for recreation includes the project area and waterbodies that could be affected by the project (see Table 4-1 in Section 4.2 for the list of waterbodies and their associated river miles). In 2015, visitors spent $660.2 million in Deschutes County, the fourth highest amount among Oregon counties (Dean Runyan Associates 2015). Recreation opportunities within TID include trails and parks. Rivers in the surface water area of potential effect, as described in Section 4.10.2, are used for a variety of recreation activities. The District's canals and laterals do not contain fish due to functioning fish screens at the District's diversions on Tumalo Creek and the Deschutes River. Use of the canals and laterals to fish, swim, float, or pursue any other activities that are not a function of the District is prohibited.

4.6.1 Trail and Bikeway Activities

The Deschutes River Trail, operated by Bend Park and Recreation District (BPRD), is a popular walking, hiking, and biking trail. In 2002, TID partnered with BPRD to allow expansion of the trail system along the piped section of the BFC (BPRD 2017a).

The District's maintenance roads are used regularly by hikers, bikers, runners, and horseback riders where the ROW is not fenced by property owners. While using the maintenance roads, the trail users have views of the irrigation canals and the surrounding area. Although the District does not prohibit public use of the maintenance road, users are technically trespassing on District or private land. The exception is on maintenance roads included in the Bend Urban Trails Plan joint-use agreement between TID and BPRD. An informal trail on BLM land runs along the Tumalo Reservoir Feed lateral, with the potential of BLM building a new trailhead in the near future.

Biking also occurs on public roads that intersect the project area. Twin Bridges Scenic Bikeway is a popular bike route with a high volume of traffic. This Bikeway is a 36-mile loop that begins at Drake Park in Bend. The route passes through Shevlin Park, the community of Tumalo, and to the east of Tumalo Reservoir (Deschutes County 2017a). The Bikeway crosses TID's canals and laterals that would be modernized under the proposed action at multiple points (see Figure 4-10).

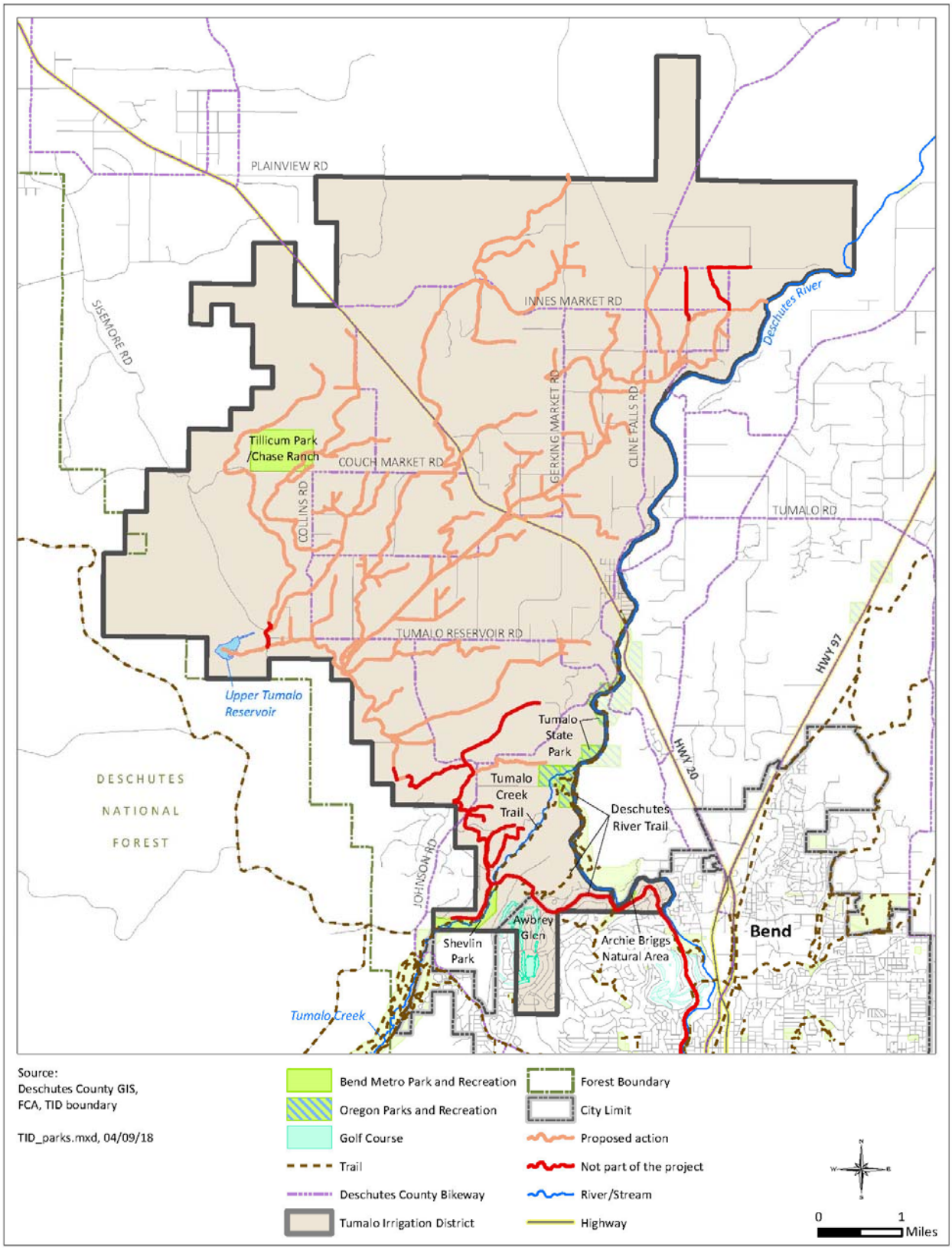


Figure 4-10. Recreation Including Parks, Trails, and Bikeways in the Tumalo Irrigation District.

4.6.2 Park Activities

Three parks are adjacent to the project area: Shevlin Park, Tumalo State Park, and Tillicum Regional Park/Chase Ranch. Tumalo State Park is bisected by the Deschutes River and is a popular area for wading, swimming, and inner-tubing (OPRD 2017). The western side of the park falls within TID; no canals or laterals that are included with the proposed action pass through the park. Shevlin Park is a 652-acre regional park with a small section falling within TID's boundaries. Tumalo Creek flows through the park, which is used for hiking, biking, events, and other recreational activities (BPRD 2017b). The Tumalo Diversion Dam is located 0.5 mile downstream from the park. Tillicum Regional Park/Chase Ranch is managed by BPRD. A house onsite is rented to BPRD employees. There are no established walking trails, but people use the Park to walk their dogs as well as fly drones and model planes (S. Sulia, personal communication, July 5, 2017). Laterals that would be modernized under the proposed action (i.e., the West Couch Lateral, Highline Lateral, and Chambers Ditch) are located within the southeast section of Tillicum Regional Park/Chase Ranch.

4.6.3 River Activities

Waterbodies downstream of the District's diversions include the Deschutes River and Tumalo Creek. These stretches of river provide opportunities for many types of recreational activities including rafting, kayaking, floating, stand up paddle boarding, and fishing. Two stretches of river within the area of potential effect are designated through the Oregon Scenic Waterways Act (Oregon Revised Statute [ORS] 390.826) as Recreational River Areas: (1) the Deschutes River from the northern Urban Growth Boundary of the City of Bend at approximately river mile 161 downstream to Tumalo State Park at approximately river mile 158; (2) the Deschutes River from Harper Bridge (RM 190.6) to the intersection of the Deschutes National Forest boundary at RM 184.8. These two scenic waterway reaches have been designated Recreation River Areas due to their accessibility and are managed to allow for compatible recreational uses (see Section 4.13 for further discussion). Tumalo Reservoir, located within TID, has been closed to recreation and public access since 1988 (Rieck 2016).

4.7 Socioeconomic Resources

The area of potential effect for socioeconomics is Deschutes County. The area of potential effect includes the communities of Bend, Redmond, and Tumalo (Figure 4-11).

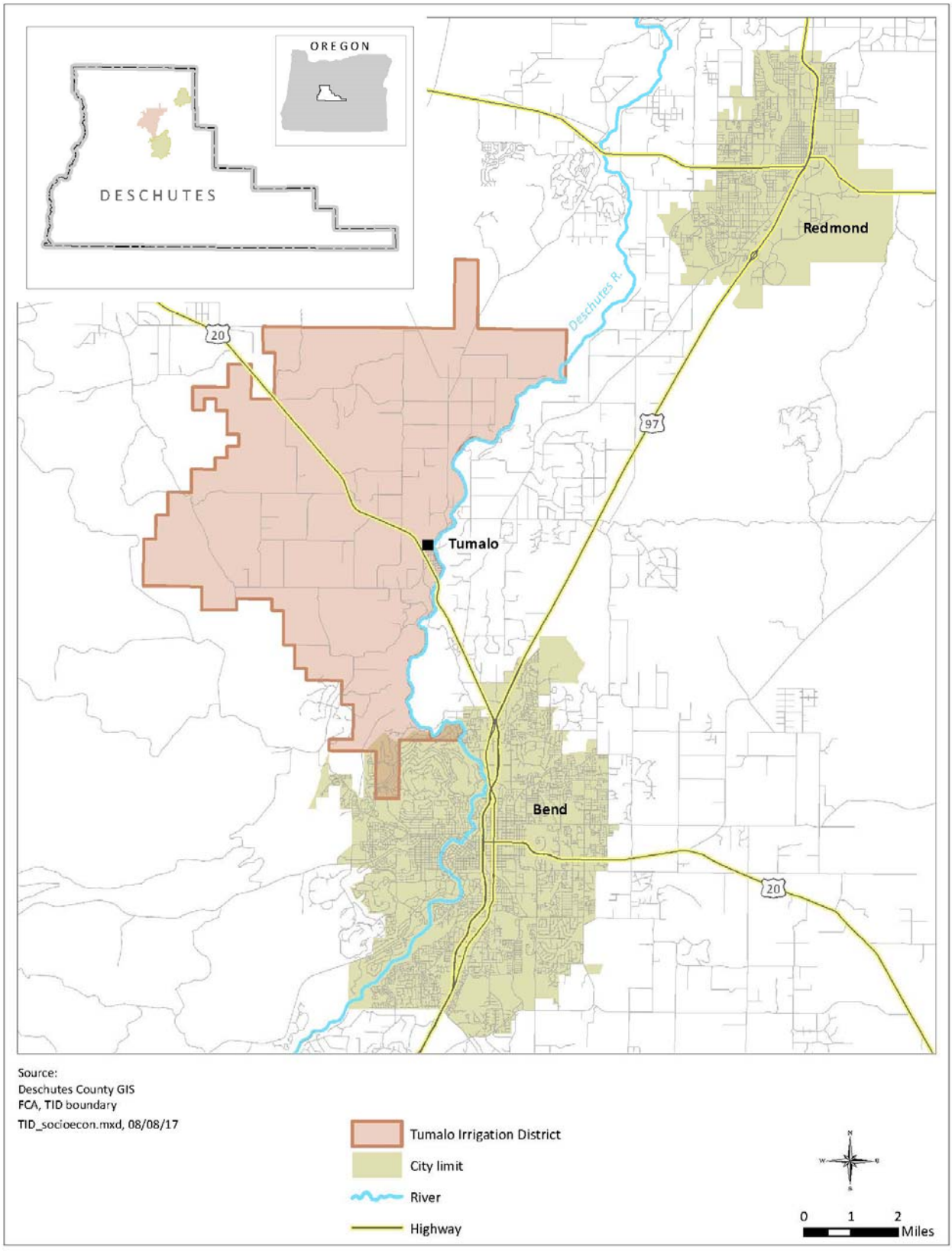


Figure 4-11. Location of the Tumalo Irrigation District within the Socioeconomic Area of Potential Effect.

4.7.1 Population

Generally, the area of potential effect has seen consistent growth over the past 10 years (2005 to 2015). The county has grown by 14 percent between 2005 and 2015, while the state had a growth rate of 8 percent during the same period of time (U.S. Census Bureau 2015). Table 4-6 shows population estimates for Deschutes County; the nearby communities of Redmond, Bend, and Tumalo; and the State of Oregon. The Oregon Office of Economic Analysis estimates that Deschutes County could reach a population of 241,223 by 2040.

Table 4-6. Population Characteristics by City, County, and State.

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				
Deschutes County	143,490	166,622	14%	56
Cities and Towns				
Redmond	20,010	27,450	37%	1,635
Bend	70,330	87,017	24%	2615
Tumalo	393[3]	538	37%	314
State				
Oregon	3,631,440	3,939,233	8%	40

Notes:
Sources: 1. U.S. Census Bureau 2005; 2. U.S. Census Bureau 2015; 3. U.S. Census Bureau 2010. Data for the population in 2005 was unavailable for Tumalo; population estimate shown is from 2010.

Ethnicity and race are shown for the area of potential effect in Table 4-7. Deschutes County is predominantly white with all other races accounting for less than 13 percent of the population. Deschutes County contains a lesser percent of persons identifying as Hispanic or Latino than the state and national average. In Deschutes County, the percent of persons identifying as American Indian or Alaska Native exceed the state percentage and is similar to the national level.

Table 4-7. Race by County, State, and U.S., 2015.

Population Criteria	Unit	Deschutes County	Oregon (State)	United States
Total Population		166,622	3,939,233	316,515,021
White	Number	146,449	3,043,010	197,258,278
	Percent	87.9%	77.2%	62.3%
African American	Number	734	69,105	38,785,726
	Percent	0.4%	1.8%	12.2%
Hispanic or Latino	Number	12,831	485,646	54,232,205
	Percent	7.7%	12.3%	17.1%
Asian	Number	1,969	154,496	16,054,074
	Percent	1.2%	3.9%	5.1%
American Indian or Alaska Native	Number	890	36,347	2,078,613
	Percent	0.5%	0.9%	0.7%
Native Hawaiian or Pacific Islander	Number	166	14,334	499,531
	Percent	0.1%	0.4%	0.2%
Identified Two or more races	Number	3,558	130,767	6,968,165
	Percent	2.1%	3.3%	2.2%
Some Other Race Alone	Number	25	5,528	638,429
	Percent	0.0%	0.1%	0.2%

Notes:
Source: U.S. Census Bureau 2015

4.7.2 Area Employment and Income

The economy within the area of potential effect is described by employment/unemployment numbers, employment by industry, income, and agricultural activity. Table 4-8 summarizes employment by industry classification. Educational services, health care and social assistance provides the highest number of employment positions throughout the county.

Table 4-9 demonstrates the labor force characteristics for Deschutes County and Oregon in 2017. Unemployment is lower in Deschutes County than the state average.

Table 4-8. Employment by Industry and Percent Employment Rates in the Project Area, 2015.

	Oregon		Deschutes County	
Employment Sectors	**Number of People**	**Percent of Oregon Employment**	**Number of People**	**Percent of County Employment**
Agriculture, forestry, fishing and hunting, and mining	60,535	3.4%	2,330	3.1%
Construction	99,157	5.5%	5,306	7.1%
Manufacturing	204,094	11.4%	6,403	8.6%
Wholesale trade	51,908	2.9%	1,358	1.8%
Retail Trade	215,805	12.1%	9,619	12.9%
Transportation, warehousing, and utilities	73,724	4.1%	2,013	2.7%
Information	33,058	1.8%	2,159	2.9%
Finance and insurance, real estate, rental, and leasing	102,145	5.7%	4,327	5.8%
Professional, scientific, management, and administrative and waste management services	190,080	10.6%	8,554	11.5%
Educational services, health care, and social assistance	413,562	23.1%	15,472	20.7%
Arts, entertainment, recreation, accommodation, and food services	176,909	9.9%	10,046	13.5%
Other services (except public administration)	88,177	4.9%	4,450	6.0%
Public administration	80,653	4.5%	2,562	3.4%
Total Employed- all sectors	**1,789,807**	**100%**	**74,599**	**100%**

Notes:
Source: U.S. Census Bureau 2015

Table 4-9. Labor Force Characteristics of Deschutes County Compared to the State of Oregon, 2017.

Indicator	**Deschutes County**	**Oregon (State)**
Labor Force	93,444	2,104,077
Employed	89,625	2,017,292
Unemployed	3,820	86,786
Unemployment Rate	4.1%	4.1%

Notes:
Source: USBLS 2017

Household income and persons living below the poverty level are summarized in Table 4-10. Information is presented for two income indicators: median household income and per capita income. Income in Deschutes County is the same as median income in the State of Oregon; however, both are comparable to the median income in the U.S. The percent of persons living below poverty in Deschutes County is similar to that of the U.S. but slightly lower than the state.

Table 4-10. Income and Poverty Rates in Deschutes County as Compared to the State of Oregon, 2015.

Indicator	Deschutes County	Oregon (State)	United States
Median Household Income	$51,223	$51,243	$53,889
Per Capita Income	$29,158	$27,684	$28,930
Persons in Poverty	14.6%	16.5%	15.5%

Notes:
Source: U.S. Census Bureau 2015

4.7.3 Agricultural Statistics

Table 4-11 presents summarized agricultural information for Deschutes County from the 2012 USDA Census of Agriculture (USDA 2012) and the 2007 USDA Census of Agriculture (USDA 2007). The top crop item produced in the county by acreage is forage (defined as all hay and haylage, grass silage, and greenchop).

Table 4-11. Agricultural Statistics Associated with Deschutes County.

Agricultural Statistic	2012	2007	Percent Change
Number of Farms	1,283	1,405	-9.5%
Land in Farms (acres)	131,036	129,369	1.3%
Average Size of Farm (acres)	102	92	9.8%
Median Size of Farm (acres)	20	20	0%
Market value of products sold	$20,570,000	$19,759,000	3.9%
Crop Sales	$11,127,000	$9,051,000	18.7%
Livestock Sales	$9,442,000	$10,708,000	-13.4%
Average per Farm	$16,033	$14,063	12.2%

Notes:
Source: USDA 2012, USDA 2007

4.8 Vegetation

Effects on vegetation resources are not expected to extend beyond the project area; therefore, the area of potential effect for these resources is bound by the limits of the project area.

4.8.1 Ecoregion

The area of potential effect and majority of the proposed project area lies primarily in the Deschutes River Valley level four ecoregion, a part of the larger level three Blue Mountains 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 the botanically similar level four High Lava Plains ecoregion to the southeast. Because of the proximity of the Cascade Mountains ecoregion to the west, stream density and water availability are high. As a result, human population density is much higher than in some nearby ecoregions (Thorson et al. 2003).

A smaller section of the proposed project area lies in the level four Ponderosa Pine/Bitterbrush Woodland ecoregion 9d, a part of the level three Eastern Cascades Slopes and Foothills ecoregion 9. The Pine/Bitterbush Woodland ecoregion is in the rain shadow of the Cascade Range. Compared to ecoregions to the west, it experiences more extreme temperatures and receives less precipitation. The topography includes undulating volcanic plateaus and canyons. Within the ecoregion, the frigid soils are often derived from ash and are well drained. Unlike the Pumice Plateau ecoregion to the south, lodgepole pine does not have a strong population presence.

4.8.2 Vegetation Communities

Over the past 100 years, land use has changed much of the vegetation within 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 cheatgrass has also threatened the survival and diversity of native perennial grasses and forbs while increasing the risk of severe hot wild fire in the proposed project area. Due to the exclusion of fire, dense stands of small diameter juniper, sage, and bitterbrush cover vast areas of lands once dominated by large diameter juniper and grasses.

The common natural vegetation found within TID's ROW are ponderosa pine, western juniper, big sagebrush and low sagebrush, rabbit brush, wild rye and bunch grasses, some species of wildflowers, and other plant species commonly found in the dry Central Oregon steppe environment; other shrubs found in the area include bitterbrush, Idaho fescue, Sandberg bluegrass, and cheatgrass (Table 4-12). Figure 4-12 and Figure 4-13 provides a visual example of typical vegetation surrounding a canal.

Table 4-12. Common Vegetation within Tumalo Irrigation District's ROW.

Vegetation Species	Scientific Name
Big sagebrush	*Artemisia tridentata*
Bitterbrush	*Pseudoroegneria spicata*
Black cottonwood	*Populus balsamifera*
Bulrush	*Scirpus* spp.
Idaho fescue	*Festuca idahoensis*
Low sagebrush	*Artemisia arbuscula*
Ponderosa pine	*Pinus ponderosa*
Rabbit brush	*Ericameria nauseosa*
Sandberg bluegrass	*Poa sandbergii*
Western juniper	*Juniperus occidentalis*

Notes:
Source: Franklin and Dyrness 1988

Source: Reclamation 2010.

Figure 4-12. A Canal and Maintenance Road during Irrigation Season.

Source: Reclamation 2010

Figure 4-13. An Example of Typical Vegetation on the Margin of a Lateral during the Off-Irrigation Season When Canals and Laterals are Dewatered.

In some areas, a fringe of opportunistic hydrophytic (water-loving) plants has formed along the margins of the top of the canal bank represented predominately by bulrush, black cottonwood, and willow. Occurring sporadically, it is a few feet wide in scattered locations and does not function as a habitat type due in part to infrastructure maintenance activities. The District's infrastructure is maintained during the off-season by grading and clearing, and no vegetation is allowed to develop within the canals.

4.8.3 Special Status Species

No ESA endangered, threatened, species of concern, or candidate plant species or their designated critical habitats, or Oregon special status species are known to occur within the project area. There are three special status species with potential to occur in Deschutes County: federal candidate whitebark pine, Oregon threatened pumice grape-fern, and federal species of concern and Oregon threatened Peck's milkvetch. Both whitebark pine and pumice grape fern typically occur in subalpine and timberline zones. Based on the USFWS Information for Planning and Conservation database, District and elemental observations, the Oregon Department of Agriculture (ODA) identification of species population centers, and the elevation and plant communities these two generally inhabit, it is unlikely that the pumice grape-fern and whitebark pine would occur within the project area. Therefore, these two special status plant species will not be discussed further.

Peck's milkvetch occurs in sagebrush-juniper woodlands, ponderosa pine forests, and lodgepole pine forests, preferring sandy soils with minimal organic matter and pumice, in varying amounts, from Mt. Mazama's eruption. In Oregon, Peck's milkvetch is broadly grouped by the ODA into three population centers: barren pumice flats near Chemult (60 miles south of the project area), east of

Chiloquin in open ponderosa pine stands (100 miles south of the project area), and in Deschutes County between Sisters and Bend (within the area of potential effect) (ODA 2017b). As discussed in Section 4.4, the project area crosses the BLM Peck's Milkvetch ACEC. The District has not documented any Peck's milkvetch where the project area and the ACEC overlap.

4.8.4 Invasive Species–Noxious Weeds

The Oregon State Weed Board defines a noxious weed as a terrestrial, aquatic, or marine plant that is a top priority for action to be taken by weed control programs and the greatest public menace (ORS 569.615). Certain noxious weeds are so pervasive that they have been classified by ORS 569.350 to be a menace to public welfare (ODA 2017a). The Deschutes County Noxious Weed Program has an active eradication program and provides financial and technical support to private landowners, which would include patrons of TID (Deschutes County 2017b).

Table 4-13 lists the noxious weeds known to occur in the project area (E. Keith, personal communication, July 12, 2017). The District has recently started herbicide application in problem areas of the ROW (K. Rieck, personal communication, June 27, 2017).

Table 4-13. Invasive Species-Noxious Weeds Known to Occur in the Area of Potential Effect.

Vegetation Species	Scientific Name	Deschutes County Noxious Weed Rating[1]
Spotted knapweed	*Centaurea stoebe*	B
Diffuse knapweed	*Centaurea diffusa*	B
Yellow flag iris	*Iris pseudacorus*	B
Bull thistle	*Cirsium vulgare*	C
Common mullein	*Verbascum thapsus*	C
Russian thistle	*Salsola* spp.	B
Kochia	*Kochia scoparia*	B
Cheatgrass	*Bromus tectorum*	C
Poison hemlock	*Conium maculatum*	B
Ribbon grass	*Phalaris arundinacea* var. *picta*	B
Reed canary grass	*Phalaris arundinacea*	C

Notes:
1. The Deschutes County Noxious Weed Policy and Classification System designates three weed categories. "A" designated weeds are of highest priority for control and are subject to intensive eradication, containment, or control measures using county resources. "B" designated weeds have a limited distribution; intensive containment control and monitoring by landowners is required, and support from the County is provided when resources allow. "C" designated weeds are the lowest priority for control. They have a widespread distribution; landowner control and monitoring are recommended.

4.9 Visual Resources

Effects on visual resources as a result of the proposed action are expected to extend beyond the project area to include adjacent lands from which the proposed action can be viewed. Canals and laterals that would be modernized under the proposed action pass through irrigated crop and pasture land with farm equipment as a common feature of the landscape. Interspersed with the irrigated land is uncultivated agriculture land as well as forest land with ponderosa pines and western juniper. Some of the canals and laterals can be seen by nearby residences. Canals and laterals in the project area can also be seen from public road crossings as shown in Figure 4-14 to Figure 4-18, and from public lands.

The District's irrigation season typically is from April through mid-October. During this time the District's canals and laterals carry water. Outside of the irrigation season, typically from mid-October through March, TID's canals and laterals do not carry water and are typically dry. The District provides "stock runs," water delivered through the system to fill patrons' ponds used for livestock, three times outside of the irrigation season. Although the canals are not naturally formed waterways, some viewers may consider them water features during the irrigation season.

Figure 4-14. View of Couch Lateral Looking East from Bridge along Sisemore Road in 2017.

Source: Reclamation 2010.

Figure 4-15. View of Couch Lateral Dewatered outside of the Irrigation Season.

Figure 4-16. View of Columbia Southern Lateral near the Intersection of Pinehurst Road and Highway 20 in 2017.

Figure 4-17. View of West Branch Lateral Looking Southwest where it Crosses Pinehurst Road in 2017.

Figure 4-18. View of West Branch Lateral Crossing Pinehurst Road Looking Northeast in 2017.

4.10 Water Resources

The area of potential effect for surface water includes waterbodies that could be affected by the project (see Table 4-1 in Section 4.2 for the list of waterbodies and their associated river miles). These waterbodies include Crescent Lake, Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek. The upstream end of Lake Billy Chinook, at the confluence of the Deschutes, Crooked, and Metolius Rivers, serves as the downstream boundary of the area of potential effect. The area of potential effect for groundwater is limited to the upper Deschutes Basin.

The District primarily obtains water from Tumalo Creek at the TFC. It also obtains supplemental stored water from Crescent Lake, which is in the Cascade Range about 84 miles upstream from Bend on the Deschutes River. Crescent Lake relies on annual snowmelt and precipitation for inflow. The lake was constructed as a rock crib dam in the 1920s, but was rebuilt between 1954 and 1957 by Reclamation. Crescent Lake has a usable storage capacity of 86,900 acre-feet. Water from Crescent Lake is released throughout the year; during the irrigation season, it is released as necessary to supply the District's water rights. The water is conveyed through Crescent Creek, the Little Deschutes River, and the Deschutes River to the District's BFC diversion (RM 166) in Bend. It experiences an 18 percent conveyance loss from Crescent Creek to Benham Falls and an additional 7 percent conveyance loss from Benham Falls to the City of Bend before it enters the BFC pipeline at the BFC diversion. TID staff control diversion rates at the BFC diversion. In addition to stored water rights, the District also retains a 9.5 cfs live flow water right in the Deschutes River that is subject to diversion at the BFC intake. The District does not discharge to natural waterbodies at the terminal ends of its system.

The proposed action could affect water releases from Crescent Lake and streamflow in Crescent Creek, the Little Deschutes River, and the Deschutes River. The proposed action could also affect streamflow in Tumalo Creek downstream from the TFC diversion.

4.10.1 Water Rights

The District provides irrigation water to approximately 7,417 acres using two diversions. Of this total current irrigated acreage, 7,002 acres would be affected by the project. The District holds water rights with priority dates between 1900 and 1913. These rights have all been adjudicated and certificated. The District's primary water right is on Tumalo Creek, a tributary of the Deschutes River. The District holds other water rights on Crater Creek, Little Crater Creek, and Three Springs Branches – seasonal streams that are diverted into the upper reaches of Tumalo Creek. The District holds supplemental live-flow rights from the Deschutes River, a tributary to the Columbia River. The District also holds supplemental storage rights from Crescent Lake. These rights are delivered through Crescent Creek, the Little Deschutes, and the Deschutes River.

The beneficial uses allowed under the District's water rights are livestock, irrigation, industrial, and storage uses. Water right transfers associated with canal piping projects over the past 20 years have modified some of the District's water rights, allocating water rights to instream use. These conservation projects piped over 36,000 feet of canal, conserving 11.2 cfs of water in Tumalo Creek and 2,825 acre-feet in Crescent Lake. During the peak irrigation season, the District's water rights

allow it to divert up to 207 cfs of water from Tumalo Creek, or a combination of Tumalo Creek and the Deschutes River supplemental rights. The District rarely exceeds a combined diversion total of 178 cfs as a result of previous conservation projects.

In 1987, the Oregon legislature passed the Instream Water Rights Act and created the statutory framework necessary to establish instream water rights. OWRD holds these rights in trust for the public, but they can be purchased, leased, or gifted to the state by anyone within Oregon looking to either obtain water rights for their property, lease their water rights instream, or gift their water rights to the state for permanent instream use (Golden and Aylward 2006; OAR 690-077). OWRD regulates instream rights based on a rate, duty, and priority date in the same manner that they regulate traditional water rights. Oregon's Allocation of Conserved Water Program (OAR 690-018) is one method to create instream water rights in Oregon. Several reaches in the area of potential effect, including Crescent Creek, the Deschutes River, and Tumalo Creek, have instream water rights that serve as preliminary streamflow restoration targets (Appendix E.7).

4.10.2 Surface Water Hydrology

Historically, the spring-fed Deschutes River had relatively consistent streamflows seasonally and annually (DRC 2012). Hydrological conditions and channel morphology have changed with the construction and operation of reservoirs, dams, and diversions on the river and its tributaries. Water is now managed for irrigation use, resulting in lower flows downstream from reservoirs during the winter months, higher flows downstream from reservoirs during the summer months, and lower flows downstream from irrigation diversions during the spring, summer, and fall.

Over the past 15 years, streamflows in the Deschutes River and Tumalo Creek have increased in response to collaborative restoration efforts by the irrigation districts and their partners. July median streamflow in the Deschutes River at North Canal Dam (RM 164.8) more than tripled from 2002 to 2012, from 47 cfs to 158 cfs (Mork 2016). In response to a reduction in instream leases and water voluntarily left instream by irrigation districts, July median streamflow dropped in 2013 to 129 cfs. It has steadily crept upward since 2013 to a 2015 July median flow of 136 cfs (Mork 2016). Streamflow restoration efforts by the District and its partners have yielded similar results in Tumalo Creek. July median daily average streamflow in the creek increased from 5 cfs in 2001 to a high of 58 cfs in 2012, averaging between 12 to 15 cfs (Mork 2016). OWRD measures this streamflow at stream gauging stations and ensures that leases, transfers, and conserved water remain instream.

The upper Deschutes Basin has experienced a general drying trend for several decades (Gannett and Lite 2013) and is susceptible to future changes in precipitation and the amount and timing of spring runoff (Shelton and Fridirici 2001). Models suggest that increased rain and a decrease in snowpack combined with an accelerated rate of spring snowmelt will influence the future water supply in the area; these changes will make managing the water supply more difficult (Shelton and Fridirici 2001; Reclamation 2016). This trend has potential for a decrease in annual mean streamflow as well as decreases in groundwater discharge to spring-fed streams (Gannett and Lite 2013).

The following sections summarize surface water hydrology in each waterbody. Graphs are provided to display the historic daily[6] average baseline streamflow and the modified daily average baseline streamflow. The historic daily average baseline streamflow involves available data from water years[7] prior to recent agreements between the District and local environmental groups. The modified daily average baseline streamflow involves data from water years following the recent agreements. Figure 4-19 presents the waterbodies included in the surface water hydrology area of potential effect.

[6] The daily average streamflow is the mean streamflow over a whole day.
[7] A water year is defined as the 12-month period from October 1 for any given year through September 30 of the following year.

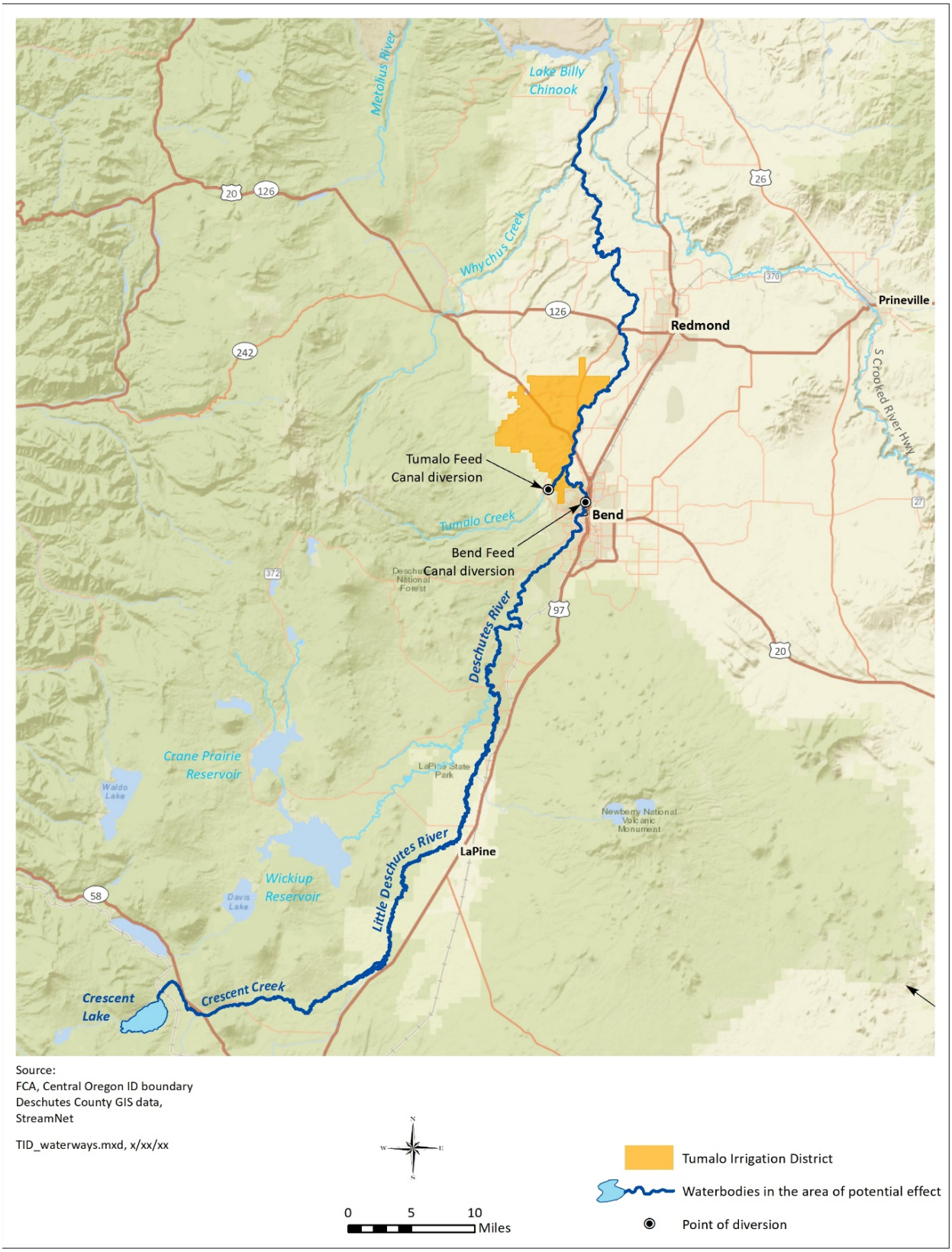


Figure 4-19. Waterbodies Included in the Area of Potential Effect for Surface Water Resources.

4.10.2.1 Crescent Lake

The proposed action may affect operations of Crescent Lake. Crescent Lake, upstream from the City of Bend on Crescent Creek, relies on annual snowmelt and precipitation for inflow. The District stores water in Crescent Lake to meet irrigation demands and releases water from the lake throughout the year. During the irrigation season, TID releases water as necessary to supply the District's water rights. The water is conveyed through Crescent Creek, the Little Deschutes River, and the Deschutes River to the District's BFC diversion in Bend.

4.10.2.2 Crescent Creek, Crescent Lake Dam (RM 30) to the mouth (RM 0)

The proposed action may affect streamflow rates in Crescent Creek. Releases from Crescent Lake control streamflow in Crescent Creek. Crescent Creek streamflow varies within and between years depending on reservoir operations and climate conditions (Figure 4-20). Outside of the irrigation season, the District has historically released at least 5 cfs from Crescent Lake into Crescent Creek under an informal agreement with OWRD to increase streamflow and improve aquatic resources (OWRD 2005). Any future flow restoration activities, including instream transfers and allocation of conserved water, are additive to the 5 cfs established in the 2005 agreement and released outside of the irrigation season to improve aquatic resources and their habitat (OWRD 2005).

In 2016, TID agreed to voluntarily release additional streamflow from Crescent Lake outside the irrigation season to benefit Oregon spotted frog populations in Crescent Creek (Center for Biological Diversity, et al. v. U.S. Bureau of Reclamation and Arnold Irrigation District, et al. 2016). Under this Stipulated Settlement Agreement with the Center for Biological Diversity,[8] TID agreed to maintain a minimum of 20 cfs in Crescent Creek outside the irrigation season. These conditions have been maintained since the expiration of the Settlement Agreement in compliance with the 2017 Biological Opinion (BiOp) for Bureau of Reclamation dam operations (Reclamation 2017). Water releases exceeding the formerly agreed upon 5 cfs are not legally protected instream.

Crescent Creek downstream of Crescent Lake has instream water rights that serve as preliminary streamflow restoration targets (Appendix E.6). Water right certificate #73234 is a junior water right (October 11, 1990) for the flows shown below in Table 4-14 and providing a target for the flows that are needed for fish migration, spawning, egg incubation, fry emergence, and juvenile rearing between the Crescent Lake (RM 30) to the mouth of Crescent Creek (RM 0).

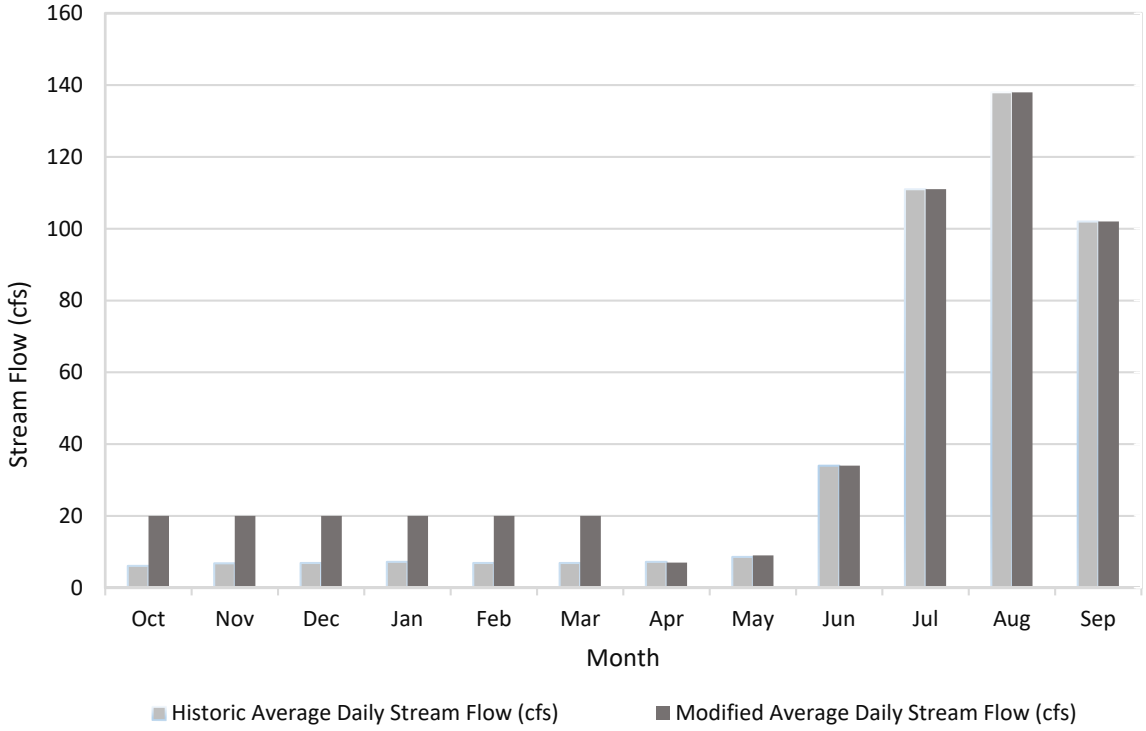
Table 4-14. Target Streamflows in Crescent Creek based on Certificate #73234

Instream Rates (cfs)											
Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
75	75	125	125	125	75	50	50	50	50	108	125

Daily average streamflow in Crescent Creek from 1984 to 2017 is shown in Figure 4-20 below.

[8] In addition to TID interim operation adjustments to Crescent Lake dam and reservoir, this Stipulated Settlement Agreement prompted interim operation adjustments for Districts operating Wickiup and Crane Prairie dams and reservoirs and a completion of the consultation and biological opinion by USFWS on effects of such operations on Oregon spotted frogs (Reclamation 2017).

Streamflows from 1984 to 2014 are noted on the figure as "historic average daily streamflow." Streamflows in 2016 and 2017 are representative of conditions after implementation of the Stipulated Settlement Agreement, and are called "modified average daily streamflow.



Note:

Data for historic streamflows represent the 1984 through 2014 water years. Data for the modified streamflows represent October 2016 through September 2017. Average streamflows represent the 50 percent exceedance streamflows.

Figure 4-20. Historic and Modified Daily Average Streamflows in Crescent Creek downstream from Crescent Lake at OWRD Gauge No. 14060000.

4.10.2.3 Little Deschutes River, Crescent Creek (RM 57) to the mouth (RM 0)

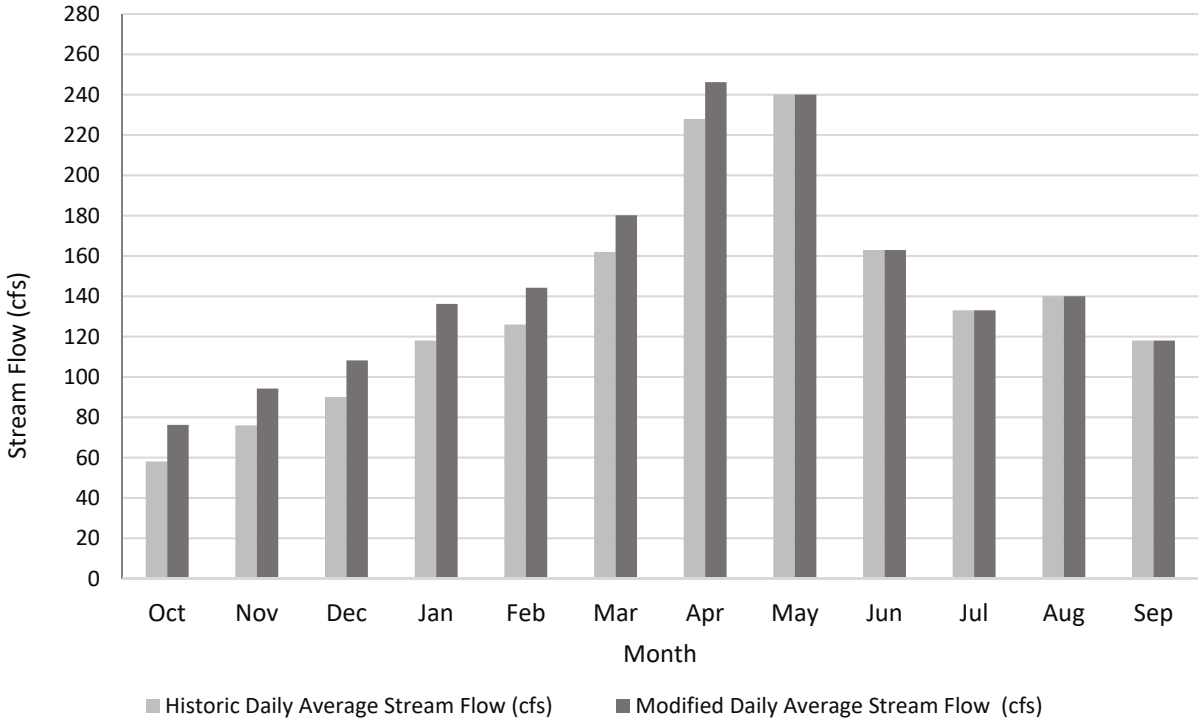
The Little Deschutes River is a free-flowing tributary to the Deschutes River. It enters the Deschutes River at RM 192.5. Precipitation, snowmelt, and releases from Crescent Lake affect streamflow in the Little Deschutes River from Crescent Creek (RM 57) to the mouth (RM 0). Streamflow in this reach varies seasonally depending on upstream reservoir operations and irrigation demands.

