RECLAMATION

Managing Water in the West

Draft Feasibility-Level Special Study Report

Odessa Subarea Special Study

Columbia Basin Project, Washington

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office
Yakima, Washington

State of Washington
Office of Columbia River
Department of Ecology
Wenatchee, Washington

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Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The mission of the Department of Ecology is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations.

Acronyms and Abbreviations

amsl	above mean sea level
BCA	benefit-cost analysis
BCR	benefit-cost ratio
BRBC	Black Rock Branch Canal
BPA	Bonneville Power Administration
CBP	Columbia Basin Project
Corps	U.S. Army Corps of Engineers
CSRIA	Columbia Snake River Irrigator's Association
CRP	Conservation Reserve Program
cwt	hundredweight
DEIS	Draft Environmental Impact Statement
EA	Environmental Assessment
ECBID	East Columbia Basin Irrigation District
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
ELC	East Low Canal
EOM	end of month
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended
FCRPS	Federal Columbia River Power System
FDR	Lake Roosevelt
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
gpm	gallons per minute
GWMA	Columbia Basin Ground Water Management Area
IDC	interest during construction
IMPLAN	IMpact analysis for PLANning
ITA	Indian Trust Asset
Management Act	Columbia River Water Resource Management Act
Management Program	Columbia River Basin Water Management Program
M&I	municipal and industrial
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MW	megawatts
NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
NFI	net farm income
NMFS	National Marine Fisheries Service
NRA	national recreation area
NRCS	Natural Resources Conservation Service
O&M	operation and maintenance
Odessa Subarea	Odessa Ground Water Management Subarea
Odessa DEIS	Odessa Subarea Special Study Draft Environmental Impact Statement
OMR&P	operation, maintenance, replacement, and power
OWRD	Oregon Water Resources Department
P&Gs	*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*

PASS	Project Alternative Solutions Study
RMP	Resource Management Plan
POS	Plan of Study
psi	pounds per square inch
QCBID	Quincy-Columbia Basin Irrigation District
RCW	Revised Code of Washington
Reclamation	Bureau of Reclamation
ROD	Record of Decision
SCBID	South Columbia Basin Irrigation District
SEPA	State Environmental Policy Act
Secretary	Secretary of the Interior
SRSP	Steamboat Rock State Park
State	State of Washington
Study	Odessa Subarea Special Study
Study Area	Odessa Subarea Special Study Area
TERO	Tribal Employment Rights Ordinances
USDA	U.S. Department of Agriculture
Service	U.S. Fish and Wildlife Service
VRA	Voluntary Regional Agreement
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WSPRC	Washington State Parks and Recreation Commission
WSU	Washington State University

Executive Summary

The Bureau of Reclamation (Reclamation), Washington State Department of Ecology (Ecology), and Columbia Basin Project (CBP) irrigation districts are studying the potential to deliver surface water from CBP to irrigated lands that currently rely on a declining groundwater supply from the Odessa Groundwater Management Subarea (Odessa Subarea).

About this Report

This feasibility-level Special Study Report is prepared in compliance with the requirements of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies* (U.S. Water Resources Council, 1983) (P&Gs). It presents a discussion of the formulation of alternatives, a description of the feasibility-level designs and cost estimates for the alternatives considered, and the results of the P&Gs-specific analyses.

Information in this Special Study Report is based on a variety of sources, including the *Draft Environmental Impact Statement, Odessa Subarea Special Study* (Reclamation, 2010 [Odessa DEIS]).

Technical reports containing the feasibility-level drawings and cost estimates are available at http://www.usbr.gov/pn/programs/ucao_misc/odessa/

Further background information is available at the following websites:

- Ecology's Office of Columbia River, Odessa Subarea Special Study: http://www.ecy.wa.gov/programs/wr/cwp/cr_odessa.html
- Reclamation's Pacific Northwest Region, Columbia-Cascades Area Office, Odessa Subarea Special Study: http://www.usbr.gov/pn/programs/ucao_misc/odessa/

Project and Authorized Study Area

The CBP is a multipurpose water development project in the central part of the State of Washington (State), east of the Cascade Range. The key structure, Grand Coulee Dam, is on the mainstem of the Columbia River about 90 miles west of Spokane.

Construction of the CBP was anticipated to occur in phases over a 70-year period to irrigate a total of 1.029 million acres. The CBP currently serves a total of about 671,000 acres in Grant, Adams, Walla Walla, and Franklin Counties, with some northern facilities located in Douglas County.