This reach of the Little Deschutes River has instream water rights that serve as preliminary streamflow restoration targets (Appendix E.6). Water right certificate #73226 is a junior water right (October 11, 1990) for the flows shown below in Table 4-15 to support fish migration, spawning, egg incubation, fry emergence, and juvenile rearing between the mouth of the Crescent Creek (RM 57) to the mouth (RM 0).

Table 4-15. Target Streamflows in the Little Deschutes River based on Certificate #73226

Instream Rates (cfs)											
Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
200	200	236	240	240	200	126	74.5	92.2	116	164	196

Figure 4-21 displays the Little Deschutes' historic daily average baseline streamflow (1984 to 2014) and the modified daily average baseline streamflow (October 2016 to September 2017) representing the requirements of the Stipulated Settlement Agreement in place, shown by month and measured in cfs. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions.



Note:
Data for historic streamflows represent the 1984 through 2014 water years. Data for the modified streamflows represent October 2016 through September 2017. Average streamflows represent the 50 percent exceedance streamflows.

Figure 4-21. Historic and Modified Daily Average Streamflows in the Little Deschutes River at La Pine, Oregon, at OWRD Gauge No. 1406300.

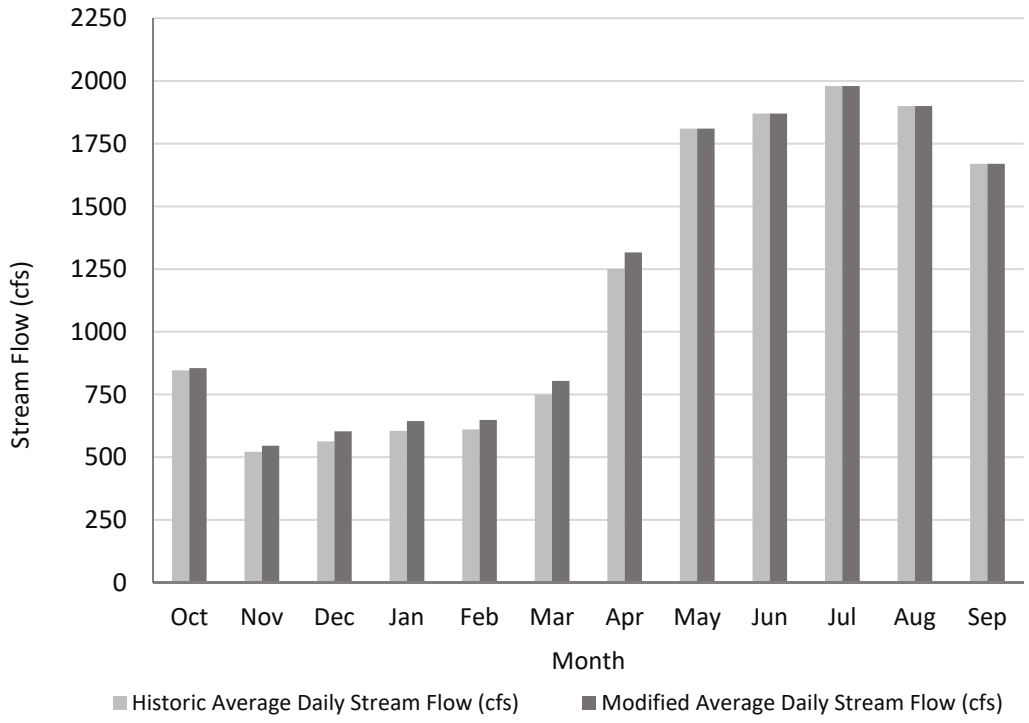
4.10.2.4 Deschutes River, Little Deschutes River (RM 192.5) to the BFC diversion at Steidl Dam (RM 166)

Reservoir releases, tributary inflows, irrigation diversions, and groundwater interactions drive streamflow in this reach of the Deschutes River. Crane Prairie Reservoir, Wickiup Reservoir, and Crescent Lake store water upstream from this reach. Their operations decrease winter streamflow and increase summer streamflow from unregulated conditions (Figure 4-22). Water released from Crescent Lake during the irrigation season is conveyed through Crescent Creek, the Little Deschutes River, and the Deschutes River until it is diverted at the BFC diversion at Steidl Dam (RM 166). A

portion of the streamflow enters into the groundwater aquifer through the porous volcanic riverbed and banks upstream from the City of Bend. OWRD accounts for these losses when accounting for dam releases, water available for diversion, and water protected instream.

This reach of the Deschutes River has instream water rights that serve as preliminary streamflow restoration targets (Appendix E.6). Water right certificate #59777 is a junior water right (November 3, 1983) for a year round flow of 400 cfs and provides a target for what flows are needed for fish, wildlife, their habitat quality, or recreation between the mouth of the Little Deschutes River (RM 192.5) to the mouth of the Spring River (RM 190.4). Water right certificate #59778 is a junior water right (November 3, 1983) for a year round flow of 660 cfs to support aquatic life and minimize pollution between the mouth of Spring River (RM 190.4) to North Canal Dam (RM 164.8).

Figure 4-22 displays the Deschutes River at Benham Falls' historic daily average baseline streamflow (1984 to 2014) and the modified daily average baseline streamflow (October 2016 to September 2017) representing the requirements of the Stipulated Settlement Agreement in place, shown by month and measured in cfs. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions.



Note:
Data for historic streamflows represent the 1984 through 2014 water years. Data for the modified streamflows represent October 2016 through September 2017. Average streamflows represent the 50 percent exceedance streamflows.

Figure 4-22. Historic and Modified Average Daily Streamflows in the Deschutes River at Benham Falls at OWRD Gauge No. 14064500.

4.10.2.5 Tumalo Creek TFC diversion (RM 2.5) to the mouth (RM 0)

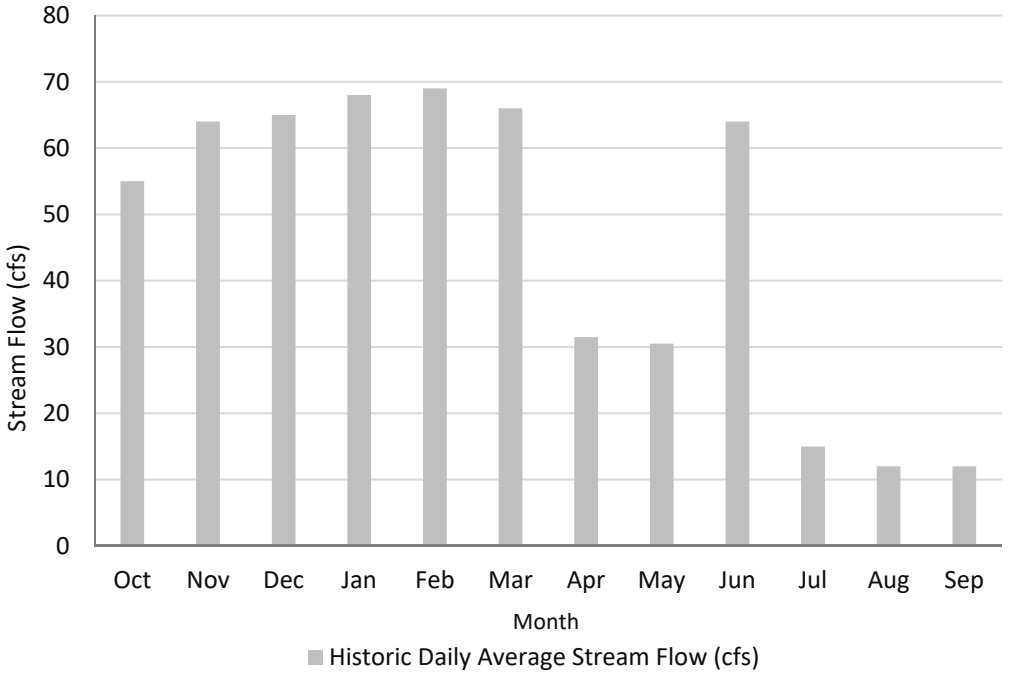
The hydrology of Tumalo Creek is largely influenced by snowmelt, precipitation, and groundwater discharge from springs. Tumalo Creek and its tributaries (Bottle Creek, Bridge Creek, Happy Valley Creek, Middle Fork, North Fork, Rock Creek, South Fork, and Spring Creek) are unusual in the area due to their response to rain-on-snow events, which result in large increases of streamflow. Streamflow upstream from the TFC diversion (RM 2.5) typically peaks at 200 to 300 cfs during the spring due to snowmelt. During the irrigation season, the District's diversions influence streamflow in Tumalo Creek downstream from the TFC diversion (RM 2.5).

This reach of the Tumalo Creek has instream water rights that serve as preliminary streamflow restoration targets (Appendix E.6). Water right certificate #73222 is a junior water right (October 11, 1990) for the flows shown below in Table 4-16 to support fish migration, spawning, egg incubation, fry emergence, and juvenile rearing from the South Fork Tumalo Creek to the mouth of Tumalo Creek.

Table 4-16. Target Streamflows in Tumalo Creek Based on Certificate #73222

Instream Rates (cfs)											
Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
47	47	68.7	76.6	82	47	32	32	47	65.3	47	47

Historically, the District diverted up to all of the water from the creek to meet peak irrigation demands in most years. The District and its partners' extensive investments in conservation have permanently increased streamflow in the creek. Currently, the District typically maintains at least 10 to 12 cfs downstream from this diversion during the irrigation season in order to operate its fish screen and passage structures (Figure 4-23). This streamflow is typically present but not legally protected instream. Water allocated to instream water rights in Tumalo Creek are legally protected from the TFC diversion (RM 2.5) to the mouth (RM 0) and then into the Deschutes River to Lake Billy Chinook (RM 120).



Note:
Data for historic streamflows represent the 1998 through 2016 water years. Average streamflows represent the 50 percent exceedance streamflows.

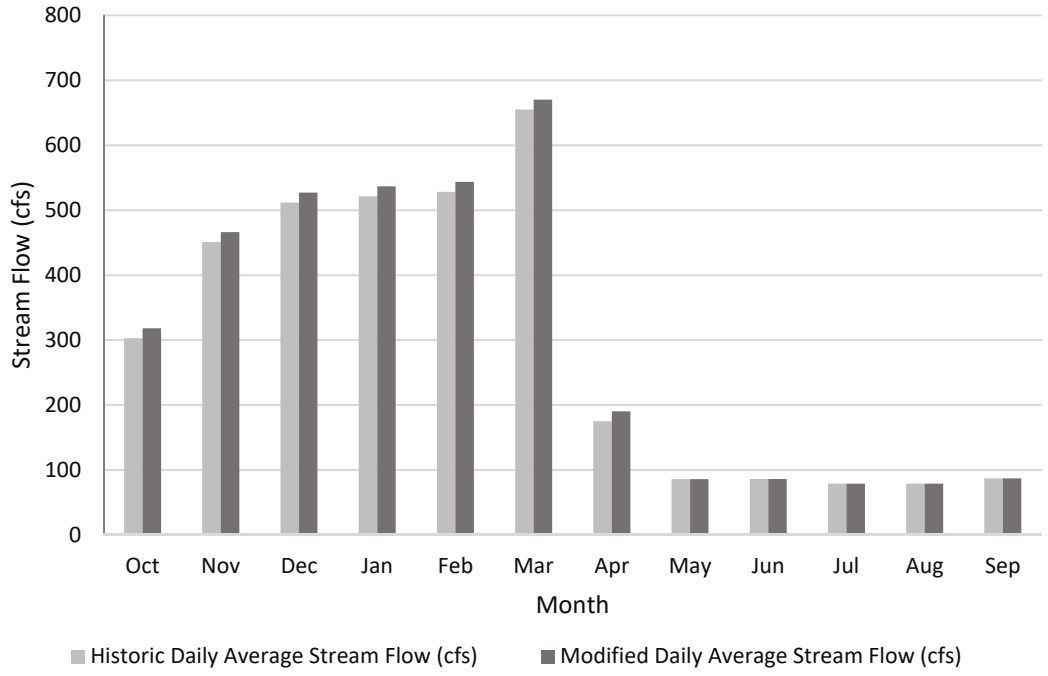
Figure 4-23. Historic Daily Average Streamflows in Tumalo Creek Downstream from the Tumalo Feed Canal Diversion at OWRD Gauge No. 14073520.

4.10.2.6 Deschutes River, BFC diversion at Steidl Dam (RM 166) to Lake Billy Chinook (RM 120)

Central Oregon, Arnold, Lone Pine, North Unit, and Swalley Irrigation Districts divert water from the Deschutes River at the City of Bend. These irrigation diversions influence streamflow patterns in the Deschutes River downstream from the City of Bend (Figure 4-24). Historically, these irrigation districts maintained a minimum of 30 cfs instream in this reach under a voluntary agreement. Extensive conservation efforts by the irrigation districts and their partners starting in the 2000s have enhanced streamflow during the irrigation season. Currently, the irrigation districts maintain approximately 130 cfs downstream from their diversions at the City of Bend during the summer irrigation season.

This reach of the Deschutes River has instream water rights that serve as preliminary streamflow restoration targets (Appendix E.6). The ODFW has a pending water right requesting a year round flow of 250 cfs and providing a target for what flows are needed for fish, wildlife, their habitat quality, or recreation between the North Canal Dam (RM 164.8) to Round Butte Reservoir (Lake Billy Chinook; RM 120).

Figure 4-24 displays the historic daily average baseline streamflow and the modified daily average baseline streamflow representing the requirements of the Stipulated Settlement Agreement in place, downstream from the City of Bend. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions.



Note:
Data for historic streamflows represent the 1984 through 2014 water years. Data for the modified streamflows represent October 2016 through September 2017. Average streamflows represent the 50 percent exceedance streamflows.

Figure 4-24. Historic and Modified Daily Average Streamflows in Deschutes River Downstream from the City of Bend at OWRD Gauge No. 14070500.

4.10.3 Surface Water Quality

The Oregon Department of Environmental Quality (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 United States Code [U.S.C.] 1251 et seq.) The 2012 303(d) list is effective for CWA purposes. The Deschutes River and its tributaries in the area of potential effect are included on Oregon's 303(d) list for not meeting water quality standards for temperature, dissolved oxygen, pH, sedimentation, turbidity, and/or chlorophyll a (Table 4-17).

Water management in the Deschutes Basin has altered seasonal streamflow patterns, increasing streamflows above historic levels in some reaches and decreasing streamflows below historical levels in other reaches. Low flows affect water quality in the Deschutes River by exacerbating temperature and dissolved oxygen problems. The following sections describe existing 303(d)-listed impairments in the surface water area of potential effect. Oregon Department of Environmental Quality is required to develop total maximum daily loads (TMDLs) for rivers and streams in the Upper Deschutes and Little Deschutes basins (these impairments may extend upstream or downstream of the reaches included in Table 4-17).

Table 4-17. Impaired Waterbodies in the Surface Water Area of Potential Effect.

Waterbody No.	Name	Area of Potential Effect	Parameters Included on Oregon's 303(d) List
1	Crescent Creek	Crescent Lake Dam (RM 30) to the mouth (RM 0)	Temperature
2	Little Deschutes River	Crescent Creek (RM 57) to the mouth (RM 0)	Temperature Dissolved oxygen
3	Deschutes River	Little Deschutes River (RM 192.5) to the Bend Feed Canal diversion at Steidl Dam (RM 166)	Temperature Dissolved oxygen Chlorophyll a pH Sedimentation Turbidity
4	Deschutes River	Bend Feed Canal diversion at Steidl Dam (RM 166) to Lake Billy Chinook (RM 120)	Temperature Dissolved oxygen
5	Tumalo Creek	Tumalo Feed Canal diversion (RM 2.5) to the mouth (RM 0)	Temperature

Notes:
Source: ODEQ 2012

4.10.3.1 Temperature

Crescent Creek, Little Deschutes River, Deschutes River, and Tumalo Creek do not meet stream temperature criteria within the area of potential effect (Table 4-17). The temperature criterion that applies throughout the area of potential effect is 18 °C (64.4 degrees Fahrenheit [°F]), which is designed to protect salmon and trout rearing and migration. There is an additional criterion designed to protect bull trout spawning and juvenile rearing that currently applies in Crescent Creek above RM 11. This criterion is 12 °C (53.6 °F). Elevated stream temperatures affect aquatic species including native fish by exacerbating conditions that cause stress and disease, raise their metabolism, and reduce growth rates. Low streamflows, reduced streamside vegetation, and widened channels can all contribute to elevated stream temperatures.

4.10.3.2 Dissolved Oxygen

In the area of potential effect, all of the Little Deschutes River and the Deschutes River waters do not meet Oregon's standards for dissolved oxygen during trout spawning season from January 1 to May 15 (Table 4-17; ODEQ 2012). Year-round, dissolved oxygen levels in the Little Deschutes and in a portion of the area of potential effect in the Deschutes River (RM 192.5-171.7) are not high enough to meet Oregon's standards either (ODEQ 2012). Low dissolved oxygen levels can affect aquatic life by reducing habitat quality and quantity, changing behavior, or reducing growth rates. Excess nutrient inputs, associated algae growth and die-off, and elevated stream temperatures can all contribute to lower dissolved oxygen levels.

4.10.3.3 pH

pH is a measure of the acidity or alkalinity of a waterbody. Within the area of potential effect, the most downstream 2.2 miles of the Deschutes River between the Little Deschutes River (RM 192.5) and the BFC diversion (RM 166) and all the Deschutes River from the BFC diversion (RM 166) to Lake Billy Chinook (RM 120) exceed Oregon's pH standard with higher, or more alkaline, pH values

(ODEQ 2012; Table 4-17). Higher pH can affect aquatic life by changing the solubility or biological availability of chemicals in the water.

4.10.3.4 Sedimentation

Sedimentation refers to deposits of silt, sand, or other small particles in a river. In the area of potential effect, 21 miles of the Deschutes River between the Little Deschutes River (RM 192.5) and the BFC diversion (RM 166) do not meet Oregon's standards for sedimentation (ODEQ 2012; Table 4-17). The Oregon Department of Environmental Quality set this standard to protect resident fish and aquatic life and salmonid fish spawning and rearing in the river. In the Deschutes River, lower winter flows and higher summer flows have contributed to increased bank erosion. Increased bank erosion contributes to increased sediment in the river. The river carries this sediment downstream and deposits it along the riverbed. Deposited sediment can affect fish and aquatic life by reducing the quantity and quality of available habitat.

4.10.3.5 Turbidity

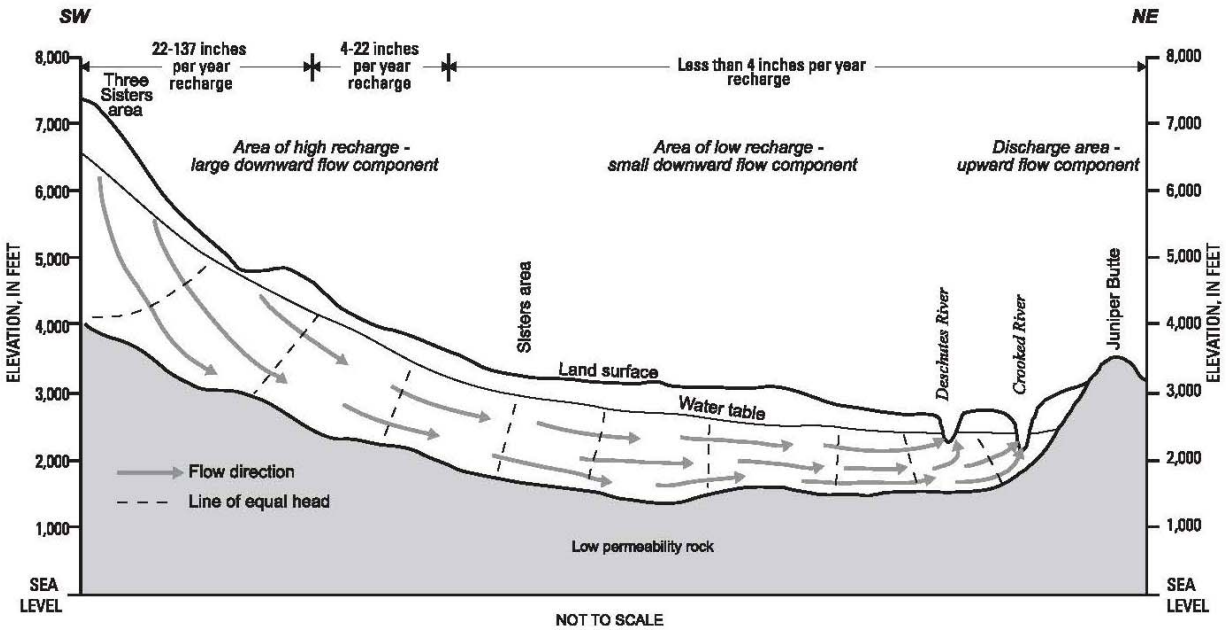
Turbidity is a measure of water cloudiness. Within the area of potential effect, 21 miles of the Deschutes River between the Little Deschutes River (RM 192.5) and the BFC diversion (RM 166) do not meet Oregon's turbidity standard during the spring and summer (ODEQ 2012; Table 4-17). This standard is set to protect aesthetics, resident fish and aquatic life, and water supply in the river. Suspended sediment, algae, and other suspended or dissolved materials contribute to increased turbidity.

4.10.3.6 Chlorophyll a

Chlorophyll a is a specific type of chlorophyll that is measured to evaluate the amount of algae in a waterbody. Monitoring chlorophyll levels is a direct way of tracking algal growth; surface waters that have high chlorophyll conditions are typically in correlation with high levels of nutrients, commonly phosphorus and nitrogen. In the area of potential effect, 21 miles of the Deschutes River between the Little Deschutes River (RM 192.5) and the BFC diversion (RM 166) do not meet Oregon's standards during the summer (ODEQ 2012; Table 4-17). The Oregon Department of Environmental Quality set this standard to protect multiple uses in the river, including resident fish and aquatic life. High chlorophyll a indicates excess algal growth in the river. Excess algae often contribute to low dissolved oxygen concentrations. Excess algae grown can be caused by both natural influences and nutrient inputs (from sources such as fertilizer or leaking septic tanks) into the waterbody.

4.10.4 Groundwater

The area of potential effect for groundwater is limited to the upper Deschutes Basin. The area of potential effect is bounded on the north by Jefferson Creek, the Metolius River, the Deschutes River, and Trout Creek; the east by the geological change between the Deschutes Formation and the much less permeable John Day Formation; on the south by the drainage divides between the Deschutes Basin and the Fort Rock and Klamath Basins; and on the west by the Cascade Mountain Range. Previous groundwater studies define the upper Deschutes Basin and provide context for groundwater within the area of potential effect (Gannett et al. 2001, Gannett and Lite 2013, Figure 4-25).



Source: Gannett et al. 2001

Notes:

Flow generally moves east then north before discharging to the streams along the edge of the Cascade Range or the streams and rivers near the confluence of the Metolius, Deschutes, and Crooked Rivers

Figure 4-25. Precipitation Recharge in a Deschutes Basin Regional Aquifer.

Within the upper Deschutes Basin, precipitation in the Cascade Range provides 3,500 cfs of annual groundwater recharge. Inflows from outside the upper Deschutes provide an additional 850 cfs of recharge. Canal leakage across the region provides approximately 411 cfs of additional recharge based on 2008 data (Gannett et al. 2001; Gannett and Lite 2013, Gannett et al. 2017). Subsequent canal lining and piping projects have further reduced canal leakage.

Groundwater generally flows east and then north through the basin. Approximately half of this groundwater discharges into streams through springs along the edge of the Cascade Mountains. The remainder of this groundwater discharges into streams and rivers near the confluence of the Metolius, Deschutes, and Crooked Rivers (Gannett et al. 2001; Figure 4-25).

Due to the porous geology of the area, groundwater levels and stream discharge are associated with movement of water between surface and groundwater sytems. The rivers, streams, and irrigation canals in the Upper Deschutes watershed all show seepage losses indicative of the area's permeable geology (Gannett et al. 2001). A loss assessment study in 2016 measured 48 cfs of peak-season loss in TID's canals due to seepage and evaporation (TID 2017). The water that is lost as canal seepage from the District's canal and laterals likely enters the regional groundwater system that discharges near or into Lake Billy Chinook. The groundwater flows in the area are generally parallel to Tumalo Creek; as a result, the canal seepage does not return to Tumalo Creek and does not become available to other water users in Tumalo Creek (OWRD 2005).

Cascade Range aquifers in the upper Deschutes Basin have experienced a general drying trend since the 1950s. Climate oscillations remain the primary driver of these declines (Gannett et al. 2001;

Gannett et al. 2003). A U.S. Geological Survey study between 1997 and 2008 investigated the influence of canal lining, groundwater pumping, and climate on water level trends in the region. The study found an approximate 5- to 14-foot decline in groundwater levels in the central part of the region, which includes the proposed project area (Gannett and Lite 2013). The study found that 60 to 70 percent of the measured decline was associated with climate variations, 20 to 30 percent of the measured decline was associated with increased groundwater pumping, and 10 percent was associated with canal lining and piping (Gannett and Lite 2013). At the basin-scale, natural fluctuations in groundwater discharge largely mask the effects of development on discharge from the regional aquifer (Gannett et al. 2001).

4.11 Wetlands and Riparian Areas

The area of potential effect for wetlands and riparian areas consists of the project area and the wetlands and riparian areas adjacent to the following 162 miles of rivers and streams: Crescent Lake, Crescent Creek from Crescent Lake Dam (RM 30) to the mouth (RM 0), the Little Deschutes River from the confluence with Crescent Creek (RM 57) to the mouth (RM 0), the Deschutes River downstream of the confluence with the Little Deschutes River (RM 192.5), and Tumalo Creek downstream from the TFC diversion (see Figure 4-19).

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 a wide variety of aquatic and terrestrial species. Wetlands in the area of potential effect may be subject to federal or state regulations depending on their characteristics. Within the State of Oregon, wetlands are managed under two laws, the CWA, and Oregon Removal-Fill Law. The U.S. Army Corps of Engineers (USACE) administers Section 404 of the CWA with the oversight of the U.S. Environmental Protection Agency (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).

Oregon Department of State Lands (ODSL) implements the Removal-Fill Law (ORS 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.

Language provided in the 1986, Final Rule for Regulatory Programs of the Corps of Engineers (1986 Final Rule) identified 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, EPA 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 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, the U.S. Court of Appeals for the Sixth Circuit stayed the 2015 Final Rule nationwide pending further action of the court. This reinstated the "significant nexus" jurisdiction standard from Rapanos v. United States.

Water typically flows through the canals and laterals in the project area during the irrigation season, between April and mid-October. Water may also occasionally flow through these canals outside of the irrigation season for stock water deliveries or be present as standing water following rain or snow events. Wetland plants are sometimes found along the banks of irrigation canals and laterals within the project area, as the hydrology provided by the canals and laterals can create favorable growing conditions during a portion of the year. Hydrophytic plants found along these open canals and laterals include black cottonwood, bulrush, and others (Table 4-18). Although some canals and laterals may have hydrology and vegetation indicative of a wetland, they only contain water during the irrigation season and do not meet functional criteria of wetlands, nor are they regulated as wetlands by ODSL or USACE. These canals and laterals meet exemptions under the Oregon Removal-Fill Law for specific agricultural activities in wetlands and other waters of the state.

The National Wetland Inventory (NWI) geographic information systems data (USFWS 2016) shows that about 23 wetland features sporadically occur adjacent to canals and laterals within the area of potential effect; however, these have not been field verified.

Wetland plants and habitat functions in these areas are further limited by routine canal maintenance activities and dewatering outside of the irrigation season.

Table 4-18. Wetland Plant Species within the Area of Potential Effect.

Wetland Plant Species	**Scientific Name**
Alder species	*Alnus* spp.
Aspen species	*Populus* spp.
Black cottonwood	*Populus balsamifera*
Willow species	*Salix* spp.
Bulrush species	*Scirpus* spp.
Ragwort species	*Senecio* spp.
Sedge species	*Carex* spp.

Notes: Source: RDG 2005

Wetlands are found within and sporadically adjacent to the 162 miles of river (see Section 4.10) downstream of existing diversions within the area of potential effect. Wetlands include the streams and reservoirs themselves (Crescent Creek, Little Deschutes River, Deschutes River, and Tumalo Creek, and Crescent Lake) and depressional wetlands adjacent to affected waterbodies. These depressional wetlands generally occur in low-lying areas.

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 are typically associated with high water tables due to the close proximity to aquatic ecosystems, certain soil characteristics, and a range of vegetation that requires free water or conditions that are moister than normal (Oakley et al. 1985). These zones are transitional between aquatic and upland zones and have a variety of vegetation ranging from grasses, to sedges, to willows, alder, and aspen with minimal conifer encroachment.

Riparian areas of varying size and quality occur adjacent to natural waterbodies in the area of potential effect. Low late fall, winter, and early spring streamflows associated with upstream reservoir storage limits riparian vegetation in Crescent Creek and the Deschutes River (RDG 2005). Low streamflows along these reaches can expose the channel bed and river banks, facilitating increased erosion and fine sediment delivery following freeze-thaw processes and increased spring streamflows (RDG 2005). In Tumalo Creek, winter flows are maintained in their near-natural state but summer flows are severely limited downstream from the TFC 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). As riparian areas become hydrologically disconnected from their adjacent stream channels, they lose many of their ecological functions.

4.12 Wildlife Resources

Effects on wildlife including threatened and endangered species as a result of the proposed action are not expected to extend beyond the project area; therefore, the area of potential effect is defined as the project area when considering wildlife resources.

4.12.1 General Wildlife

A suite of terrestrial wildlife species has the potential to occur in the project area. Generally, wildlife present consists of habitat generalists or edge species with the ability to adapt or exploit the urban environment. These species are tolerant to fragmentation, disturbance, and urbanization, and include species such as deer, coyote, skunk, grey squirrel, raccoon, and red-tailed hawk (Blair 1996; Ditchkoff et al. 2006; McKinney 2002; and Shochat et al. 2006).

Wildlife within the project area may use the canal and lateral system 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. However, given the

fragmented, disturbed nature of habitat and continued urbanization and biotic homogenization, habitat within the project area likely supports less species diversity and a greater percentage of exotic flora and fauna than native, intact, undisturbed habitat types support.

Table 4-19 lists wildlife species commonly seen within the project area.

Table 4-19. Wildlife Species Likely to Occur within the Tumalo Irrigation District – Irrigation Modernization Project Area.

Wildlife Species	Scientific Name
Bat	*Vespertilionidae* spp.
Coyote	*Canis latrans*
Desert horned lizard	*Phrynosoma platyrhinos*
Golden mantled ground squirrel	*Spermophilus lateralis*
Mule deer	*Odocoileus hemionus*
Northern flicker	*Colaptes auratus*
Osprey	*Pandion haliaetus*
Pygmy rabbit	*Brachylagus idahoensis*
Pygmy short-horned lizard	*Phrynosoma douglasii*
Raccoon	*Procyon lotor*
Red-tailed hawk	*Buteo jamaicensis*
Rufous hummingbird	*Selasphorus rufus*
Turkey vulture	*Cathartes aura*
Western gray squirrel	*Sciurus griseus*
Western rattlesnake	*Crotalus viridus*
Western skink	*Eumeces skiltonianus*
Yellow pine chipmunk	*Eutamias amoenus*

Notes:
Source: ODFW 2017b

4.12.2 MBTA/BGEPA Species

Bird species listed in Table 4-20 potentially occur within the project area and are protected under the Migratory Bird Treaty Act (MBTA) or the Bald and Golden Eagle Protection Act (BGEPA). Although migratory birds are known to occur in the project area and its vicinity, limited habitat is provided within the project area and TID's ROW due to maintenance activities that remove vegetation on an annual basis.

Table 4-20. MBTA/BGEPA Species Potentially Occurring within the Project Area.

MBTA/BGEPA Species	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*
Brewer's sparrow	*Spizella breweri*
Calliope hummingbird	*Stellula calliope*
Cassin's finch	*Carpodacus cassinii*
Eared grebe	*Podiceps nigricollis*
Flammulated owl	*Otus flammeolus*
Fox sparrow	*Passerella iliaca*
Golden eagle	*Aquila chrysaetos*
Green-tailed towhee	*Pipilo chlorurus*
Lewis's woodpecker	*Melanerpes lewis*
Loggerhead shrike	*Lanius ludovicianus*
Long-billed curlew	*Numenius americanus*
Olive-sided flycatcher	*Cantopus cooperi*
Peregrine falcon	*Falco peregrinus*
Pinyon jay	*Gymnorhinus cyanocephalus*
Rufous hummingbird	*Selasphorus rufus*
Sage thrasher	*Oreoscoptes montanus*
Short-eared owl	*Asio flammeus*
Swainson's hawk	*Buteo swainsoni*
Western grebe	*Aechmophorus occidentalis*
White-headed woodpecker	*Picoides albolavatus*
Williamson's sapsucker	*Sphyrapicus thyroidus*
Willow flycatcher	*Empidonax traillii*

Notes:
Source: USFWS 2017

The USFWS maintains a database of known golden and bald eagle nesting sites. Two golden eagle nesting sites are known within the TID service area. No known bald eagle nests occur within the project area although it is possible that a nest could be located near irrigation ponds and/or a proposed pipeline (J. Cordova, personal communication, August 23, 2017).

4.12.3 Federally Listed Species

The USFWS maintains a list of wildlife species protected under the ESA that may occur in Deschutes County (USFWS 2017). As noted previously, no species or federally designated critical habitat occurs within the project area or area of potential effect with the exception of Oregon spotted frog, steelhead, and bull trout, which are discussed in Section 4.2.3.

4.12.4 State Listed Species

The 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 2017a). There are no state-listed terrestrial species known to occur within the irrigation canals or any other areas where work associated with the proposed action would occur.

4.13 Wild and Scenic Rivers

There are several waterways federally designated as Wild and Scenic Rivers (Public Law 90-542; 16 U.S.C. 1271 et seq.) that may be affected by the proposed action. Ten miles of Crescent Creek, from Crescent Lake (RM 30) to the west section line of Section 13, T24S, R7E (approximately RM 20) is classified as "Recreation" with the Outstandingly Remarkable Value of Scenery. The Deschutes River from Wickiup Reservoir (RM 226.8) to the Bend Urban Growth boundary at the southwest corner of Section 13, T18S, R11E (approximately RM 172) is classified as both "Scenic" and "Recreation" with Outstandingly Remarkable Values including: Cultural, Fish, Geologic, Historic, Recreation, Scenery, Wildlife, and Botany. However, only the section from the Deschutes River's confluence with the Little Deschutes River (RM 192.5) downstream to RM 172 is located in the area of potential effect. In addition, the Deschutes River from Odin Falls (RM 139.9) to the upper end of Lake Billy Chinook (RM 120) is classified as "Scenic" with its Outstandingly Remarkable Values including: Cultural, Fish, Geologic, Recreation, Scenery, Wildlife, Hydrology, Botanical/Ecological, and Wilderness.

In addition to federally designated Wild and Scenic Rivers, several waterways in the area of potential effect are designated through the Oregon Wild and Scenic Rivers Act (Oregon Revised Statute [ORS] 390.826) as Oregon Scenic River Waterways. These locations, with specific exclusions and classifications, are detailed in Table 4-21.

Table 4-21. Waterbodies in the Area of Potential Effect designated as Oregon Scenic River Waterways.

Waterbody No.	River	Classification	Reach
1.	Upper Deschutes River	Scenic River Area[1]	From the Deschutes National Forest boundary in Section 20, T19S, R11E (approximately RM 184.8) to the Bend Urban Growth Boundary (approximately RM 172)
2.	Upper Deschutes River	River Community Area[2]	From RM 172 to RM 171
3.	Upper Deschutes River	Recreational River Area[3]	From RM 190.6 to approximately RM 184.8
4.	Middle Deschutes River	Scenic River Area	From Deschutes Market Road (approximately RM 157) to the south boundary of the Wilderness Study Area (approximately RM 131), with the exception of the Clines Falls Dam and powerhouse between State Highway 126 Bridge (RM 144.9) and RM 144 and the Crooked River Ranch River Community Area (RM 129.9 to RM 131.5)
5.	Middle Deschutes River	River Community Area	From RM 164 to approximately RM 161; from RM 129.9 to RM 131.5; and from RM 124.3 to RM 125.25
6.	Middle Deschutes River	Recreational River Area	From the northern Bend Urban Growth Boundary (RM 161) to Tumalo State Park (RM 158)
7.	Middle Deschutes River	Natural River Area[4]	From the south boundary of the Wilderness Study Area as approximately RM 131 to Lake Billy Chinook (RM 120), with the exception of RM 129.9 to RM 131.5.

Notes:

1. Those designated scenic waterways or segments with related adjacent lands and shorelines, are still largely primitive and largely undeveloped except for agriculture and grazing, but accessible in places by roads. These classified areas will be administered to maintain or enhance their high scenic quality, recreational value, fishery, and wildlife habitat, while preserving their largely undeveloped character and allowing continuing agricultural uses.
2. Those designated areas of a scenic waterway where density of structures or other developments already exist and provide for precludes application of a more restrictive classification.
3. Those designated scenic waterways that are readily accessible by road or railroad, that allow a wide range of compatible river-oriented public outdoor recreation opportunities, to the extent that these do not impair substantially the natural beauty of the scenic waterway or diminish its esthetic, fish and wildlife, scientific and recreational values.
4. Those designated scenic waterways that are generally inaccessible except by trail or the river, with related adjacent lands and shorelines essentially primitive. These classified scenic waterways will be administered to preserve their natural, wild, and primitive condition, essentially unaltered by the effects of man, while allowing compatible recreational uses, other compatible existing uses, and protection of fish and wildlife.

5 Alternatives

5.1 Formulation Process

In order to determine the most viable alternatives to meet the project's purpose and need, TID considered the needs of the water users, goals for conservation and restoration, resources and funding available, and the current status of the District's previous improvements. The comments received during the scoping period and Draft Plan-EA review period were incorporated into the alternatives formulation process. Alternatives considered during project development but eliminated from the 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 alternatives eliminated from detailed study are discussed in Section 5.2. Three separate alternatives were selected for further consideration and are presented in Section 5.3.

5.2 Alternatives Eliminated from Detailed Study

Nine alternatives were considered but eliminated from detailed study. The following six of these alternatives were eliminated due to logistics, social or environmental reasons, or inability to meet the purpose and need of the project:

- Piping outside the ROW
- Conversion to dryland farming
- Fallowing farm fields through transfer or leasing
- Voluntary duty reduction
- On-farm efficiency upgrades
- Private lateral piping

Three alternatives were eliminated due to costs: steel pressurized piping, polyvinyl chloride (PVC) pressurized piping, and the exclusive or partial use of groundwater for irrigation. These alternatives were evaluated with respect to capital and ongoing annual costs over a 100-year period of analysis. The evaluation was based on seven individual project groups, which represent canals and laterals that would undergo construction during the same period. The cost analysis indicated that the District would have to replace steel and PVC piping at least once during the 100-year analysis period for each project group. These piping alternatives were eliminated as a result of these replacement costs. The partial use of groundwater was eliminated due to the logistics of acquiring groundwater rights and ongoing annual electricity costs that would increase the District's annual operating costs by 17 percent.

These are described in more detail below and Table 5-1 presents the net present value of the steel piping, PVC piping, and partial groundwater use alternatives and the HDPE Piping Alternative evaluated in the SIP for each of the seven project groups.

5.2.1 Pipeline Realignment

Pipeline realignment would convert the District's system to pipes. However, instead of following the same path of the existing canals and laterals, in some cases the pipes would be laid in a new alignment (or path across the landscape). New alignments would be selected to continue to serve all patrons but, when possible, would take a more direct route to decrease the length of piping needed. Approximately 89 percent of land adjacent to TID's current system is privately owned. Realignment would require acquiring new easements or ROW across these private lands, which have been divided into smaller parcels with many different owners over time. Depending on the proposed alignment, a ROW across public land could potentially be necessary.

New easements would disrupt prime farmland and residential living areas, and the easements would be difficult to secure from enough landowners to be feasible. Pipeline realignment outside the existing ROW would require the irrigation district to pay market price for the easements and negotiate with multiple landowners, which would be a complex, expensive, and time-consuming process. Pipeline realignment would meet the sponsors' objectives; however, this alternative was eliminated from further study due to legal costs, logistical complexity, and social effects to adjacent landowners.

5.2.2 Conversion to Dryland Farming

The lack of rainfall through the growing season coupled with hot temperatures and desiccating winds, as well as generally shallow and well to excessively drained soils with low storage potentials, generally less than five inches, makes dryland farming infeasible within the District. This is supported by William Renwick's "Changes in Deschutes County Irrigated Agriculture Since 1950" (Renwick 1975). In his report, Renwick described the formation of irrigation districts after new farmers found dryland farming to be impossible and concluded, "The calculated net irrigation requirements vary with annual and monthly fluctuation in precipitation, but it is evident that irrigation is necessary for raising the area's major crops."

In these dryland farming systems where rainfall is 10-15 inches per year, a fallow every other year is necessary. In TID, production would substantially decrease if dryland farming were entertained and farmers could potentially sell their land due to the development pressure Deschutes County is experiencing. Dryland farming would be inconsistent with ensuring agricultural production is maintained in an area undergoing rapid urbanization. Dryland farming would meet the sponsors' objectives to improve water conservation. This alternative was eliminated because it would not meet the objectives to improve water delivery reliability and public safety for District-owned canal and lateral infrastructure, and it would be inconsistent with public policy supporting agricultural land use.

5.2.3 Fallowing Farm Fields

Fallowing farm fields includes permanently transferring or temporarily leasing water rights from irrigated lands or otherwise not using water rights appurtenant to irrigated lands. Fallowing farm fields would use less irrigation water within the District and would therefore allow more water to be kept instream for fish, wildlife, and habitat. This water would be legally protected instream if the associated water rights were leased or transferred instream. Fallowing farm fields would exacerbate

the water conveyance challenges that the District already experiences (see Section 2.1.1 and Section 2.1.2) because it would affect flow rates across the District and water reliability to certain patrons.

Fallowing farm fields would meet the sponsors' objective to conserve water, but this alternative would not improve water delivery reliability and public safety for District-owned canal and lateral infrastructure. Fallowing farm fields was eliminated from further study as it would not meet the purpose and need to improve water delivery reliability and public safety for District-owned canal and lateral infrastructure, and it would be contrary to public policy supporting and maintaining existing agricultural land uses (see Section 4.4.2).

5.2.4 Voluntary Duty Reduction

Duty reduction refers to patrons voluntarily accepting less than their full water delivery rate from the District. A reduction in duty could allow the District to divert less water, which would leave more water instream. This water would not be permanently protected instream through a new instream water right.

Because this alternative would be voluntary and at the discretion of individual landowners, there would be no certainty that water would be saved and that streamflow would be restored. If duty reductions by patrons were substantial enough, they could exacerbate the water conveyance challenges that the District already experiences in its open canals and laterals, which would be similar to the challenges associated with fallowing farm fields (see Section 5.2.3). The District would also have logistical challenges in working with many individual landowners to encourage adoption of this alternative.

Voluntary duty reduction was eliminated from further study because of the logistical challenges, the potential to exacerbate water conveyance challenges in the District, and because it would not meet the purpose and need to improve water delivery reliability and public safety for District-owned canal and lateral infrastructure.

5.2.5 On-Farm Efficiency Upgrades

The on-farm efficiency upgrades alternative refers to TID patrons upgrading their on-farm infrastructure to use irrigation technologies that provide a more precise application of water. These technologies can have greater application efficiencies. On-farm infrastructure is distinct from District canals and laterals because it is owned and operated by patrons. Once delivered by the District and arriving on-farm, water can either be released to flow over the land for flood irrigation or stored in a holding pond for sprinkler irrigation systems. The typical on-farm systems include center-pivots, wheel-lines, hand-lines, K-lines, drip systems, and flood irrigation. Each irrigation practice has a different irrigation efficiency (i.e., its ability to deliver the irrigation water to the crop root system across the full field being irrigated). Farms within the District primarily use pump and sprinkler systems. On average, the irrigation efficiency of farms within TID is estimated at 70 percent (TID 2017).

This alternative would meet the objective of conserving water; however, it would be logistically challenging for the District to implement at a large scale. Implementing on-farm efficiency upgrades to achieve water savings at the scale of modernizing District infrastructure would require voluntary

participation from many individual landowners. Because the District does not have responsibility for or authority over on-farm irrigation infrastructure, there would be no guarantee that individual landowners would participate. However, the proposed action does not preclude landowners' otherwise upgrading their on-farm infrastructure or receiving assistance to do so through other programs.

Project sponsors must have the legal authority and resources to carry out, operate, and maintain works of improvement (Public Law 83-566 Section 2 and Section 4(3)). Because TID lacks the statutory authority or responsibility to carry out, operate, and maintain on-farm infrastructure owned by TID patrons, on-farm efficiency upgrades are not within the scope of actions that TID can entertain as the Project Sponsor. Therefore, consistent with PL 83-566 authorities under which this plan is being prepared, this alternative was not qualified as a stand-alone alternative or as an additional measure added to an alternative under consideration; as such, it was not fully analyzed in this plan.

On-farm efficiency upgrades were eliminated from further study because of the logistical challenges and because they would not meet the purpose and need to improve water delivery reliability and public safety for District-owned canal and lateral infrastructure.

5.2.6 Piping Private Laterals

Piping private laterals refers to converting from patron-owned, open laterals to piped laterals from the District's point of delivery to the point of use on-farm. Private laterals are owned and operated by patrons; the District does not have responsibility for the operation or maintenance of private laterals.

Similar to on-farm efficiency upgrades, piping private laterals would meet the objective of conserving water; however, it would be logistically challenging for the District to implement at a large scale for the same reasons as on-farm efficiency upgrades (see Section 5.2.5). Piping private laterals was eliminated from further study because of these logistical challenges and because it would not meet the purpose and need to improve water delivery reliability and public safety for District-owned canal and lateral infrastructure.

5.2.7 Piping with Steel or Polyvinyl Chloride

Under the piping alternative, the District would install pipe in the remaining 1.9 miles of canals and 66.9 miles of laterals. The lengths, diameters, and range of pressure ratings used for the piping alternative were estimated based on the engineering analysis completed in the TID SIP.

5.2.7.1 Steel Piping

Under the steel piping alternative, spiral welded steel pipe would be installed in 68.8 miles of canals and laterals. Spiral welded steel was selected that conforms to requirements of the American Water Works Association C200 standard. Steel pipe conforming to American Water Works Association C200 was selected because it is considered an industry consensus standard and is a prominent guide for the manufacture of steel pipe for water and wastewater applications in North America (Bambie and Keil 2013).

Steel pipe typically has a design life of 50 years under irrigation water delivery applications (M. Thalacker, personal communication, November 8, 2017). Pipe diameters of the spiral welded steel pipe would range in size from 6 to 84 inches and pressure ratings designed to accommodate a range for pressures from up to 997 to 1,111 pounds per square inch (psi), depending on the pipe diameter and thickness. Unlike HDPE, steel pipe cannot be shaped to conform into canal alignments; therefore, additional elbows would be required. Capital costs were estimated based on the lengths and diameters quantified and the additional elbows required. These costs were also estimated with constant dollars as per the Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies. Annual operating costs associated with the steel piping alternative were estimated based on TID's current operating budget and assumed that equipment, maintenance, and labor costs would decrease. Assuming a design life of 50 years, capital costs, replacement costs, and annual operations and maintenance costs for the steel piping alternative were estimated. The cost for each project group associated with the steel piping alternative range from $8,308,000 to $38,764,000 over 100 years. Based on this cost, the steel piping alternative was eliminated from further study (see Appendix D for cost details).

5.2.7.2 Polyvinyl Chloride Piping

Under the PVC piping alternative, 66.9 miles of the delivery system would be piped with PVC and 1.9 miles would be piped with HDPE. PVC would be installed for pipe diameters from 6 inches up to 54 inches, and HDPE would be installed in diameters from 63 to 84 inches because PVC pipe is only manufactured in diameters up to 54 inches. Schedule 41 PVC was selected for this alternative, which can accommodate working pressures up to 100 psi, and the HDPE pipe would accommodate working pressures up to 100 psi.

The lifespan of a piping system depends on many different factors. Proper installation and operation of the piping system are key to achieving a long service life. Assuming a piping system is ideally installed and operated, the main factor affecting the pipe's service life is the number and magnitude of surge/water hammer events the system experiences. Surge/water hammer events are caused by valve operations, changing irrigation demand in the system, pump startup and shutdown, quick hydropower turbine shutdowns due to power failures, and any other factors causing fast changes in the piping system flow rate (B. Cronin, personal communication, July 27, 2018).

The USDA-NRCS practice standard lifespan for irrigation pipeline is 20 years (NRCS n.d.). This lifespan is based on long-term experience with primarily PVC pipe irrigation system installations (B. Cronin, personal communication, July 27, 2018). The Plastics Pipe Institute's online software indicates that with the average number of surge/water hammer events expected in a pipeline network, the lifespan of a typical 24-inch, 125 psi pressure rated PVC pipe would be 14 years with a safety factor of two (Plastics Pipe Institute 2015). PVC is also more prone to failure under freezing conditions, and the TID system is used to deliver water several times during the winter for livestock. During these periods, the PVC pipe system would be more likely to freeze and potentially rupture and fail. PVC piping has been installed in irrigation districts in the Deschutes Basin and experienced premature failure, especially in Districts where stock water is delivered during the winter (M. Thalacker, personal communication, November 8, 2017). Considering all of the information above, a PVC design life of 33 years was assumed for purposes of this analysis.

In assessing PVC as a potential piping material, other factors were taken into consideration. PVC joints have a higher potential to leak, which would result in additional replacement costs. In terms of earthquake resiliency, pipe material such as HDPE has been shown to be more resilient in both lab tests (Oliphant et al. 2012; Cornell University et al. 2009) and in seismic events in places such as New Zealand and Japan (Ballantyne 2013).

The annual O&M costs associated with the PVC piping alternative are expected to be the same as the steel piping alternative. The capital costs were estimated based on the lengths and diameters of the PVC piping. Capital costs also account for additional elbow fittings that will be necessary to conform the PVC pipe into the existing canal alignments. These costs reflect constant dollars as per the P&G. Assuming a design life of 33 years and taking into consideration the estimated capital costs, replacement costs, and annual O&M costs, the net present value for each project group ranged between $4,940,000 to $24,391,000 (2018 dollars) over 100 years (see Appendix D for cost details). Although PVC piping would meet the sponsors' objectives, the PVC alternative was eliminated based on the availability of a more resilient and longer lasting material that would achieve the sponsors' objectives at a lower cost across the lifespan of the project (see Appendix D for cost details).

5.2.8 Exclusive or Partial Use of Groundwater

The exclusive or partial use of groundwater in place of surface water for irrigation was also initially considered as possible alternatives under the proposed action. To use groundwater in the Deschutes Basin, the District would have to apply for groundwater rights under OWRD's Deschutes Basin Groundwater Mitigation (DBGM) program pursuant to OAR 690-505-0500. The DBGM program is part of OWRD's goal to limit groundwater use by imposing restrictions to new users obtaining groundwater rights. Under the DBGM program, only 32.98 cfs are available, and it is unlikely the District could obtain rights to all the remaining water (S Henderson, personal communication, August 14, 2017). Given that only 32.98 cfs is available under this program, the District's exclusive use of groundwater to entirely replace their use of surface water is not feasible.

The partial use of groundwater would utilize the remaining groundwater available under the DBGM program where the District would transfer 32.98 cfs of their surface water rights to groundwater rights. Laterals in the northwestern portion of the TID delivery system would be selected for the conversion to groundwater use, which include the Beasley, North Spaulding, Spaulding, West Branch Columbia Southern East and West, Couch, East Couch, West Couch, Gainsforth, and Chambers Ditch laterals. These account for 23.5 miles of the delivery system and serve approximately 1,900 irrigated acres and 119 points of delivery to individual users. Assuming the application rate of 7.48 gallons per minute per acre that was used in the TID SIP, groundwater would need to meet a demand of 14,365 gallons per minute or 32.1 cfs over the irrigation season for the portion of the District that would be converted to groundwater use. The District would decommission the laterals and corresponding 119 points-of-diversion and construct 119 individual wells. Based on the average well depth of existing wells in the District, the constructed wells were assumed to have a well depth of 267 feet. The remaining 45 miles of the delivery system would be replaced with HDPE pipe.

Capital costs were estimated based on the well construction costs for the 119 wells and HDPE piping costs for the remaining 45 miles of the delivery system. These costs reflect constant dollars as per the P&G. Annual O&M costs associated with partial groundwater use are expected to be higher than O&M costs associated with piping due to the increased energy requirements to pump groundwater. A design life of 50 years for each well was selected based on well design guidance provided in the NRCS Engineering Handbook (NRCS 2010). Based on common engineering experience, each well pump was assumed to have a design life of 25 years. Assuming a design life of 50 and 25 years for the well and well pumps, respectively, capital costs, replacement costs, and annual operations and maintenance costs for the partial use of groundwater alternative for each project group were estimated to range from $4,278,000 to $19,811,000 over 100 years. Based on this cost and the logistical constraints associated with obtaining groundwater rights, partial use of groundwater was eliminated from further study (see Appendix D for cost details).

Table 5-1. Net Present Value of Alternatives Considered for the Tumalo Irrigation District – Irrigation Modernization Project.

	Alternative			
Project Groups	**HDPE Piping**	**PVC & HDPE Piping**	**Steel Piping**	**Groundwater and & HDPE Piping**
1	$7,468,000	$7,305,000	$8,308,000	$7,468,000
2	$12,178,000	$15,045,000	$25,736,000	$12,178,000
3	$5,295,000	$6,688,000	$11,428,000	$5,295,000
4	$8,500,000	$10,158,000	$18,149,000	$11,573,000
5	$7,405,000	$9,117,000	$16,643,000	$11,191,000
6	$19,346,000	$24,391,000	$38,764,000	$19,811,000
7	$4,278,000	$4,940,000	$8,102,000	$4,278,000

Notes:
1. Costs presented were rounded to the nearest $1,000.
2. The costs presented for HDPE piping reflect the initial estimate quantified in the SIP; therefore, these costs do not match the HDPE costs presented elsewhere in the document.

5.3 Alternatives Description

Of the several project alternatives that were considered for the TID Irrigation Modernization Project, three were selected for further evaluation:

- No Action (Future without Project): Improvements to existing open canals and laterals occur as funding becomes available and are not reasonably certain to occur;
- Canal Lining Alternative: Line existing open canals and laterals with polyethylene geocomposite covered with shotcrete; and
- High-Density Polyethylene Pressurized Piping Alternative (or the "HDPE Piping Alternative"): Replace the existing canals and laterals with a closed conduit HDPE pressurized pipeline system.

These alternatives are discussed further in the following sections and include only TID-owned infrastructure.

5.3.1 No Action (Future without Project)

Under the No Action Alternative, the District would continue to operate and maintain its existing canal, lateral, and pipe 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 under a project-by-project approach at the large scale necessary to modernize the District's infrastructure.

Without PL 83-566 funding, neither the Canal Lining nor the HDPE Piping Alternative would occur in the foreseeable future. Therefore, for the purposes of this Plan-EA, the No Action Alternative is a near-term continuation of the District's standard operation procedures. Instream flows would not be enhanced for fish, and energy use and cost would remain high. Without pressurized water, the current individual on-farm pumps would continue to require an estimated 6 million kilowatt hours per year. Agriculture in the area would continue to be susceptible to inconsistent water supply and increased production costs.

The No Action Alternative contributes to the sponsors' objectives as follows:

- Improve water conservation: This alternative continues existing water loss in the District's system of 48 cfs (approximately 15,115 acre-feet of water throughout the entire irrigation season) from canal seepage and evaporation.
- Increase water delivery reliability to farms: This alternative maintains existing operations and infrastructure and would only improve irrigation water delivery reliability if the District secures additional funding sources. Effects on the District's water supply from potential regulations and changes in precipitation patterns could force farmers to fallow fields or discontinue irrigated agriculture.
- Reduce O&M costs: This alternative maintains existing energy use and associated costs for farmers. The use of individual pumps requires an energy use of over 6 million kilowatt hours per year across the District at a cost of up to $584,400 per year. This energy use emits approximately 4,600 metric tons of carbon emissions per year. District canal and maintenance costs would remain the same as District personnel would have to continue timely system maintenance that include removal of debris and foreign material that hinder system operation and perform repairs to the banks and slopes of the open canal and lateral system. This alternative would limit the reduction of O&M costs for the District until individual projects are completed.
- Enhance streamflow and habitat conditions for fish and aquatic species: The District would allocate conserved water instream incrementally as projects are completed. This alternative would affect streamflow and habitat conditions along Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek as projects are completed, however these benefits are not reasonably certain to occur.

- Improve public safety: This alternative would not reduce the drowning risks associated with open canals.

5.3.2 Canal Lining Alternative

The Canal Lining Alternative involves the installation of an impervious system to cover 65.1 miles of canals and laterals; current piping in the system would not be replaced with lined canals. Materials typically employed include geomembranes, rubber liners, shotcrete, and/or similar materials. This alternative would require reshaping the current canals to a trapezoidal form, while sub-grade preparation, installation of the liner, and applying a coating for protection. Five representative cross sections of the existing system were identified to size the trapezoid cross sections and are described in further detail in Section 5.3.2.1. Construction of the Canal Lining Alternative would occur in seven project groups[9] over the course of 11 years.

Canals and laterals identified for lining would be accessed from TID's existing maintenance roads when possible. Existing maintenance roads and overland access routes commonly used for O&M would require few, if any, improvements for use during construction.

Temporary overland travel routes within TID's existing ROW would be necessary to access certain canals and laterals associated with the proposed action that do not have established maintenance roads. To facilitate restoration, temporary travel routes would be left in their natural condition with only minimal altering when necessary to allow travel during construction. The most direct route possible would be used to access the construction area. Any work needed to create equipment access would occur prior or concurrently with lining.

Vegetation clearing prior to construction, reseeding, and vegetation management of TID's ROW during construction would be completed according to TID's current vegetation management practices and NRCS Oregon and Washington Guide for Conservation Seedings and Plantings (NRCS 2000). During construction, clearing of vegetation would be minimized to the extent practicable with locations for vehicle and equipment access, staging, and storage selected to avoid trees and other slow-growing vegetation. Trees would only be removed if they pose a safety threat to construction crews working in the canal or lateral trench. Following construction, all disturbed areas would be reseeded with consultation with NRCS and weeds would be managed per the protocol laid out in NRCS Oregon and Washington Guide for Conservations Seedings and Plantings (NRCS 2000). Weeds would be controlled within the ROW using hand pulling during the first year after reseeding, and a combination of hand pulling and herbicide application in the second year if weeds become problematic. In regards to operations and maintenance over the life of the proposed action, TID would remove volunteer and dead trees when necessary (K. Rieck, personal communication, June 27, 2017).

Fences would need to be installed along dangerous sections or areas that are easily accessible by public in order to increase public safety and reduce District liability. These fences would be chosen to prevent the public from nearing the edge or entering canal and would be standard chain link with

[9] Project Group refers to groupings of canals and laterals that would undergo construction during the same period.

3-wire barbed wire cap per NRCS guidelines. In canals with depths greater than 2.5 feet, safety ladders would be installed every 750 feet.

During the irrigation season from April to October, maintenance work would be performed on an as-needed basis. Operation procedures regarding patron deliveries would remain the same as current procedures. During the winter months, outside of the irrigation season, TID would perform system component maintenance including patron valve battery changes, meter maintenance, valve repairs, and repairs to cracks and leaks in the lining throughout the canal and lateral system.

The Canal Lining Alternative contributes to the sponsors' objectives as follows:

- Improve water conservation: This alternative would reduce water loss from canal seepage by approximately 43 cfs (approximately 13,604 acre-feet of water throughout the entire irrigation season) through installing impervious materials between the porous soil and water flowing in the system. Water loss in an open, lined system is estimated to be 10 percent based on studies of canal lining (Swihart and Haynes 2002), compared to up to 30 percent loss in the current, unlined system. Lined canals are vulnerable to tears or cracks in the lining and when torn or cracked, leakage from lined canals is similar to that from unlined canals.

- Increase water delivery reliability to farms: Modernizing the system would improve irrigation water delivery reliability for 7,002 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.

- Reduce O&M costs: This alternative is anticipated to increase O&M costs for the District by $52,800 per year over the life of the project. Canal lining has a varying lifespan as short as 40 years and can require extensive maintenance to continue operating at high efficiency (Swihart, J. & Haynes, J. 2002). In addition, this alternative maintains existing energy use and associated costs for farmers. The use of individual pumps requires an energy use of over 6 million kilowatt hours per year across the District at a cost of up to $584,400 per year. This energy use emits approximately 4,600 metric tons of carbon emissions per year.

- 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 through the State of Oregon's Allocation of Conserved Water Program. Under this alternative, the District would conserve approximately 43 cfs and legally reduce its water right by the amount of conserved water. The District would fully fund this alternative through public and public interest sources. Under this funding model, the District would allocate and legally protect 100 percent of the conserved water instream through Oregon's Allocation of Conserved Water Program (ORS 537.470). The District would allocate the conserved water instream incrementally following completion of each project group. Streamflow and habitat conditions along Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek would benefit incrementally.

- Improve public safety: Without fences, this alternative would not reduce the drowning risks associated with open canals and laterals. Lining the canals and laterals would increase the

water velocity and make the sides slippery and more difficult for people in the water to grasp and climb out. Fences would need to be installed along dangerous sections or areas that are easily accessible by public in order to increase public safety and reduce District liability. Safety ladders would have to be installed within canals to provide the opportunity for escape. The cost analysis of this alternative includes fencing and safety ladders in the total construction cost.

The estimated total project cost for the Canal Lining Alternative over the 100-year period of analysis is $84,334,900. The total average annual project cost amortized over 100 years at 2.75 percent would be $3,197,700. O&M is estimated to increase from the current amount by $52,800 per year.

5.3.2.1 Project-Specific Components

The District would implement the Canal Lining Alternative over seven different project groups (Figure 5-1). Upon completion of all seven project groups, TID would have lined 65.1 miles of open canals and laterals. Five different, representative cross sections were identified in TID's existing delivery system and used to define five trapezoidal cross sections for canal lining.

The delivery laterals would require a trapezoidal channel with a base width ranging from 1 to 4 feet and a top width ranging from 5 to 20 feet, respectively. The TFC channel would have a base width of 4 feet and a top width of 28 feet. Side slopes would be 2 horizontal to 1 vertical. This configuration allows for 1 foot of freeboard in the channel. The cross-sectional area of the laterals would range from about 3 to 48 square feet and the TFC would be about 96 square feet.

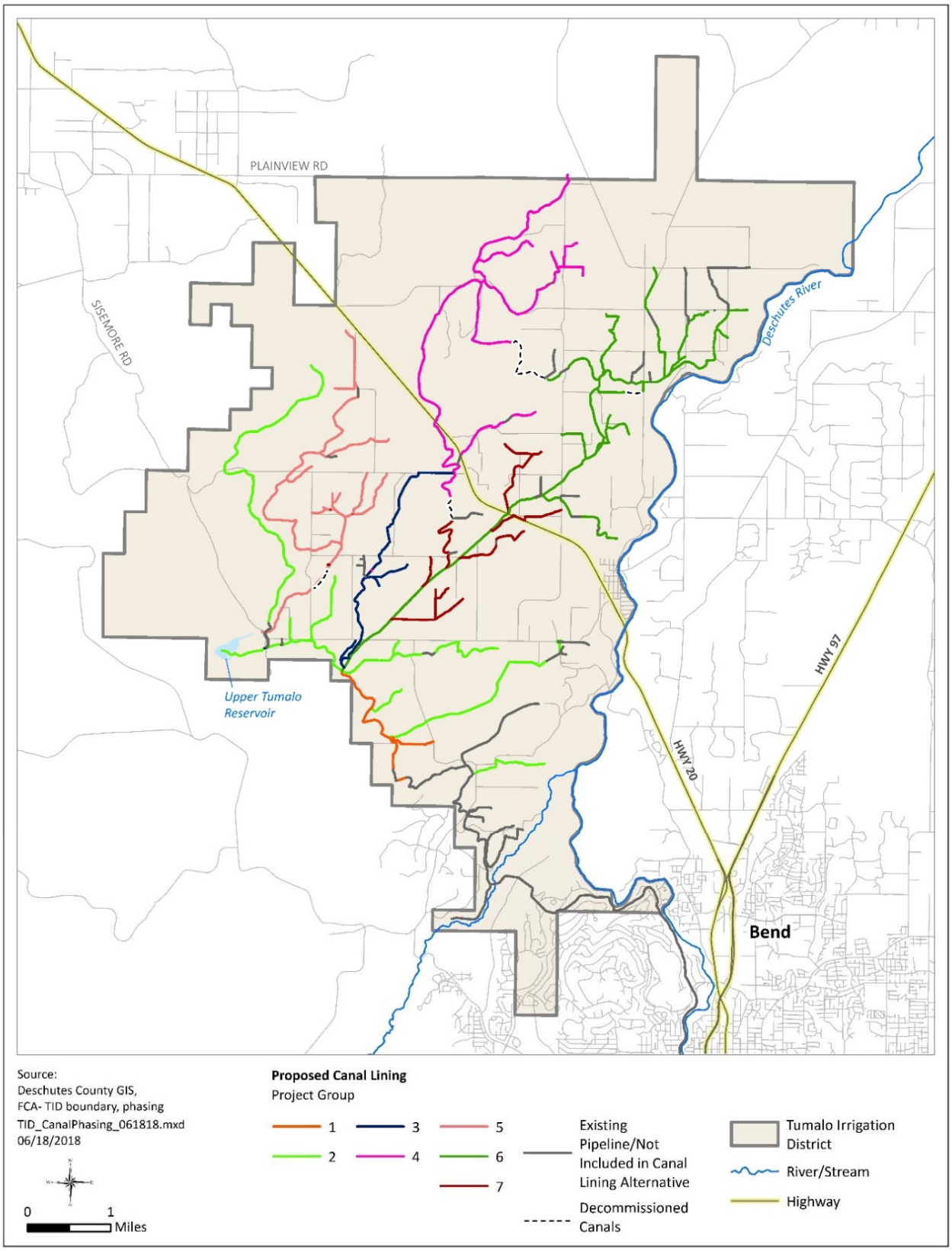


Figure 5-1. Project Groups of the Canal Lining Alternative for Tumalo Irrigation District - Irrigation Modernization Project.

5.3.3 HDPE Piping Alternative

In the HDPE Piping Alternative, the District would install HDPE pipe over 68.8 miles[10]: 1.9 miles of canals and 66.9 miles of laterals. The remaining un-piped segment of the TFC would be piped with 84-inch solid wall HDPE. The remaining portions of the delivery system would be pressurized with HDPE single walled pipe. Pipe size, based on hydraulic modeling, would range in diameter from 6 to 84 inches (TID 2017). Construction of the HDPE Piping Alternative would occur in seven project groups over the course of 11 years.

Construction of the piping and pressurization alternative would include: mobilization and staging of construction equipment, delivery of piping to construction areas, excavation of trenches, fusing of pipelines, placement of pipe, compaction of backfill, and restoration and reseeding of the disturbed areas. In some locations, construction access would need to be created prior to bringing pipes or equipment into construction areas. This could include removal of vegetation within the construction area. Appropriately sized construction equipment would be used to minimize disturbance in the construction area.

Installation of the pipeline would most likely require some borrow or fill material as well as storage areas for pipe, other materials, and construction equipment. These areas have not yet been identified. Areas that have been previously disturbed and are accessible through existing access routes would be selected.

Canals and laterals identified for piping would be accessed from TID's existing maintenance roads when possible. Existing maintenance roads and overland access routes commonly used for O&M would require few, if any, improvements for use during construction.

Temporary overland travel routes within TID's existing ROW would be necessary to access certain canals and laterals associated with the proposed action that do not have established maintenance roads. To facilitate restoration, temporary travel routes would be left in their natural condition, with only minimal altering when necessary to allow travel during construction. The most direct route possible would be used to access the construction area. Any work needed to create equipment access would occur prior or concurrently with piping.

Vegetation clearing prior to construction, reseeding, and vegetation management of TID's ROW during construction would be completed according to TID's current vegetation management practices and NRCS Oregon and Washington Guide for Conservation Seedings and Plantings (NRCS 2000). During construction, clearing of vegetation would be minimized to the extent practicable with locations for vehicle and equipment access, staging, and storage selected to avoid trees and other slow-growing vegetation. Trees would only be removed if they pose a safety threat to construction crews working in the canal or lateral trench. After construction, all disturbed areas would be reseeded with consultation with NRCS and weeds would be managed per the protocol laid out in NRCS Oregon and Washington Guide for Conservations Seedings and Plantings (NRCS

[10] Throughout the Plan-EA, the HDPE Piping Alternative refers to piping 68.8 miles of canals and laterals, while the Canal Lining Alternative refers to lining 65.1 miles of currently open canals and laterals. The difference in lengths between the two alternatives is due to the two data sets used.

2000). Weeds would be controlled within the ROW using hand pulling during the first year after reseeding, and a combination of hand pulling and herbicide application in the second year if weeds become problematic. In regards to operations and maintenance over the life of the proposed action, TID would remove volunteer and dead trees when necessary (K. Rieck, personal communication, June 27, 2017).

O&M under the HDPE Piping Alternative would consist of an ongoing pipe inspection program that would systematically cover inspection of the entire system over a period of several years (most likely a 10-year cycle). During the irrigation season from April to mid-October, work would be performed on an as-needed basis. During the winter months, outside of the irrigation season, TID would perform system component maintenance including patron valve battery changes, meter maintenance, patron and District operational valve maintenance, air and vacuum valve maintenance, pressure reducing station filter maintenance, and valve repairs.

The HDPE Piping Alternative contributes to the sponsors' objectives as follows:

- Improve water conservation: This alternative would reduce water loss from canal seepage and evaporation by 48 cfs (approximately 15,115 acre-feet of water throughout the entire irrigation season) through installing pressurized HDPE pipe for all open canals and laterals.

- Increase water delivery reliability to farms: Modernizing the system would improve irrigation water delivery reliability for 7,002 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 efficiency, allowing existing carry water to be available for patrons and further reducing the need to spill excess water as the system becomes on demand.

- Reduce O&M costs: HDPE pipes are UV resistant, water hammer resistant, and have high tensile strength. During installation HDPE pipes are welded together, and therefore the need for expensive fittings and thrust blocks are minimized. HDPE pipe is easy to install, bendable, retains its properties between -220°F and 180°F, and has a design life of 100 years. Because HDPE pipe requires less O&M than an open system, TID would direct its attention to telemetry for measurement and system adjustments from Crescent Lake to optimize water conservation. In addition, a pressurized pipeline allows for the elimination of individual pumps serving farms across the District and the conservation of approximately 4 million kilowatt hours per year. It would reduce patron pumping costs by approximately $325,500 per year and reduce carbon emissions by approximately 2,300 metric tons per year.

- 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 through the State of Oregon's Allocation of Conserved Water Program. Under this alternative, the District would conserve 48 cfs and legally reduce its water right by the amount of conserved water. The District would fully fund this alternative through public and public interest sources. Under this funding model, the District would allocate and legally protect 100 percent of the conserved water instream through Oregon's Allocation of Conserved Water Program. The District would allocate the conserved water

instream incrementally following completion of each project group. Streamflow and habitat conditions along Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek would benefit incrementally.

- Improve public safety: Converting open canals and laterals to buried pipe would eliminate the risk of drowning.

The estimated total project cost for the HDPE Piping Alternative over the 100-year period of analysis is $43,326,000. The total average annual project cost amortized over 100 years at 2.75 percent is $1,128,400. Over the lifetime of the project, O&M is estimated to decrease by $126,600 per year.

5.3.3.1 Project–Specific Components

The District would implement the HDPE Piping Alternative over the seven different project groups (Figure 5-2). Upon completion of all seven project groups, TID would replace 1.9 miles of canals and 66.9 miles of laterals in its system with gravity-pressurized buried pipe. The open portion of the TFC would be piped with 84-inch solid wall HDPE. The remaining portions of the delivery system would be pressurized with HDPE single walled pipe. Pipe required based on hydraulic modeling would range in diameter from 6 to 84 inches (TID 2017).

Under this alternative, 543 existing turnouts would be upgraded to pressurized delivery systems. Currently numerous TID turnouts are shared by patrons. In order to provide pressurization benefits and better water management, the majority of these existing shared turnouts would be converted to individual turnouts by the addition of approximately 119 new turnouts. Modifications to each turnout would include an appropriately sized tee from the mainline or lateral, a pressure relief valve, a gear-actuated plug valve, a magnetic meter, a combination air and vacuum relief valve, and associated hardware and spool pipe segments (TID 2017). Three pressure-reducing valves (PRV) would also be installed as part of the proposed action to alleviate high pressures within the system.

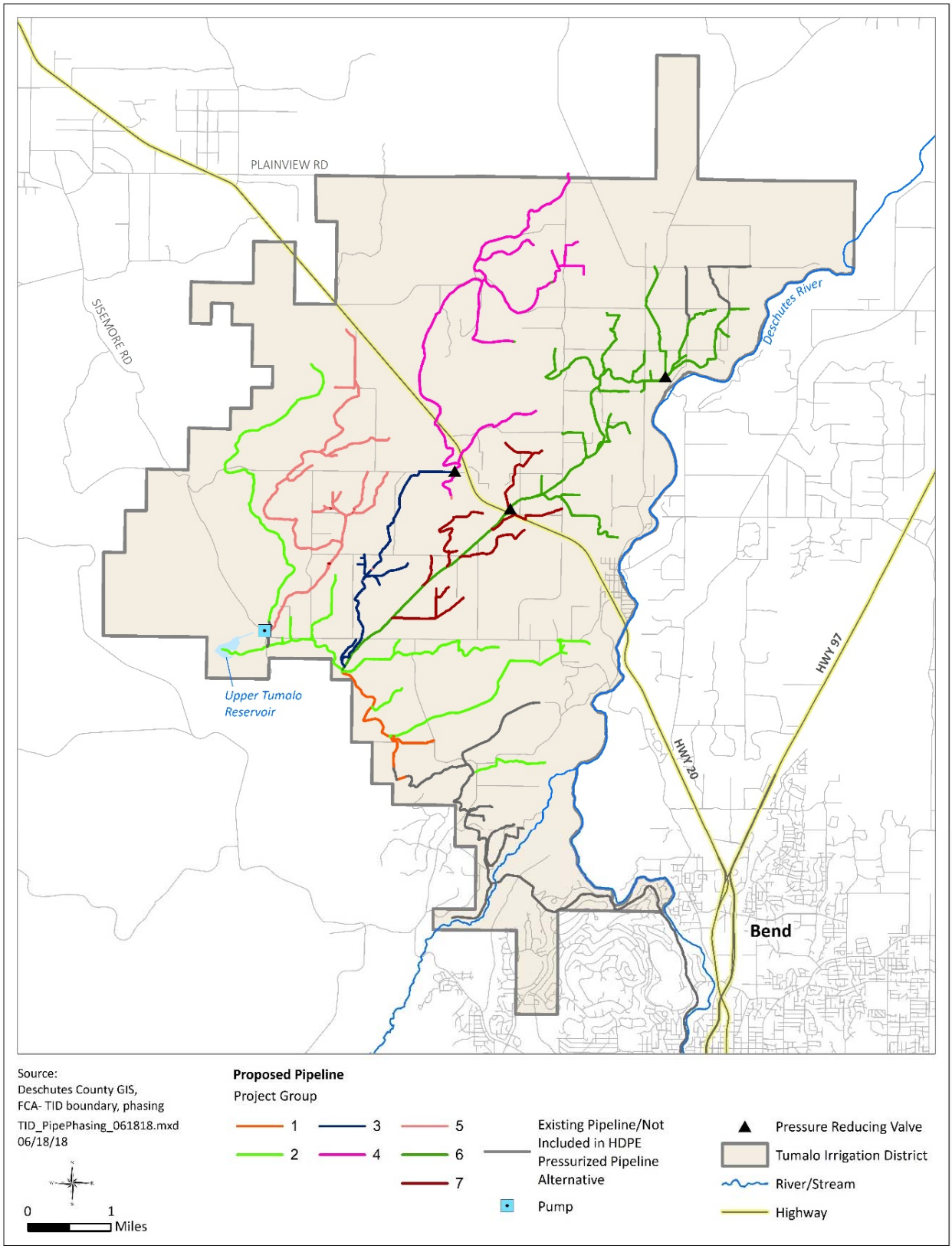


Figure 5-2. Project Groups of the HDPE Piping Alternative for Tumalo Irrigation District - Irrigation Modernization Project.

5.4 Summary and Comparison of Alternatives

Table 5-2 compares the No Action/Future without Project (Alternative 1), the Canal Lining Alternative (Alternative 2), and the HDPE Piping Alternative (Alternative 3). The table summarizes measures addressed as well as environmental, social, cultural, and economic effects.

Table 5-2. Summary and Comparison of Alternative Plans

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
Measures to address	Habitat for fish and wildlife	Instream flows and habitat would not be improved.	Allocation of conserved water to instream flows would improve water quality and enhance habitat.	Allocation of conserved water to instream flows would improve water quality and enhance habitat.
	Public safety	Canals and laterals would be left open and drowning would remain a risk.	The lined canal would have steeper concrete side slopes and faster water velocities than the existing canal. Canals and laterals would be left open and fencing would be installed along dangerous sections. Drowning would remain a risk.	Drowning risk would be eliminated.
	Water delivery reliability for agriculture	Water delivery reliability for agriculture would not be improved as infrastructure and operations would not change.	Water delivery reliability for agriculture would improve for irrigators within the District.	Water delivery reliability for agriculture would improve for irrigators within the District. Pressurized water would be available to irrigators when they need it.
Installation Costs	NRCS Contribution	$0	$64,410,000	$29,781,700
	SLO Contribution	$0	$19,924,900	$13,544,300
	Total	$0	$84,334,900	$43,326,000
NED Account			**Project Group 1[1]**	
	Average Annual Cost			
	Installation	$0	$196,600	$199,800
	OM&R[2]	$0	$2,200	$0
	Other Direct Costs[3]	$0	$5,000	$5,200
	Total	$0	$203,800	$205,000
	Annual Benefits[4]	$0	$177,400	$205,600
	Annual Costs[5]	$0	$203,800	$205,000
	Annual Net Benefits[6]	$0	-$26,400	$600
	Annual Remaining Flood Damage	N/A	N/A	N/A

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
	Project Group 2[1]			
NED Account	Average Annual Cost			
	Installation	$0	$692,000	$198,300
	OM&R[2]	$0	$12,700	$0
	Other Direct Cost[3]	$0	$4,500	$2,400
	Total	$0	$709,200	$200,700
	Annual Benefits[4]	$0	$148,400	$269,300
	Annual Costs[5]	$0	$709,200	$200,700
	Annual Net Benefits[6]	$0	-$560,800	$68,600
	Annual Remaining Flood Damage	N/A	N/A	N/A
	Project Group 3[1]			
NED Account	Average Annual Cost			
	Installation	$0	$304,500	$104,700
	OM&R[2]	$0	$4,100	$0
	Other Direct Costs[3]	$0	$2,400	$1,300
	Total	$0	$311,000	$106,000
	Annual Benefits[4]	$0	$79,600	$135,600
	Annual Costs[5]	$0	$311,000	$106,000
	Annual Net Benefits[6]	$0	-$231,400	$29,600
	Annual Remaining Flood Damage	N/A	N/A	N/A
	Project Group 4[1]			

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
NED Account	Average Annual Cost			
	Installation	$0	$544,300	$120,100
	OM&R[2]	$0	$9,000	$0
	Other Direct Costs[3]	$0	$2,700	$1,400
	Total	$0	$556,000	$121,500
	Annual Benefits[4]	$0	$88,200	$205,100
	Annual Costs[5]	$0	$556,000	$121,500
	Annual Net Benefits[6]	$0	-$467,800	$83,600
	Annual Remaining Flood Damage	N/A	N/A	N/A
	Project Group 5[1]			
NED Account	Average Annual Cost			
	Installation	$0	$447,800	$97,400
	OM&R[2]	$0	$8,100	$0
	Other Direct Costs[3]	$0	$2,000	$1,000
	Total	$0	$457,900	$98,400
	Annual Benefits[4]	$0	$61,200	$133,500
	Annual Costs[5]	$0	$457,900	$98,400
	Annual Net Benefits[6]	$0	-$396,700	$35,100
	Annual Remaining Flood Damage	N/A	N/A	N/A
	Project Group 6[1]			
NED Account	Average Annual Cost			
	Installation	$0	$840,500	$346,300
	OM&R[2]	$0	$14,300	$0
	Other Direct Costs[3]	$0	$8,100	$4,100
	Total	$0	$862,900	$350,400
	Annual Benefits[4]	$0	$243,400	$495,800

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
	Annual Costs[5]	$0	$862,900	$350,400
	Annual Net Benefits[6]	$0	-$619,500	$145,400
	Annual Remaining Flood Damage	N/A	N/A	N/A
	Project Group 7[1]			
NED Account	Average Annual Cost			
	Installation	$0	$92,200	$45,200
	OM&R[2]	$0	$2,400	$0
	Other Direct Costs[3]	$0	$2,300	$1,200
	Total	$0	$96,900	$46,400
	Annual Benefits[4]	$0	$65,800	$124,100
	Annual Costs[5]	$0	$96,900	$46,400
	Annual Net Benefits[6]	$0	-$31,100	$77,700
	Annual Remaining Flood Damage	N/A	N/A	N/A

Notes:

1. All Costs and Benefits presented in the table for the HDPE Alternative and Canal Lining Alternative are included as a change from the No Action Alternative. Costs and Benefits for the No Action Alternative are shown as $0 to represent there would be no change to the existing costs and benefits.
2. OM&R costs for the HDPE Alternative are included in the annual benefits row, as they would decrease and therefore be a benefit to the District.
3. Other Direct Costs for the Canal Lining Alternative consist of increased groundwater pumping costs associated with reduced recharge in the basin and increased carbon costs. Other Direct Costs for the HDPE Alternative consist of increased groundwater pumping costs associated with reduced recharge in the basin.
4. For the HDPE Piping Alternative, quantified benefits include instream flow benefits, reduced OM&R costs, reduced carbon outputs, and reduced energy costs from pumping. For the Canal Lining Alternative quantified benefits include instream flow.
5. For the HDPE Piping Alternative, costs include annualized installation costs and increased groundwater pumping costs associated with reduced recharge in the basin. For the Canal Lining Alternative, costs include annualized installation costs, increased groundwater pumping costs associated with reduced recharge in the basin, increased carbon costs, and increased OM&R costs.
6. Annual Net Benefits shown for the HDPE Piping Alternative and Canal Lining Alternative are the additional net benefits compared to the No Action Alternative.

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
Environmental Quality (EQ) Account	**Geology and Soils**			
	Geology	No effect	No effect	No effect
	Erosion	Minor effects from ongoing erosion of canals and laterals.	Negligible short-term effects during construction.	Negligible short-term effects during construction.
	Prime Farmlands	No effect	Minor short-term effects during construction.	Minor short-term effects during construction.
Environmental Quality (EQ) Account	**Water**			
	Surface- Water Quality	No effect	Potential to improve 162 miles of stream 303d listed for temperature, dissolved oxygen, Chlorophyll a, pH, sedimentation, or turbidity.	Potential to improve 162 miles of stream 303d listed for temperature, dissolved oxygen, Chlorophyll a, pH, sedimentation, or turbidity. Potential to improve irrigation water quality delivered to patrons by preventing contaminants in agricultural tailwater, such as herbicides and pesticides, from entering the District's canals and laterals.
	Surface- Water Quantity	No effect	Allocation of conserved water to instream water rights of approximately 43 cfs to be legally protected within 162 river miles.	Allocation of conserved water to instream water rights of approximately 48 cfs to be legally protected within 162 river miles. As sections of the District become piped, the conveyance system would convert into an on-demand system allowing water to remain instream (not diverted) when not being utilized by patrons.
	Groundwater- Quantity	No effect	Reduction to recharge by approximately 13,500 acre-feet. Recharge through cracks and tears would continue to occur.	Reduction to recharge by approximately 15,000 acre-feet.
	Regional Water Resources Plan	No effect	Allocation of conserved water to instream water rights aligns with goals and objectives of regional water resources plans.	Allocation of conserved water to instream water rights aligns with goals and objectives of regional water resources plans.