The Odessa Subarea is in the eastern part of the CBP and overlaps the CBP boundaries. In 1967, the Washington Legislature designated the Odessa Subarea

as a ground water management area because of groundwater level declines resulting from pumping (Washington Administrative Code [WAC] 173-128A, Odessa Ground Water Management Subarea).

Reclamation is authorized to implement additional development phases of the CBP as long as the Secretary of the Interior (Secretary) finds it to be economically justified and financially feasible. Reclamation can only deliver water to approximately 102,600 acres authorized to receive CBP water within the Odessa Subarea. These lands form the the Odessa Subarea Special Study Area (Study Area) for this Special Study Report. Figure ES- 1 shows this overlap.

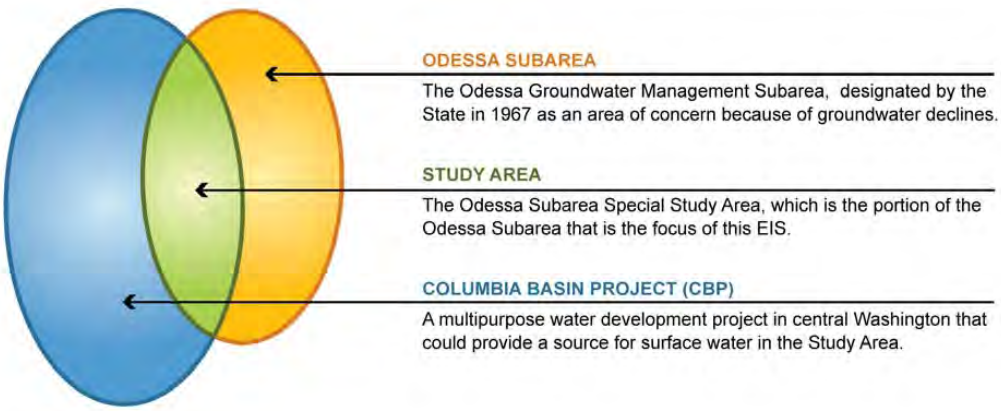


Figure ES- 1. Common location terms used in this Special Study Report

Problems and Opportunities

Since the early 1980s, groundwater levels have progressively dropped by 100 to 200 feet in nearly half of the production wells, at an average decline rate of 6 to 8 feet per year. Groundwater in the Odessa Subarea is currently being depleted to such an extent that water must be pumped from great depths. Most of the groundwater wells in the area currently are drilled to a depth of 800 to 1,000 feet, with maximum well depths as great as 2,100 feet. As a result of the current conditions of groundwater decline in the Odessa Subarea (including the Study Area), the ability of farmers to irrigate their crops is at risk. Domestic, commercial, municipal, and industrial uses, as well as water quality are also affected.

The overall area of decline has spread and deepened over the past 30 years as wells have been drilled deeper. Groundwater wells also are used to support municipal, industrial, and domestic uses in the Study Area. More than 80 percent of the public and domestic drinking water in the mid-Columbia Basin comes from groundwater. Similar to irrigation wells, the wells for municipal, industrial, and domestic uses also are at risk from dropping aquifer levels. For example, based on historical groundwater level data, water levels in some of the municipal and industrial wells have declined more than 100 feet in the past 30 years.

GWMA estimated that about 600 groundwater wells for irrigation exist in the Study Area. These wells have been classified into five levels that rank the wells from most dependable to least dependable. Level 1 (5 percent of all wells) and Level 2 wells (30 percent of all wells) are suitable for meeting the irrigation requirements of high-water-use crops such as potatoes for an entire irrigation season. Level 3 and Level 4 wells (combined, 60 percent of all wells) may be able to meet irrigation requirements for part of the year, but would not be able to meet the irrigation requirements for high-water-use crops for an entire irrigation season. Level 5 wells (5 percent of all wells) are assumed to have been abandoned. Acres previously irrigated with these wells typically go into a dryland wheat rotation.

The Level 2, 3, and 4 wells in the Study Area have been declining in dependability over time. Aquifer levels have been dropping, and farmers have been forced to deepen wells in order to sustain irrigated crop practices. These groundwater wells are expected to continue declining in dependability into the future and farmers would progressively discontinue pumping altogether due to pumping costs and water quality concerns.