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
	Conserved Water	No effect	Potential to conserve approximately 43 cfs currently lost through seepage in conveyance canals and laterals.	Potential to conserve approximately 48 cfs currently lost through seepage and evaporation in conveyance canals and laterals.
	Water Rights	No effect District will continue to struggle in supplying patrons their full water rights due to conveyance inefficiencies.	Allocation of conserved water to instream water rights of approximately 43 cfs through Oregon's Allocation of Conserved Water Program. District would have an efficient conveyance system to supply patrons their full water rights.	Allocation of conserved water to instream water rights of approximately 48 cfs through Oregon's Allocation of Conserved Water Program. District would have an efficient conveyance system to supply patrons their full water rights.
	Water Leasing	No effect	Potential for reduction in instream leasing limitations for patrons.	Removal of instream leasing limitations for patrons.
	Wild and Scenic Rivers	No effect	There would be no direct effects to the 146.5 river miles of designated Wild and Scenic Rivers and State Scenic Waterways located within the area of potential effect. A reduced District diversion rate and the allocation of instream water rights would have indirect effects by restoring the designated waterways to a more natural hydrologic regime.	There would be no direct effects to the 146.5 river miles of designated Wild and Scenic Rivers and State Scenic Waterways located within the area of potential effect. A reduced District diversion rate and the allocation of instream water rights would have indirect effects by restoring the designated waterways to a more natural hydrologic regime.
	Wetland and Riparian Areas			

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
Environmental Quality (EQ) Account	Wetlands	No effect	Project canals and laterals are not considered jurisdictional wetlands by state or federal agencies. The National Wetland Inventory (NWI) geographic information systems data (USFWS 2016) shows that about 23 wetland features sporadically occur adjacent to canals and laterals within the area of potential effect; however, these features have not been field verified. Wetland determinations and/or delineations of areas adjacent to canals in areas where work would occur will be conducted prior to implementation of construction of each project group, and wetlands will be avoided to the extent practicable. Wetland habitat adjacent to stream reaches downstream of Crescent Lake Dam and TID's diversions would experience additional flows, which will enhance wetlands along 162 miles of rivers through allocation of instream water rights and reduced diverted water at District diversions.	Project canals and laterals are not considered jurisdictional wetlands by state or federal agencies. The National Wetland Inventory (NWI) geographic information systems data (USFWS 2016) shows that about 23 wetland features sporadically occur adjacent to canals and laterals within the area of potential effect; however, these features have not been field verified. Wetland determinations and/or delineations of areas adjacent to canals in areas where work would occur will be conducted prior to implementation of construction of each project group, and wetlands will be avoided to the extent practicable. Wetland habitat adjacent to stream reaches downstream of Crescent Lake Dam and TID's diversions would experience additional flows, which would enhance wetlands along 162 miles of rivers through allocation of instream water rights and reduced diverted water at District diversions.
	Riparian Areas	No effect	Reduction of available water to riparian plants found along canals and laterals in project area. Effects will be offset by the benefits and enhancement to riparian areas along 162 miles of river through instream water right transfers and reduction of diverted water at District diversions.	Reduction of available water to riparian plants found along canals and laterals in project area. Effects will be offset by the benefits and enhancement to riparian areas along 162 miles of river through instream water right transfers and reduction of diverted water at District diversions.
	Fish and Wildlife			

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
Environmental Quality (EQ) Account	Bald and Golden Eagle Protection Act	No effect	No effect; best management practices would include operating outside the USFWS-approved buffer distances. If operating within the recommended buffer distance, the District would operate outside of the nesting season.	No effect; best management practices would include operating outside the USFWS-approved buffer distances. If operating within the recommended buffer distance, the District would operate outside of the nesting season.
	Terrestrial Endangered and Threatened Species	No effect.	No effect.	No effect.
	Fish and Fish Habitat	No effect.	Minor to moderate, long-term effects due to 162 miles of improved stream fishery.	Minor to moderate, long-term effects due to 162 miles of improved stream fishery.
	Aquatic Endangered and Threatened Species	No effect.	No effect to bull trout. Minor beneficial effects to steelhead and Oregon spotted frog.	No effect to bull trout. Minor beneficial effects to steelhead and Oregon spotted frog.
	General Wildlife and Wildlife Habitat	No effect.	The newly lined canal would have steeper concrete side slopes and faster water velocities than the existing canal, posing a drowning risk to large mammals. Fencing along the canals would alter the land use patterns of wildlife. Lining of canals would remove available water to riparian vegetation, thus potential for reduced habitat. This risk would be mitigated by reseeding with native vegetation.	Piping of canals would remove available water to riparian vegetation, thus potential for reduced habitat. This risk would be mitigated by reseeding with native vegetation.
	Migratory Bird Treaty Act Species	No effect	No effect; the District is operating outside the primary nesting period for migratory birds of concern (April 15 through July 15) and raptors (April through July).	No effect; the District is operating outside the primary nesting period for migratory birds of concern (April 15 through July 15) and raptors (April through July).
Environmental Quality (EQ) Account	**Vegetation**			
	General vegetation	No effect	Minor, short-term effects to approximately 150 acres of vegetation due to construction.	Minor, short-term effects to approximately 161 acres of vegetation due to construction.

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
	Invasive Species	No effect	Negligible effects due to construction.	Minor, long-term effects resulting from decreased transport of invasive species through canals.
	Special Status Species	No effect	Negligible effects expected. Surveys would be completed prior to construction in the BLM Peck's milkvetch ACEC. If surveys detect plants within the project area, there would be negligible long-term effects based upon proposed mitigation measures.	Negligible effects expected. Surveys would be completed prior to construction in the BLM Peck's milkvetch ACEC. If surveys detect plants within the project area, there would be negligible long-term effects based upon proposed mitigation measures.
Environmental Quality (EQ) Account	**Human Environment**			
	Land Use	No effect	No direct effect. Long-term, indirect effects would occur due to the support of current agricultural land use and existing zoning designations.	No direct effect. Long-term, indirect effects would occur due to the support of current agricultural land use and existing zoning designations.
	Recreation	No effect	Negligible to minor, short-term, effects during construction. Moderate long-term effects due to the loss of hiking and biking use of the ROW from safety fencing installed.	Negligible to minor, short-term, effects during construction.
	Historic, Cultural, and Scientific Resources	No effect	Long-term effects on historic properties require consultation with State Historic Preservation Office and appropriate mitigation measures, which would be identified prior to construction and completed concurrent with or after construction. Mitigation would limit effects to moderate.	Long-term effects on historic properties require consultation with State Historic Preservation Office and appropriate mitigation measures, which would be identified prior to construction and completed concurrent with or after construction. Mitigation would limit effects to moderate.
Other Social Effects Account	Visual Resources	No effect.	Minor, short-term effects due to construction activities. Moderate, long-term effects due to the change in appearance from new fences and concrete.	Minor, short-term effects due to construction activities. Minor, long-term effects due to the change in appearance from open canals and riparian plants to buried pipe with upland vegetation.

Watershed Plan Element	Item or Concern	No Action Alternative	Alternative 2 Canal Lining	Alternative 3 HDPE Piping (NED Recommended)
	Tribal, religious, sacred, or cultural site	No effect.	The project area would be surveyed prior to construction to avoid effects on archaeological resources.	The project area would be surveyed prior to construction to avoid effects on archaeological resources.
Regional Economic Development Account	Local jobs during construction	N/A	100	50
	Annual jobs from recreation	N/A	Magnitude/direction of recreation visitation impacts not known, so no Regional Economic Development (RED) benefits quantified.	Magnitude/direction of recreation visitation impacts not known, so no RED benefits quantified.
	Other Economic Sector Jobs	120	120	130
	Beneficial Effects Annualized (Millions, 2017$)			
	Region	$3.6	$5.4	$4.2
	Rest of Nation	N/A[1]	N/A	N/A
	Adverse Effects Annualized (Millions, 2017$)[2]			
	Region	$0.9	$0.9	$0.8
	Rest of Nation	$0	$3.0	$1.1
	1. Not applicable 2. Note that this includes only the direct costs (no indirect/induced costs are included). Also, total RED effects at the regional level may be minimal as changes in OM&R costs may largely result in income transfers between individuals (i.e., OM&R savings may be offset by reduced District wages and construction sector income), which would reduce changes in net regional income.			

6 Environmental Consequences

This section evaluates the environmental consequences of the No Action Alternative, HDPE Piping Alternative, and Canal Lining Alternative. The effects of the three alternatives were evaluated with respect to each resource discussed in Section 4. When considering each resource, the intensity and duration of effects were evaluated using either a quantitative or a qualitative approach. The intensity of an effect was classified as either negligible, minor, moderate, or major. The duration of an effect was classified as temporary, short-term, or long-term, where the period of an effect is dependent on the resource. Table E-1 in Appendix E presents the intensity threshold matrix used to categorize and define the range of expected effects.

6.1 Cultural Resources

The area of potential effects for archaeological and historical resources is described in Section 4.1.

Pursuant to the NHPA of 1966, as amended, federal agencies must take into account the potential effect of an undertaking on historical properties, which refers to cultural resources listed in, or eligible for listing in, the National Register of Historic Places. Recommendations of eligibility require consultation with the Oregon SHPO, and a determination of effects must be agreed upon by the consulting parties. Any finding of "historic properties adversely affected" would require that the consulting parties enter into a Memorandum of Agreement requiring a method of treatment for the adverse effect that is acceptable to all of the consulting parties. Adverse effects could include physical destruction; alteration through repair or maintenance; removal from original location; neglect; visual, audible, or atmospheric changes; transfer, lease, or sale. The Memorandum of Agreement would stipulate that the treatment would be successfully completed prior to the initiation of project construction. The purpose of the Memorandum of Agreement is to ensure effects on cultural resources as a result of system modification are successfully mitigated and are not classified as major.

The District signed a Memorandum of Agreement with SHPO in 2006 to meet Section 106 requirements for a previous project. The Memorandum of Agreement applied to the TFC (Project Group 1) and the Highline/Couch laterals (parts of Project Groups 2 and 5). It was determined by SHPO that piping these segments would have an adverse effect on historical resources. The Memorandum of Agreement accepted the HAER documentation as mitigation for the effects of piping the TFC and Highline/Couch laterals, provided the terms of the agreement are fulfilled. The HAER determined that several features of the District were eligible for listing on the National Register of Historic Places, including the TFC and the Columbia Southern Canal. Both the TFC and Columbia Southern Canal are part of the proposed action.

A tiered EA approach is being used to meet Section 106 requirements for the remaining portions of the proposed action. This approach involves consultation with SHPO to address resource concerns related to the entire project, while site-specific issues and effects are addressed in subsequent site-specific studies nearer to their implementation date. The tiered approach would complete site-specific archaeological and historical resource surveys on a schedule that would align with the proposed action's 11-year installation period.

The District and NRCS are in consultation with SHPO about mitigation for the proposed action's adverse effects on cultural resources. Mitigation measures under consideration include informational signing at trailheads or publicly significant locations, development of an informational brochure for interpretative use, and historical information for the District's website. These measures would be completed concurrently with or after construction.

6.1.1 No Action (Future without Project)

6.1.1.1 Archaeological Resources

Under the No Action Alternative, the canal and laterals would remain open. Until the canal and laterals are modernized, there would be no opportunity to disturb archaeological resources. O&M activities would continue and may potentially increase in frequency and intensity as the water conveyance system deteriorates over time. Eventually, system failures may cause disturbances that could inadvertently affect archaeological resources.

6.1.1.2 Historical Resources

The District would not utilize PL 83-566 funding to modernize canals and laterals. Until the canal and laterals are modernized, there would be no effects on historical resources other than O&M activities.

6.1.2 Canal Lining Alternative

Reshaping the District's canal and laterals to a trapezoidal form and lining with geomembranes, rubber liners, shotcrete, and/or similar materials would alter the design, materials, and workmanship of TID's infrastructure, which has the potential to adversely affect cultural and historical resources.

6.1.2.1 Archaeological Resources

No archaeological resources were found during surveys that covered the TFC (Project Group 1) and the Highline/Couch laterals (parts of Project Groups 2 and 5) of the Canal Lining Alternative (Stuemke 2006 and 2017). Following the tiered EA approach, site-specific archaeological surveys would be competed for each project group prior to construction for areas not already surveyed. All construction would take place in previously disturbed areas. An Inadvertent Discovery Plan would be followed if archaeological resources were discovered during project excavation, as described below.

6.1.2.2 Historical Resources

The 2006 Memorandum of Agreement with SHPO would apply to the TFC (Project Group 1) and the Highline/Couch laterals (parts of Project Groups 2 and 5). Surveys for historical resources in the remaining portions of the Canal Lining Alternative would be completed prior to construction, and mitigation measures such as those listed above would be identified in consultation with SHPO prior to construction. Mitigation measures would be completed concurrently with or after construction. An Inadvertent Discovery Plan would be followed if historical or cultural resources were discovered during project excavation, as described below.

Overall, the effects on potential cultural resources from the Canal Lining Alternative would be moderate and long-term in intensity because mitigation for each project group would be completed in consultation with SHPO.

6.1.3 HDPE Piping Alternative

Converting the District's canal and laterals to buried pipe would alter the design, materials, and workmanship of TID's infrastructure, which has the potential to adversely affect cultural and historical resources.

6.1.3.1 Archaeological Resources

No archaeological resources were found during surveys that covered the TFC (Project Group 1) and the Highline/Couch laterals (parts of Project Groups 2 and 5) of the HDPE Piping Alternative (Stuemke 2006 and 2017). Following the tiered EA approach, site-specific archaeological surveys would be competed for each project group prior to construction for areas not already surveyed. All construction would take place in previously disturbed areas. An Inadvertent Discovery Plan would be followed if archaeological resources were discovered during project excavation, as described below.

6.1.3.2 Historical Resources

The 2006 Memorandum of Agreement with SHPO would apply to the TFC (Project Group 1) and the Highline/Couch laterals (parts of Project Groups 2 and 5). Surveys for historical resources in the remaining portions of the HDPE Piping Alternative would be completed prior to construction and mitigation measures such as those listed above would be identified in consultation with SHPO prior to construction. Mitigation measures would be completed concurrently with or after construction. An Inadvertent Discovery Plan would be followed if historical or cultural resources were discovered during project excavation, as described below.

Overall, the effects on potential cultural resources from the HDPE Piping Alternative would be moderate and long-term in intensity because mitigation for each project group would be completed in consultation with SHPO.

6.1.4 Compliance and Best Management Practices

Effects on cultural resources would be minimized by implementing the following practices under both alternatives unless otherwise specified:

- Based on the 2006 Memorandum of Agreement, the HAER documentation would be sufficient mitigation for piping the TFC (Project Group 1) and the Highline/Couch laterals (parts of Project Groups 2 and 5). Since the Canal Lining Alternative involves different modifications but would have a similar overall effect on historical integrity, it is expected the HAER would also be sufficient mitigation for lining the TFC and the Highline/Couch laterals. If the HAER is not sufficient mitigation for these portions, additional mitigation would be agreed upon with SHPO, NRCS, and the District prior to construction.

- Following the tiered EA approach, site-specific archaeological and historical resource surveys would be completed for the remaining portions of either alternative closer to their implementation date.
- Further consultation resulting in a Memorandum of Agreement would be completed between SHPO, NRCS, and the District for either alternative. The Memorandum of Agreement would address cultural resource concerns related to the entire proposed action and agree to appropriate mitigation measures for all features found to be eligible for inclusion on the National Register of Historic Places. Mitigation measures would be completed concurrently with or after construction. By incorporating these mitigation measures that have been accepted by SHPO, the mitigation efforts would successfully mitigate effects to cultural resources.
- An Inadvertent Discovery Plan would be followed if archaeological or historical materials, including human remains, were encountered during construction. The plan would require construction to stop accordingly, consultation with SHPO and NRCS cultural resources staff, and notification to appropriate Tribes. Continuation of construction would occur in accordance with applicable guidance and law.

6.2 Fish and Aquatic Resources

The areas of potential effect for fish and aquatic resources are discussed in Section 4.2.

6.2.1 No Action (Future without Project)

6.2.1.1 General Fish and Aquatic Species

The No Action Alternative would have no effect on fish and aquatic species in the project area and in the area of potential effect. The District would continue to divert water from Tumalo Creek and the Deschutes River for consumptive use at the current rate. The project area canals and laterals would continue to leak water. The same amount of water would continue to be stored in Crescent Lake and routed along Crescent Creek, the Little Deschutes River, and the Deschutes River to the BFC. The same amount of water would also be diverted from Tumalo Creek at the TFC diversion. The reduced flow in the area of potential effect would continue to reduce the potential fish habitat and compromise water quality for fish and aquatic species.

6.2.1.2 Federally Listed Fish and Aquatic Species

Oregon spotted frog, steelhead, and bull trout populations would continue to be managed by state and federal agencies in the No Action Alternative. Habitat would likely not change substantially from its current state.

6.2.2 Canal Lining Alternative

6.2.2.1 General Fish Species

The Canal Lining Alternative is expected to conserve approximately 43 cfs of water that would be partitioned between Crescent Lake (approximately 38 percent) during the non-irrigation season and Tumalo Creek (approximately 62 percent) during the irrigation season. These allocations by source

and by season are estimates based on conserved water applications associated with similar projects completed in TID that have already completed the State of Oregon's administrative process for the allocation of conserved water (see OAR 690-018).

The conserved water allocations between Crescent and Tumalo Creeks may change following a thorough review of the application by OWRD who may order a different allocation to avoid affecting other water users at either source.

See Sections 4.10.2 and 6.10.3 for detailed discussion about conserved water and allocation.

As a result of the Canal Lining Alternative, the protection of conserved water below Crescent Creek Dam during the non-irrigation season may affect the affected river reaches differently depending on average instream flow. In the following reaches, the conserved water protected instream would have minor, long-term effects on fish species:

- Crescent Creek: Crescent Lake Dam (RM 30) to mouth (RM 0)
- Little Deschutes River: Crescent Creek (RM 57) to the mouth (RM 0)
- Upper Deschutes River: Little Deschutes River (RM 192.5) to the BFC diversion at Steidl Dam (RM 166)

Because conserved water from Crescent Lake Dam released into this reach would legally and permanently protect instream flow that was previously voluntarily protected by the District (see Section 4.10.2.2 for discussion about the 2016 Stipulated Settlement Agreement and continued compliance with the 2017 BiOp [Reclamation 2017]), the habitat available to fish is expected to remain. The passing of protected, conserved water from the upper Deschutes into the middle Deschutes below Steidl Dam to Lake Billy Chinook (RM 120), however, would have negligible effects on fish species because instream flow during the non-irrigation season is already above restorative targets set by ODFW (see Section 4.10.2.6).

In Tumalo Creek (TFC diversion [RM 2.5] to the mouth [RM 0]), conserved water would be allocated during the irrigation season. At this time, the District already commits 10 to 12 cfs of water below the TFC diversion to operate its fish screen and passage structures. In addition to this water, the Canal Lining Alternative would add and protect approximately 27 cfs. This action would have moderate, long-term effects on fish species because enhanced streamflows would increase the amount of habitat available to fish species in this reach, especially during the summer months when streamflows are low.

The Canal Lining Alternative would also have minor, long-term effects on fish species in the middle Deschutes River from the confluence with Tumalo Creek (RM 160) to Lake Billy Chinook (RM 120). The enhanced streamflows would increase the amount of habitat available to fish species in this reach, especially during the irrigation season when streamflows are low and when the ODFW restorative instream water target is rarely met (see Sections 4.10.2.6 and 6.10.2.2).

6.2.2.2 General Aquatic Species

Lining the canals and laterals with concrete would remove the limited amount of habitat available for bullfrog, western toad, Pacific treefrog, and long-toed salamander available in canals and laterals.

The habitat that would be lost is not considered critical to the long-term survival of these species (S. Wray, personal communication, November 17, 2017).

The Canal Lining Alternative would have minor, long-term effects on aquatic species on the following reaches because legally protecting the instream flow provided by the 2016 Stipulated Settlement Agreement and continued with the 2017 BiOp (Section 4.10.2.2) during the non-irrigation season would ensure that habitat available for aquatic species would remain:

- Crescent Creek: Crescent Lake Dam (RM 30) to mouth (RM 0)
- Little Deschutes River: Crescent Creek (RM 57) to the mouth (RM 0)
- Upper Deschutes River: Little Deschutes River (RM 192.5) to the BFC diversion at Steidl Dam (RM 166)

Increased streamflows in the following reaches during the irrigation season would result in minor, long-term effects on aquatic species because habitat available for species would be enhanced:

- Tumalo Creek: TFC diversion (RM 2.5) to the mouth (RM 0)
- Middle Deschutes: confluence of Tumalo Creek (RM 160) to Lake Billy Chinook (RM 120)

6.2.2.3 Federally Listed Fish and Aquatic Species

The Canal Lining Alternative may have minor, beneficial effects to federally listed fish and aquatic species. Within the affected project area, the federally listed Oregon spotted frog occurs in Crescent Creek, Little Deschutes River, and upper Deschutes River. Conserved water released from Crescent Lake Dam as a result of the Canal Lining Alternative would provide legal protections for water that has been released by the District since 2016 due to an interim agreement (see Section 4.10.2.2). This protective action would ensure the long-term benefit of Oregon spotted frog and their critical habitat (see Appendix E.9 for a letter of concurrence from USFWS). All PCEs of the Oregon spotted frog critical habitat would benefit from the Canal Lining Alternative (see Appendix E, Table E-2 of this Plan-EA). This action is consistent with the recommendations of USFWS Oregon Spotted Frog Biological Opinion (Reclamation 2017, pp. 128, 129, and 160).

The Middle Columbia River steelhead population can potentially access the Deschutes River as far upstream as Big Falls (RM 132, Section 4.2.1). Due to the magnitude of increased flow in this reach, as a result of the Canal Lining Alternative, there would be no effect on this population.

Increased instream flow during the irrigation season, as a result of the Canal Lining Alternative, would not affect bull trout in the middle Deschutes River. Bull trout forage in the middle Deschutes River upstream as far as Big Falls (roughly 30 miles downstream of Bend) during the winter, and are believed to be absent from that river reach the rest of the year. Therefore, because of the timing and magnitude of this increased flow during the irrigation season summer months, there would be no effect on bull trout populations.

6.2.3 HDPE Piping Alternative

6.2.3.1 General Fish Species

The HDPE Piping Alternative would have no direct effects on fish species in the project area. Although the HDPE Piping Alternative is expected to conserve 48 cfs rather than 43 cfs as described in the Canal Lining Alternative, the indirect effects on fish species within the area of potential effect would be qualitatively the same as those effects described above.

As in the Canal Lining Alternative, conserved water generated by the HDPE Piping Alternative would be allocated between Crescent Lake (approximately 38 percent) during the non-irrigation season and Tumalo Creek (approximately 62 percent) during the irrigation season. See Section 4.10.2 and 6.10.3 for detailed discussion about conserved water and allocation.

6.2.3.2 General Aquatic Species

The HDPE Piping Alternative would result in minor, direct effects on aquatic species. Replacing the canals and laterals with pipe would remove the limited amount of habitat available for bullfrog, western toad, Pacific treefrog, and long-toed salamander in the canals and laterals. The habitat that would be lost is not considered critical to the long-term survival of these species (S. Wray, personal communication, November 17, 2017).

The HDPE Piping Alternative would have minor, long term-effects on aquatic species in reaches affected by the project. The effects would be the same as described in the Canal Lining Alternative.

6.2.3.3 Federally Listed Fish and Aquatic Species

The HDPE Piping Alternative may have minor, beneficial effects to federally listed fish and aquatic species. The effects on the Oregon spotted frog, bull trout, and steelhead would be the same as described in the Canal Lining Alternative.

6.2.4 Compliance and Best Management Practices

The ESA establishes a national program for the conservation of threatened and endangered species, and the preservation of the ecosystems on which they depend. The ESA is administered by the USFWS for wildlife and freshwater species and by NMFS for marine and anadromous species. The ESA defines procedures for listing species, designating critical habitat for listed species, and preparing recovery plans. It also specifies prohibited actions and exceptions. Section 7 of the ESA, called "Interagency Cooperation," is the mechanism by which federal agencies ensure the actions they take, including those they fund or authorize, do not jeopardize the existence of any listed species. Under Section 7 of the ESA, federal agencies must consult with USFWS when any action the agency carries out, funds, or authorizes (such as through a permit) may affect a listed endangered or threatened species.

Implementation of the HDPE Piping Alternative or the Canal Lining Alternative may have minor, long-term effects on federally listed species. Section 7 consultation under the ESA with USFWS is complete (see Appendix E.9 for a letter of concurrence from USFWS).

Although the Middle Columbia River steelhead population is potentially present in the Deschutes River as far upstream as Big Falls (RM 132), this populations is classified as a NEP under section 10(j) of ESA (76 *Federal Register* 28715, 2011). Because the NEP is located outside a National Wildlife Refuge or National Park, and because implementation of the HDPE Piping Alternative or the Canal Lining Alternative is an entirely beneficial action, not likely to jeopardize the continued existence of the species, consultation with NMFS is not necessary (76 *Federal Register* 28715, 2011; 81 *Federal Register* 33416, 2016).

6.3 Geology and Soils

The area of potential effect for geology and soils is discussed in Section 4.3.

6.3.1 No Action (Future without Project)

Under the No Action Alternative, continued operation of the canal system would have minor effects on erosion and soils. Ongoing erosion of canals and laterals, as well as any erosion that might be occurring on farms that use flood irrigation, would persist.

6.3.2 Canal Lining Alternative

6.3.2.1 Geology

Protection of unique geological features and the siting of project components in relation to potential geologic hazards are considered when evaluating potential effects of the Canal Lining Alternative on geological resources. The implementation of the Canal Lining Alternative would not alter underlying lithology or geologic formations in the area of potential effect; therefore, no effects to geological resources are expected to occur.

6.3.2.2 Soils

Construction of the Canal Lining Alternative would include grading the existing trench, as described in Section 5.3.2, and disturbance of soils adjacent to canals to anchor the geomembrane. The volume of soil disturbed would vary for each canal depending upon its size. Based on top width, canals were grouped into five different classes. Applying assumptions for the canal depth, channel steepness, and anchor berm dimensions (Swihart and Haynes 2002), the maximum volume of soil that would be disturbed under the Canal Lining Alternative was estimated to be 189,965 cubic yards (see Appendix E for detailed calculations). After construction, soil layers would be permanently disturbed. The hydric soils lining the canals were placed when the delivery system was originally built; therefore, this soil profile is not representative of pre-development conditions. The Canal Lining Alternative would not affect any soil profiles existing prior to the construction of the original delivery system.

Following construction, areas disturbed by construction would be covered by soil and replanted. Overall, minor, short-term effects on soil resources are anticipated because proposed soil stabilization measures would be in place and the effect occurs over a large contiguous area over time.

Farmland Classification

Under the Canal Lining Alternative, construction would result in the temporary disturbance of approximately 156 acres of the project area that are classified as prime farmlands if irrigated and/or farmlands of state importance. These lands are currently not being cultivated; therefore, no farmlands would be removed from production as a result of the Canal Lining Alternative.

No long-term effects would be expected to any federal or state-level farmland designations. Minor short-term effects on agriculturally important soils would be expected during construction, but adherence to best management practices (BMPs) would minimize these effects.

Erosion Susceptibility

Erosion resulting from precipitation events may occur in disturbed and cleared areas within the project area. The National Pollutant Discharge Elimination System program, implemented by ODEQ, would require a 1200-C General Construction Stormwater Permit (1200-C Permit) for construction activities including clearing, grading, excavation, materials or equipment staging and stockpiling that would disturb one or more acres of land and have the potential to discharge into a public waterbody. Since none of the areas within the project discharge to a public waterbody, a 1200-C Permit would not be required.

Construction BMPs would be implemented to minimize soil erosion; therefore, no effects on soils would be anticipated. BMPs could include installing silt fencing, straw wattles, or geotextile filters; applying water to disturbed soil to prevent wind erosion; and revegetating disturbed areas as soon as possible after disturbance, as appropriate.

Vegetation clearing, soil disturbances, and grading that would be completed during construction for the Canal Lining Alternative would have negligible and short-term effects on soils. BMPs would be implemented during construction to reduce these effects.

6.3.3 HDPE Piping Alternative

6.3.3.1 Geology

Protection of unique geological features and the siting of project components in relation to potential geologic hazards are considered when evaluating potential effects of the HDPE Piping Alternative on geological resources. The implementation of the HDPE Piping Alternative would not alter underlying lithology or geologic formations in the area of potential effect; therefore, no effects to geological resources are expected to occur.

6.3.3.2 Soils

Construction activities would include excavation of existing soils, placement of the pipe, and burial of the pipe with the excavated soil material. The volume of soil disturbed would vary for each canal and lateral, depending on its width, its depth, and the diameter of the proposed pipe that would be installed. Using the designed pipe diameters that were determined in the SIP and applying general assumptions for the depth and width of excavation that would be required, the maximum volume of

soil that would be disturbed under the HDPE Piping Alternative was estimated to be 174,028 cubic yards (see Appendix E for detailed calculations).

The hydric soils lining the canals were placed when the delivery system was originally built; therefore, this soil profile is not representative of pre-development conditions. The HDPE Piping Alternative would not affect any soil profiles existing prior to the construction of the original delivery system. After construction, soil layers would be permanently disturbed and the pipe would be permanently buried in the path of the pipeline. Areas disturbed by construction would be covered by soil and replanted. Overall, minor, short-term effects on soil resources are anticipated because proposed soil stabilization measures would be in place and the effect occurs over a large contiguous area over time.

Farmland Classification

Under the HDPE Piping Alternative, the installation of buried pipelines would result in the temporary disturbance of approximately 156 acres of the project area that are classified as prime farmlands if irrigated and farmlands of state importance. These lands are currently not being cultivated; therefore, no farmlands would be removed from production as a result of the HDPE Piping Alternative.

TID's open delivery system would be converted to a gravity-pressurized system. Increased system efficiencies may increase crop production, which is particularly important in the 43 percent of District land that is classified as prime farmland if irrigated. In addition, piping the canal and laterals prevents sediment and other contaminants, such as herbicides and pesticides, from entering the water supply for TID's patrons. As a result, soil quality could improve with reduced pollutants in the irrigation water.

No long-term effect would be expected to any federal or state-level farmland designations. Minor, short-term effects on agriculturally important soils would be expected during construction, but adherence to BMPs would minimize these effects. There would be a minor, long-term effect on farmlands due to improved irrigation water quantity.

Erosion Susceptibility

Compliance measures that would be implemented during construction of the HDPE Piping Alternative to reduce effects on soils are described as follows. Erosion resulting from precipitation events may occur in disturbed and cleared areas within the project area. The National Pollutant Discharge Elimination System program, implemented by ODEQ, would require a 1200-C General Construction Stormwater Permit (1200-C Permit) for construction activities such as clearing, grading, excavation, materials or equipment staging and stockpiling that would disturb one or more acres of land and have the potential to discharge into a public waterbody. All of the seven project groups of the HDPE Piping Alternative would disturb at least 5 acres, but none of the project groups discharges to a public waterbody; therefore, a 1200-C Permit would not be required.

During construction, existing maintenance roads would provide access to most of the project area. Given that the pipe segments would be installed in 50- or 100-foot lengths, the District may use temporary travel routes within its existing ROW. The use of temporary travel routes would result in soil compaction and temporary increases in construction-related erosion and stormwater runoff. However, these effects would be largely mitigated by the implementation of erosion control measures. Proper design of the temporary travel routes, the implementation of adequate controls for any stormwater runoff, and other BMPs would reduce erosion and potential effects on soils.

Construction BMPs would be implemented to minimize soil erosion; therefore, no effects on soils would be anticipated. BMPs could include installing silt fencing, straw wattles, or geotextile filters; applying water to disturbed soil to prevent wind erosion; and revegetating disturbed areas as soon as possible after disturbance, as appropriate.

Vegetation clearing, soil disturbances, and grading that would be completed during construction for the HDPE Piping Alternative would have negligible and short-term effects on soils. BMPs would be implemented during construction to reduce these effects. Soil erosion over the long-term would be greatly reduced where buried pipeline would replace open canals. Reduced on-farm soil erosion and reduced deep percolation losses could also occur depending on management decisions.

6.3.4 Compliance and Best Management Practices

The following BMPs would be implemented as part of both the Canal Lining Alternative and the HDPE Piping Alternative (unless stated otherwise) to reduce effects on soils:

- Ground disturbances would be limited to only those areas necessary to safely implement both the Canal Lining Alternative and the HDPE Piping Alternative.
- Work would be confined within the existing ROW whenever possible to preserve existing vegetation and private property. The ROW would be clearly marked in the field prior to construction.
- Construction limits would be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.
- Work crews would carry spill cleanup kits, and, in times of burn bans or wildfire concerns, each crew would have a fire suppression kit.
- Project construction activities would be conducted in accordance with the project's spill prevention and cleanup plan.

6.4 Land Use

The area of potential effect and project area for land use is discussed in Section 4.4.

6.4.1 No Action (Future without Project)

Under the No Action Alternative, irrigated agriculture producers would continue to face increasing water supply uncertainty. Water supplies would continue to be unreliable, and agriculture producers

would likely continue to irrigate fewer acres of land or grow different crops. Compounded with anticipated population increases and associated developmental pressures, agricultural lands would continue to be increasingly vulnerable to transitioning to a different land use.

The No Action Alternative would not have a direct effect on land use within the ROW. The District's canals and laterals would continue to operate as an open system.

6.4.2 Canal Lining Alternative

6.4.2.1 Agricultural Land Use

There would be no direct effect on agricultural use during or after construction of the Canal Lining Alternative. Increased water delivery reliability and improved control over water delivery would have long-term indirect effects on agricultural land use because water uncertainty would be reduced for farmers. Water supply uncertainty and ongoing drought can limit the type of crops grown as farmers choose drought resistant species or convert more-water-intensive crops to less-water-intensive crops.

Increasing water delivery reliability could decrease the developmental pressures to convert agricultural land (that was not being planted or producing low yields due to water scarcity) to other uses. This alternative would support current zoning designations and state land use goals (discussed below in the HDPE Piping Alternative).

6.4.2.2 ROW Land Use

There would be no effect on TID's ROW; it would continue to be used for the conveyance of irrigation water and O&M. There would be no changes in property ownership. During O&M of the system, the District's ditch walkers would continue to be present in the ROW to ensure there are no blockages or other issues. Over the 100-year analysis of the project, the ROW would see increased levels of human traffic and disturbance every 40 years when the canal lining would be replaced. District staff and ditch riders would continue to be present in the ROW, with the potential of becoming increasingly present as the system ages and requires more maintenance.

The District's ROW that passes through the Peck's milkvetch ACEC was granted through the Carey Act, which predates BLM management of the land. The BLM has been consulted regarding the proposed project (see Section 7 of the Plan-EA).

6.4.3 HDPE Piping Alternative

6.4.3.1 Agricultural Land Use

There would be no direct effect to agricultural use during or after construction of the alternative. Construction would not cause any interruption to water deliveries or long-term change in the agricultural land use. Increased water delivery reliability would have long-term indirect effects on agricultural land use, as it would reduce water uncertainty for farmers. Water supply uncertainty and ongoing drought can limit the type of crops grown as farmers choose drought resistant species or convert more water intensive crops to less water intensive crops. Implementation of the HDPE Piping Alternative would allow for more diversity in the types of crops grown in the District because of water supply security.

Reducing pumping costs and increasing the reliability of water delivery could decrease pressure to convert agricultural land to other uses. This alternative would support current zoning designations and State land use goals because the resulting certainty of agricultural water would assure that the minimum irrigated acre requirements for parcels within EFU subzones would be met. Implementation of the HDPE Piping Alternative would also similarly promote Statewide Planning Goal 3: to maintain agricultural lands (Oregon Department of Land Conservation and Development 2010). Increased water supply security would allow irrigated farmland to be protected and not have to be removed from production due to water scarcity.

6.4.3.2 ROW Land Use

Effects to ROW land use under the HDPE Piping Alternative are similar to those discussed under the Canal Lining Alternative except for the level of human traffic. During O&M of the system, there would be a decrease in the presence of District staff in the ROW, as they no longer need to patrol the open canals or laterals. The HDPE Piping Alternative would only require construction once (at the beginning) of the 100-year period of analysis. There would be no subsequent construction and related increases in human traffic.

6.4.4 Compliance and Best Management Practices

The following BMPs would be implemented as part of both the Canal Lining Alternative and HDPE Piping Alternative (unless otherwise indicated) to reduce effects on land use:

- Standard construction safety procedures and traffic control measures would be employed to reduce the risk of collisions between construction vehicles and other vehicles, pedestrians, or bicyclists while construction is ongoing.
- Traffic control measures would be coordinated by the construction contractor with the Oregon Department of Transportation, the Deschutes County Sheriff, and local emergency services before working in the U.S. Highway 20 ROW.
- Lane closures on roadways would be avoided during peak travel periods where possible to reduce potential traffic delays from construction vehicles.
- The condition of roadways and work zones would be communicated to travelers via the District's website or other communication channels.
- Adjacent landowners would be provided a construction schedule prior to beginning construction.

6.5 Public Safety

The area of potential effect for public safety is discussed in Section 4.5.

6.5.1 No Action (Future without Project)

The District would not pipe the remaining canal and laterals with funding from PL 83-566. Under the No Action Alternative, the canals and laterals would remain open. The No Action Alternative

would provide no immediate or foreseeable changes to the current delivery infrastructure. The risk of drowning could increase as urban and suburban areas grow and surround more of the District.

6.5.2 Canal Lining Alternative

The Canal Lining Alternative would install fencing along dangerous sections or areas that are easily accessible by public in order to increase public safety and reduce District liability. These fences would be chosen to prevent the public from nearing the edge or entering the canal and would be a standard chain link with 3-wire barbed wire cap per NRCS guidelines. In canals with depths greater than 2 feet, safety ladders would be installed every 750 feet.

The risk of drowning would be reduced but not eliminated. If someone were to fall into the lined canal, escape would be more difficult than in an unlined canal due to increased water velocity and the removal of all adjacent vegetation. This alternative would have minor, long-term effects on public safety.

6.5.3 HDPE Piping Alternative

The HDPE Piping Alternative would eliminate the drowning risk from open canals. This would result in minor, long-term effects on public safety since the possibility of a more serious accident would be eliminated. While not identified as a resource concern, the HDPE Piping Alternative would also eliminate any potential flooding risk from canal overflow, and the durability of the HDPE pipe would increase seismic resiliency.

6.5.4 Compliance and Best Management Practices

The following BMPs would be implemented as part of both the Canal Lining Alternative and the HDPE Piping Alternative to reduce effects to public safety:

- Roadway lane closures would be avoided during peak travel periods where possible to reduce potential traffic and pedestrian safety issues.
- Ground disturbances would be limited to only those areas necessary to safely implement the action.
- Work would be confined within the existing ROW whenever possible to preserve existing vegetation and private property. The ROW would be clearly marked in the field prior to construction.
- Work crews would carry spill cleanup kits, and in times of burn bans or wildfire concerns, each crew would have a fire suppression kit.

The following BMPs would only be implemented as part of the Canal Lining Alternative to reduce effects to public safety:

- A standard chain link fence with 3-wire barbed wire cap would be chosen per NRCS guidelines.

- Safety ladders would be installed every 750 feet in canals with depths greater than 2 feet.

6.6 Recreation Resources

The area of potential effect for recreation resources is discussed in Section 4.6.

6.6.1 No Action (Future without Project)

The No Action Alternative would have no effect on recreation resources in the area of potential effect.

6.6.2 Canal Lining Alternative

Construction of the Canal Lining Alternative would have minor, short-term effects for trail, bikeway, and Tillicum Park recreational users because of reroutes or delays during construction. Visitors would still be able to use the park during construction; however, their experience could be affected by visible construction activities and localized noise disruption. These effects would be minor and short-term because construction would occur over a discrete period.

Over the 100-year lifespan of the project these construction effects would occur every 40 years during replacement and repair of the lining. After construction there would be long-term, moderate effects to recreation, as newly installed fencing along canals and laterals would prevent the informal use of ROW for activities such as hiking and biking.

During construction, recreational activities along and on the river would not be affected. After construction, river activities, including recreational fishing, would be indirectly affected by an increase in streamflows from the allocation of conserved water. Overall, there would be a negligible, long-term effect to recreational resources because effects would be localized in scope and would not alter any existing recreational uses.

6.6.3 HDPE Piping Alternative

Construction of the HDPE Piping Alternative would have similar minor, short-term effects on trail, bikeway, and Tillicum Park recreational users as the Canal Lining Alternative. There would be no loss of user days during the construction period. Effects due to construction would only occur once during the 100-year period of analysis for each individual Project Group.

In the long-term, recreational use of Tillicum Park and the informal recreational use of the ROW for walking would not change; however, recreationists would have views of a vegetated corridor rather than either open water or an empty canal, depending on the season. This effect is considered in the NED but does not have a monetized value.

Effects to river recreation are the same as those under the Canal Lining Alternative, discussed above. Overall, there would be a negligible, long-term effect to recreational resources because effects would be localized in scope and would not alter any existing recreational uses.

6.6.4 Compliance and Best Management Practices

The following BMPs would be implemented as part of both the Canal Lining Alternative and the HDPE Piping Alternative (unless otherwise indicated) to reduce effects on recreation resources:

- Roadway lane closures would be avoided during peak travel periods where possible to reduce potential traffic delays from construction vehicles.
- The condition of roadways, work zones, and maintenance roads would be communicated to travelers via the District's website, or other communication channels.
- Standard construction safety procedures and traffic control measures would be employed to reduce the risk of collisions between construction vehicles and other vehicles, pedestrians, or bicyclists while construction is ongoing.

6.7 Socioeconomic Resources

The area of potential effect for socioeconomics is discussed in Section 4.7. To estimate the total economic impacts of the three alternatives, in terms of jobs and income supported, this analysis uses a 2015 IMPLAN economic impact model of Deschutes County.

6.7.1 No Action (Future without Project)

For the No Action Alternative, the total economic activity supported by TID agricultural production is estimated at approximately 120 jobs and $3.6 million in average annualized income. Approximately 100 of those jobs would be in agriculture with an additional 20 jobs in other economic sectors. Approximately $1.9 million would be agricultural income and an additional $1.7 million would be income in other sectors benefiting from agricultural expenditures and income.

6.7.2 Canal Lining Alternative

Implementation of the Canal Lining Alternative would have a minor, short-term effect on employment and income in Deschutes County from construction activities.

6.7.2.1 Regional Economic Development

The Canal Lining Alternative construction expenditures of approximately $85.6 million (incurred every 40 years) would support construction sector jobs and income. These expenditures would also provide economic ripple effects that increase jobs and income in other economic sectors in Deschutes County. Economic ripple effects would result from the construction sector spending on labor, materials, and services. This spending would spur increased sales and economic activity in other sectors (such as hardware stores and construction equipment businesses supplying construction businesses). Impacts of construction sector spending in these other sectors are known as indirect impacts. As household incomes rise from the construction and the indirectly impacted economic sectors, household spending would also increase and generate increased economic activity in sectors such as retail, wholesale trade, personal services industries, and real estate (known as induced impacts). Total job and income impacts of the economic activity supported by the proposed

project are the sum of the direct impacts (construction sector) and the indirect/induced impacts (in other economic sectors).

The $85.6 million in construction expenditure is spread over 11 years, supporting approximately 100 jobs annually and $4.5 million in average annual income (annualized over 111 years[11] this equates to approximately $1.8 million in annualized average income benefits). Of these impacts, during the 11-year construction period, approximately 60 jobs and $3.2 million in annual average income are in the construction sector (direct impacts), while the remaining 40 jobs and $1.3 million in annual income are in other sectors.

After construction is complete, the Canal Lining Alternative would result in minimal changes in basin pumping costs and increased District OM&R costs (approximately $60,000 per year). As discussed above, changes in OM&R may have minimal regional economic development effects (i.e., changes in OM&R expenditures may largely result in an income transfer between TID patrons, TID staff, and the local construction/repair sector), so effects of this change in expenditure are not quantified in this regional economic development analysis.

No changes to agricultural production are expected in the Canal Lining Alternative. To the extent that increased streamflows enhance recreation and support additional recreation visitation and spending in Deschutes County, the long-term regional economic impact would be much larger.

6.7.2.2 National Economic Development Benefits

A National Economic Development (NED) benefit cost analysis has been performed to evaluate the benefits of the Canal Lining Alternative (see Appendix D). This evaluation includes identification of the No Action Alternative economic damages, and estimation of the NED benefits of the alternatives to the identified problems. The analysis uses NRCS guidelines for the evaluation of NED benefits as outlined in the Economic and Environmental Principles and Guidelines for Water Related Land Resources Implementation Studies, and NRCS Natural Resources Economics Handbook.

6.7.3 HDPE Piping Alternative

Implementation of the HDPE Piping Alternative would have a minor, short-term effect on employment and income in Deschutes County from construction activities, and a moderate, long-term effect on agricultural production and related farm household income in the County.

6.7.3.1 Regional Economic Development

The HDPE Piping Alternative construction expenditures of nearly $43.3 million would support construction sector jobs and income. These changes would also provide economic ripple effects that increase jobs and income in other economic sectors in Deschutes County (these effects are described in the Canal Lining Alternative).

[11] Note that each project has a 100-year life but that since construction takes 11 years, benefits extend out to year 110 and therefore, the analysis period for all project groups is 111 years.

The $43.3 million in construction expenditure is spread over 11 years, supporting approximately 50 jobs annually and $2.3 million in average annual income (annualized over 111 years this equates to approximately $0.6 million in annualized average income benefits). Of these impacts, approximately 30 jobs and $1.6 million in annual income would be in the construction sector (direct impacts), while the remaining 20 jobs and $0.7 million in annual income would be in other sectors.

The HDPE Pressurized Piping Alternative may also result in increased farm productivity (increased yields), but these effects are not quantified due to limited data. The HDPE Pressurized Piping Alternative would also result in slightly lower OM&R expenses for TID. However, the effects on District wages and employment are expected to be minimal. Reduced OM&R and pumping costs may largely result in an income transfer between TID patrons, TID staff, and the local construction, repair, and electricity sectors. As such, regional economic development effects are expected to be limited for this reduced expenditure (i.e., less than the rounding margin of error) so effects are not quantified in this regional economic development analysis. To the extent that increased streamflows enhance recreation and support additional recreation visitation and spending in Deschutes County, the long-term regional economic impact would be much larger.

6.7.3.2 National Economic Development Benefits

A NED benefit cost analysis has been performed to evaluate the benefits of the HDPE Piping Alternative (see Appendix D). This process is described in the Canal Lining Alternative.

6.8 Vegetation

The area of potential effect for vegetation is discussed in Section 4.8.

6.8.1 No Action (Future without Project)

Under the No Action Alternative, vegetation associated with the network of open irrigation canals and laterals would persist, and adjacent native upland vegetation would remain in its current condition.

6.8.2 Canal Lining Alternative

6.8.2.1 General Vegetation

Construction of the Canal Lining Alternative would involve grading the existing trench to the specifications described in Section 5.3.2, disturbance of lands adjacent to canals for construction equipment access and anchoring of the geomembrane, and use of the existing ROW for movement and staging of construction equipment and materials. During construction, herbaceous, shrub, and woody vegetation along the canals and laterals within the ROW would be temporarily disturbed through activities such as clearing, crushing, and digging. It is expected that all access would be possible with existing maintenance roads.

Construction activities would temporarily disturb approximately 150 acres of existing vegetation within the 27,964-acre District boundary. Potential vegetation disturbance along canals and laterals is described in Table 6-1 and Table 6-2. Opportunistic riparian vegetation that is located along canals and laterals would be permanently removed (see Section 6.11.2.2 for further discussion).

Table 6-1. Potential Vegetation Disturbance along Canals and Laterals under the Canal Lining Alternative.

System Element	Proposed Lining (feet)	Total Width of Disturbance Adjacent to the System (feet)	Additional Width of Disturbance on Side of Canal/Lateral Maintenance Road (feet)	Total Disturbed Vegetation Area (acres)
Canals	12,715	14	15	9
Laterals	331,167	10	8	140
			Total	**149**

Table 6-2. Potential Vegetation Disturbance along Turnouts under the Canal Lining Alternative.

System Element	Units	Disturbance Width (feet)	Disturbance Length (feet)	Total Disturbed Vegetation Area (acres)
Turnouts	490	10	10	1

After construction, areas disturbed by construction and areas where the geomembrane has been anchored and covered by soil would be replanted with native grasses and forbs with NRCS's guidance. Some trees that are dependent upon the canal for seepage may not survive the construction of this Alternative.

Over the project's life, vegetation within the ROW would be maintained according to TID's vegetation management program and NRCS Oregon and Washington Guide for Conservation Seedings and Plantings (NRCS 2000). Trees would not be allowed to establish above the areas where the geomembrane is anchored. After 40 years, the expected lifespan of the canal lining, vegetation would be disturbed again during the replacement process. Similar short-term construction effects would be expected.

Implementation of the Canal Lining Alternative would have a minor, long-term effect on vegetation because disturbance occurs over less than one percent of the District and measures designed to minimize effects on vegetation, such as clearly flagging construction areas, would be implemented (additional measures are identified in Sections 6.8.4 and 8.4).

6.8.2.2 Invasive Species - Noxious Weeds

During construction, exposed soils would create temporarily susceptible areas where weeds could establish themselves. The movement of construction vehicles could provide opportunities to transport weeds to new locations. During construction, the contractor would utilize BMPs such as avoiding unnecessary ground disturbances and using erosion control measures that are free of weeds and weed seeds.

After construction, weeds would be managed according to the protocol in NRCS Oregon and Washington Guide for Conservation Seedings and Plantings (NRCS 2000). Weeds would be controlled within the ROW using hand pulling during the first year after reseeding and a combination of hand pulling and herbicide application in the second year if weeds become problematic. Implementation of the Canal Lining Alternative would have a negligible effect on noxious weeds because the spread of noxious weeds during construction would be controlled through BMPs.

6.8.2.3 Special Status Species

Currently no special status species occur within the project area; therefore, no effects are expected. Prior to beginning construction within the ROW that crosses the Peck's milkvetch ACEC, a pre-construction survey for Peck's milkvetch would be completed and any subsequent action or mitigation necessary would occur in consultation with BLM. Additional mitigation within the Peck's milkvetch ACEC to minimize project effects would include potting, care, and replanting during the appropriate planting window for individual plants that would have been directly affected by the project.

While there is potential for the species to be present, there have been no observations by the District of Peck's milkvetch in their ROW. Implementation of the Canal Lining Alternative would result in potentially more O&M of the system, and therefore higher disturbance in the ROW. Any potential plants that may occur in the future are anticipated to be limited in number and potential project effects would not affect the ecological integrity of the population. As such, a negligible, long-term effect would be expected.

6.8.3 HDPE Piping Alternative

6.8.3.1 General Vegetation

Construction of the HDPE Piping Alternative would involve trenching for pipe placement primarily in existing canals, disturbance of lands adjacent to canals for construction equipment access, and use of the existing ROW for movement and staging of construction equipment and materials. Figure 6-1 shows vegetation along the TFC during the irrigation season, before a previous piping project.

Source: Deschutes River Conservancy 2012

Figure 6-1. The Tumalo Feed Canal before a Previous Piping Project.

During construction, existing maintenance roads within the ROW would provide access to most of the project area. Figure 6-2 is illustrative of typical construction activities associated with replacing open irrigation canals with pipeline. Given that the pipe segments would be installed in 50- or 100-foot lengths, some temporary travel routes within the ROW would be necessary along canals and laterals that are not accessible by existing roads.

Figure 6-2. An Example of Construction on a Tumalo Irrigation District Lateral using an Existing Maintenance Road.

Temporary travel routes would be selected to minimize effects on vegetation and avoid tree removal. Selection of construction areas adjacent to canals and travel routes would consider existing vegetation and avoid mature trees to the extent practicable. Pruning would occur entirely within TID's Carey Act ROW and would not exceed what is required for equipment clearance.

During construction, herbaceous, shrub, and woody vegetation along the canals, laterals, turnouts, and within the ROW would be temporarily disturbed through activities such as clearing, crushing, and digging. These activities would temporarily disturb approximately 161 acres of existing vegetation within the 27,964-acre District boundary. Potential vegetation disturbance along canals and laterals is described in Table 6-3 and Table 6-4. Opportunistic riparian vegetation that is located along canals and laterals would be permanently removed (see Section 6.11 for further discussion).

Table 6-3. Potential Vegetation Disturbance along Canals and Laterals under the HDPE Piping Alternative.

System Element	Proposed Piping (feet)	Total Width of Disturbance Adjacent to the System (feet)	Additional Width of Disturbance Adjacent to Maintenance Roads (feet)	Subtotal Disturbed Vegetation Area (acres)
Canals	9,852	16	15	7
Laterals	353,293	10	8	149
			Total	**156**

Table 6-4. Potential Turnout Vegetation Disturbance under the HDPE Piping Alternative.

System Element	Units	Disturbance Width (feet)	Disturbance Length (feet)	Total Disturbed Vegetation Area (acres)
Turnouts	663	10	30	5

After construction, the project alignment would be re-contoured and planted with a seed mix of native grasses and forbs. Planting would be done in consultation with NRCS. Vegetation within the ROW would return to the historic upland habitat. Figure 6-3, Figure 6-4, and Figure 6-5 show examples of vegetation along the BFC and TFC post-installation for similar piping projects. Some trees that are dependent upon the canal for water may not survive the construction of the HDPE Piping Alternative. Prior experience with piping in TID has shown that with active irrigation by the property owner, 70 to 80 percent of the well-established trees within the project area would survive after piping (20 to 30 percent of the trees that do not normally survive in such a location without the canal did not survive after piping). The District would remove trees in the ROW that do not survive piping for the two years following construction at adjacent landowners' requests and during maintenance season.

In the long-term, at least 41 acres of vegetation would be gained because open canals and laterals would be piped and then covered with topsoil and seeded. Over the project's life, vegetation within

the ROW would be maintained according to TID's vegetation management program and NRCS Oregon and Washington Guide for Conservation Seedings and Plantings (NRCS 2000). Trees would not be allowed to establish above the buried pipe because roots may interfere with future maintenance.

Implementation of the HDPE Piping Alternative would have a minor, long-term effect on vegetation because disturbances occurs over less than one percent of the District, and mitigation measures designed to minimize effects to vegetation, such as re-vegetating with native grasses and forbs in consultation with NRCS, would be implemented (other measures are identified in Sections 6.8.4 and 8.4). Additionally, the conversion of open canals to buried pipes with new vegetation seeded on top would add 41 acres of native vegetation to the project area.

Figure 6-3. A Section of the Bend Feed Canal after a Piping Project.

Source: Reclamation 2010.

Figure 6-4. A Section of the Bend Feed Canal Approximately Four Months after a Piping Project.

Source: Deschutes River Conservancy 2013

Figure 6-5. A Section of the Tumalo Feed Canal after a Piping Project.

6.8.3.2 Invasive Species - Noxious Weeds

Construction activities and temporary effects would be similar to those described under the Canal Lining Alternative, as would post construction weed management. After construction, the closed

system no longer presents opportunities for aquatic noxious weeds to grow or spread to other areas of the District.

Implementation of the HDPE Piping Alternative would have a minor, long-term effect on noxious weeds. The spread of noxious weeds during construction would be controlled through BMPs, and the conversion to a piped system would reduce the spread of noxious weeds through the open canal system.

6.8.3.3 Special Status Species

Construction activities and effects on Special Status Species are the same as those discussed above for the Canal Lining Alternative. However, implementation of the HDPE Piping Alternative would result in less O&M of the system, and therefore less disturbance of the ROW in the BLM Peck's milkvetch ACEC.

6.8.4 Compliance and Best Management Practices

To reduce the disruption to existing vegetation and minimize the spread of noxious weeds as a result of the construction of either the Canal Lining or HDPE Piping Alternative, the following BMPs that have been utilized and successful in previous piping projects would be implemented (applicable to both alternatives unless identified otherwise):

- Prior to construction that crosses the Peck's milkvetch ACEC, a survey would be completed for Peck's milkvetch. If plants were detected, individual plants affected by construction would be excavated, potted, cared for, and replanted during the appropriate planting window. Surveys and mitigation would be done in consultation with BLM.
- Construction limits would be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.
- Ground disturbances would be limited to only those areas necessary to safely implement either alternative.
- Work would be confined within the existing ROW whenever possible to preserve existing vegetation and private property. The ROW would be clearly marked in the field prior to construction.
- Temporary travel routes for the HDPE Piping Alternative would be selected and utilized to minimize effects on vegetation and avoid the removal of trees.
- After construction, under the HDPE Piping Alternative, the project area would be re-contoured and planted with a seed mix of native grasses and forbs. Planting would be done in consultation with NRCS.
- After construction and re-seeding, vegetation within the ROW would be maintained according to TID's vegetation management program and NRCS Oregon and Washington's Guide for Conservation Seedings and Plantings (NRCS 2000).

6.9 Visual Resources

The area of potential effect for visual resources is defined in Section 4.9. Effects on visual resources occur when project activities visually standout from the existing landscape or introduce disruptive visual characteristics. The visibility of the activity or modification and the sensitivity of the viewer influence the magnitude of the effect. For example, there would be less effect from an action surrounded by thick vegetation or an action that blends into the landscape. This visual analysis was based on evaluations of aerial and ground-based photographs of the proposed project sites and preliminary design information.

Visual effects were assessed based on the potential of the proposed action to alter scenic resources or to degrade the visual character of the project area. The evaluation of temporary or short-term visual effects considered whether construction activities could substantially degrade the existing visual character or quality of the site or surrounding area. The evaluation also considered the duration over which any such changes would occur. Because of their short-term nature, construction activities occurring in an area for less than one year are typically considered to have a less-than-major effect on visual quality.

Actions with long-term visual effects, such as constructing new or altered structures, grading roads, removing trees, and introducing new sources of light and glare, can permanently alter the landscape in a manner that could affect the existing visual character or quality of the area, depending on the perspective of the viewer. Since damaging scenic resources such as trees, rock outcroppings, and other features typically constitute a long-term effect, the potential for project implementation to damage scenic resources was evaluated solely as a long-term effect and differentiated from construction-related effects.

6.9.1 No Action (Future without Project)

Under the No Action Alternative, TID would not modernize the remaining canals and laterals with funding from PL 83-566. The canals and laterals would remain open and unlined. There would be no changes to visual resources, and local residents and visitors would continue to see open canals and laterals as they now exist from public and private viewpoints. Open canals and laterals would hold water during the irrigation season from April through mid-October.

6.9.2 Canal Lining Alternative

Under the Canal Lining Alternative, construction activities, including use of heavy equipment within the ROW would be visible to residents, motorists, and recreationists in the area. Vegetation would be cleared within TID's ROW in some areas where access for construction equipment is necessary, and disturbance to existing mature trees would be minimized to the extent possible. During construction, there would be minor, short-term effects to visual resources because the construction activities would draw attention to the setting. However, similar large equipment is used for agricultural production and in the maintenance of canals and is therefore a common feature in the landscape. Construction would follow the BMPs listed below in Section 6.9.4 to minimize any visual disruptions.

Following construction, the impervious lining would eliminate water seepage along the canals and laterals, and as a result, vegetation species dependent on moist or saturated soils would not occur along the banks of the canals and laterals. Riparian vegetation would no longer be part of the viewshed. In addition, the Canal Lining Alternative would involve reshaping the canals and laterals into trapezoidal channels with sloping sides and a flat bottom. Depending on the specific materials and design used, shotcrete or other lining material may extend several feet above the water line or extend over the bank and be visible. These attributes could change viewers' experiences of the canals and laterals from a more stream-like to a more industrial appearance when the canals are full, or empty and snow-free. Additionally, chain link fence topped with barbed wire would be installed along the canals and laterals for public safety. These fences would stand out from the existing landscape features because of their height and they would disrupt a direct, unimpeded view of the canal.

After construction, disturbed areas including the banks of the lined canals and laterals would be planted with a seed mix of native grasses and forbs in consultation with NRCS. As these plantings mature, the lined canals and laterals would blend into the surrounding landscape. Trees that were not removed during construction would also be part of the vegetated corridor. The open, lined canal and laterals would continue to hold water during the irrigation season from April through mid-October.

Overall, the visual change from earthen, unlined canals to lined, trapezoidal canals with fencing is expected to have a moderate, long-term effect on visual resources.

6.9.3 HDPE Piping Alternative

Under the HDPE Piping Alternative, construction activities, including use of heavy equipment within the ROW and pipe laying, would be visible to residents, motorists, and recreationists in the area. Vegetation would be cleared within TID's ROW in some areas where pipe is laid or access for construction equipment is necessary and disturbance to existing mature trees would be minimized to the extent possible. There would be minor, short-term effects to visual resources because the construction activities would draw attention to the setting. However, similar large equipment is used for agricultural production and in the maintenance of canals and is therefore a common feature in the landscape. Construction would follow the BMPs discussed below to minimize any visual disruptions.

After construction, areas adjacent to the canal would be restored to near prior contours. The area over the pipe would be graded to blend with the side of the canal. Disturbed areas, including the newly buried pipes, would be planted with a seed mix of native grasses and forbs in consultation with NRCS. Recreationists would have views of a vegetated corridor rather than either open water or an empty canal, depending on the season. Disturbance to existing mature trees during construction would be minimized to the extent possible, and these trees would be part of the vegetated corridor. The visual loss of waterways for recreationists and property owners could not be monetized because of insufficient data; a further discussion can be found in the NED (Appendix D).

Overall, the visual change from canal to buried pipe would be expected to have a minor, long-term effect because the revegetated corridor would blend in with the natural landscape following revegetation.

6.9.4 Compliance and Best Management Practices

The following BMPs would be implemented as part of both the Lining and HDPE Piping Alternative (unless noted otherwise) to reduce effects to visual resources:

- The construction would occur during the daytime to minimize disturbance to any recreationists, landowners, or other individuals in the vicinity of the construction area.
- Ground disturbances would be limited to only those areas necessary to safely implement the alternatives.
- Work would be confined within the existing ROW whenever possible to preserve existing vegetation and private property. The ROW would be clearly marked in the field prior to construction.
- Construction limits would be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.
- Temporary travel routes would be selected and utilized to minimize effects to vegetation and avoid the removal of trees.
- Selection of construction areas adjacent to canals and travel routes would consider existing vegetation and avoid mature trees to the extent practicable.
- Pruning would be entirely within TID's ROW and would not exceed what is required for equipment clearance.
- During construction, the contractor would use erosion control measures that are free of weeds and weed seeds.
- Immediately after construction, areas with disturbed soils including newly covered pipes (under the HDPE Piping Alternative) would be planted with a seed mix of native grasses and forbs.

6.10 Water Resources

The areas of potential effect for water resources are discussed in Section 4.10.

6.10.1 No Action (Future without Project)

Under the No Action Alternative, the canal and laterals would remain open. This section discusses the future of the project area and area of potential effect without a full system modernization implementation and completion in relation to water resources.

6.10.1.1 Surface Water Rights

Under the No Action Alternative, TID would not create instream water rights through Oregon's Allocation of Conserved Water Program. The District would not permanently reduce its water right or permanently protect water instream in Tumalo Creek, Crescent Creek, the Little Deschutes River, or the Deschutes River. A portion of the water diverted at the TFC and BFC diversions would continue to seep into the ground before reaching any farms.

6.10.1.2 Surface Water Hydrology

The No Action Alternative would not be reasonably certain to convert the District's open canal and laterals to a modernized system. Water diverted into TID's canals and laterals would continue to seep through the porous volcanic substrate. The District would continue to experience delivery shortages during most years. The No Action Alternative effects on the surface water hydrology are described in the following sections.

Crescent Lake

There would be no effect on water resources within Crescent Lake.

Crescent Creek, Crescent Lake Dam (RM 30) to the Mouth (RM 0)

There would be no effect on water resources in Crescent Creek. Any voluntary releases from Crescent Lake for fish and wildlife would not be permanently and legally protected instream under an instream water right.

Little Deschutes River, Crescent Creek (RM 57) to the Mouth (RM 0)

There would be no effect on water resources within the Little Deschutes River from the confluence with Crescent Creek (RM 57) to the mouth (RM 0). Any voluntary releases from Crescent Lake for fish and wildlife would not be permanently and legally protected instream under an instream water right.

Deschutes River, Little Deschutes River (RM 192.5) to the BFC Diversion at Steidl Dam (RM 166)

There would be no effect on water resources in the Deschutes River from the confluence with the Little Deschutes River (RM 192.5) to the BFC diversion at Steidl Dam (RM 166). Any voluntary releases from Crescent Lake for fish and wildlife would not be permanently and legally protected instream under an instream water right.

Tumalo Creek, TFC diversion (RM 2.5) to the Mouth (RM 0)

There would be no effect on water resources in Tumalo Creek from the TFC diversion (RM 2.5) to the mouth (RM 0). The District would continue to maintain at least 10-12 cfs downstream from the TFC diversion during the irrigation season. Instream water rights in the creek would not change.

Deschutes River, BFC Diversion at Steidl Dam (RM 166) to Lake Billy Chinook (RM 120)

There would be no effect on water resources in the Deschutes River from Steidl Dam (RM 166) to the confluence with Tumalo Creek (RM 160), and subsequently to Lake Billy Chinook (RM 120).

Any voluntary releases from Crescent Lake for fish and wildlife would not be permanently and legally protected instream under an instream water right. The District would continue to divert water from the BFC in a volume that accounts for seepage loss. No additional water would be protected instream downstream from the TFC diversion on Tumalo Creek.

6.10.1.3 Surface Water Quality

There would be no effect on surface water quality in the area of potential effect. The Deschutes River and its tributaries in the area of potential effect would continue to be included on Oregon's 303(d) list for not meeting temperature, dissolved oxygen, pH, sedimentation, turbidity, and/or chlorophyll a water quality standards (Table 4-17).

The irrigation canal and lateral system would continue to collect irrigation tailwater, subsequently delivering contaminates, such as herbicides and pesticides, to patrons down gradient in the system. This concern is especially relevant to a patron dairy producer and farms that sell food products to the local farmers' markets.

6.10.1.4 Groundwater

There would be no effect on groundwater in the project area or the area of potential effect.

6.10.2 Canal Lining Alternative

This section discusses the environmental consequences of implementation of the Canal Lining Alternative. Included and discussed below are the effects to surface water and groundwater present in the project area and the area of potential effect.

6.10.2.1 Surface Water Rights

Following construction, TID would create permanent instream water rights for Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River through Oregon's Allocation of Conserved Water Program (ORS 537.470).

The amount of water allocated instream would be determined based on the amount of water conserved through implementation of the Canal Lining Alternative. The District has identified that implementation of the Canal Lining Alternative would conserve approximately 43 cfs. The District would allocate 100 percent of the conserved water created for instream use. The District would allocate the conserved water instream incrementally following completion of each project group of the Canal Lining Alternative.

Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 16 cfs) of the conserved water would be allocated to Crescent Creek and 62 percent (approximately 27 cfs) would be allocated to Tumalo Creek. These allocations by source and by season are estimates based on conserved water applications associated with similar, completed projects in TID that have already completed the State of Oregon's administrative process for the allocation of conserved water (see OAR 690-018). These allocations may change following a thorough review of the application by OWRD who may order a different allocation in an attempt to avoid affecting other water users at either source. The instream water rights created as an effect of

the Canal Lining Alternative would carry the same priority dates as TID's water rights. The District would permanently reduce its own water rights by corresponding rates and volumes, permanently reducing the rates of diversion at the TFC diversion and the BFC diversion.

In Crescent Creek, the conserved water would be permanently protected instream from the Crescent Lake Dam (RM 30) to the mouth (RM 0), the Little Deschutes River from the confluence with Crescent Creek (RM 57.3) to the mouth (RM 0), and the Deschutes River from the confluence with the Little Deschutes River (RM 192.5) to Lake Billy Chinook (RM 120). This conserved water would be stored in and released from Crescent Lake.

In Tumalo Creek, the conserved water would be permanently protected instream from the District's TFC diversion (RM 2.5) to the confluence with the Deschutes River and in the Deschutes River from Tumalo Creek (RM 160) to Lake Billy Chinook (RM 120).

Following construction, completion of each project group of the Canal Lining Alternative would directly affect TID patrons by ensuring delivery of existing water rights throughout the irrigation season. Implementation of the Canal Lining Alternative would improve water supplies for both patrons and instream uses; therefore, minor, long-term effects would occur.

6.10.2.2 Surface Water Hydrology

Environmental effects on surface water hydrology from implementation of the Canal Lining Alternative would vary throughout the area of potential effect. All environmental effects to surface water hydrology are assumed beneficial. Transferring surface water rights for instream conservation would have an overall minor, long-term effect in the area of potential effect. Effects on individual reaches are identified below.

Crescent Lake

Implementation of the Canal Lining Alternative would have minor, long-term effects on Crescent Lake. At capacity, the volume of water held in Crescent Lake currently is 86,900 acre-feet. The Canal Lining Alternative would allocate 4,949 acre-feet of water in Crescent Lake to instream use through Oregon's Allocation of Conserved Water Program. The District currently releases this water from Crescent Lake, diverts it, and loses it through canal and lateral seepage. Implementation of the Canal Lining Alternative would allow the District to use less stored water over the irrigation season. Irrigation season releases from Crescent Lake Dam would decrease accordingly. The State would determine its desired timing for the release of this 4,949 acre-feet from Crescent Lake during the fall, winter, and spring. As a result, this alternative may affect reservoir elevations within the lake during any given year.

Crescent Creek, Crescent Lake Dam (RM 30) to the Mouth (RM 0)

Implementation of the Canal Lining Alternative would have minor, long-term effects on Crescent Creek. The Canal Lining Alternative would affect Crescent Creek from Crescent Lake Dam (RM 30) to the mouth (RM 0). The Canal Lining Alternative would create 4,949 acre-feet of instream water rights in this reach through Oregon's Allocation of Conserved Water Program. The conserved water would be incrementally protected instream following completion of each project group, protecting

4,949 acre-feet of streamflow outside of the irrigation season. The conserved water would legally protect 16 cfs instream against appropriation out of the irrigation season. ODFW has an instream water right for this reach (varies seasonally from 50 cfs in late summer to 125 cfs in late winter), which is not met outside the irrigation season. Therefore, this permanent flow would assist in meeting these junior water rights.

Summer releases from the Crescent Lake Dam would also decrease, as the District would require less water following implementation of the Canal Lining Alternative. This would reduce summer flows within this section of Crescent Creek and return it to a more natural hydrologic regime.

Little Deschutes River, Crescent Creek (RM 57) to the Mouth (RM 0)

Implementation of the Canal Lining Alternative would have minor, long-term effects on the Little Deschutes River. The Canal Lining Alternative would affect Little Deschutes River from the confluence with Crescent Creek (RM 57) to the mouth (RM 0). The Canal Lining Alternative would create 4,059 acre-feet of instream water rights in this reach through Oregon's Allocation of Conserved Water Program (after accounting for an 18 percent channel loss from Crescent Creek to Benham Falls, as required by OWRD). The conserved water would be incrementally protected instream following completion of each project group, protecting 4,059 acre-feet of streamflow in this reach outside of the irrigation season. The conserved water would legally protect 13.5 cfs instream against appropriation outside of the irrigation season. ODFW has an instream water right for this reach (varies seasonally from 74.5 cfs in late summer to 240 cfs in early spring), which is rarely met. Therefore, this permanent flow would assist in meeting these junior water rights outside of the irrigation season.

Summer releases from the Crescent Lake Dam would also decrease, as the District would require less water following implementation of the Canal Lining Alternative. This would reduce summer flows within these sections of Crescent Creek, the Little Deschutes River, and the Deschutes River and return it to a more natural hydrologic regime.

Deschutes River, Little Deschutes River (RM 192.5) to the BFC Diversion at Steidl Dam (RM 166)

Implementation of the Canal Lining Alternative would have minor, long-term effects on the Deschutes River. The Canal Lining Alternative would affect the Deschutes River from the confluence with the Little Deschutes River (RM 192.5) to the BFC diversion at Steidl Dam (RM 166). The Canal Lining Alternative would create 3,775 acre-feet of instream water rights in this reach through Oregon's Allocation of Conserved Water Program (after accounting for a 7 percent channel loss between Benham Falls and Bend as required by OWRD). The conserved water would be incrementally protected instream following completion of each project group, protecting 3,775 acre-feet of streamflow outside of the irrigation season. The conserved water would legally protect 12.5 cfs instream against appropriation outside of the irrigation season. ODFW has an instream water right for this reach, which is not always met outside of the irrigation season. Therefore, this permanent flow would assist in meeting these junior water rights.

Summer releases from the Crescent Lake Dam would also decrease, as the District would require less water following implementation of the Canal Lining Alternative. This would reduce summer flows within this section of the Deschutes River and return it to a more natural hydrologic regime.

Tumalo Creek, TFC diversion (RM 2.5) to the Mouth (RM 0)

Implementation of the Canal Lining Alternative would have moderate, long-term effects on Tumalo Creek. The Canal Lining Alternative would affect Tumalo Creek downstream from the TFC diversion. The Canal Lining Alternative would create up to 27 cfs of instream water rights in this reach through Oregon's Allocation of Conserved Water Program. The conserved water would be incrementally protected instream following completion of each project group, increasing streamflows in this reach during the irrigation season. The conserved water would be legally protected instream and unavailable for appropriation. In addition, the Canal Lining Alternative's reduced demand in the BFC would leave additional capacity that would allow for trades between the Deschutes River and Tumalo Creek. The ODFW has an instream water right for Tumalo Creek, which is rarely met during the irrigation season. These additional streamflows would assist in meeting these junior instream water rights.

Deschutes River, BFC Diversion at Steidl Dam (RM 166) to Lake Billy Chinook (RM 120)

The Canal Lining Alternative would have a minor, long-term effect on the Deschutes River from Steidl Dam (RM 166) to Lake Billy Chinook (RM 120) outside of the irrigation season. As described above, the Canal Lining Alternative would create 3,775 acre-feet of instream water rights in this reach through Oregon's Allocation of Conserved Water Program. The conserved water would be incrementally protected instream following completion of each project group, protecting 3,775 acre-feet of streamflow in this reach outside of the irrigation season. The conserved water would legally protect 12.5 cfs instream against appropriation outside of the irrigation season.

In addition, the Canal Lining Alternative would have a minor, long-term effect on the Deschutes River from the confluence with Tumalo Creek (RM 160) to Lake Billy Chinook (RM 120) during the irrigation season. The Canal Lining Alternative would create up to 27 cfs of instream water rights in this reach through Oregon's Allocation of Conserved Water Program.

The historic daily average streamflow in this reach varies between 85.5 cfs to 391.5 cfs during the irrigation season. The ODFW has a pending instream water right for 250 cfs in this reach, which is rarely met during the irrigation season. Therefore, this additional flow would assist in meeting these junior water rights.

6.10.2.3 Surface Water Quality

Implementation of the Canal Lining Alternative would have a moderate, long-term effect on water quality within the area of potential effect due to improved streamflows as described below. The Canal Lining Alternative would provide permanent instream rights in Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek in addition to a potential increase in the inactive storage capacity of Crescent Lake Reservoir. This protected streamflow would affect water quality in streams and rivers within the area of potential effect. These streams currently do not meet

water quality standards under Section 303(d) of the CWA (33 U.S.C. 1251 et seq.) See Section 4.12.2 for a more detailed description of these impaired reaches.

Increasing streamflows in Tumalo Creek would decrease water temperatures in the Deschutes River past the confluence (Park and Foged 2009; Mork 2016). This decrease in water temperature past the confluence may have an indirect effect on other water quality components including dissolved oxygen, pH, and chlorophyll a.

Implementation of the Canal Lining Alternative would contribute to increased streamflows in Crescent Creek downstream from Crescent Lake Dam. It would contribute to improved streambank stability, sedimentation, and scour below Crescent Lake. Restoring wetlands and riparian function along most of the study reach would help address many of the identified resource concerns. Developing a riparian corridor that is healthy, resilient, and diverse would improve stream stability, expand aquatic and riparian habitat, and positively influence stream temperature and other water quality parameters including sedimentation, chlorophyll a, pH, and dissolved oxygen. This change would occur because as water enters a wetland it slows down and moves around wetland plants, and much of the suspended sediment drops out and settles to the wetland floor. Plant roots and microorganisms on plant stems in the soil absorb excess nutrients that can cause excess algae growth that is harmful to fish and other aquatic life.

The irrigation canal and lateral system would continue to collect irrigation tailwater, subsequently delivering contaminates, such as herbicides and pesticides, to patrons down gradient in the system. This concern is especially relevant to a patron dairy producer and farms that sell food products to the local farmers' markets.

Implementation of the Canal Lining Alternative would be expected to have a moderate, long-term effect on water quality for waterbodies that are 303(d) listed and in the area of potential effect.

6.10.2.4 Groundwater

No groundwater resources would be extracted or consumptively used as part of the Canal Lining Alternative; however, lining of irrigation canals and laterals may affect groundwater hydrology associated with canal leakage. Following construction, reduction in canal leakage is expected to result in reduced groundwater recharge during the irrigation season. A seepage loss assessment performed in 2016 calculated water loss at a rate of 48 cfs throughout the entire District (TID 2017). This estimate included evaporation, so it is anticipated that the entire 48 cfs does not contribute to the aquifer. Prior studies have found that canal lining and piping has a relatively small effect on groundwater recharge in the upper Deschutes Basin (Gannett and Lite 2013; Gannett et al. 2001; Gannett et al. 2003).

Extrapolating from a prior study (Gannett and Lite 2013), the average relationship between canal recharge and groundwater levels in the central part of the Deschutes Basin is approximately 1 foot of groundwater elevation drop per 377,000 acre-feet of reduced canal recharge. The Canal Lining Alternative would reduce canal seepage, and associated groundwater recharge, by up to approximately 13,604 acre-feet annually in this part of the Deschutes Basin. On average, for this part of the Deschutes Basin, this decrease in recharge translates into a decreased groundwater elevation

of approximately 0.036 feet annually. An important caveat is that localized effects on groundwater from implementation of the Canal Lining Alternative would differ throughout the area of potential effect. Over the course of 50 years, this annual drop results in a cumulative decreased average groundwater elevation of 2 feet.

As described in Section 4.10.3, changes in canal and lateral seepage account for only a small portion of changes in groundwater recharge in this part of the Deschutes Basin. Climate remains the primary factor affecting groundwater levels in the region. The U.S. Geological Survey estimated that the combined effects of climate and groundwater pumping accounted for approximately 90 percent of the observed decrease in groundwater levels in the region, and canal piping and lining accounted for 10 percent of that decrease (Gannett and Lite 2013).

It is also important to note that, over time, the lining of the canal will often tear and breakdown. This would allow leakage of canal water to recharge the groundwater system.

Water conserved through the Canal Lining Alternative would be allocated instream to Crescent Creek and Tumalo Creek. OWRD calculates an 18 percent channel loss from Crescent Creek Gauging Station No. 14060000 to Benham Falls Gauging State No. 14064500 on the Deschutes River and a 7 percent channel loss from Benham Falls to the City of Bend on the Deschutes River (Figure 6-6; OWRD 2005). The additional groundwater recharge created through increased streamflows associated with the Canal Lining Alternative would enter regional groundwater system upgradient from the proposed action. It would reduce any effects of canal piping and lining on regional groundwater recharge. Based on this information, the Canal Lining Alternative's effects on groundwater would be negligable and long-term.

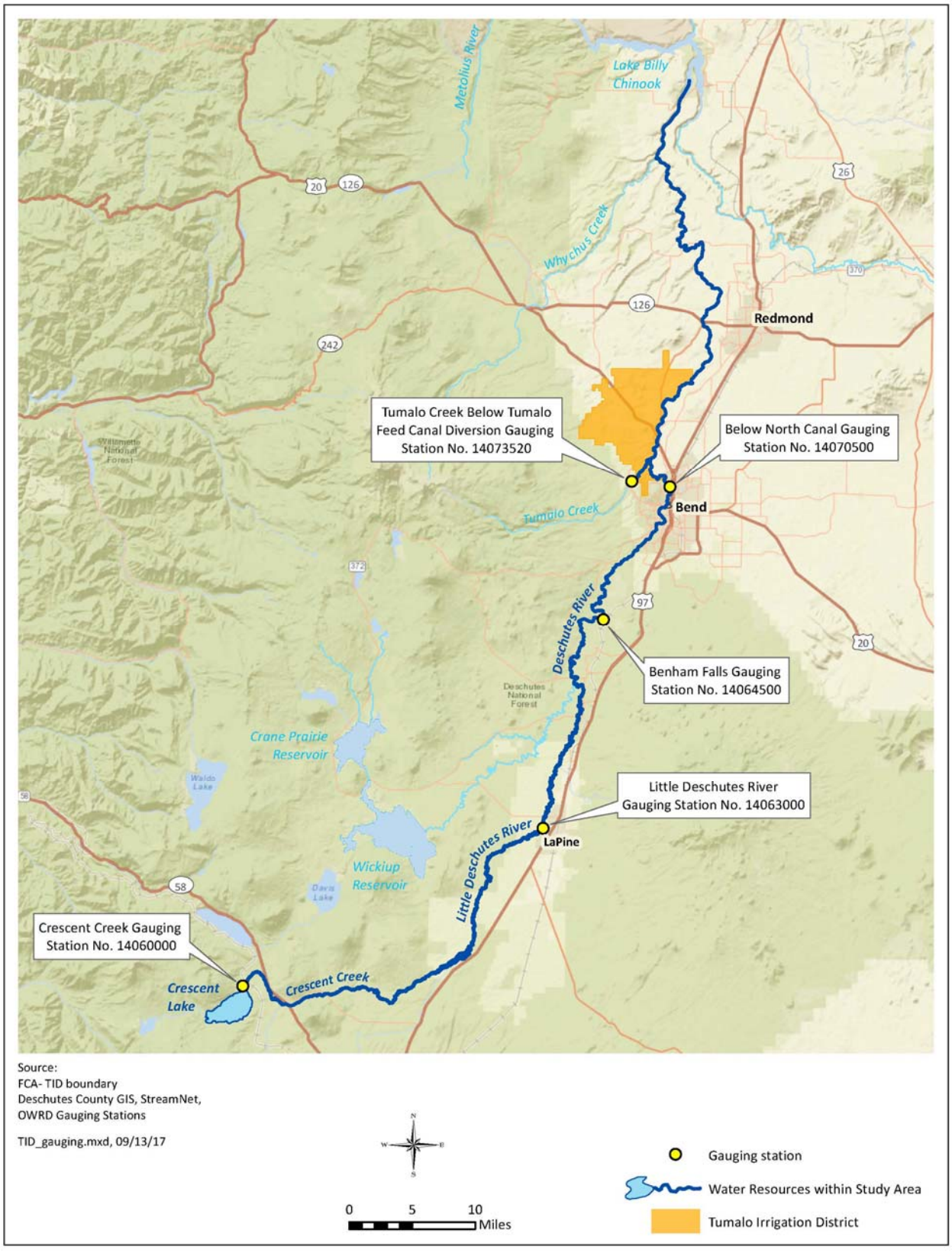


Figure 6-6. Location of Gauging Stations No. 14060000, 14063000, and 14064500 within the Tumalo Irrigation District Area of Potential Effect.

6.10.3 HDPE Piping Alternative

This section discusses the environmental consequences of implementation of the HDPE Piping Alternative. Included and discussed below are the effects to surface water and groundwater present in the project area and the area of potential effect.

6.10.3.1 Surface Water Rights

Following construction, TID would create permanent instream water rights in Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River through Oregon's Allocation of Conserved Water Program (ORS 537.470). Storage rights in Crescent Lake are discussed below.

The amount of water allocated instream would be determined based on the amount of water conserved through implementation of the HDPE Piping Alternative. The District has identified that the HDPE Piping Alternative would conserve 48 cfs. Under this alternative, the District would legally reduce their water right by the amount of conserved water. Correspondingly, the District would allocate and legally protect 100 percent of the conserved water instream through Oregon's Allocation of Conserved Water Program. The District would allocate the conserved water instream incrementally following completion of each project group of the HDPE Piping Alternative.

Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 18 cfs) of the conserved water would be allocated to Crescent Creek, and 62 percent (approximately 30 cfs) would be allocated to Tumalo Creek. These allocations by source and by season are estimates based on conserved water applications associated with similar, completed projects in TID that have already completed the State of Oregon's administrative process for the allocation of conserved water (see OAR 690-18). These allocations may change following a thorough review of the application by OWRD who may order a different allocation in an attempt to avoid affecting other water users at either source. The instream water rights created as an effect of the HDPE Piping Alternative would carry the same priority dates as TID's water rights. The District would permanently reduce its own water rights by corresponding rates and volumes, permanently reducing the rates of diversion at the TFC diversion and the BFC diversion.

In Crescent Creek, the conserved water would be permanently protected instream from the Crescent Lake Dam (RM 30) to the mouth (RM 0), the Little Deschutes River from the confluence with Crescent Creek (RM 57.3) to the mouth (RM 0), and the Deschutes River from the confluence with the Little Deschutes River (RM 192.5) to Lake Billy Chinook (RM 120). This conserved water would be stored in and released from Crescent Lake.

In Tumalo Creek, the conserved water would be permanently protected instream from the District's TFC diversion (RM 2.5) to the confluence with the Deschutes River and in the Deschutes River from Tumalo Creek (RM 160) to Lake Billy Chinook (RM 120).

Following construction, completion of each project group of this alternative would directly affect TID patrons by ensuring delivery of existing water rights throughout the irrigation season. As sections of the District become piped, the conveyance system would convert into an on-demand system allowing water to remain instream when not being utilized. Implementation of the HDPE

Piping Alternative would improve water supplies for both patrons and instream uses; therefore, minor, long-term effects would occur.

6.10.3.2 Surface Water Hydrology

Environmental effects on surface water hydrology from implementation of the HDPE Piping Alternative would occur at different extents for different locations throughout the area of potential effect. All environmental effects within surface water hydrology are assumed to be beneficial. Transferring surface water rights for instream conservation would have an overall minor, long-term effect in the area of potential effect. Effects on individual reaches are identified below.

Crescent Lake

Implementation of the HDPE Piping Alternative would have minor, long-term effects on Crescent Lake. The volume of water held in Crescent Lake currently averages 86,900 acre-feet. The HDPE Piping Alternative would allocate a projected 5,499 acre-feet of water in Crescent Lake to instream use through Oregon's Allocation of Conserved Water Program. The District currently releases this water from Crescent Lake, diverts it, and loses it through canal and lateral seepage. Implementation of the HDPE Piping Alternative would allow the District to use less stored water over the irrigation season. Irrigation season releases from Crescent Lake Dam would decrease accordingly. The State would determine its desired timing for the release of this 5,499 acre-feet from Crescent Lake during the fall, winter, and spring. As a result, this alternative may affect reservoir elevations within the lake during any given year.

Crescent Creek, Crescent Lake Dam (RM 30) to the Mouth (RM 0)

Implementation of the HDPE Piping Alternative would have minor, long-term effects on Crescent Creek. The HDPE Piping Alternative would affect Crescent Creek from Crescent Lake Dam (RM 30) to the mouth (RM 0). The HDPE Piping Alternative would create a projected 5,499 acre-feet of instream water rights in this reach through Oregon's Allocation of Conserved Water Program. The conserved water would be incrementally protected instream following completion of each project group, protecting 5,499 acre-feet of streamflow outside the irrigation season. Under the 2016 Stipulated Settlement Agreement, TID releases a minimum of 20 cfs into Crescent Creek outside the irrigation season. Although these conditions have been maintained since the expiration of the Agreement in compliance with the 2017 BiOp for Reclamation dam operations (see Section 4.10.2.2), that water is not legally protected against diversion (Reclamation 2017). If managed as a flat release rate, the conserved water generated through the HDPE Piping Alternative would permanently and legally protect up to 18 cfs instream against appropriation outside the irrigation season in addition to 5 cfs that TID releases through an informal agreement with OWRD (see Section 4.10.2.2). ODFW has an instream water right for this reach (the quantity varies seasonally from 50 cfs in late summer to 125 cfs in late winter), which is not met outside the irrigation season. Therefore, this protected flow would assist in meeting these junior water rights. Summer releases from the Crescent Lake Dam would also decrease, as the District would require less water following implementation of the HDPE Piping Alternative. This would reduce summer flows within this section of Crescent Creek and return it to a more natural hydrologic regime.