This has prompted public concern about the declining aquifers and associated economic and other effects, which resulted in a directive by the U.S. Congress and the Washington Legislature to investigate the problem. This study investigates ways to:

- Address declining groundwater supply for agriculture and other uses in the Study Area;
- Evaluate and implement actions to avoid significant economic loss to the region's agricultural sector because of continued decline of groundwater supply; and
- Address environmental concerns and interests, including Columbia River seasonal flow objectives for salmon and steelhead, and habitats of importance to other sensitive species.

Plan Formulation

Reclamation began this Study in 2005. Reclamation's Plan of Study (POS) (Reclamation, 2006 [Odessa POS]) provided the study background and purpose, described potential issues, outlined study steps and requirements, and identified required resources. Reclamation completed a pre-appraisal-level investigation through a project alternative solutions study (PASS) in late 2006 (Reclamation, 2006 [PASS]). The Objectives Team and the Technical Team conducted the PASS together. The Objectives Team was comprised of various stakeholders in the Study area, including Federal and State agencies, local governments, Tribes, CBP irrigation districts, and groundwater irrigators. This team developed study objectives that were used to rank alternative concepts. The alternatives were screened using four "tests of viability" criteria for evaluating a Federal water resource project under the P&Gs, and the *Initial Alternative Development and*

Evaluation, Odessa Subarea Special Study, report was produced (Reclamation, 2006 [PASS]).

Reclamation completed an appraisal-level study in March 2008 entitled, *Appraisal-Level Investigation Summary of Findings* (Reclamation, 2008 [Appraisal]). The appraisal-level study covered the same Study Area as the Odessa DEIS. Four water delivery alternatives and six water supply options were evaluated.

Alternatives and Feasibility-Level Designs and Cost Estimates

Based on the outcomes of plan formulation, Reclamation evaluated eight action alternatives to replace groundwater used for irrigation with surface water for eligible acres in the Study Area. Under all of the action alternatives, current and ongoing Columbia River and CBP programs, commitments, and operations continue. The alternatives address the problems and opportunities to varying degrees, as well as a No Action Alternative.

The eight action alternatives fall into two groups—four partial-replacement alternatives, which would replace groundwater supplies south of I-90; and four full-replacement alternatives, which would replace groundwater supplies throughout the Study Area, both north and south of I-90. Within each of those groups, the four alternatives evaluate various combinations of water supply sources from Banks Lake, Lake Roosevelt, or a proposed Rocky Coulee Reservoir.

Delivery Systems

The action alternatives fall into two categories based on how much surface water is delivered and where it would be delivered to replace groundwater-irrigated acreage in the Study Area. Including the No Action Alternative, this creates three categories, as listed below:

- **Alternative 1—No Action**: No additional surface water supply would be provided from the CBP to replace groundwater-irrigated acreage in the Study Area. No new facilities would be built, and no existing facilities would be expanded. The only existing programs or activities that would address the declining groundwater conditions in the Study Area would be the incremental release from Lake Roosevelt (30,000 acre-feet to support agriculture in the Study Area), which is part of the Columbia River Management Program MOU and the Coordinated Conservation Program.

- **Alternative 2—Partial Groundwater Irrigation Replacement**: This category of delivery alternatives focuses on enlarging the existing East Low Canal and providing CBP surface water to approximately 57,000 acres currently using groundwater south of I-90 (Map 1-1). No surface water

replacement would be provided to most of the remaining groundwater-irrigated acres in the Study Area north of I-90. The total CBP surface water supply needed for the partial-replacement alternatives would be 176,343 acre-feet.

Major facility development necessary for the partial-replacement alternatives would include expanding the capacity of 43.3 miles of the existing East Low Canal south of I-90, extending the canal by 2.1 miles, and developing a pressurized pipeline system to distribute water from the canal to the farmlands.

- **Alternative 3—Full Groundwater Irrigation Replacement**: This category of delivery alternatives would provide CBP surface water to most groundwater-irrigated acreage in the Study Area (approximately 102,600 acres). Lands south of I-90 would be served by enlarging the East Low Canal, as described for the partial-replacement alternatives. Lands north of I-90 would be served by construction of the East High Canal system, as shown on Map 1-1. The total CBP surface water supply needed for the full-replacement alternatives would be 347,137 acre-feet.

In addition to the facilities described for the partial-replacement alternatives, the full-replacement alternatives would require construction of 71.6 miles of new canal, plus associated siphons, tunnels, wasteways, and a small re-regulating reservoir, as well as a pressurized pipeline distribution system.

Water Supply Options

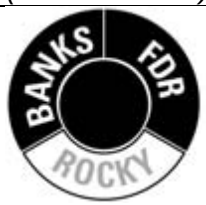
Water supply options that could store the replacement surface water supply for use in the Study Area consist of potential modification to the operations of existing CBP storage facilities, including Banks Lake and Lake Roosevelt (FDR), as well as the potential construction of a new Rocky Coulee Reservoir.

Range of Alternatives

Four different combinations of existing and new reservoirs are analyzed to provide stored water from the Columbia River. These combinations are analyzed for each of the two broad categories (partial- and full-replacement). Table ES- 1 shows the matrix for these alternatives and provides the alternatives' full names, symbols, and descriptions used in this Special Study Report and the Odessa DEIS.

Map 1-1 provides an overall map of the features for all alternatives.

Table ES- 1. Alternative Names

	Delivery Alternative 2: Partial Replacement	**Delivery Alternative 3: Full Replacement**
Water Supply Option A—Banks Lake, would use storage in and additional drawdowns from Banks Lake, exclusively	 Alternative 2A: Partial Replacement Using the Banks Lake Supply Option *(2A Partial—Banks)*	 Alternative 3A: Full Replacement Using the Banks Lake Supply Option *(3A Full—Banks)*
Water Supply Option B—Banks Lake and FDR, would use existing storage in Banks Lake and Lake Roosevelt, resulting in drawdowns from both reservoirs	 Alternative 2B: Partial Replacement Using the Banks Lake and FDR Supply Option *(2B Partial—Banks + FDR)*	 Alternative 3B: Full Replacement Using the Banks Lake and FDRSupply Option *(3B Full—Banks + FDR)*
Water Supply Option C—Banks Lake and Rocky Coulee Reservoir, would use existing storage in Banks Lake, plus a new Rocky Coulee Reservoir	 Alternative 2C: Partial Replacement Using the Banks Lake and Rocky Coulee Supply Option *(2C Partial—Banks + Rocky)*	 Alternative 3C: Full Replacement Using the Banks Lake and Rocky Coulee Supply Option *(3C Full—Banks + Rocky)*
Water Supply Option D—Banks Lake, Lake Roosevelt, and Rocky Coulee Reservoir, would use a combination of all three storage facilities.	 Alternative 2D: Partial Replacement Using the Banks Lake, FDR, and Rocky Coulee Supply Options Combined *(2D Partial—Combined)*	 Alternative 3D: Full Replacement Using the Banks Lake, FDR, and Rocky Coulee Supply Options Combined *(3D Full—Combined)*

Summary of Estimated Costs

The following table provides a summary of the estimated costs for the alternatives. These cost estimates should only be used to compare alternatives. All the alternatives used the same assumptions and unit prices, so these are directly comparable from a cost standpoint. "Construction Costs" includes field costs—the costs to construct the facilities and noncontract costs. "Noncontract costs" include land acquisition, engineering and design, permitting, and other costs. "IDC" stands for Interest During Construction, and "OMR&P" refers to Operation, Maintenance, Replacement, and Power.

Table ES- 2. Summary of Alternative Cost Estimates ($ millions)

Alternative	Construction Costs	IDC Costs	Total Costs	Maximum Annual OMR&P Costs (Year 2045+)*
1: No Action	--	--	--	$3.3
2A: Partial—Banks	$728.3	$113.3	$841.6	$6.9
2B: Partial—Banks + FDR	$728.3	$113.3	$841.6	$6.9
2C: Partial—Banks + Rocky	$1,004.5	$160.4	$1,164.9	$7.9
2D: Partial—Combined	$1,004.5	$160.4	$1,164.9	$7.9
3A: Full—Banks	$2,582.4	$408.7	$2,991.1	$15.9
3B: Full—Banks + FDR	$2,582.4	$408.7	$2,991.1	$15.9
3C: Full—Banks + Rocky	$2,858.6	$455.8	$3,314.4	$17.0
3D: Full—Combined	$2,858.6	$455.8	$3,314.4	$17.0

* Since the construction periods vary by phase, this maximum annual OMR&P cost does not occur until year 2045 after all construction phases are completed.

Summary of Accounts

National Economic Development (NED) Account

The Federal objective is to contribute to national economic development consistent with protecting the Nation's environment. The NED account measures the beneficial and adverse monetary effects of each alternative in terms of changes in the value of the national output of goods and services.