Little Deschutes River, Crescent Creek (RM 57) to the Mouth (RM 0)

Implementation of the HDPE Piping Alternative would have minor, long-term effects on the Little Deschutes River. The HDPE Piping Alternative would affect the Little Deschutes River from the confluence with Crescent Creek (RM 57) to the mouth (RM 0). The HDPE Piping Alternative would create a projected 4,509 acre-feet of instream water rights in this reach through Oregon's Allocation of Conserved Water Program (after accounting for an 18 percent channel loss from Crescent Creek to Benham Falls, as required by OWRD). Although the District currently releases water instream from Crescent Lake Dam into Crescent Creek that flows into the Little Deschutes during the non-irrigation season in compliance with the 2017 BiOp, this water is not legally protected (Reclamation 2017). The conserved water generated through the HDPE Piping Alternative would be incrementally protected instream following completion of each project group. If managed as a flat release rate, the conserved water would legally and permanently protect 15 cfs instream against appropriation outside the irrigation season. ODFW has an instream water right for this reach (the quantity varies seasonally from 74.5 cfs in late summer to 240 cfs in early spring), which is rarely met. Therefore, this protected flow would assist in meeting these junior water rights outside the irrigation season.

Summer releases from the Crescent Lake Dam would also decrease, as the District would require less water following implementation of the HDPE Piping Alternative. This would reduce summer flows within this section of the Little Deschutes River and return it to a more natural hydrologic regime.

Deschutes River, Little Deschutes River (RM 192.5) to the BFC Diversion at Steidl Dam (RM 166)

Implementation of the HDPE Piping Alternative would have minor, long-term effects on the Deschutes River. The HDPE Piping Alternative would affect the Deschutes River from the confluence with the Little Deschutes River (RM 192.5) to the BFC diversion at Steidl Dam (RM 166). The HDPE Piping Alternative would create a projected 4,194 acre-feet of instream water rights in this reach through Oregon's Allocation of Conserved Water Program (after accounting for a 7 percent channel loss between Benham Falls and Bend as required by OWRD). In this reach, any water instream as a result of the District's releases outside the irrigation season in compliance with the 2017 BiOp is not legally protected. The conserved water generated through the HDPE Piping Alternative would be incrementally protected instream following completion of each project group, legally protecting a projected 4,194 acre-feet of streamflow outside of the irrigation season and permanently protecting flows created under the conditions of the 2016 Stipulated Settlement Agreement. ODFW has an instream water right for this reach, which is not always met outside of the irrigation season. Therefore, these protected instream water rights would assist in meeting the desired flows under this junior water right.

Summer releases from the Crescent Lake Dam would also decrease, as the District would require less water following implementation of the HDPE Piping Alternative. This would reduce summer flows within this section of the Deschutes River and return it to a more natural hydrologic regime.

Tumalo Creek, TFC diversion (RM 2.5) to the Mouth (RM 0)

Implementation of the HDPE Piping Alternative would have moderate, long-term effects on Tumalo Creek. The HDPE Piping Alternative would affect Tumalo Creek downstream from the TFC diversion. The HDPE Piping Alternative would create a projected 30 cfs of instream water rights in this reach through Oregon's Allocation of Conserved Water Program. The conserved water would be incrementally protected instream following completion of each project group, increasing streamflows in this reach during the irrigation season. The conserved water would be legally protected instream and unavailable for appropriation. In addition, the HDPE Piping Alternative's reduced demand in the BFC would leave additional capacity that would allow for trades between the Deschutes River and Tumalo Creek. The ODFW has an instream water right for Tumalo Creek, which is rarely met during the irrigation season. These additional streamflows would assist in meeting these junior water rights.

As project groups of the District become piped, the conveyance system would convert into an on-demand system allowing water to remain instream (not be diverted at the TFC diversion) when not being utilized.

Deschutes River, BFC Diversion at Steidl Dam (RM 166) to Lake Billy Chinook (RM 120)

The HDPE Piping Alternative would have a minor, long-term effect on the Deschutes River from Steidl Dam (RM 166) to Lake Billy Chinook (RM 120) outside of the irrigation season. As described in Section 6.10.2.1, the HDPE Piping Alternative would create a projected 4,194 acre-feet instream water rights in this reach through Oregon's Allocation of Conserved Water Program. The conserved water would be incrementally protected instream following completion of each project group, legally protecting up to 4,194 acre-feet of streamflow in this reach outside the irrigation season.

As project groups of the District become piped, the conveyance system would convert into an on-demand system during the irrigation season. An on-demand system allows the District to divert only the water that patrons need and leave the remainder instream.

In addition, the HDPE Piping Alternative would have a minor, long-term effect on the Deschutes River from the confluence with Tumalo Creek (RM 160) to Lake Billy Chinook (RM 120) during the irrigation season. The HDPE Piping Alternative would create a projected 30 cfs of instream water rights in this reach through Oregon's Allocation of Conserved Water Program. The conserved water would be incrementally protected instream following completion of each project group, protecting up to 30 cfs of streamflow during the irrigation season (see Table E-14 in Appendix E.6 for projected flows following these conservation projects). The conserved water would be unavailable for appropriation.

The pre-project, daily average streamflow in this reach varies between 85.5 cfs to 391.5 cfs during the irrigation season. ODFW has a pending instream water right for 250 cfs in this reach, which is rarely met during the irrigation season. Therefore, this additional flow would assist in meeting these junior water rights.

6.10.3.3 Surface Water Quality

Implementation of the HDPE Piping Alternative would have a moderate, long-term effect on water quality within the area of potential effect due to improved streamflows as described below. The HDPE Piping Alternative would provide permanent instream rights in Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek in addition to a potential increase in the inactive storage capacity of Crescent Lake Reservoir. This protected streamflow would affect water quality in streams and rivers within the area of potential effect. These streams currently do not meet water quality standards under Section 303(d) of the CWA (33 U.S.C. 1251 et seq.) See Section 4.12.2 for a more detailed description of these impaired reaches.

Increasing streamflows in Tumalo Creek would decrease water temperatures in the Deschutes River past the confluence (Park and Foged 2009; Mork 2016). This decrease in water temperature past the confluence may have an indirect effect on other water quality components including dissolved oxygen, pH, and chlorophyll a.

Implementation of the HDPE Piping Alternative would protect streamflows in Crescent Creek downstream from Crescent Lake Dam. This protection would ensure continued improvement to streambank stability, sedimentation, and scouring below Crescent Lake. Restoring wetlands and riparian function along most of the study reach would help resolve many of the identified resource concerns. Developing a riparian corridor that is healthy, resilient, and diverse would improve stream stability, expand aquatic and riparian habitat, and positively influence stream temperature and other water quality parameters including sedimentation, chlorophyll a, pH, and dissolved oxygen. This change would occur because as water enters a wetland it slows down and moves around wetland plants, and much of the suspended sediment drops out and settles to the wetland floor. Plant roots and microorganisms on plant stems in the soil absorb excess nutrients that can cause excess algae growth that is harmful to fish and other aquatic life.

Implementation of HDPE Piping Alternative would prevent the system from collecting irrigation tailwater, such as herbicides and pesticides, thus improving the water quality delivered to patrons. Water quality is especially relevant to a patron dairy producer and farms that sell food products to the local farmers' markets.

The HDPE Piping Alternative is expected to have a moderate, long-term effect on water quality for waterbodies that are 303(d) listed and in the area of potential effect.

6.10.3.4 Groundwater

No groundwater resources would be extracted or consumptively used as part of the HDPE Piping Alternative; however, piping of irrigation canals and laterals may affect groundwater hydrology associated with canal leakage. Following construction, reduction in canal leakage is expected to result in reduced groundwater recharge during the irrigation season. A seepage loss assessment performed in 2016 calculated water loss at a rate of 48 cfs throughout the entire District (TID 2017). This estimate includes evaporation, so it is anticipated that the entire 48 cfs does not contribute to the aquifer. Prior studies have found that canal lining and piping has a relatively small effect on groundwater recharge in the upper Deschutes Basin (Gannett and Lite 2013; Gannett et al. 2001; Gannett et al. 2003).

Extrapolating from a prior study (Gannett and Lite 2013), the average relationship between canal recharge and groundwater levels in the central part of the Deschutes Basin is approximately 1 foot of groundwater elevation drop per 377,000 acre-feet of reduced canal recharge. The HDPE Piping Alternative would reduce canal seepage, and associated groundwater recharge, by up to approximately 15,115 acre-feet annually in this part of the Deschutes Basin. On average, for this part of the Deschutes Basin, this decrease in recharge translates into a decreased groundwater elevation of approximately 0.040 feet annually. An important caveat is that localized effects on groundwater from implementation of the proposed project would differ throughout the area of potential effect. Over the course of 50 years, this annual drop results in a cumulative decreased average groundwater elevation of 2 feet.

As described in Section 4.10.3, changes in canal and lateral seepage account for only a small portion of changes in groundwater recharge in this part of the Deschutes Basin. Climate remains the primary factor affecting groundwater levels in the region. The U.S. Geological Survey estimated that the combined effects of climate and groundwater pumping accounted for approximately 90 percent of the observed decrease in groundwater levels in the region, and canal piping and lining accounted for 10 percent of that decrease (Gannett and Lite 2013).

Water conserved through the HDPE Piping Alternative would be allocated instream to Crescent Creek and Tumalo Creek. OWRD calculates an 18 percent channel loss from Crescent Creek Gauging Station No. 14060000 to Benham Falls Gauging State No. 14064500 on the Deschutes River and a 7 percent channel loss from Benham Falls to the City of Bend on the Deschutes River (OWRD 2005). The additional groundwater recharge created through increased streamflows associated with the HDPE Piping Alternative would enter regional groundwater system upgradient from the proposed action. It would reduce any effects of canal piping and lining on regional groundater recharge. Based on this information, the effects on groundwater would be negligable and long-term.

6.10.4 Compliance and Best Management Practices

The following compliance measures and BMPs would be implemented to mitigate any effects on water resources resulting from either the Canal Lining Alternative or the HDPE Piping Alternative (unless otherwise noted):

- Proper erosion control.
- Allocation of the conserved water to permanent instream water rights in Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River through Oregon's Allocation of Conserved Water Program (ORS 537.470).

6.11 Wetlands and Riparian Areas

The area of potential effect for wetlands and riparian areas are discussed in Section 4.11.

6.11.1 No Action (Future without Project)

This section discusses the future of the project area and area of potential effect without project implementation and completion in relation to wetlands and riparian areas. Under the No Action Alternative, the District's canals and laterals would remain open. The District's open canal and laterals would continue to lose 48 cfs through seepage.

6.11.1.1 Wetlands

The No Action Alternative would have no effect to any wetland features or sporadic hydrophytic vegetation occurring adjacent to District canals and laterals. It would also not provide a more natural hydrograph to support wetlands adjacent to the 162 miles of waterbodies downstream of Project diversions. Conditions that have allowed hydrophytic plants to opportunistically grow along the open canals and laterals would continue.

6.11.1.2 Riparian Areas

This alternative would not enhance flows and benefit riparian areas in the area of potential effect. Low streamflows during the late fall, winter, and early spring in Crescent Creek, the Little Deschutes River, and low streamflows during the late spring, summer, and early fall in Tumalo Creek downstream from the TFC diversion would continue to limit riparian vegetation growth and establishment.

6.11.2 Canal Lining Alternative

This section discusses the potential environmental consequences to wetlands and riparian areas under the Canal Lining Alternative. Following construction, approximately 43 cfs currently lost through seepage during the irrigation season would instead remain instream (see Section 6.10.2). Eliminating canal seepage would have direct effects on hydrophytic plants opportunistically growing in and along the canals and laterals, on wetlands adjacent to the canal and laterals, and indirect effects on riparian areas adjacent to natural waterbodies downstream of the District's diversions.

6.11.2.1 Wetlands

Although canals and laterals may have hydrology and vegetation indicative of a wetland in places, District operations meet exemptions under the Oregon Removal-Fill Law for specific agricultural activities in wetlands and other waters of the state (S. Kelly, personal communication, November 2016). Based on a review of the NWI geographic information systems data (USFWS 2016), there are no wetland features within project canals or laterals. Hydrophytic vegetation grows opportunistically along the canals and laterals in some areas. Further, approximately 23 wetland features are shown in the NWI data to occur near or adjacent to project canals or laterals; however, these have not been field verified. Consultation with USACE and ODSL would be completed prior to construction, and measures would be taken as required to identify and mitigate impacts to potential jurisdictional wetlands and Waters of the United States.

The Canal Lining Alternative could have direct effects on hydrophytic vegetation and wetlands adjacent to irrigation canals and laterals in the project area.

Hydrophytic vegetation or wetlands in some areas directly adjacent to the canals could be removed or buried during excavation, fill, placement of lining materials, or other construction activity; however, wetlands would be avoided to the extent practicable. After completion of canal lining, seepage losses would be eliminated along with the saturated soils necessary for hydrophytic plant growth along some canals. This could also limit water availability to wetlands adjacent to the canals or laterals if they are dependent upon canal seepage for hydrology.

The Canal Lining Alternative would have no effect on privately owned and operated excavated water storage ponds that occur in the project area.

Because the effects of this alternative could directly affect or reduce water availability to wetlands and hydrophytic vegetation occurring in places near or adjacent to the 65.1 miles of open canal and laterals in the project area, minor effects are assumed to occur to wetland habitat along canals and laterals within the project area. However, these effects would be offset by gains in water quality and habitat function in the 162 miles of natural riverine systems downstream of Crescent Lake and TID's diversions (in the project's area of potential effects) as a result of increased instream flows that contribute towards a more natural hydrologic regime and improved hydrologic connectivity with wetland vegetation. Based on the information provided above, the Canal Lining Alternative would have a minor effect on wetlands in the short-term and a negligible-to-minor effect on wetlands in the long-term.

6.11.2.2 Riparian Areas

Changes in a stream's hydrologic regime alter streambank structure, sediment transport dynamics, and hydrologic connectivity with riparian vegetation (National Research Council 2002). This alternative would provide improved habitat function within the 162 miles of rivers and streams in the study area by protecting winter flows downstream of Crescent Lake and providing additional irrigation season flows in Tumalo Creek that are more similar to the natural hydrograph. Reduced bank erosion along the rivers and streams in the study area could occur if riparian vegetation became more established along stream channels and functionality of the riparian areas increases.

Restablishing a more natural hydrologic regime in these reaches could allow the river channel to supply water to riparian areas via infiltration through channel banks. This change would enhance riparian function by facilitating processes such as surface and groundwater exchange, physical and chemical transformations, and supporting riparian plant communities. Based on the information provided above, the Canal Lining Alternative would have a minor effect on riparian areas in the short-term and a negligible-to-minor effect on riparian areas in the long-term as instream conservation is implemented.

6.11.3 HDPE Piping Alternative

This section discusses the potential environmental consequences to wetlands and riparian areas from implementation of the HDPE Piping Alternative. Following construction, 48 cfs that is currently diverted and lost through seepage and evaporation would instead remain instream (see Section 6.10.3). Eliminating canal seepage would have direct effects on hydrophytic plants opportunistically growing in and along the canals and laterals, and on wetlands adjacent to the canals and laterals.

This would also have indirect effects on riparian areas adjacent to natural waterbodies downstream of Crescent Lake and the District's TFC diversion. Permanently protecting flows in Crescent Creek created under the conditions of the 2016 Stipulated Settlement Agreement and increasing flows to Tumalo Creek downstream of the TFC diversion, could allow for enhancement to streamside vegetation.

6.11.3.1 Wetlands

Although canals and laterals may have hydrology and vegetation indicative of a wetland in places, operations by the District meet exemptions under the Oregon Removal-Fill Law for specific agricultural activities in wetlands and other waters of the state (S. Kelly, personal communication, November 2016). Hydrophytic vegetation grows opportunistically along the canals and laterals in some areas. Based on a review of the NWI geographic information systems data (USFWS 2016), there are no wetland features within project canals or laterals. Further, approximately 23 wetland features are shown in the NWI data to occur near or adjacent to project canals or laterals; however, these have not been field verified. Consultation with USACE and ODSL will be completed prior to construction, and measures will be taken as required to identify and mitigate impacts to potential jurisdictional wetlands and Waters of the United States.

Hydrophytic vegetation or wetlands in some areas directly adjacent to the canals could be removed or buried during excavation, fill, placement of lining materials, or other construction activity; however, wetlands would be avoided to the extent practicable. The District would follow appropriate reclamation procedures in order to revegetate disturbed areas as uplands. Figure 6-1 through Figure 6-5 demonstrate the before and after effects of a previous TFC piping project on hydrophytic vegetation. After completion of pipe installation, seepage losses would be eliminated along with the saturated soils necessary for opportunistic hydrophytic plant growth along some canals. This could also limit water availability to wetlands adjacent to the canals or laterals if they are dependent upon canal seepage for hydrology.

The HDPE Piping Alternative would have no effect on excavated water storage ponds that occur in the project area.

Because the effects of this alternative could reduce water availability to wetlands and hydrophytic vegetation occurring in places near or adjacent to the 65.1 miles of open canal and laterals in the project area, minor effects are assumed to occur to wetland habitat along canals and laterals within the project area. However, these effects would be offset by gains in water quality and habitat function in the 162 miles of natural riverine systems downstream of TID's diversions in the project's area of potential effects as a result of protection and addition of instream flows that contribute towards a more natural hydrologic regime and increasing hydrologic connectivity with wetland vegetation. Based on the information provided above, the HDPE Piping Alternative would have a minor effect on wetlands in the short-term and a negligible-to-minor effect on wetlands in the long-term.

6.11.3.2 Riparian Areas

Changes in a stream's hydrologic regime alter streambank structure, sediment transport dynamics, and hydrologic connectivity with riparian vegetation (National Research Council 2002). This

alternative would continue to provide improved habitat function within the 162 miles of rivers and streams in the study area by protecting winter flows downstream of Crescent Lake and providing additional irrigation-season flows that are more similar to the natural hydrograph in Tumalo Creek. Reduced bank erosion along the rivers and streams in the study area could occur as riparian vegetation becames more established along stream channels and riparian area functionality increases.

Restablishing a more natural hydrologic regime in these reaches could allow the river channel to supply water to riparian areas via infiltration through channel banks. This change would enhance riparian function by facilitating processes such as surface and groundwater exchange, physical and chemical transformations, and supporting riparian plant communities. Based on the information provided above, the HDPE Piping Alternative would have a minor effect on riparian areas in the short-term and a negligible-to-minor effect on riparian areas in the long-term as instream conservation is implemented.

6.11.4 Compliance and Best Management Practices

The replacement of an open channel with a pipe or the lining of an open channel is considered an irrigation exemption under the USACE Regulatory Guidance Letter No. 07-02 Exemption for Construction or Maintenance of Irrigation Ditches and Maintenance of Drainage under Section 404 Part 323.4(a)(3) of the CWA. Under this exemption, no Nationwide Permit is required for the disturbance to wetlands within the project area. Coordination and consultation with USACE will occur prior to project implementation to ensure the project meets exemption criteria.

Executive Order 11988 requires federal agencies to avoid to the extent possible the long- and short-term effects associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Canals and laterals in both the Canal Lining Alternative and the HDPE Piping Alternative are not located within the 100-year floodplain and would be compliant with EO 11988. In addition, wetlands found along canals and laterals in the Canal Lining Alternative and the HDPE Piping Alternative are classified by NRCS as being either excavated by humans or created or modified by a human-created barrier; therefore, both the Canal Lining Alternative and the HDPE Piping Alternative would be compliant with EO 11990 regarding the protection of wetlands.

The following BMPs would be implemented to mitigate any effects on wetlands and riparian areas resulting from either the Canal Lining Alternative or the HDPE Piping Alternative (unless otherwise noted):

- Following project implementation, appropriate reclamation procedures would be followed in order to revegetate disturbed areas as uplands while controlling noxious weeds.
- Work would be confined within the existing ROW whenever possible to preserve existing vegetation and private property. The ROW would be clearly marked in the field prior to construction.
- Construction limits would be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.

- Disturbance of jurisdictional wetlands would be avoided during construction.

6.12 Wildlife Resources

The area of potential effect for wildlife resources is discussed in Section 4.12.

6.12.1 No Action (Future without Project)

The No Action Alternative would have no effect on wildlife in the project area.

6.12.2 Canal Lining Alternative

6.12.2.1 Wildlife

Effects on terrestrial wildlife communities resulting from implementation of the Canal Lining Alternative would be direct and indirect as well as short-term and long-term. During construction, terrestrial wildlife could experience noise disturbance due to the operation of heavy equipment, habitat removal due to cutting of trees and other vegetation removal, or injury due to collision with construction equipment or habitat removal. Canals in the Canal Lining Alternative are located in agricultural areas where use of heavy equipment is commonplace. Therefore, most wildlife in the area is accustomed to noise in the area and these disturbances are anticipated to be minor.

The canal and laterals within the project area provide seasonal artificial wetland and elements of riparian habitat across the landscape as well as a source of drinking water for wildlife. As canal and lateral systems are lined and fenced, habitats are expected to shift from artificial wetlands to uplands; and the distribution patterns of wildlife within the area would change. The fence and barbed wire cap would alter the land use patterns of large ungulates by removing their access to these water sources and the vegetation they support. Densities of smaller species dependent on these habitats could decrease locally and shift to other more suitable habitat in the area as vegetation removal would occur. However, this alternative would have no effect on excavated water storage ponds that occur in the project area. These ponds would still allow for summer water and habitat availablilty to wildlife. The newly lined canal would also have steeper concrete side slopes and faster water velocities than the existing canal. This could pose a drowning risk to large mammals.

Wintering or migrating birds would be minimally affected by construction disturbance because they have the flexibility to move away from disturbances to other suitable areas. There is no expected direct effect to breeding migratory songbirds or waterbirds as construction activities would occur outside the nesting season.

The District is working with USFWS to ensure minimal disturbance to bald or golden eagles nesting near the project area. The critical nesting period for bald and golden eagles is January 1 through August 31. Two golden eagle nests are located near the project area, and, although no bald eagle nests are documented, it is possible that a bald eagle nest could be located near a proposed pipeline or irrigation pond (Cordova 2017). Site visits with a USFWS biologist confirmed that the locations of the golden eagle nests are a substantial distance from any planned construction activity. The District would continue to work with USFWS to ensure that appropriate buffers are maintained

between construction activities and active nests or that construction in areas with known nests is avoided during the critical nesting period.

Although implementation of the Canal Lining Alternative would remove habitat adjacent to open canals, project implementation would provide increased instream flows in Crescent Creek, the Deschutes River, and Tumalo Creek, which would enhance riparian habitat in these reaches. Riparian areas in stream reaches with improved streamflows would provide more consistent access to water for hydrophytic plants. Enhanced riparian habitat could provide improved terrestrial wildlife habitat.

Overall, the Canal Lining Alternative would have a minor, long-term effect on general wildlife in the area of potential effect.

6.12.2.2 Threatened and Endangered Species

The Canal Lining Alternative would have no effect on threatened or endangered terrestrial species. As noted in Section 4.12.3 and Section 4.12.4, no terrestrial species or federally designated critical habitat occurs within the project area or area of potential effect.

6.12.3 HDPE Piping Alternative

6.12.3.1 Wildlife

Effects on terrestrial wildlife communities resulting from implementation of the HDPE Piping Alternative would be direct and indirect as well as short-term and long-term. During construction, terrestrial wildlife could experience noise disturbance due to the operation of heavy equipment, habitat removal due to cutting of trees and other vegetation removal, or injury due to collision with construction equipment or habitat removal. Canals in the HDPE Piping Alternative are located in agricultural areas where use of heavy equipment is commonplace, therefore most wildlife in the area are accustomed to noise in the area and these disturbances are anticipated to be minor.

The canal and laterals within the project area provide seasonal artificial wetland and elements of riparian habitat across the landscape, as well as a source of drinking water for wildlife. As canal and lateral systems are piped and habitats shift from artificial wetlands to uplands, the distribution patterns of wildlife within the area could change. Large ungulates could alter their land use patterns in response to removal of these water sources and the vegetation they support. Densities of smaller species dependent on these habitats could decrease locally and shift to other more suitable habitat in the area. However, this alternative would have no effect on excavated water storage ponds that occur in the project area and this would still allow for summer water and habitat availablilty to wildlife. Wintering or migrating birds would be minimally affected by construction disturbance because they have the flexibility to move away from disturbances to other suitable areas. There is no expected direct effect to breeding migratory songbirds or waterbirds as construction activities would occur outside the nesting season.

The District is working with USFWS to ensure minimal disturbance to bald or golden eagles nesting near the project area. The critical nesting period for bald and golden eagles is January 1 through August 31. Two golden eagle nests are located near the project area and although no bald eagle nests

are documented, it is possible that a bald eagle nest could be located near a proposed pipeline or irrigation pond (Cordova 2017). Site visits with a USFWS biologist confirmed that the locations of the golden eagle nests are a substantial distance from any planned construction activity. The District would continue to work with USFWS to ensure that appropriate buffers are maintained between construction activities and active nests or that construction in areas with known nests is avoided during the critical nesting period.

Although implementation of the HDPE Piping Alternative would remove habitat adjacent to open canals, project implementation would protect and provide additional instream flows in Crescent Creek, Little Deschutes River, Deschutes River, and Tumalo Creek (see Section 4.10.2 and 6.10.3 for allocation of conserved water). Protection of these instream flows would enable continued enhancement of riparian habitat in these reaches. Riparian areas in stream reaches with improved streamflows would experience more consistent access to water for hydrophytic plants. Enhanced riparian habitat would provide improvement to terrestrial wildlife habitat.

Construction activities would cause short-term negligible effects on wildlife due to increased human presence and noise. However, piping of irrigation canals would potentially reduce human presence through the project area; fewer trips to maintain ditches and headgates would be necessary. This change would result in fewer human-wildlife conflicts and improve seclusion for wildlife. In addition, the HDPE Piping Alternative could remove barriers to movement of ungulates and other terrestrial wildlife within the project area as open canals are converted to buried pipelines. Although some species may use canals as a water source, canals and laterals can have adverse effects on wildlife due to risk of drowning and the barrier that they create to terrestrial movement (Beier et al. 2008). As this alternative would be implemented over time, ungulates and other terrestrial wildlife would have ample time to adjust and find new water sources.

Overall, the HDPE Piping Alternative would have a minor, long-term effect on general wildlife in the area of potential effect.

6.12.3.2 Threatened and Endangered Species

The HDPE Piping Alternative would have no effect on threatened or endangered terrestrial species. As noted in Section 4.12.4, no terrestrial species or federally designated critical habitat occurs within the project area or area of potential effect.

6.12.4 Compliance and Best Management Practices

Bald and golden eagles typically use the same nest sites year after year. The District is working with a USFWS biologist to determine the most recent locations of active nests and how to best operate within the project area that would minimize any potential effects. BMPs that would be implemented for both the Lining and HDPE Piping Alternative would include project construction outside the USFWS-approved buffer distances. If construction occurs within the recommended buffer distance, the District would avoid the nesting season.

Project construction would occur outside the primary nesting period for migratory birds of concern (April 15 through July 15) and raptors (April through July). For rare occasions where construction of

either alternative would occur during the primary nesting period, construction would occur outside of the recommended buffer distance of any known nests. Should an active nest be found, construction would be paused and a consultation with a local USFWS biologist would occur to determine the following steps.

To mitigate for loss of functional habitat, the District would complete timely and appropriate revegetation of the construction area. Seed mixes would consist of native vegetation and would be approved by the local Soil and Water Conservation District or NRCS. In addition, the District would limit the construction footprint to the smallest area practicable.

Under both the Canal Lining and HDPE Piping Alternatives, there would be potential for wildlife to be trapped in dewatered trenches left open overnight during construction periods. To avoid this, ramps of size deemed appropriate by a USFWS biologist would be placed in trenches. These ramps would be strong enough to allow large animals to escape.

The Canal Lining Alternative would install a standard chain link fence with 3-wire barbed wire cap, chosen per NRCS guidelines. This would limit wildlife access to the canals and would reduce the potential for wildlife to fall into the canals and drown.

6.13 Wild and Scenic Rivers

The area of potential effect for Wild and Scenic Rivers is discussed in Section 4.13.

6.13.1 No Action Alternative (Future without Project)

The No Action Alternative would have no effect on designated Wild and Scenic Rivers or State Scenic Waterways in the area of potential effect.

6.13.2 Canal Lining Alternative

There would be no direct effects to designated Wild and Scenic Rivers and State Scenic Waterways following implementation of the Canal Lining Alternative. Increased streamflows (discussed in Section 6.10.2) as a result of water conservation in the designated river sections are consistent with the Outstanding Remarkable Values (ORV) in each area. Adverse effects are not expected in the Wild and Scenic River areas or in the State Scenic Waterways; therefore, consultation is not warranted.

6.13.3 HDPE Piping Alternative

There would be no direct effects to designated Wild and Scenic Rivers and State Scenic Waterways following implementation of the HDPE Piping Alternative. Increased streamflows (discussed in Section 6.10.3) in the designated river sections as a result of water conservation are consistent with the ORVs in each area. Adverse effects are not expected in the Wild and Scenic River areas or in the State Scenic Waterways and therefore, consultation is not warranted.

6.13.4 Compliance and Best Management Practices

The following compliance measures and BMPs would be implemented to mitigate any effects on Wild and Scenic River areas or State Scenic Waterways resulting from either the Canal Lining Alternative or the HDPE Piping Alternative (unless otherwise noted):

- Ground disturbances would be limited to only those areas necessary to safely implement both the Canal Lining Alternative and the HDPE Piping Alternative.
- Work would be confined within the existing ROW whenever possible to preserve existing vegetation and private property. The ROW would be clearly marked in the field prior to construction.
- Construction limits would be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.
- Work crews would carry spill cleanup kits, and, in times of burn bans or wildfire concerns, each crew would have a fire suppression kit.
- Project construction activities would be conducted in accordance with the project's spill prevention and cleanup plan.
- Allocation of the conserved water to permanent instream water rights in Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River through Oregon's Allocation of Conserved Water Program (ORS 537.470).

6.14 Cumulative Effects

This section includes a description of past, current, reasonably foreseeable future actions, and cumulative effects organized by resource and then by alternative. The cumulative effects are assumed to be the same for the Canal Lining and HDPE Piping alternatives except where stated differently.

6.14.1 Past Actions

Past actions considered in this analysis include land development activities related to irrigated agriculture (consisting of construction of the canal system, previous piping projects, and diversions), urban and suburban development, industrial land and water uses, commercial development, water diversions for non-agricultural uses, and transportation infrastructure. The nature and extent of these past actions and how they have influenced the existing environment are described for each resource in Section 4.

The first documented canal in the TID system was dug in 1883 and diverted water from Tumalo Creek to provide water to surrounding farms and ranches for crops and livestock. The TID system was formalized in 1902 and reorganized as an irrigation district under Oregon State law; it assumed the name "Tumalo Irrigation District" in 1922. Seven other irrigation districts were developed within the Deschutes River subbasin during this timeframe, collectively altering the hydrology of the

Deschutes River and the Little Deschutes River. Over time there has been increasing pressure to reduce the effects of irrigation needs on the natural water cycle in the Deschutes River basin.

6.14.2 Current and Reasonably Foreseeable Future Actions

Current actions are those projects, developments, and other actions that are presently underway, because they are either under construction or occurring on an ongoing basis. Reasonably foreseeable future actions generally include those actions formally proposed or planned, or highly likely to occur based on available information. Various sources including local, state, and federal agency websites and city and county staff were consulted to obtain information about current and potential future development in the project area. The following sections describe these current actions and reasonable foreseeable future actions.

6.14.2.1 Land Use and Development

Ongoing agricultural activities, including farming and grazing in the project area, are not expected to change from current conditions. Land use development in the project area is managed according to the Deschutes County Comprehensive Plan and Deschutes County zoning regulations and is implemented by Deschutes County Planning Department. Land development activities are expected to continue into the future. These activities would include agricultural, residential, commercial, and industrial land uses, as well as maintenance of public lands for their intended uses.

6.14.2.2 Habitat Conservation Plan

The District, other irrigation districts in the Deschutes Basin, state and federal agencies, local municipalities, and environmental groups are collaborating to develop a multi-species Habitat Conservation Plan (HCP) for the upper Deschutes Basin for listed species and those that may become listed during the 20- to 50-year life of the HCP, including the Oregon spotted frog, bull trout, chinook salmon, steelhead salmon, and sockeye salmon. The plan is planned for completion in 2019. The HCP is still in draft form; covered activities will likely include:

- Storage and release of irrigation water from:
  - Crane Prairie Reservoir
  - Wickiup Reservoir
  - Crescent Lake Reservoir
  - Prineville Reservoir
  - Ochoco Reservoir
- Diversion of irrigation water
- Conveyance and delivery of irrigation water
- Irrigation return flows
- Existing hydropower
- City of Prineville water use activities

6.14.2.3 Deschutes Basin Irrigation District Modernization

Other irrigation districts in the Deschutes Basin are working to modernize their infrastructure, and would implement projects similar to that proposed by TID in this Plan-EA. Districts most likely to obtain necessary funding and permitting to begin work in the next 2 years are Central Oregon Irrigation District (COID) and Swalley Irrigation District (SID). Modernization of SID's irrigation infrastructure would involve piping approximately 16.6 miles of canals over the course of 7 years starting in 2019 if funding is made available. Modernization of COID's Pilot Butte Canal system would involve a total of 174 miles of canals over the course of 11 years starting in 2019 if funding is made available.

If all proposed projects are constructed, these two districts would cumulatively convert approximately 191 miles of open canals and ditches to piped systems and conserve 172 cfs of water that would otherwise be lost to seepage and evaporation in the Deschutes Basin over the course of 11 years.

6.14.3 Cumulative Effects by Resource

Cumulative effects are considered for each resource using the intensity threshold matrix (Appendix E) in combination with past, present, and reasonably foreseeable future actions.

6.14.3.1 Cultural Resources

Cultural resources in the project area have likely been affected due to past, present, and ongoing development activities such as agriculture, land development, forestry, and any other ground disturbing projects. Like the proposed action, other reasonably foreseeable future actions in the vicinity of the project area have the potential to disturb previously undiscovered cultural resources. The proposed action would likely have moderate cumulative effects on historic properties because any potential effects on historic canal structures would be completed in compliance with the NHPA, and any previously undiscovered archaeological resources would be managed as directed by SHPO. Mitigation measures for reasonably foreseeable future projects would likely be similar to those identified for the proposed action that would minimize effects on cultural resources. Cumulative effects on cultural resources from the proposed action in combination with other past, present, and reasonably foreseeable projects are therefore considered moderate.

6.14.3.2 Fish and Aquatic Species

Past actions including road construction, road maintenance, and urban and suburban development projects would have minor effects on fish in combination with the proposed action. The potential effects from these past projects in TID and the Deschutes Basin, such as sediment entering waterbodies or aquatic habitat disturbance, would be temporary and likely complete before construction of the proposed action.

Because TID's irrigation diversions are screened and the conveyance systems do not provide fish habitat, they do not have a direct effect on fish and aquatic species in the irrigation infrastructure itself. Irrigation diversions and reservoir operations are responsible for most of the past and ongoing direct and indirect effects related to water availability and seasonality on fish communities and associated riverine habitat in the area of potential effect.

Ongoing land use activities in the project area are not expected to change from current conditions. Future land developments and irrigation district modernization projects may cause indirect effects on fish, such as sediment inputs or aquatic habitat disturbance, and could potentially affect waters within the same watershed as the proposed action. However, reasonably foreseeable future actions are all proposed for improving aquatic habitat conditions. These actions include the HCP and installation of other irrigation modernization programs in the Deschutes Basin.

The cumulative effects of the HCP implementation and the proposed action would be negligible in Crescent Creek, as current flows in Crescent Creek are consistent with those anticipated from the proposed action and the HCP. No saved water from COID and SID projects would be returned instream to Crescent Creek. Because Tumalo Creek is not included in the HCP and TID is the only irrigation district to divert water from this waterbody, there would be no cumulative effects due to future foreseeable projects in this reach. Increased streamflow in Tumalo Creek as a result of TID's project implementation would affect streamflow in the middle Deschutes River downstream of Tumalo Creek. Other foreseeable projects may also increase streamflow in the middle Deschutes, and therefore, would result in cumulative increases in streamflow in the middle Deschutes River downstream of the confluence with Tumalo Creek during the irrigation season.

Implementation of the proposed action, when combined with other future actions, is anticipated to have a minor cumulative effect on aquatic species. Implementation of other irrigation modernization programs could have an additive effect on the amount of water conserved, and therefore would provide additional flexibility in managing water rights in the Deschutes Basin.

6.14.3.3 Geology and Soils

Past, ongoing, and future actions in the surrounding area that effect the geology and soils include agricultural uses, land development, and water management activities, as discussed above. The amount of soil affected by the proposed action is small compared to the area affected by other past, present, and reasonably foreseeable future actions in the area; the proposed action would have minor, cumulative effects on geology and soils.

6.14.3.4 Land Use

The project area has been substantially altered over the past century by a variety of human activities, including agricultural development, livestock grazing, urban and suburban development, and road construction. Implementation of the proposed action would support existing land uses, as would implementation of future actions, including the HCP and additional irrigation district modernization. Since these actions would collectively support existing land uses, implementation of the proposed action would have negligible cumulative effects on land use.

6.14.3.5 Public Safety

Past and ongoing operation of agricultural equipment and vehicle traffic in the project area would continue to create risks to public safety, but these risks are not expected to change from current conditions. Implementation of additional irrigation modernization would improve public safety by eliminating the risk of drowning in open canals. In combination with past, present, and reasonably

foreseeable future actions, the proposed action is anticipated to have minor cumulative effects on public safety.

6.14.3.6 Recreation

In general, canals in the proposed action do not support any recreational pursuits; however, increased streamflows resulting from implementation of the proposed action would have a negligible indirect effect on recreation in areas away from these canals. A potential future project to include an informal trail on BLM land would run along the Tumalo Reservoir Feed lateral and include a new trailhead in the near future.

Past, ongoing, and future land uses and developments in the project area would be expected to support recreation in the same way that it is currently supported. Effects on recreation from the proposed action would be negligible, and since other actions are anticipated to be negligible, the cumulative effects on recreational resources are expected to be negligible.

6.14.3.7 Socioeconomic Resources

Past actions, including agricultural development, other land development, and recently completed projects, have had minor effects on socioeconomics. There are no other known future projects that would affect socioeconomic resources in the area of potential effect. Since the effects on socioeconomics from the proposed action are considered minor, the cumulative effects on socioeconomics from the proposed action in combination with other past, present, and reasonably foreseeable projects are also considered minor.

6.14.3.8 Vegetation

Agricultural activities, livestock grazing, vegetation control along roads, and urban and suburban development are responsible for most of the past and ongoing effects on vegetation in the project area and in the region. Livestock grazing can introduce and spread weed species, degrade native vegetation communities, and trample riparian and wetland areas. In addition, vegetation control activities generally include herbicide applications to control vegetation and noxious weeds, and mechanically cutting vegetation. The amount of vegetation that would be affected by the proposed action is small compared to the area affected by past and ongoing agricultural activities, livestock grazing, vegetation control along roads, and other utility corridors in the area. In addition, these past actions are not expected to change measurably from current conditions, resulting in minor additional cumulative effects.

6.14.3.9 Visual Resources

Past land use actions have changed the visual character of the project area. Agricultural and urbanization associated activities have altered the visual resources in the region by removing native vegetation, adding new infrastructure, and creating increased human activity within the landscape. Agricultural and urban land uses are anticipated to continue and become more prominent as the region is one of the fastest growing in the state and nation. There would be minor effects on the rural agricultural visual character of the landscape in the project area, resulting in minor cumulative effects when combined with other past, present, and reasonably foreseeable future actions.

6.14.3.10 Water Resources

Past actions over the last 120 years that have affected water resources include urban and agricultural development, road construction, road maintenance, and other irrigation projects. Since the early 1990s, there has been increasing interest in conserving water in the Deschutes River. The District and other Deschutes area irrigation districts have implemented various water conservation projects. These efforts have included piping existing irrigation canals, on-farm conservation, water management changes, and changes to crop production.

After over 20 years of conservation efforts, the District has completed several water conservation and pressurized pipe projects. These include the installation of HDPE pipe in approximately 5 miles of the BFC, an additional 4.2 miles of the TFC, and in several laterals stemming from the TFC and the Columbia Southern Canal. Projects completed by TID and other districts in the region have greatly benefitted stakeholders throughout the basin.

Ongoing and reasonably foreseeable future actions that could affect water resources include the implementation of the HCP and irrigation modernization in other irrigation districts that divert water from the Deschutes River.

Cumulative effects to surface water resources from the proposed project and other past, present, and reasonably foreseeable future actions are expected to be negligible in Crescent Creek and the Little Deschutes River. Current stream flows in Crescent Creek and the Little Deschutes River are consistent with those anticipated from the proposed project and the HCP, and irrigation modernization in other irrigation districts will not affect Crescent Creek and the Little Deschutes River.

Cumulative effects to surface water resources from the proposed project and other past, present, and reasonably foreseeable future actions are expected to be minor (seasonal increase) in the Deschutes River downstream from the confluence with the Little Deschutes River. The HCP and irrigation modernization in other irrigation districts may seasonally increase stream flows outside of the irrigation season (mid-October to March) to benefit aquatic species. This seasonal increase will be attenuated by tributary and groundwater inputs downstream.

The proposed project would increase surface flows in Tumalo Creek; however, the HCP and future projects with SID and COID would not, and therefore TID's project would not have a cumulative effect on water resources in that reach. Flows added to Tumalo Creek as a result of project implementation would have a minor cumulative effect (seasonal increase) on streamflow in the Deschutes River downstream from its confluence with Tumalo Creek. This cumulative effect would only occur during the irrigation season (April to mid-October) with restored flows from implementation of TID and other irrigation districts' projects.

Seepage from TID's canals most likely percolates to shallow aquifers, where it is extracted for groundwater consumption or ultimately discharges into the Deschutes River (Gannett et al. 2017). The piping of canals and laterals associated with reasonably foreseeable future actions in other irrigation districts would occur on the eastern side of the Deschutes River, and TID's canals are on the western side of the river. These reasonably foreseeable future actions are not expected to affect

groundwater in TID's project area. However, cumulative effects on groundwater may occur at the wider basin scale. With the potential implementation of SID and COID irrigation modernization projects, groundwater levels are expected to decline 0.6 feet and 5 feet, respectively, over the course of 50 years. In total, these cumulative effects, with TID, could affect groundwater levels in parts of the greater Deschutes Basin by up to 7.6 feet in 50 years.

Groundwater levels in the Deschutes Basin are influenced by a combination of factors, including but not limited to climate, canal and lateral leakage, and pumping (Gannett and Lite 2013, Gannett et al. 2017). Removing leakage from canal and laterals in the Deschutes Basin through piping or lining project is estimated to have contributed to up to 10 percent of the observed decline in groundwater levels in some parts of the basin (Gannett and Lite 2013, Gannett et al. 2017). Although this number varies spatially, climate generally has the largest impact on groundwater recharge (Gannett et al. 2017). The implementation of the proposed action and other past, present, and reasonably foreseeable future actions is anticipated to have a minor cumulative effect on water resources, as implementation of other irrigation modernization programs could reduce groundwater infiltration via leaky canals and increase the amount of water that is conserved in the Deschutes Basin.

Water quality could be affected by nonpoint source pollution such as erosion and runoff associated with ongoing and reasonably foreseeable construction and land development activities. The proposed action would be constructed at a time when there was no water in the canal system or immediately adjacent to the system if there is water in the canals. The proposed action and reasonably foreseeable future actions are anticipated to increase stream flow in waterbodies in the area of potential effect, helping to meet local partners' objectives for water quality enhancement and having a minor cumulative effect on water resources.

6.14.3.11 Wetlands and Riparian Areas

Past actions that have affected wetlands, riparian areas, and floodplains consist of the construction of irrigation infrastructure, including existing canals, piping, and associated infrastructure, and operational and maintenance activities. Leakage from the canal and laterals has contributed to localized artificial wetlands adjacent to the project area as described in Section 4.11. Potential project area wetland cumulative effects could result if other projects and actions were to affect wetland functions (i.e., water quality, hydrology, and wildlife habitat). The reasonably foreseeable future actions in the project area that could have wetland effects include agricultural activities, vegetation control along roads and utility corridors, and urban and suburban development. These activities are also responsible for past and ongoing project area wetland effects. Because wetland impacts from implementation of the proposed action would be minimal and localized, and because the project would protect streamflow in Crescent Creek and add additional streamflow in Tumalo Creek, which would benefit downstream riparian wetlands, the cumulative effect of the proposed action and other past, present, and reasonably foreseeable future projects on wetlands would be minor.

Current maintenance and use of agricultural infrastructure, livestock grazing, and development are expected to continue in the project area. Changes to wetland and riparian area vegetation caused by the proposed action would be relatively minor compared to other activities in the area; cumulative effects on vegetation from the proposed action in combination with other past, present, and reasonably foreseeable projects are considered minor.

6.14.3.12 Wildlife

Agriculture, urban, and suburban development have affected wildlife and wildlife habitat in the project area since the late 1800s. Agricultural activities have substantially altered the habitat in the region by removing native vegetation communities in some areas and diverting streamflow. Livestock grazing occurs in much of the region around the area of potential effect and can result in the introduction and spread of weed species, the degradation of native habitat, and trampling of riparian and wetland areas. Some native habitats have been replaced with disturbance-tolerant or introduced species assemblages that may support different wildlife than previously existed. These ongoing activities would continue to affect wildlife and wildlife habitat in the project area.

Some wildlife currently use open canals and laterals as a water source. Implementation of the proposed action would cause wildlife to find other water sources, as they did prior to installation of the canals. Since other past, present, and reasonably foreseeable future actions would have different effects on wildlife, and effects of the proposed action on wildlife would happen over a period of time in which animals would be able to adapt, the cumulative effect on wildlife from implementation of the proposed action would be minor.

In addition, vegetation control activities, including herbicide applications to control noxious weeds and mechanical cutting of vegetation, are ongoing actions that contribute to wildlife habitat changes. The amount of wildlife habitat that would be affected by the proposed action is small compared to the area affected by past and ongoing agricultural activities, livestock grazing, vegetation control, and urban and suburban development in the area. In addition, the intensity of these ongoing actions is not expected to change measurably in the future, resulting in minor additional cumulative effects.

6.14.3.13 Wild and Scenic Rivers

Sections of Crescent Creek and the Deschutes River have been designated under the National Wild and Scenic River Act, and a section of the Deschutes River is designated as an Oregon State Scenic Waterway. These past actions aimed to protect these designated sections from changes that generally alter their scenic, recreational, and ecological qualities. Changes to the current and future management of these sections, which are located within the area of potential effects of the proposed action, are expected to be negligible. These wild and scenic sections will continue to be managed by federal and state agencies consistent with their designations.

7 Consultation, Coordination, and Public Participation

The District and its partners planned and conducted numerous agency coordination and public involvement activities throughout the development of the Plan-EA. These activities included public meetings, informational sessions, presentations, press announcements, and frequent correspondence with federal, state, and local resource agencies; agriculture interests; and other interest groups and individuals. The project development process was designed to work collaboratively with partners, agencies, tribes, and stakeholders to ensure transparency and cooperation towards a solution that fits within the framework of the purpose and need for action.

7.1 Preliminary Investigative Report and Public Scoping

A Preliminary Investigative Report (PIR) (FCA 2017) was prepared to provide sponsors, local partners, agencies, and the public with information to evaluate the goals and objectives of the project. During the development of the PIR, project sponsors conducted initial consultation with natural resource agencies and stakeholders in the Deschutes Basin.

Announcements for the Public Scoping Meeting and Scoping Comment Period

- NRCS public notice (June 16, 2017): https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/newsroom/pnotice/?cid=nrcseprd1333640
- These public notices were also published in the Capital Press Ag Weekly Newspaper and the Bend Bulletin. Ads were published in the Capital Press once a week for 3 weeks; ads were published in the Bend Bulletin twice a week for 3 weeks.
- NRCS press release (June 19, 2017): https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/newsroom/releases/?cid=NRCSEPRD1334010
- KTVZ Channel 21 news story (June 19, 2017): http://www.ktvz.com/news/irrigation-district-canal-piping-plans-up-for-public-input/551703403
- TID website announcement (June 20, 2017): http://tumalo.org/tumalo-irrigation-district-irrigation-modernization-project/
- TID letter mailed to all patrons (June 21, 2017)
- DBBC Facebook post (June 21, 2017)
- Bend Bulletin article (June 26, 2017): http://www.bendbulletin.com/localstate/5400420-151/change-coming-to-central-oregon-irrigation-districts
- NRCS letter to Confederated Tribes of Warm Springs for invitation to public scoping meetings and offer to set up consultation with the Tribes, signed by NRCS State Conservationist (June 30, 2017)
- Bend Bulletin guest column (July 6, 2017) by Craig Horrell, Central Oregon Irrigation District Manager: http://www.bendbulletin.com/opinion/5427265-151/guest-column-watershed-plan-needs-public-involvement?referrer=section
- KBND News article (July 6, 2017): http://kbnd.com/kbnd-news/local-news-feed/312557
- FCA Facebook post (July 6, 2017)
- TID website request for comments (July 7, 2017): http://tumalo.org/get-involved/
- NRCS Oregon Twitter post (July 10, 2017)
- DBBC Facebook post (July 20, 2017)

A website was launched on June 16, 2017 to inform the public and share project information. Oregonwatershedplans.org includes the following information:

- Overview of NRCS PL 83-566 funding program
- Overview of NEPA and Watershed Plan-EA public participation process
- Frequently Asked Questions about the Watershed Plan-EA process
- Background on the District, the Draft Plan-EA and appendices, the PIR and appendices, and presentations and handouts from public meetings
- Contact information and how to submit public comments
- Email signup option for more information; subscribers receive updates over the course of the project development

Public Information Session/Environmental Stakeholder Meeting

- June 22, 2017 at 6:00 p.m. at Trinity Episcopal Church, 469 NW Wall Street, Bend, OR 97701
- Members of the public were invited to hear an overview of NRCS PL 83-566 funding program, NEPA and the Watershed Plan-EA process, and an overview of the proposed project scope and water conservation need. Attendees were given an opportunity to ask questions and were given the oregonwatershedplans.org website for more information about how they could participate in the Watershed Plan-EA process.
- Presenters: Margi Hoffmann, Farmers Conservation Alliance

TID Public Scoping Meeting

- July 6, 2017 from 5:30 p.m. to 6:30 p.m. at Tumalo Community Church Meeting Room, 64671 Bruce Avenue, Bend, OR 97703
- Participants had an opportunity to learn more about the proposed irrigation improvements and discuss their comments, ideas, and concerns.
- Presenters:
  - Tom Makowski, Natural Resources Conservation Service
  - Kenneth B. Rieck, Manager, Tumalo Irrigation District
  - Margi Hoffmann, Farmers Conservation Alliance
  - Bridget Moran, United States Fish and Wildlife Service

Basin Study Work Group Steering Committee Meeting (Open to the Public)

- July 13, 2017 at Deschutes Services Building, 1300 NW Wall Street, Bend, OR 97701

- Participants were informed about the PL 83-566 funding opportunity and the proposed irrigation improvements, and were given information on how to submit comments for the public record.
- Presenter: Brett Golden, Farmers Conservation Alliance

Tumalo Irrigation District Board Meetings (Open to the Public)

Board meeting minutes that relate to PL 83-566 funding, watershed plan, and public participation:

- May 9, 2017
  - Congressional approval of Federal PL 83-566 funding was discussed in addition to the District's need for a Watershed Plan-EA to access funding.
  - A resolution was discussed that stated the Board was committed to developing State and private funding to match Federal PL 83-566 funds for Fiscal Year 2017-2018 for up to $5 million. All board members signed the resolution and it was approved unanimously. See Appendix E for a copy of the resolution.
- June 13, 2017
  - The Board heard an update on PL 83-566 funds and potential sources of matching funds.
  - The upcoming public meeting on July 6, 2017 was discussed; invitations to attend the meeting would be mailed to every water patron in the District.
  - The District is in the process of applying for groundwater mitigation credits from the State for the water that is being released from Crescent Lake for the Oregon spotted frog during the winter months. If the application is approved, the income could be used as a source of funds for matching the PL 83-566 grant.[12]
  - District Manager Rieck directed design to begin for Project Group 1 (or referred to by the District and original SIP as Phase IV B and V) of canal piping in order to be prepared when PL 83-566 funds become available, at which time the District would pipe the canal as far as funds allow.
- July 11, 2017
  - The Board was briefed on the results of the public scoping meeting that was held on July 6, 2017. District Manager Rieck stated that comments could be submitted during the public scoping period and that more information could be found at oregonwatershedplans.org.
  - District Manager Rieck stated that a second meeting would be held in order to receive comments that would be incorporated into the Watershed Plan. The District has a goal of completing the Watershed Plan by the end of September 2017.
- May 8, 2018

[12] Water for groundwater mitigation credits would only come from water associated with projects not funded by PL 83-566.

- The Board was briefed on the progress of the Watershed Plan-EA and signed a resolution that concomitant to 100 percent public funding, TID would legally protect 100 percent of conserved water from the project through Oregon's Allocation of Conserved Water Program. See Appendix E for a copy of the resolution.

Informational Materials Available to the Public

- PIR and Appendices, made available prior to public scoping meetings.
- Four-page public handouts, made available prior to public scoping meetings.
- Meeting presentation slides, made available after public scoping meetings.

7.2 List of Persons and Agencies Consulted

The following lists include persons and agencies with a vested interest in the Plan-EA or those consulted during the planning process. This includes agencies that provided formal or required consultation or individuals who were conferred with and who provided substantial input. Coordination with state and local agencies has been ongoing since project inception.

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

- Bend Parks and Recreation District
- City of Bend
- Deschutes County

Agencies that have been involved with the project include the following state and federal resource agencies:

- Business Oregon
- Oregon Department of Energy (ODOE)
- Oregon Department of Environmental Quality (ODEQ)
- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Department of State Lands (ODSL)
- Oregon Governor's Office
- Oregon Water Resources Department (OWRD)
- Oregon Watershed Enhancement Board (OWEB)
- State Historic Preservation Office (SHPO)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Army Corps of Engineers (USACE)
- U.S. Bureau of Land Management (BLM)

Tribes that have been consulted regarding the TID Irrigation Modernization Project include:

- Confederated Tribes of Warm Springs (CTWS)

Other stakeholders for this project include:

- TID patrons
- Adjacent landowners
- Upper Deschutes Watershed Council (UDWC)
- Deschutes River Conservancy (DRC)
- Central Oregon Land Watch
- WaterWatch of Oregon
- Trout Unlimited
- Coalition for the Deschutes
- Interested public

Table 7-1 describes communications with agency personnel that were consulted during development of the Plan-EA.

Table 7-1. Agency Consultation and Communication Record.

Date	Contact, Agency	Communication
October 21, 2016	Bridget Moran, USFWS	• Overview of PL 83-566 Watershed Planning Program • Overview of Tumalo, Swalley, and Central Oregon Irrigation Districts proposed System Improvement Plans • Discussion of basin-wide fish and wildlife concerns/needs
November 6, 2016	Kyle Gorman, OWRD	• Overview of PL 83-566 Watershed Planning Program • Overview of Tumalo, Swalley, and Central Oregon Irrigation Districts proposed System Improvement Plans • Discussion of basin-wide fish and wildlife concerns/needs
December 2, 2016	Brett Hodgson, ODFW	• Overview of PL 83-566 Watershed Planning Program • Overview of Tumalo, Swalley, and Central Oregon Irrigation Districts proposed System Improvement Plans • Discussion of basin-wide fish and wildlife concerns/needs

Date	Contact, Agency	Communication
January 6, 2017	Greg Ciannella, OWEB	• Overview of PL 83-566 Watershed Planning Program • Overview of Tumalo, Swalley, and Central Oregon Irrigation Districts proposed System Improvement Plans • Discussion of basin-wide fish and wildlife concerns/needs
January 27, 2017	Kyle Gorman, OWRD	• Overview of PL 83-566 Watershed Planning Program • Overview of Tumalo, Swalley, and Central Oregon Irrigation Districts proposed System Improvement Plans • Discussion of basin-wide fish and wildlife concerns/needs
June 14, 2017	Bridget Moran, USFWS	• Overview of Endangered Species Act
June 23, 2017	Bridget Moran, USFWS	• Overview of Watershed Planning process for Tumalo, Swalley, and Central Oregon Irrigation Districts • Overview of Preliminary Investigative Reports • Overview of the Public Scoping meetings on July 6, 2017 (Tumalo and Swalley) and July 10, 2017 (Central Oregon)
July 6, 2017	Bridget Moran, USFWS Tom Makowski, NRCS Annette Liebe, Oregon Governor's Office Rob DelMar, ODOE Kelly Hill, ODEQ Kyle Gorman, OWRD Ian Johnson, Oregon SHPO Jessica Gabriel, Oregon SHPO Tom DiCorcia, Business Oregon Brett Hodgson, ODFW	• Overview of the Watershed Planning process for Tumalo, Swalley, and Central Oregon Irrigation Districts • Overview of Preliminary Investigative Reports • Overview of public participation website – oregonwatershedplans.org • Overview of Public Participation meetings July 6, 2017 (Tumalo & Swalley) and July 10, 2017 (Central Oregon)
July 2017	Eric Nigg, ODEQ	• Overview of the Watershed Planning process for Tumalo, Swalley, and Central Oregon Irrigation Districts • Overview of Preliminary Investigative Reports • Overview of public participation website – oregonwatershedplans.org • Overview of Public Participation meetings July 6, 2017 (Tumalo & Swalley) and July 10, 2017 (Central Oregon)
July 11, 2017	Annette Liebe, Oregon Governor's Office	• Update on Tumalo, Swalley, and Central Oregon Irrigation District Watershed Plans
July 20, 2017	Paul Henson, State Supervisor, USFWS Bridget Moran, USFWS	• Letter from NRCS to USFWS requesting PL 83-566 Section 12 consultation

Date	Contact, Agency	Communication
July 20, 2017	Bridget Moran, USFWS	• Overview of Watershed Planning process next steps for Tumalo, Swalley, and Central Oregon Irrigation Districts • Habitat Conservation Plan process and next steps
August 11, 2017	Teal Purrington, BLM Alice Beals, OPRD	• Overview of the Watershed Planning process for Tumalo, Swalley, and Central Oregon Irrigation Districts and public agency managed lands falling within the project area
August 14, 2017	Sasha Sulia, BPRD	• Overview of the Watershed Planning process for Tumalo, Swalley, and Central Oregon Irrigation Districts and public agency managed lands falling within the project area
August 17, 2017	Nancy Pustis, ODSL	• Overview of the Watershed Planning process for Tumalo, Swalley, and Central Oregon Irrigation Districts and public agency managed lands falling within the project area
August 29, 2017	Jerry Cordova, USFWS	• Discussion of eagle habitat and construction mitigation for Tumalo, Swalley, and Central Oregon Irrigation Districts
September 5, 2017	Teal Purrington, BLM Jamie Rhoades, BLM	• Discussion of ROW crossing BLM land
September 19, 2017	Anita Andazola, USACE	• Email exchange between NRCS about upcoming Plan-EA
October 5, 2017	Annette Liebe, Oregon Governor's Office Kyle Gorman, OWRD Ami Keiffer, Business Oregon Tom Rowley, Business Oregon Bridget Moran, USFWS	• Update on Habitat Conservation Plan process • Update on Basin Study Work Group process • Update on PL 83-566 Watershed Plans for Tumalo, Swalley, and Central Oregon Irrigation Districts • Update on NHPA Section 106 & ESA Section 7 compliance
March 20, 2018	Anita Andazola, USACE	• Email from NRCS about upcoming release of the Plan-EA and uploading the document to USACE site.
June 19, 2018	Bridget Moran, USFWS	• Discussion of instream flow in Crescent Creek on Oregon spotted frog • Identified need to review of the effects of instream flow in the Deschutes Basin on Oregon spotted frog and bull trout
June 26, 2018	Bridget Moran, USFWS Jennifer O'Reilly, USFWS Gary Diridoni, NRCS	• Discussion about NEPA and ESA Section 7 compliance • Discussion about initiating information consultation with USFWS through biological assessment letter

Date	Contact, Agency	Communication
July 10, 2018	Gary Diridoni, NRCS Tom Makowski, NRCS Kevin Conroy, NRCS Shawn Big Knife, NRCS Kathy Ferge, NRCS Bobby Brunoe, CTWS Brad Houslet, CTWS Bridget Moran, USFWS	• Consultation regarding TID Irrigation Modernization Project and Plan-EA
July 13, 2018	Anita Andazola, USACE	• Email from NRCS requesting any comments on the Plan-EA • USACE will determine jurisdiction and/or eligibility for exemption during project implementation

7.3 Review of the Draft Plan-EA

NRCS published the proposed Draft Plan-EA on oregonwatershedplans.org on April 16, 2018 for a 30-day comment period ending on May 22, 2018. During the comment period, NRCS hosted a public outreach meeting on May 8, 2018. Specific public outreach activities for the Draft Plan-EA included:

- NRCS Public Notice (April 16, 2018): https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/newsroom/pnotice/?cid=nrcseprd1395633
- NRCS News Release (April 16, 2018): https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/newsroom/releases/?cid=NRCSEPRD1395629
- KTVZ News story (April 16, 2018): http://www.ktvz.com/news/tumalo-irrigation-canal-piping-draft-plan-released/730396341
- FCA email to stakeholder list (April 16, 2018)
- TID website announcement (April 17, 2018): http://tumalo.org/public-meeting-scheduled-for-tumalo-watershed-plan/
- Capital Press article (April 17, 2018): http://www.capitalpress.com/Water/20180417/piping-to-save-water-in-tumalo-irrigation-district
- Bend Bulletin article (April 22, 2018): http://www.bendbulletin.com/localstate/6176950-151/piping-project-coming-to-tumalo
- TID letter to patrons and owners of adjacent properties (April 23, 2018)

- Bend Bulletin public notice (May 4, 2018)
- FCA email to stakeholder list (May 7, 2018)
- Public outreach meeting (May 8, 2018) from 6:00 – 7:30 PM at Cascades Academy 19860 Tumalo Reservoir Road, Bend, OR 97703
- FCA email to stakeholder list (May 21, 2018)

NRCS conducted government-to-government consultation with the CTWS. NRCS sent an initial letter to the CTWS Tribal Historic Preservation Officer outlining the project and initial planning. NRCS sent a consultation letter and provided the CTWS Tribal Historic Preservation Officer with a hard copy of the Draft Plan-EA. NRCS staff met with the CTWS staff on July 10, 2018.

Comments on the Draft Plan-EA were submitted in person at the public meeting, by email to wsp@tumalo.org, online at oregonwatershedplans.org, and by mail to Farmers Conservation Alliance, Tumalo Watershed Plan, 11 3rd St, Suite 101, Hood River, OR 97031.

NRCS received 57 comments on the proposed Draft Plan-EA. Comments were received from the following agencies and public entities: City of Bend; Oregon Department of Transportation, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, Oregon Water Resources Department through the Regional Solutions Program on behalf of the Governor's Office; and USFWS. Comments were also received from Central Oregon Land Watch, Coalition for the Deschutes, Deschutes Redbands Trout Unlimited Chapter, League of Women Voters of Deschutes County, Trout Unlimited, Water Watch of Oregon, and the general public.

NRCS has reviewed all public comments and has made changes, as appropriate, to the final Plan-EA based on those comments and internal review. Each comment received consideration in the development of the final rule. According to the NEPA Handbook 6.9.2.1, substantive comments do one or more of the following:

- Question, with reasonable basis, the accuracy of information in the EIS or EA.
- Question, with reasonable basis, the adequacy of, methodology for, or assumptions used for the environmental analysis.
- Present new information relevant to the analysis.
- Present reasonable alternatives other than those analyzed in the EIS or EA.
- Cause changes or revisions in one or more of the alternatives.

A summary of substantive and/or recurring comments received on the Draft Plan-EA are listed below. For a full list of comments and responses, see Appendix A.

- Effect on local groundwater levels and private wells from reduced groundwater recharge

- Effect on cold springs along the middle Deschutes River from reduced groundwater recharge
- Concern over methodology for allocation of conserved water between Tumalo Creek and Crescent Creek
- Request to further consider other alternatives such as on-farm efficiency upgrades, private lateral piping, voluntary duty reduction, leasing, and transfers
- Request that water conserved from the project be in addition to existing water placed instream by the District
- Request that duty rates do not increase above current average (3.5 acre-feet/acre per year)
- Request that all water saved by the proposed project be protected instream and verified by a third party
- Effect on wildlife along the canal and laterals from piping
- Effect on trees and vegetation along the canal and laterals from piping, especially mature ponderosa pines
- Effect on property values from piping the canal and laterals

8 Preferred Alternative

8.1 Selection of the Preferred Alternative

The project sponsors selected the HDPE Piping Alternative as the Preferred Alternative based on its ability to meet the purpose and needs for the project and provide the most environmental and social benefits. The Preferred Alternative is the only alternative that meets the SLOs' purpose and needs and meets the NED benefit cost ratio.

8.2 Rationale for the Preferred Alternative

The TID Irrigation Modernization Project is a large agricultural water efficiency project focused on Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River. The project would address natural resource concerns by improving water conservation, improving water delivery reliability to farms, reducing O&M costs, enhancing streamflow and habitat conditions for fish and aquatic species in the Deschutes Basin, and improving public safety. Implementation of the Preferred Alternative would accomplish these purposes through piping and pressurizing 68.8 miles of TID's canal and lateral system.

NRCS PL 83-566 funds can be applied to projects that meet any of the eight authorized project purposes outlined in Sections 3 and 4 of that law. The Preferred Alternative meets one of these eight purposes: Agricultural Water Management (Purpose 5) through irrigation water conservation, water

quality improvement, and agricultural water supply; fish and wildlife habitats would be conserved and improved through associated increases in streamflow.

8.3 Measures to be Installed

TID would replace 1.9 miles of the TFC and 66.9 miles of laterals in its system with gravity-pressurized buried pipe. The un-piped portion of the TFC would be piped with 84-inch HDPE. The remaining open portions of the delivery system would be pressurized with HDPE single-walled pipe. Pipe size, determined through hydraulic modeling, would range in diameter from 6 to 84 inches (TID 2017).

Under this alternative, 543 existing turnouts would be upgraded to pressurized delivery systems. Currently numerous TID existing turnouts are shared by patrons. In order to provide pressurization benefits and better water management, the majority of these shared turnouts would be converted to individual turnouts by the addition of approximately 119 new turnouts. The pressure of water deliveries can vary depending on the demands of other patrons and overall diversion flow into the system. On-farm piping, fittings, and other appurtenances for each patron may not be rated to accommodate these pressure fluctuations; therefore, a pressure relief valve was included for each upgrade and new turnout. Each turnout would also include an appropriately sized tee from the mainline or lateral, a gear-actuated plug valve, a magnetic meter, a combination air and vacuum relief valve, and associated hardware and spool pipe segments (TID 2017). Three pressure-reducing valves would also be installed as part of the Preferred Alternative to alleviate high pressures across the system. The improvements described above would be broken into seven project groups as summarized in Table 8-1. At the time the SIP was finalized, the number assigned to each group reflected the sequential order that each project group would be completed. Since the completion of the SIP, TID has decided to combine project groups; the naming of project groups in the Plan-EA reflect those combinations and are therefore different than those in the SIP.

Table 8-1. Summary of the Tumalo Irrigation District Canals and Laterals that would be Piped under the Preferred Alternative for the Tumalo Irrigation District—Irrigation Modernization Project.

Project Group	Canal(s) and/or Lateral(s) in Project Group	Project Components					
		Flow (gpm)	Diameter (in)	Pressure Rating Index	Length of Piping (feet)	Upgraded Turnouts	Pressure Reducing Valves
1	Tumalo Feed Canal	47,106-50,545	84	N/A	12,716	10	N/A
	Kerns	224	6	32.5			
2	Tumalo Res. Feed	299-11,473	6	32.5	81,596	127	N/A
	Steele	301-774	6-10	32.5			
	Rock Springs	288-333	6	32.5			
	Highline	800-3,756	6-24	17-32.5			
	2 Rivers	-	6-12	32.5			
	Parkhurst	672-2,761	6-18	21-32.5			
	Gill	0	6	32.5			
	Lacy	52-1,734	6-12	26-32.5			
3	Allen	7,698-11,492	28-34	26-32.5	25,519	46	N/A
	Allen Sublateral West	290-316	6	32.5			
	Allen Sublateral South	183-247	6	32.5			
	McGinnis Ditch	147-312	6	32.5			
4	West Branch Columbia So. West	4,771-7,535	6-28	26-32.5	61,551	91	1
	Beasley	153-687	6-8	26-32.5			
	Spaulding	1,671-3,226	6-20	19-26			
	N. Spaulding	142	6	19-32.5			
5	Couch	103-5,976	6-26	32.5	55,950	89	N/A
	West Couch	696-3,416	6-20	15.5-32.5			
	West Couch Sublateral East	384-1,166	6-10	26-32.5			
	Chambers (Lafores) Ditch	52-322	6	32.5			

Project Group	Canal(s) and/or Lateral(s) in Project Group	Project Components					
		Flow (gpm)	Diameter (in)	Pressure Rating Index	Length of Piping (feet)	Upgraded Turnouts	Pressure Reducing Valves
	East Couch	202-672	6-16	32.5			
	Gainsforth	161-282	6	32.5			
6	North Columbia So. West	334-2,615	6-16	32.5	90,163	221	2
	Jewett	880-2,256	10-16	26-32.5			
	Conarn East	75	6	26			
	Putnam	1,297-1,757	6-14	21-32.5			
	West Branch Columbia So. East	37-1,193	6-12	26			
	Conarn	85-355	6	26			
	Phiffer	302-1,679	6-12	32.5			
	Hooker Creek	888-1,260	10-12	32.5			
	Hammond	368-1,808	6-14	26-32.5			
	North Hammond	300-710	6-8	32.5			
	Columbia Southern TFC to PRV	18,555-33,899	48-63	21-32.5			
	Columbia Southern PRV to Tail	10,280-17,760	6-42	26-32.5			
	North Columbia So. East	37-1,794	6-24	32.5			
7	Hillburner	338-676	6-24	32.5	35,650	79	N/A
	Gerking	75-494	6-8	19-21			
	Kickbush	461-574	6-8	21			
	West Branch Columbia So. South	561-1,215	6-8	26			
	Flannery Ditch	162-452	6-12	26			
	Tellin Ditch	202-589	6	32.5			
				Total Quantity	**363,145**	**663**	**3**

Construction of the HDPE Piping Alternative would include mobilization and staging of construction equipment, delivery of pipe to construction areas, excavation of trenches, fusing of pipelines, placement of pipe, compaction of backfill, and restoration and reseeding of the disturbed areas. In some locations, construction access would need to be created prior to bringing pipes or equipment into construction areas. This could include removal of vegetation within the construction area. Appropriately sized construction equipment would be used to minimize disturbance in the construction area. Borrow material would most likely be needed to backfill the canal surrounding the pipeline, assuming little to no material is available from prior canal dredging activities.

Construction would generally occur during the off-irrigation season (mid-October to March) with the majority of construction taking place during the first quarter of each calendar year. Project Group 1 construction could begin as early as the last few months of 2018.

Implementation of this project would be one component of a broader natural resource management effort by TID and other organizations in the area. In 2016, the State of Oregon approved TID's Water Management and Conservation Plan (Tumalo Irrigation District and Black Rock Consulting 2016). TID identified piping irrigation canals and providing pressurized water as integral parts of reaching the Deschutes River Conservancy's goal of 250 cfs for the Deschutes River. The Deschutes River Conservancy's goal is based on the ODFW pending instream water right for 250 cfs in the Middle Deschutes reach, where flows are rarely met during the irrigation season. Therefore, this additional flow from the Preferred Alternative would assist in meeting these junior water rights. Additionally, through its membership with seven other irrigation districts in the DBBC, TID is working to coordinate assets and resources to improve patron services, conserve water, and enhance river conditions for wildlife and recreation throughout the Deschutes Basin. Other DBBC districts are concurrently pursuing system modernization through piping and pressurization and are collaborating with state and federal agencies, local municipalities, and environmental groups to develop a multispecies HCP. The HCP is planned for completion in 2019.

8.4 Minimization, Avoidance, and Compensatory Mitigation Measures

Project design features and BMPs that would be applied during construction to avoid and minimize effects on environmental and social resources are described below.

8.4.1 Pre-Construction

- Adjacent landowners would be provided a construction schedule prior to beginning construction.
- Ground disturbances would be limited to only those areas necessary to safely implement the Preferred Alternative.
- Work would be confined within the existing ROW whenever possible to preserve existing vegetation and private property. The ROW would be clearly marked in the field prior to construction.

- Within the ROW that crosses the Peck's milkvetch ACEC, a survey would be completed for Peck's milkvetch. If plants were detected, ndividual plants affected by construction would be excavated, potted, cared for, and replanted during the appropriate planting window. Surveys and mitigation would be done in consultation with BLM.
- Construction limits would be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.
- Disturbance of jurisdictional wetlands would be avoided during construction.
- Appropriate erosion control measures would be utilized.
- The condition of roadways and work zones would be communicated to travelers via the District's website or other communication channels.
- Site-specific archaeological and historical resource surveys would be completed prior to construction.

8.4.2 Construction

- Stormwater and erosion BMPs would be implemented as appropriate.
- Construction would generally occur during the daytime and in the winter months to minimize disturbance to recreationists, landowners, or other individuals in the vicinity of the project area.
- Construction would occur primarily outside the USFWS-approved buffer distances for any known bald and golden eagle nests. If operating within the recommended buffer distance, the District would operate outside of the nesting season.
- Should an active bald or golden eagle nest be found during construction, construction would be paused and a consultation with a local USFWS biologist would occur to determine the following steps.
- Construction would occur primarily outside the primary nesting period for migratory birds of concern (April 15 through July 15) and raptors (April through July). For rare occasions where construction would occur during the primary nesting period, construction work would operate outside of the recommended buffer distance of any known nests. Should an active nest be found, construction would be paused and consultation with a local USFWS biologist would occur to determine the following steps.
- In appropriate cases and under consultation with ODFW, ramps would be placed in pipeline trenches to avoid the potential of wildlife becoming trapped overnight.
- Appropriate emission control devices would be required for all construction equipment.
- Work crews would carry spill cleanup kits, and in times of burn bans or wildfire concerns, each crew would have a fire suppression kit.

- Project construction activities would be conducted in accordance with the project's spill prevention and cleanup plan.
- Temporary travel routes would be selected and utilized to minimize effects on vegetation and avoid the removal of trees.
- Selection of construction areas adjacent to canals and travel routes would consider existing vegetation and avoid mature trees to the extent practicable.
- Pruning would be entirely within TID's ROW and would not exceed what is required for equipment clearance.
- During construction, the contractor would use erosion control measures that are free of weeds and weed seeds.
- When needed, water or other dust suppressants would be used on unpaved roads and areas of ground disturbance to minimize dust and any effects on air quality.
- Standard construction safety procedures and traffic control measures would be employed to reduce the risk of collisions between construction vehicles and other vehicles, pedestrians, or bicyclists while construction is ongoing.
- Traffic control measures would be coordinated by the construction contractor with the Oregon Department of Transportation, the Deschutes County Sheriff, and local emergency services prior to working in the U.S. Highway 20 ROW.
- Lane closures on roadways would be avoided during peak travel periods where possible to reduce potential traffic delays from construction vehicles.
- The condition of roadways and work zones would be communicated to travelers via the District's website, or other communication channels.
- Immediately after construction, areas with disturbed soils and newly covered pipes would be planted with a seed mix of native grasses and forbs. Vegetation within the ROW would be maintained according to TID's vegetation management program and NRCS Oregon and Washington's Guide for Conservation Seedings and Plantings (NRCS 2000).
- After construction, areas adjacent to the canal would be restored to near prior contours in order to blend with the surrounding landscape.
- Following completion of individual project groups, conserved water would be allocated to permanent instream water rights in Tumalo Creek, Crescent Creek, the Little Deschutes River, and the Deschutes River through Oregon's Allocation of Conserved Water Program (ORS 537.470).
- Further consultation resulting in a Memorandum of Agreement would be completed between SHPO, NRCS, and the District, addressing cultural resource concerns and agreed upon mitigation measures for all features found to be eligible for inclusion on the National

Register of Historic Places. Mitigation measures would be completed concurrently with or after construction.

- Mitigation measures under consideration for effects on cultural resources include informational signing at trailheads or publicly significant locations, development of an informational brochure for interpretative use, and historical information for the District's website.

- An Inadvertent Discovery Plan would be followed if archaeological or historical materials, including human remains, are encountered during construction. The plan would require construction to stop accordingly, consultation with SHPO and NRCS cultural resources staff, and notification to appropriate Tribes. Continuation of construction would occur in accordance with applicable guidance and law.

8.4.3 Operations and Maintenance

- Vegetation within the ROW would be maintained according to TID's vegetation management program and NRCS Oregon and Washington's Guide for Conservation Seedings and Plantings (NRCS 2000).

- Weeds would be controlled within the ROW using hand pulling during the first year after reseeding, and a combination of hand pulling and spot spraying in the second year if weeds become problematic. Thereafter, weeds would be managed per county standards.

- At adjacent landowner's requests and during maintenance season, the District would remove trees in the ROW that do not survive piping for two years following construction.

8.5 Land Rights and Easements

The Preferred Alternative and construction activities would be located entirely within the District's ROW, which were granted under the Carey Act. The District's ROW under the Carey Act extends 50 feet on each side of the canal from the toe of the bank for a total easement width of 100 feet plus the width of the canal.

8.6 Permits and Compliance

As discussed in Section 8.3, the Preferred Alternative would be implemented in project groups. Permitting specific to each project group would be conducted at the time that funding is available for implementation. Prior to implementing each project group, NRCS would complete an onsite EE utilizing NRCS-CPA-52 form. This process would determine if that project group meets the applicable project specifications and other conditions as developed in this EA and assess the environmental effects of any alternatives to the project group. If it is determined that there are significant issues or concerns, or if resource concerns have not been adequately evaluated through the programmatic approach in this EA, a separate analysis and appropriate agency consultation would be prepared as necessary.

Further, TID would acquire all necessary permits prior to construction. These may include the following:

8.6.1 Local and County

- **Deschutes County Planning**: Under OAR Chapter 340, Division 18, a Land Use Compatibility Statement would be submitted for county approval prior to construction.
- **Deschutes County Floodplain Administrator**: All work would be outside of the 100-year floodplain; no permitting requirement has been identified.

8.6.2 State

- **Department of Environmental Quality**: The National Pollutant Discharge Elimination System program, implemented by ODEQ, would require a permit for construction activities including clearing, grading, excavation, and materials and equipment staging and stockpiling that would disturb one or more acres of land and have the potential to discharge into a public waterbody. The seven project groups under the Preferred Alternative would each disturb more than 5 acres but none of them discharges into a public waterbody.
- **Oregon Water Resources Department**: To change the place of use, character of use, and/or point of diversion/appropriation of a water right, a water right transfer application must be approved by OWRD. The District would apply for an Allocation of Conserved Water associated with the Preferred Alternative under ORS 537.
- **Department of State Lands**: A wetland fill permit from ODSL would not be required for work in existing canals and laterals. Prior to initiation of construction of each project group, a wetland determination and/or delineation would be conducted, and wetlands would be avoided to the extent practicable. If jurisdictional wetlands occur in areas outside of canals where work will be done, a wetland fill permit from ODSL would be obtained.
- **Oregon Fish Passage Law:** Since August 2001, the owner or operator of an artificial obstruction located in waters in which native migratory fish are currently or were historically present must address fish passage requirements prior to certain trigger events, such as the construction, installation, replacement, extension, or repair of culverts, roads, or any other hydraulic facilities. Laws regarding fish passage are found in ORS 509.580 through ORS 509.910 and in OAR 635, Division 412. TID's irrigation diversions have functioning fish screens and provide both upstream and downstream fish passage; no fish are present within existing canals and laterals, therefore no additional consultation, or permitting is required.
- **Oregon Department of Transportation:** The District would apply for all pertinent construction permits as required by ODOT prior to beginning construction.

8.6.3 Federal

- **Bureau of Land Management:** No permitting is necessary due to the ownership seniority of TID's Carey Act ROW over BLM. Consultation will occur as it relates to Peck's milkvetch conservation prior to construction.
- **National Historic Preservation Act Section 106**: Pursuant to 36 CFR Part 800 of the NHPA (1966, as amended in 2000), and the regulations of the Advisory Council on Historic

Preservation implementing Section 106 of the NHPA (54 U.S.C. 306108), federal agencies must take into account the potential effect of an undertaking on "historic properties," which refers to cultural resources listed in or eligible for listing in the National Register of Historic Places. Consultation with SHPO to fulfill Section 106 obligations would be completed for each project group prior to implementation.

- **Clean Water Act:**
  - **Section 404**: Under Section 404(f)(1)(C) of the CWA, discharges of dredged or fill material associated with construction or maintenance of irrigation ditches, or the maintenance (but not construction) of drainage ditches, are not prohibited by or otherwise subject to regulation under Section 404. Discharges of dredged or fill material associated with siphons, pumps, headgates, wingwalls, weirs, diversion structures, and such other facilities as are appurtenant to and functionally related to irrigation ditches are included in the exemption for irrigation ditches. Under 33 CFR 323.4(a)(1)(iii)(C)(1)(i), "[c]onstruction and maintenance of upland (dryland) facilities such as ditching and tiling, incidental to the planting, cultivating, protecting, or harvesting of crops, involve no discharge of dredged or fill material into waters of the U.S., and as such never require a Section 404 permit." The construction and maintenance of irrigation ditches and maintenance of drainage ditches may require the construction and/or maintenance of a farm road. Subsection 404(f)(1)(E) exemption for discharges of dredged or fill material associated with the construction or maintenance of farm roads applies where such related farm roads are constructed and maintained in accordance with BMPs. However, in 33 CFR 323.4(a)(6) and 40 CFR 232.3(c)(6), there must be assurance that flow and circulation patterns and chemical and biological characteristics of waters of the U.S. are not impaired, that the reach of the waters of the U.S. is not reduced, and that any adverse effect on the aquatic environment would be otherwise minimized. Prior to construction activities, coordination and consultation with USACE will occur and measures taken as required to identify and mitigate impacts to potential jurisdictional wetlands and waters of the United States.
  - **Section 401**: Implemented by ODEQ, see above.

- **Farmland Protection Policy Act:** The Farmland Protection Policy Act (7 U.S.C. 4201 *et seq.*) directs federal agencies to identify and quantify adverse impacts of federal programs on farmlands. The Act's purpose is to minimize the number of federal programs that contribute to the unnecessary and irreversible conversion of agricultural land to nonagricultural uses. The project occurs primarily in EFU zones; however, all work would be done within TID's easements and ROW. The project would support agricultural productivity and the intention of the Act.

- **Endangered Species Act:** The ESA establishes a national program for the conservation of threatened and endangered species and the preservation of the ecosystems on which they depend. The ESA is administered by the USFWS for wildlife and freshwater species, and by NMFS for marine and anadromous species. The ESA defines procedures for listing species, designating critical habitat for listed species, and preparing recovery plans. It also specifies prohibited actions and exceptions. Section 7 of the ESA, called "Interagency Cooperation," is the mechanism by which federal agencies ensure the actions they take, including those

they fund or authorize, do not jeopardize the existence of any listed species. Under Section 7 of the ESA, federal agencies must consult with USFWS when any action the agency carries out, funds, or authorizes (such as through a permit) *may affect* a listed endangered or threatened species.

- Due to the magnitude and timing of increased instream flow in the Deschutes River in relation to the life history of bull trout populations located in the Deschutes River, these populations and associated critical habitat would not be affected by implementation of either action alternative under consideration. It has been determined, however, that implementation of either action alternative could affect, but is not likely to adversely affect, Oregon spotted frog because of entirely beneficial actions. Informal consultation with USFWS under ESA section 7 has been initiated and a letter of concurrence with these determinations has been received by the Service (see Appendix E.9 of this Plan-EA).

- The Middle Columbia River steelhead population, present in the Deschutes River upstream from the Pelton Round Butte Dam complex, is classified as a non-essential experimental population under section 10(j) of ESA. Because this population is located outside of a National Wildlife Refuge System and a National Park System, the action alternatives would not likely jeopardize the continued existence of the species, and the action alternatives are entirely beneficial, the population is treated as "proposed for listing". NRCS, therefore, has determined that engagement with NMFS to obtain a conference report is not necessary (76 *Federal Register* 28715, 2011; 81 *Federal Register* 33416, 2016).

- **Magnuson Stevens Act:** The Magnuson-Stevens Act established requirements for including Essential Fish Habitat (EFH) descriptions in federal fishery management plans, and requires federal agencies to consult with NMFS on activities that may adversely affect EFH (Pub. L. No. 104-297). EFH can include all streams, lakes, ponds, wetlands, and other viable waterbodies, and most of the habitat historically accessible to salmon necessary for spawning, breeding, feeding, or growth to maturity. As the project would not affect EFH, consultation under the Magnuson Stevens Act is not required.

- **Safe Drinking Water Act**: Since the project would have no direct or indirect discharge to groundwater, permitting under the Safe Drinking Water Act is not required.

- **Migratory Bird Treaty Act:** The MBTA implements various treaties and conventions between the US and other countries, including Canada, Japan, Mexico, and the former Soviet Union, for the protection of migratory birds (16 U.S.C. 703–712). Under the Act, taking, killing, or possessing migratory birds, or taking, destroying, or possessing their eggs or nests, is unlawful. The Act classifies most species of birds as migratory, except for upland and nonnative birds such as pheasant, chukar, gray partridge, house sparrow, European starling, and rock dove.

- **Bald and Golden Eagle Protection Act**: The BGEPA prohibits the taking or possessing of and commerce in bald and golden eagles, with limited exceptions (16 U.S.C. 668–668d). The Act only covers international acts of acts in "wanton disregard" of the safety of bald or

golden eagles. Two potential golden eagle nests are known to occur within 660 feet of the project area and requirements of the Act would be implemented appropriately.

8.7 Costs

Table 8-2 presents the total project cost of $43,326,000 for the Preferred Alternative. PL 83-566 funds would provide $29,781,700 of the total project cost where the remainder of the cost, $13,544,300, would be contributed by other, non-federal funds. Table 8-3 itemizes the costs for each project feature and distributes the costs between the sponsors and NRCS for each cost item.

- Construction cost accounts for all material, labor, and equipment necessary for the installation of pipe associated with the Preferred Alternative. These costs were estimated based on costs for similar installations at irrigation districts in central Oregon. Construction costs were estimated using the best available information about the project without having detailed design information.
- Engineering costs were estimated as a percentage of the cost of construction. The percentage applied for engineering costs depends on the scale of the particular pipe installation.
- The costs presented are planning level estimates and do not reflect final costs. Detailed designs and construction cost estimates would be completed prior to initiating the project. Final construction costs would only reflect the time and materials to perform the work.

8.8 Installation and Financing

The following sub-sections present the installation and financing of the Preferred Alternative. This section outlines a framework for implementing the Preferred Alternative; the sequence of installation; responsibilities of NRCS and the sponsors; contracting; real property and relocations; financing; and conditions for providing assistance.

8.8.1 Framework for Carrying out the Plan

The TID Irrigation Modernization Project would be implemented in a planned sequence as discussed in the following Section 8.8.2. The responsibilities of NRCS and the sponsors for the project are outlined in Section 8.8.3. No cost-shared on-farm measures are involved with this project; therefore, the responsibilities of individual participants do not need to be discussed. No preconditions are anticipated for installing the project.

8.8.2 Planned Sequence of Installation

The District would obtain all approvals and permits for the project prior to the start of construction. The project would be implemented in seven project groups as presented in Table 8-1. It is expected that Project Group 1 would occur over two years, Project Group 2 would occur over two years, and Project Group 6 would occur over three years. Project Groups 3-5 are each expected to be constructed over one year. The entire project (all seven project groups) would be completed over an 11-year period commencing in 2018 and ending in 2028.

8.8.3 Responsibilities

NRCS is responsible for leading the planning efforts, providing engineering design and construction oversight assistance, and certifying completion of the project. The District would be responsible for engineering design, project administration, environmental permitting, contracting, and construction implementation. The District has the needed authorities as an irrigation district organized under ORS 545 and has agreed to exercise those authorities to implement the actions described in the Plan-EA.

8.8.4 Contracting

The piping and pressurization of the delivery system would be completed using NRCS funding mechanisms. The District would be primarily responsible for overseeing and administering the construction of the project in coordination with NRCS.

8.8.5 Real Property and Relocations

Real property acquisition or relocations would not be required for the Preferred Alternative. All construction would be completed under TID's existing ROW as described in Section 8.5.

8.8.6 Financing

NRCS would provide 69 percent of the total project cost for the Preferred Alternative through PL 83-566 funding. The District is responsible for funding the remaining 31 percent of the costs, including funds that are not eligible under the National Watershed Program. Table A in the NED presents annual installation costs of each project group and the proportion of funding provided through PL 83-566 funding and other funding sources.

The District has a strong history of securing public and private funding through grants, loans, and patron assessments. According to TID's District Manager (K. Rieck, personal communication, July 25, 2017), nearly all funding is expected to be provided through grants (private or non-federal public). If necessary, approximately 31 percent of the project would be financed in this manner. If financing is required, TID expects to apply for funding through the ODEQ Clean Water State Revolving Fund. The District expects that funding from this source would be at an interest rate of 2.5 percent with a 0.5 percent annual fee paid on the remaining loan balance. These financing costs are not included in the NED analysis.

O&M costs after project completion would be provided through TID's revenues. O&M costs would not increase due to the project and would be budgeted on an annual basis.

NRCS reserves the authority and right to discontinue or reduce program benefits based on changes in agency priorities, funding availability, or TID's failure to fulfill the provisions of their agreement.

8.8.7 Conditions for Providing Assistance

Conditions for TID to receive program funds for the proposed project include TID completing a Final Watershed Plan-Environmental Assessment and NRCS issuing a Finding of No Significant Impact.

8.9 Operation, Maintenance, and Replacement

The District would be responsible for the O&M of the project for the 100 years of its design life. Prior to construction, NRCS and TID would make a separate O&M agreement based on NRCS's National Operation and Maintenance Manual. The agreement would continue through the design life of the project and could be modified with NRCS's approval.

Project sponsors and NRCS would make annual inspections of project measures to assure the quality of ongoing operations and maintenance. The District would be in charge of scheduling operations and maintenance inspections and responsible for any necessary work. The District's O&M would consist of an ongoing pipe inspection program that would systematically inspect the entire system over a period of several years (most likely a 10-year cycle).

The proposed system would continue its current operation schedule of April to mid-October, during which work would be performed on an as-needed basis. Outside of that period, TID would perform system component maintenance including valve battery changes, magnetic meter maintenance, District operational valve maintenance, air and vacuum valve maintenance, pressure reducing station filter maintenance, and valve repairs. The District would expand their current vegetation and weed management to include the areas on top of the newly piped system. All procedures would be followed as specified in the O&M agreement between project sponsors and NRCS.

8.10 Economic and Structural Tables

A summary of the economic analysis of the Preferred Alternative (NED Alternative), Canal Lining Alternative, and No Action Alternative is provided in Section 5.4. The full NED Analysis can be found in Appendix D. The Preferred Alternative would result in varying average annual benefits, costs, and benefit-cost ratios depending on the Project Group being implemented. Average annual benefits would range from $124,100 to $495,800; average annual costs would be between $46,400 and $350,400; and benefit-cost ratios fall between 1.00 and 2.67. Additionally, Appendix D contains an incremental analysis of the benefits and costs of completing each additional increment of the Preferred Alternative. The costs and benefits associated with each individual project group are gone into more detail in the following tables in this section. Table 8-2 (NWPM 506.11, Economic Table 1) presents the projected installation costs and the percentages of costs to be shared by the sponsors and NRCS for each project group.

Table 8-2. Economic Table 1—Estimated Installation Cost of the HDPE Piping Alternative, Water Resource Project Measures, Deschutes Watershed, Oregon, 2017$.[1,2]

Works of Improvement	Unit	Number			Estimated Cost (dollars)						
					Public Law 83-566 Funds			Other Funds			
		Federal land[3]	Non-Federal land	Total	Federal land NRCS[4]	Non-Federal land NRCS	Total	Federal land	Non-Federal land	Total	Total
Project Group 1	Feet	0	12,716	12,716	$0	$5,179,000	$5,179,100	$0	$1,757,000	$1,756,800	$6,935,900
Project Group 2	Feet	11,660	69,936	81,596	$787,000	$4,719,000	$5,505,300	$243,000	$1,460,000	$1,703,900	$7,209,200
Project Group 3	Feet	2,193	23,326	25,519	$260,000	$2,760,000	$3,019,600	$81,000	$862,000	$943,600	$3,963,200
Project Group 4	Feet	9,634	51,917	61,551	$557,000	$3,002,000	$3,559,400	$174,000	$935,000	$1,108,700	$4,668,100
Project Group 5	Feet	1,620	54,330	55,950	$86,000	$2,880,000	$2,965,700	$27,000	$900,000	$927,200	$3,892,900
Project Group 6	Feet	436	89,727	90,163	$45,000	$9,242,000	$9,287,200	$26,000	$5,331,000	$5,357,100	$14,644,300
Project Group 7	Feet	0	35,650	35,650	$0	$265,000	$265,400	$0	$1,747,000	$1,747,000	$2,012,400
Total project	Feet	25,544	337,601	363,145	$1,735,000	$28,047,000	$29,781,700	$551,000	$12,992,000	$13,544,300	$43,326,000

Notes: Totals may not sum due to rounding Prepared: June 2018

1. Price base: 2017 dollars.
2. Project cost as identified in the Tumalo Irrigation District System Improvement Plan prepared by Black Rock Consulting, 2016, updated to 2017 dollars and including an additional three percent project administration cost and eight percent technical assistance cost as well as permitting costs.
3. The Project would cross BLM land; however, BLM is not assisting in the installation of the works of improvement.
4. Federal agency responsible for assisting in installation of works of improvement.

Table 8-3 (NWPM Economic Table 2, 506.12), presents the project's cost distribution across project groups as well as the proportion of PL 83-566 funding and other funding sources. The average annual NED costs are shown in Table 8-4 (NWPM 506.18, Economic Table 4).

Table 8-3. Economic Table 2 —Estimated HDPE Piping Alternative Cost Distribution, Water Resource Project Measures, Deschutes Watershed, Oregon, 2017$.[1,2]

Works of Improvement	Installation Costs—PL 83-566 Funds				Installation Cost—Other Funds				Total Installation Costs
Piping	Construction	Engineering	Project Admin[3]	Total PL 83-566	Construction	Engineering	Project Admin[3]	Total Other	
Project Group 1	$4,748,100	$150,000	$281,000	$5,179,100	$1,582,700	$50,000	$124,100	$1,756,800	$6,935,900
Project Group 2	$4,605,600	$251,700	$648,000	$5,505,300	$1,535,200	$83,900	$84,800	$1,703,900	$7,209,200
Project Group 3	$2,540,900	$123,700	$355,000	$3,019,600	$846,900	$41,200	$55,500	$943,600	$3,963,200
Project Group 4	$2,972,600	$167,800	$419,000	$3,559,400	$990,900	$55,900	$61,900	$1,108,700	$4,668,100
Project Group 5	$2,459,800	$156,900	$349,000	$2,965,700	$820,000	$52,300	$54,900	$927,200	$3,892,900
Project Group 6	$7,573,000	$397,200	$1,317,000	$9,287,200	$5,072,900	$132,300	$151,900	$5,357,100	$14,644,300
Project Group 7	$0	$85,400	$180,000	$265,400	$1,680,600	$28,500	$37,900	$1,747,000	$2,012,400
TOTAL COSTS	$24,900,000	$1,332,700	$3,549,000	$29,781,700	$12,529,200	$444,100	$571,000	$13,544,300	$43,326,000

Notes: Totals may not sum due to rounding. Prepared: June 2018

1. Price base: 2017 dollars.
2. Project cost as identified in the Tumalo Irrigation District System Improvement Plan prepared by Black Rock Consulting, 2016, updated to 2017 dollars and including an additional 3 percent project administration cost and 8 percent technical assistance cost. Of total estimated costs presented in the System Improvement Plan, Black Rock Consulting estimated 75 percent is for construction and 25 percent for engineering.
3. Project Admin includes project administration, technical assistance costs, and permitting costs.

Table 8-4. Economic Table 4—Estimated Average Annual NED Costs, Deschutes Watershed, Oregon, 2017$.[1]

Works of Improvement[2]	Project Outlays (Amortization of Installation Cost)	Other Direct Costs[3] (Increased Pumping Costs Elsewhere in Basin from Reduced GW Recharge)	Total Cost
Project Group 1	$199,800	$5,200	$205,000
Project Group 2	$198,300	$2,400	$200,700
Project Group 3	$104,700	$1,300	$106,000
Project Group 4	$120,100	$1,400	$121,500
Project Group 5	$97,400	$1,000	$98,400
Project Group 6	$346,300	$4,100	$350,400
Project Group 7	$45,200	$1,200	$46,400
Total	**$1,111,800**	**$16,600**	**$1,128,400**

Notes: Totals may not sum due to rounding. Prepared: June 2018

1. Price base: 2017 dollars, amortized over 100 years at a discount rate of 2.75 percent.
2. Project groups would be completed over the course of one to three years each, such that Group 1 is completed in Year 1 and Group 7 is completed in Year 11.
3. Other direct costs include the uncompensated economic losses due to changes in resource use or associated with installation, operation, or replacement of project structures. For Project Groups 2 -7, other direct costs are presented for increased pumping costs elsewhere in the basin from reduced groundwater recharge (i.e. seepage from unlined canals). For Project Group 1, other direct costs include the cost of increased carbon emissions associated with increased groundwater pumping energy use (in all other project groups, total groundwater energy use declines so carbon is a benefit). This does not include operations, maintenance, and repair costs because these decline under the HDPE Piping Alternative, so these are presented as a benefit.

The Preferred Alternative damage reduction benefits included agricultural yields, power cost savings, reduced O&M costs, improved fish and wildlife habitat and avoided carbon emissions. Table 8-5 (NWPM 506.20, Economic Table 5a) presents the average annual watershed protection damage reduction benefits across all project groups.

Table 8-5. Economic Table 5a—Estimated Average Annual Watershed Protection Damage Reduction Benefits Tumalo Irrigation District 2017 Watershed Plan, Deschutes Watershed, Oregon, 2017$.[1]

	Damage Reduction Benefit, Average Annual	
Item	**Agricultural- related**	**Non-Agricultural- related**
Project Group 1		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$5,000	
Other - Power Cost Savings	$700	
Subtotal	$5,700	
Off-Site Damage Reduction Benefits		
Water Conservation		$199,900
Subtotal		$199,900
Total Quantified Benefits	$5,700	$199,900
Project Group 2		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$30,600	
Other - Power Cost Savings	$49,500	
Subtotal	$80,100	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$19,200
Water Conservation		$170,000
Subtotal		$189,200
Total Quantified Benefits	$80,100	$189,200
Project Group 3		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$9,300	
Other - Power Cost Savings	$25,400	

	Damage Reduction Benefit, Average Annual	
Item	**Agricultural- related**	**Non-Agricultural- related**
Subtotal	$34,700	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$9,800
Water Conservation		$91,100
Subtotal		$100,900
Total Quantified Benefits	$34,700	$100,900
Project Group 4		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$21,800	
Other - Power Cost Savings	$58,400	
Subtotal	$80,200	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$23,900
Water Conservation		$101,000
Subtotal		$124,900
Total Quantified Benefits	$80,200	$124,900
Project Group 5		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$19,300	
Other - Power Cost Savings	$31,400	
Subtotal	$50,700	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$12,600
Water Conservation		$70,200

	Damage Reduction Benefit, Average Annual	
Item	**Agricultural- related**	**Non-Agricultural- related**
Subtotal		$82,800
Total Quantified Benefits	$50,700	$82,800
Project Group 6		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$29,600	
Other - Power Cost Savings	$133,100	
Subtotal	$162,700	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$53,600
Water Conservation		$279,500
Subtotal		$333,100
Total Quantified Benefits	$162,700	$333,100
Project Group 7		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$11,000	
Other - Power Cost Savings	$27,000	
Subtotal	$38,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$10,500
Water Conservation		$75,600
Subtotal		$86,100
Total Quantified Benefits	$38,000	$86,100

Notes: Totals may not sum due to rounding. Prepared: June 2018

1. Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent.
2. These benefits would also accrue to local residents, but the majority of the value would be experienced outside the proposed project area.

Using the resulting benefits and costs from the previous two tables, Table 8-6 (NWPM 506.21, Economic Table 6) presents a comparison of the NED average annual benefits and average annual costs.

Table 8-6. Economic Table 6— Comparison of Average Annual NED Costs and Benefits, Tumalo Irrigation District 2017 Watershed Plan, Deschutes Watershed, Oregon, 2017$.[1]

Works of Improvement	Agriculture-related		Non-agricultural		Average Annual Benefits	Average Annual Cost[2]	Benefit Cost Ratio
	Reduced O&M	Power Cost Savings	Carbon Value	Instream Flow Value			
Project Group 1	$5,000	$700	$0	$199,900	$205,600	$205,000	1.00
Project Group 2	$30,600	$49,500	$19,200	$170,000	$269,300	$200,700	1.34
Project Group 3	$9,300	$25,400	$9,800	$91,100	$135,600	$106,000	1.28
Project Group 4	$21,800	$58,400	$23,900	$101,000	$205,100	$121,500	1.69
Project Group 5	$19,300	$31,400	$12,600	$70,200	$133,500	$98,400	1.36
Project Group 6	$29,600	$133,100	$53,600	$279,500	$495,800	$350,400	1.41
Project Group 7	$11,000	$27,000	$10,500	$75,600	$124,100	$46,400	2.67
Total	$126,600	$325,500	$129,600	$987,300	$1,569,000	$1,128,400	1.39

Notes: Totals may not sum due to rounding. Prepared: June 2018

1. Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent.
2. From Economic Table 4.

9 References

Allocation of Conserved Water, Or. Admin. R. § 690.18

Ballantyne, Donald. (2013). Development of Seismic Design Guidelines for Distribution Piping. Website: https://www.pnws-awwa.org/uploads/PDFs/conferences/2013/Engr%20Precon%20Session%207%20Don%20Ballantyne.pdf. Accessed May 22, 2018.

Bambie, J., and B. Keil. (2013). *Revision of AWWA C200 Steel Water Pipe Manufacturing Standard: Consensus-Based Changes Mark Significant Improvements*. Northwest Pipe Company. Vancouver, Washington.

Beier, P., D. Majka, S. Newell, and E. Garding. (2008). *Best Management Practices for Wildlife Corridors*. Flagstaff: Northern Arizona University.

Bend Park and Recreation District (BPRD). (2017a). *Bend Urban Trails Plan*. Retrieved from: http://www.bendparksandrec.org/about_us/planning__development/bend_urban_trails_plan/. Accessed July, 6 2017.

Bend Park and Recreation District (BPRD). (2017b). *Shevlin Park*. Retrieved from: http://www.bendparksandrec.org/parks/shevlin-park/. Accessed April 6, 2017.

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

Burns W., K. Mickelson, and I. Madin. (2016). *Landslide Susceptibility Overview Map of Oregon*. State of Oregon, Oregon Department of Mineral Industries. Retrieved from: http://www.oregongeology.org/pubs/ofr/p-O-16-02.htm. Accessed August 14, 2017.

Carrasco, R., and E. Moberly. (2014). *2013 Middle Deschutes Fisheries Monitoring Report: Fish Distribution and Abundance in the Middle Deschutes River*. Bend, OR: Oregon Department of Fish and Wildlife.

Center for Biological Diversity et al. v. U.S. Bureau of Reclamation et al., and Arnold Irrigation District et al. (2016). *Stipulated Settlement Agreement and Order*. United States District Court District of Oregon: Eugene Division.

Cordova, Jerry (USFWS). (2017). Personal communication (email) with Amanda Schroeder (FCA). August 23, 2017.

Cornell University, Rensselaer Polytechnic Institute, and Sciencenter Discovery Center. (2009). NEESR-SG Final Report. Ithaca NY: Cornell University. Website: https://cpb-us-w2.wpmucdn.com/sites.coecis.cornell.edu/dist/a/38/files/2014/10/2009-NEES-Final-Report-qm8d7t.pdf. Accessed May 22, 2018.

Cronin, Bill. NRCS. (2018). Personal communication (email) with Alexis Vaivoda (FCA). July 2, 2018.

Cuenca, R.H. (1992). *Oregon Crop Water Use and Irrigation Requirements.* Oregon State Extension Service. Retrieved from: https://ir.library.oregonstate.edu/concern/open_educational_resources/vh53ww12g. Accessed December 20, 2017.

Dean Runyan Associates. (2017). *Oregon Travel Impacts: 1992-2016p.* Retrieved from: http://www.deanrunyan.com/doc_library/ORImp.pdf. Accessed August 29, 2017.

Deschutes County. (2010). *Deschutes County Comprehensive Plan.* Retrieved from: https://www.deschutes.org/cd/page/planning-division. Accessed August 28, 2017.

Deschutes County. (2017a). *Bikeways of Deschutes County Oregon-Elevation Profiles.* Retrieved from: https://maps.deschutes.org/custom/basic/bikeways.html. Accessed June 30, 2017.

Deschutes County. (2017b). *Deschutes County Noxious Weed List.* Exhibit A to Resolution No. 2017-006. Retrieved from: https://www.deschutes.org/sites/default/files/fileattachments/road/page/567/deschutes_county_weed_list_updated_2017.pdf. Accessed June 28, 2017.

Deschutes River Conservancy (DRC). (2012). *Upper Deschutes River Background Paper.* Bend, OR: Deschutes River Conservancy.

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

Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Bull Trout, 70 *Federal Register* § 56211 (final rule Sept. 26, 2005) (to be codified at 50 CFR 17).

Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Oregon Spotted Frog, 81 *Federal Register* § 29336 (final rule May 11, 2016) (to be codified at 50 CFR 17).

Endangered and Threatened Species: Designation of a Nonessential Experimental Population for Middle Columbia River Steelhead Above the Pelton Round Butte Hydroelectric Project in the Deschutes River Basin, Oregon, 76 *Federal Register* § 28715 (Proposed rule May 18, 2011) (to be codified at 50 CFR 223).

Endangered and Threatened Species: Designation of Experimental Populations Under the Endangered Species Act, 81 *Federal Register* § 33416 (Final rule June 27, 2016) (to be codified at 50 CFR 222).

Farmer's Conservation Alliance (FCA). (2017). *Preliminary Investigative Report for the Tumalo Irrigation District - Irrigation Modernization Project.* Hood River, OR: Farmer's Conservation Alliance.

Federal Emergency Management Agency (FEMA). (2013). *Oregon 100-yr Flood Zones*. Washington D.C.: Federal Emergency Management Agency.

Flowers, E. (2004). *Boy's Death Renews Concerns over Safety of Urban Canals*. Bend Bulletin. July 1. Retrieved from: http://www.bendbulletin.com.

Franklin, J.F., and C.T. Dyrness, (1988). *Natural Vegetation of Oregon and Washington*. Corvallis, OR: Oregon State University Press.

Gannett, M.W., and K.E. Lite, Jr. (2013). *Analysis of 1997–2008 Groundwater Level Changes in the Upper Deschutes Basin, Central Oregon* (Scientific Investigations Report 2013-5092). Reston, WA: U.S. Geological Survey.

Gannett, M.W., K.E. Lite, J.C. Risley, E.M. Pischel, and J.L. La Marche. (2017). *Simulation of Groundwater and Surface-Water Flow in the Upper Deschutes Basin, Oregon*: (Scientific Investigations Report 2017-5097U.S). Reston, WA: US. Geological Survey.

Gannett, M.W., K.E. Lite, Jr., D.S. Morgan, and C.A. Collins. (2001). *Ground-Water Hydrology of the Upper Deschutes Basin, Oregon* (Water-Resources Investigations Report 00–4162). Portland, OR: U.S. Geological Survey.

Gannett, M.W., M. Manga, and K.E. Lite, Jr. (2003). Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow. In O'Connor, J.E. and Grant, G.E. (Eds.), *A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon* (pp. 31-49). Washington D.C.: American Geophysical Union.

Golden, B., and B. Aylward. (2006). *Instream Flow in the Deschutes Basin: Monitoring, Status and Restoration Needs*. Bend, OR: Deschutes River Conservancy.

Henderson, Sarah (OWRD). (2017). Personal communication (email) with Amanda Schroeder (FCA). August 14, 2017.

International Union for Conservation of Nature (IUCN). (2017). *Red List of Threatened Species*. Retrieved from: http://www.iucnredlist.org. Accessed June 28, 2018.

Keith, Ed. (2017). Personal communication (email) with Raija Bushnell (FCA). July 12, 2017.

Lite, K.E., Jr., and M. Gannett. (2002). *Geologic Framework of the Regional Ground-Water Flow System in the Upper Deschutes Basin, Oregon* (Water-Resources Investigations Report 02–4015). Portland, OR: U.S. Geological Survey.

Luttrell, C.T. and C. Pfaff. (2006). *Historic American Engineering Record, Number OR-151, Vicinity of Tumalo and Bend, Oregon, Deschutes County, Oregon*. Cheney, WA: Archeological and Historical Services, Eastern Washington University.

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

Mork, L. (2016). *Middle Deschutes River Instream Flow Restoration and Temperature Responses 2001-2015*. Bend, OR: Upper Deschutes Watershed Council.

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

Oakley, A.L., J.A. Collins, L.B. Everson, D.A. Heller, J.C. Howerton, and R.E. Vincent. (1985). *Riparian Zones and Freshwater Wetlands.* Boise, ID: United States Forest Service.

Oliphant, K., M. Conrad, and W. Bryce. (2012). Fatigue of Plastic Water Pipe: A Technical Review with Recommendations for PE4710 Pipe Design Fatigue. Jana Laboratories Inc.

Oregon Department of Agriculture (ODA). (2017a). *Noxious Weed Policy and Classification System 2017*. Retrieved from: http://www.oregon.gov/ODA/shared/Documents/Publications/Weeds/NoxiousWeedPolicyClassification.pdf. Accessed August 30, 2017.

Oregon Department of Agriculture (ODA). (2017b). *Astragalus Peckii Profile.* Retrieved from: http://www.oregon.gov/ODA/programs/PlantConservation/Pages/AboutPlantsAstralagusPeckii.pdf. Accessed August 25, 2017.

Oregon Department of Environmental Quality (ODEQ). (2012). *2012 Water Quality Report Geodatabase.* Retrieved from: http://www.oregon.gov/deq/Data-and-Reports/Pages/GIS.aspx. Accessed August 28, 2017.

Oregon Department of Fish and Wildlife (ODFW). (1996). *Upper Deschutes River Subbasin Fish Management Plan.* Retrieved from: https://nrimp.dfw.state.or.us/nrimp/information/docs/fishreports/Upper%20Deschutes%20River%20subbasin%201996%20Final.pdf. Accessed August 29, 2017.

Oregon Department of Fish and Wildlife (ODFW). (2017a). *Threatened and Endangered Species List.* Retrieved from: http://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp. Accessed August 28, 2017.

Oregon Department of Fish and Wildlife (ODFW). (2017b). *Wildlife Viewing Species.* Retrieved from: https://myodfw.com/wildlife-viewing/species/mammals. Accessed April 13, 2018.

Oregon Department of Fish and Wildlife (ODFW) and Confederated Tribes of Warm Springs (CTWS). (2008). *Reintroduction and Conservation Plan for Anadromous Fish in the Upper Deschutes River Sub-basin, Oregon. Edition 1: Spring Chinook Salmon and Summer Steelhead.* Retrieved from: http://www.winnememwintu.us/wp-content/uploads/2011/09/deschutes_reintro_plan_10-20-08.pdf. Accessed August 26, 2017.

Oregon Department of Land Conservation and Development (ODLCD). (2010). *Oregon's Statewide Planning Goals and Guidelines.* Retrieved from: http://www.oregon.gov/lcd/docs/goals/compilation_of_statewide_planning_goals.pdf. Accessed July 26, 2017.

Oregon Department of State Lands (ODSL). (2013). *A Guide to the Removal-Fill Permit Process*. Salem, OR: Oregon Department of State Lands.

Oregon Parks and Recreation Department (OPRD). (2017). *Tumalo State Park*. Retrieved from: http://oregonstateparks.org/index.cfm?do=parkPage.dsp_parkPage&parkId=34. Accessed September 1, 2017.

Oregon Water Resources Department (OWRD). (2005). *Final Order Approving Allocation of Conserved Water No. 37*. Special Oregon Vol. 67 p. 59. December 14, 2005. Salem, Oregon.

Oregon Water Resources Department (OWRD). (2017). *Allocation of Conserved Water*. Retrieved from: http://www.oregon.gov/owrd/pages/mgmt_conserved_water.aspx. Accessed November 10, 2017.

Orr, E., W. Orr, and E. Baldwin. (1992). *Geology of Oregon*, 4th Edition. Dubuque, IA: Kendall Hunt Publishing Company.

Park, S. and N. Foged. (2009). *Middles Deschutes River Temperature Evaluation*. Bend, OR: Brown and Caldwell.

Plastics Pipe Institute. (2015). Pipeline Analysis & Calculation Environment online tool. Website: http://ppipace.com. Accessed July 25, 2018.

Portland State University (PSU). (2015). *Oregon Population Report*. Portland, OR. Retrieved from: https://www.pdx.edu/prc/population-reports-estimates. Accessed April 11, 2018.

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

Renwick, W.R. (1975). *Changes in Deschutes County Irrigation Agriculture Since 1950*. Retrieved from: https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/pc289p038. Accessed July 29, 2017.

Rieck, Kenneth (Tumalo Irrigation District Manager). (2017a). Personal communication (email) to Brett Golden (FCA). June 27, 2017.

Rieck, Kenneth (Tumalo Irrigation District Manager). (2017b). Personal communication (various methods) to Barbara Wyse (Highland Economics). July 20, July 25, and August 7, 2017.

Rieck, K. (2016). *Tumalo Reservoir: Past, Present and Future.* Retrieved from: http://tumalo.org/wp-content/uploads/2016/08/TumaloReservoirnowandinthefuturev3.pdf. Accessed August 28, 2017.

River Design Group, Inc. (RDG). (2005). *Deschutes River – Bank Stabilization Projects Assessment.* Retrieved from: http://www.deschutesriver.org/Deschutes-River-Bank-Stabilization-Project-Assessment.pdf. Accessed August 26, 2017.

Shelton, M.L., and R. Fridirici. (2001). Water Supply and Climate Change in the Upper Deschutes Basin, Oregon. *Yearbook of the Association of Pacific Coast Geographers 63,* 77-96.

Sherrod, D., T. Edward, M. Ferns, W. Scott, R. Conrey, and G. Smith. (2004). *Geologic Map of the Bend 30-x 60-Minute Quadrangle, Central Oregon* (Geologic Investigations Series 1-2683). Denver, CO: U.S. Geological Survey.

Shochat, E., P.S. Warren, S.H. Faeth, N.S. McIntyre, and D. Hope. (2006). From Patterns to Emerging Processes in Mechanistic Urban Ecology. *Trends in Ecology and Evolution, 21,* 186-191.

Starcevich, S. (2016). *2014 Deschutes River Fisheries Monitoring Report: Occupancy and Closed-Capture Modeling of Salmonids Using Boat Electrofishing in the Middle and Upper Deschutes River.* Technical Report Oregon Department of Fish and Wildlife.

Stuemke, S. (2006). *Tumalo Irrigation District Highline/Couch Piping Project: Phase I Field Survey and Section 106 Evaluation, Deschutes County, Oregon.* Report SES 2006-002 prepared for David Evans and Associates, Inc. on behalf of the Tumalo Irrigation District.

Stuemke, S. (2017). *Tumalo Irrigation District Tumalo Feed Canal: Phase V Piping Project - Phase I Field Survey and Section 106 Evaluation, Deschutes County, Oregon.* Report SES 2017-004 prepared for the Tumalo Irrigation District.

Sulia, Sascha (Bend Parks and Recreation District Natural Resources Manager). (2017). Personal communication (email) with Raija Bushnell (FCA). July 5, 2017.

Swihart, J., and J. Haynes. (2002). *Canal-Lining Demonstration Project Year 10 Final Report.* Boise, ID: Bureau of Reclamation.

Thalacker, Mark (Three Sisters Irrigation District). (2017). Personal communication (email) with Mattie Bossler (FCA). November 8, 2017.

Thorson, T.D., S.A. Bryce, D.A. Lammers, A.J. Woods, J.M. Omernik, J. Kagan, D.E. Pater, and J.A. Comstock. (2003). *Ecoregions of Oregon* (color poster with map, descriptive text, summary tables, and photographs, map scale 1:1,500,000). Reston, Virginia: U.S. Geological Survey.

Tumalo Irrigation District (TID). (2017). *Tumalo Irrigation District System Improvement Plan.* Bend, OR: Tumalo Irrigation District.

Tumalo Irrigation District and Black Rock Consulting. (2016). *Tumalo Irrigation District Water Management and Conservation Plan.* Bend, OR: Tumalo Irrigation District and Black Rock Consulting.

U.S. Army Corps of Engineers (USACE). (1986). Final Rule for Regulatory Programs of the Corps of Engineers. *Federal Register, 51*(219), 41206-41260. November 13, 1986.

U.S. Bureau of Reclamation (Reclamation). (2010). *Tumalo Feed Canal Piping Project Final Environmental Assessment, Tumalo Irrigation District, Bend, Oregon*. Retrieved from: https://www.usbr.gov/pn/programs/ea/oregon/tumalofeedcanal/tumalo-final-ea.pdf. Accessed December 1, 2017.

U.S. Bureau of Reclamation (Reclamation). (2016). *SECURE Water Act Section 9503(c)- Reclamation Climate Change and Water 2016:* Chapter 2 Hydrology and Climate. Denver, CO: Policy and Administration. Retrieved from: https://www.usbr.gov/climate/secure/docs/2016secure/2016SECUREReport-chapter2.pdf. Accessed August 21, 2017.

U.S. Bureau of Reclamation (Reclamation). (2017). *Biological Opinion: Approval of Contract Changes to the 1938 Inter-District Agreement for Operation of Crane Prairie and Wickiup Dams and Implementation of Review of Operations and Maintenance and Safety Evaluation of Existing Dams Programs at Crane Prairie and Wickiup Dams*. U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, Bend, Oregon.

U.S. Census Bureau. (2005). *Selected Economic Characteristics*. Washington DC: U.S. Census Bureau. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed August 21, 2017.

U.S. Census Bureau. (2010). *Selected Economic Characteristics*. Washington DC: U.S. Census Bureau. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed August 21, 2017.

U.S. Census Bureau. (2015). *Selected Economic Characteristics*. Washington DC: U.S. Census Bureau. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed August 21, 2017.

U.S. Department of Agriculture (USDA). (2007). *2007 Census of Agriculture: Deschutes County, Oregon – Census of Agriculture County Profile*. Retrieved from: https://agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Oregon/. Accessed August 18, 2017.

U.S. Department of Agriculture (USDA). (2012). *2012 Census of Agriculture. Deschutes County, Oregon – Census of Agriculture County Profile*. Retrieved from: https://agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Oregon/. Accessed August 18, 2017.

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. Department of Agriculture, Natural Resources Conservation Service (NRCS). (n.d.). National Conservation Practice Standards. Website: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1076947.pdf. Accessed July 25, 2018.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). (2000). *Oregon and Washington Guide for Conservation Seedings and Plantings.* Retrieved from: http://cascadia cd.org/files/documents/OR_WA_seeding_guide.pdf. Accessed September 12, 2017.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). (2010). *National Engineering Handbook,* Chapter 32: Well Design and Spring Development. Retrieved from: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=26985.wba. Accessed August 15, 2017.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). (2014). *Title-390 National Watershed Program Handbook* (2nd ed.). Retrieved from: https://www.nrcs.usda.gov /wps/PA_NRCSConsumption/download?cid=stelprdb1251523&ext=pdf. Accessed July 29, 2017.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). (2015a). *Title-390 National Watershed Program Manual* (4th ed.). January. Retrieved from: https://directives. sc.egov.usda.gov/ViewerFS.aspx?hid=36702. Accessed June 2016.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). (2015b). *Soils Map of Deschutes County.* Retrieved from: http://data.deschutes.org/datasets/d6c80e12dd 714e9d81f6b37cb68b11ce_4. Accessed August 28, 2017.

U.S. Department of Labor, Bureau of Labor Statistics (USBLS). (2017). *Local Area Unemployment Statistics.* Washington DC: U.S. Bureau of Labor Statistics. Retrieved from: https://www. bls.gov/lau/. Accessed August 12, 2017.

U.S. Department of the Interior, Bureau of Land Management (BLM). (2005). *Upper Deschutes Record of Decision and Resource Management Plan.* Retrieved from: https://eplanning.blm.gov/epl-front-office/projects/lup/36346/90909/109316/Upper_Deschutes_RMP_ROD_%282005%29.p df. Accessed September 12, 2017.

U.S. Department of the Interior, National Park Service (NPS). (2015). *National Register of Historic Places Registration Form, Pilot Butte Canal Historic District (Cooley Road-Yeoman Road Segment).* Retrieved from: https://www.nps.gov/nr/feature/places/pdfs/15001052.pdf. Accessed September 7, 2017.

U.S. Department of the Interior, National Park Service (NPS). (2017). *National Register of Historic Places Registration Form, Pilot Butte Canal: Downtown Redmond Segment Historic District.* Retrieved from: http://www.oregon.gov/oprd/HCD/NATREG/docs/national_register_recent/OR_ DeschutesCo_PilotButteDowntownRedmondSegment.pdf. Accessed September 7, 2017.

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 August 28, 2017.

U.S. Fish and Wildlife Service (USFWS). (2017). *IPaC ECOS* (Environmental Conservation Online System). Retrieved from: https://ecos.fws.gov/ipac/. Accessed August 28, 2017.

Upper Deschutes Watershed Council (UDWC). (2014). *Middle Deschutes River Instream Flow Restoration and Temperature Responses 2001-2013*. Bend, OR: Upper Deschutes Watershed Council.

Wray, Simon (ODFW). (2017). Personal communication with Alexis Vaivoda (FCA). November 17, 2017.

547 U.S. 715. (2006). *Rapanos v. United States*. Supreme Court of the United States. June 19, 2006.

10 List of Preparers

Under the direction of NRCS, the Plan-EA was primarily developed by FCA and its subcontractor Highland Economics. The staff responsible for preparation of the Plan-EA is included in Table 10-1.

Table 10-1. List of Preparers.

Name	Title	Education	Professional Experience	Area Responsible For
FCA Watershed Plan-EA Team				
Kristin Alligood	Program Specialist	Ph.D. Biology B.A. Neuroscience	4 years	Fish and Aquatic Species, Vegetation, Cumulative Effects
Mattie Bossler	Staff Engineer	B.S. Environmental Resource Engineering	5 years	Alternatives, Geology and Soils
Raija Bushnell	Program Specialist	M.P.A. Natural Resource Policy M.S.E.S Natural Resource Management B.A. Political Science	4 years	Land Use, Recreation, Vegetation, Alternatives
Brett Golden	Program Manager	M.E.M Environmental Management A.B. Environmental and Evolutionary Biology	11 years	General
Kate Hart	Program Specialist	M.S. Earth Science B.S. Earth Science	3 years	Geology and Soils, Alternatives, General GIS
David McKay	Program Specialist	M.P.A. Environmental Policy B.A. Political Science	3 years	Purpose and Need, Visual, Cultural Resources, Public Scoping
Amanda Schroeder	Program Specialist	B.S. Natural Resource Management	3 years	Water Resources, Wetlands, Wildlife, Socioeconomics, Alternatives, Wild and Scenic Rivers, General GIS
Alexis Vaivoda	Program Specialist	M.S. Environmental Science B.S. Biology	16 years	Fish and Aquatic Species, Cultural Resources, Public Safety, General

Name	Title	Education	Professional Experience	Area Responsible For
NRCS – Oregon				
Gary Diridoni	Natural Resource Specialist	Fisheries Management Graduate Certificate B.S. Wildlife Management B.S. Interdisciplinary Studies, Ecosystem Conservation	15 years	General
Tom Makowski	Assistant State Conservationist-Watershed Resources and Planning	Ph.D. Rural Sociology M.S. Social Psychology B.S. Recreation Resource Management	30 years	General
Lakeitha Ruffin	Agricultural Economist	M.S. Agricultural Economics B.S. Agricultural Economics	8 years	Economic and Socioeconomic Analysis, Alternative Analysis, Overall Watershed Planning
Employees from Firms Under Contract with FCA				
Company	**Name**	**Education**	**Professional Experience**	**Area of Responsibility**
Highland Economics	Barbara Wyse	M.S. Environmental and Natural Resource Economics B.A. Environmental Sciences and Policy	13 years	Economic Analysis
Highland Economics	Travis Greenwalt	M.B.A. B.S. Business Finance and Management	14 years	Economic Analysis
ERM	Sandy Slayton	M.A. Ecology B.A. Environmental Science	15 years	General

11 Distribution List

A Notice of Availability for the Draft Plan-EA was distributed to federal, state, and local agencies, community representatives, and area NGOs. The agencies, representatives and organizations on the mailing list include the following:

- Bend Parks and Recreation
- Business Oregon
- Bureau of Reclamation (Reclamation)
- Central Oregon Land Watch
- City of Bend
- Coalition for the Deschutes
- Deschutes County
- Deschutes River Conservancy (DRC)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries
- Oregon Department of Agriculture (ODA)
- Oregon Department of Energy (ODOE)
- Oregon Department of Environmental Quality (ODEQ)
- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Department of State Lands (ODSL)
- Oregon Governor's Office
- Oregon Water Resources Department (OWRD)
- Oregon Watershed Enhancement Board (OWEB)
- State Historic Preservation Office (SHPO)
- Trout Unlimited
- U.S. Army Corps of Engineers (USACE)
- U.S. Bureau of Land Management (BLM)
- U.S. Department of Agriculture, U.S. Forest Service (USFS), Deschutes National Forest
- U.S. Fish and Wildlife Service (USFWS)
- Upper Deschutes Watershed Council (UDWC)
- WaterWatch of Oregon

In accordance with EO 13175, Consultation and Coordination with Indian Tribal Governments, NRCS contacted CTWS regarding the availability of the Draft Plan-EA.

The names of private stakeholders and members of the public who received notice of the Draft Plan-EA are not listed for privacy.

12 Acronyms, Abbreviations, and Short-forms

°C	degrees Celsius
°F	degrees Fahrenheit
ACEC	Area of Critical Environmental Concern
BFC	Bend Feed Canal
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BMP	best management practice
BPRD	Bend Parks and Recreation District
Carey Act	Carey Desert Land Act of 1894, governing irrigation rights-of-way
CEQ	Council on Environmental Quality
cfs	cubic feet per second
CFR	Code of Federal Regulations
COID	Central Oregon Irrigation District
CTWS	Confederated Tribes of Warm Springs
CWA	Clean Water Act
DBBC	Deschutes Basin Board of Control
DBGM	Deschutes Basin Groundwater Mitigation
District	Tumalo Irrigation District
DRC	Deschutes River Conservancy
EA	Environmental Assessment
EE	Environmental Evaluation
EFU	Exclusive Farm Use
EIS	Environmental Impact Statement
EO	Executive Order
EQ	Environmental Quality
ESA	Endangered Species Act
FCA	Farmers Conservation Alliance
FEMA	Federal Emergency Management Agency
HAER	Historic American Engineering Record No. OR-151
HCP	Habitat Conservation Plan
HDPE	high-density polyethylene

HUC	Hydrologic Unit Code
MBTA	Migratory Bird Treaty Act
N/A	Not Applicable
NEPA	National Environmental Policy Act
NED	National Economic Development
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
NWPH	National Watershed Program Handbook
NWPM	National Watershed Program Manual
O&M	operation and maintenance
OAR	Oregon Administrative Rule
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOE	Oregon Department of Energy
ODSL	Oregon Department of State Lands
OMB	Office of Management and Budget
OM&R	operation, maintenance, and replacement
ORS	Oregon Revised Statute
ORV	Outstanding Remarkable Value
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PCE	Primary Constituent Element
PIR	Preliminary Investigative Report
PL 83-566	Watershed Protection and Flood Prevention Program, Public Law 83-566
Plan-EA	Watershed Plan-Environmental Assessment

Project	Tumalo Irrigation District Irrigation Modernization Project
psi	pound per square inch
PVC	Polyvinyl Chloride
Reclamation	United States Bureau of Reclamation
RED	Regional Economic Development
RFO	Responsible Federal Official
RM	River Mile
ROW	rights-of-way
SHPO	State Historic Preservation Office
SID	Swalley Irrigation District
SIP	System Improvement Plan
SLO	Sponsoring Local Organization
TFC	Tumalo Feed Canal
TID	Tumalo Irrigation District
TMDL	total maximum daily load
UDWC	Upper Deschutes Watershed Council
USACE	United States Army Corps of Engineers
USBLS	United States Bureau of Labor Statistics
U.S.C.	United States Code
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
U.S./US	United States

13 Index

14 Appendix A-E

Appendices are provided in a separate document.

Appendix A. Comments and Responses
Appendix B. Project Maps
Appendix C. Supporting Maps
Appendix D. Investigations and Analysis Reports
Appendix E. Other Supporting Information