A NED benefit-cost analysis (BCA) compares the benefits of a proposed project to its costs. The total costs of the project are subtracted from the total benefits to measure net benefits. Benefits associated with the action alternatives were measured as changes from the No Action Alternative. If the net benefits are positive, implying that benefits exceed costs, the project could be considered economically justified. In studies where multiple alternatives are being considered, the alternative with the greatest positive net benefit would be preferred from strictly an economics perspective.

The NED BCA results for the four partial-replacement alternatives are presented in Table 5- 35 in Chapter 5. Total benefits were estimated at $1,170.2 million for all four partial-replacement alternatives. Total costs vary by alternative and range from $1,276.7 million to $1,726.1 million. Therefore, all of the partial-replacement alternatives result in negative net benefits (-$106.5 to -$555.9 million) and benefit-cost ratios of less than one (.917 to 678). As a result, none of these alternatives are considered economically justified.

The NED BCA results for the four full-replacement alternatives are also presented in Table 5- 35 in Chapter 5. To summarize, total benefits were estimated at $1,820.5 million for all four full-replacement alternatives. Total costs vary by alternative, ranging from $4,148.6 million to $4,597.9 million. Therefore, all of the alternatives result in negative net benefits (-$2,328.1 to -$2,777.4 million) and benefit-cost ratios of less than one (0.439 to 0.396). As a result, none of these alternatives are considered economically justified.

Regional Economic Development (RED) Account

This account evaluates the beneficial and adverse impacts of each alternative on the economy of the affected region, with particular emphasis on income and employment measures. The affected region reflects the geographic area where significant impacts are expected to occur. Impacts can be measured in both monetary and nonmonetary terms.

The RED analysis includes not only the initial or direct impact on the primary affected industries, but also the secondary impacts resulting from those industries providing inputs to the directly affected industries as well. This analysis also includes the changes in economic activity stemming from household spending of income earned by those employed in the sectors of the economy impacted either directly or indirectly. These secondary impacts are often referred to as “multiplier effects.” The common measures of regional economic impacts include employment (jobs), income, and regional output (sales).

The No Action Alternative would have minimal adverse impacts from a regional perspective. The four-county analysis area would see a small (less than 1 percent) net decrease in jobs, labor income, and sales. The partial-replacement alternatives would have minimal beneficial effects. There would be less than a 2 percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative. The full-replacement alternatives would

have minimal beneficial effects. There would be less than 6 percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative. These impacts are summarized in Table 5- 35 in Chapter 5 of this report.

Environmental Quality (EQ) Account

This account displays the effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources which cannot be adequately measured in monetary terms within the NED and RED accounts. The EQ analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa DEIS and summarized in Section 4.8, "Summary of Impacts," of this Special Study Report. The EQ resources considered are groundwater, water quality, vegetation and wetlands, wildlife and wildlife habitat, fisheries and aquatic resources, cultural resources, and visual resources.

Impacts were compared using indicators, a characteristic of an EQ resource that serves as a direct or indirect means of measuring or otherwise describing changes in the quantity and/or quality of an EQ resource. Scores within each impact indicator were assigned on a simple scale of 0 (No Impact) through +4 (most beneficial) or -4 (most adverse). Table ES- 3 shows the total EQ score for each alternative, listed from best to worst.

Table ES- 3. EQ rankings for alternatives

Alternative	Total EQ Score
No Action	-2.0
2C: Partial—Banks + Rocky	-2.8
2A: Partial—Banks	-2.9
2B: Partial—Banks + FDR	-2.9
2D: Partial—Combined	-5.1
3B: Full—Banks + FDR	-10.9
3D: Full—Combined	-12.2
3C: Full—Banks + Rocky	-16.3
3A: Full—Banks	-16.9

Other Social Effects (OSE) Account

This account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. Like the EQ account, the OSE analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa DEIS and summarized in Section 4.8, "Summary of Impacts" of this Special Study Report.

The OSE resources considered are land use and shoreline resources, recreation resources, and transportation

Impacts were compared using the same analyses techniques described for the EQ Account (see Section 5.3.1, "EQ Methodology"). Table ES- 4 shows the total OSE score for each alternative, listed from best to worst.

Table ES- 4. OSE rankings for alternatives

Alternative	Total OSE Score
No Action	0
2A: Partial—Banks	-1.3
2B: Partial—Banks + FDR	-1.3
3B: Full—Banks + FDR	-2.5
3A: Full—Banks	-4.7
2C: Partial—Banks + Rocky	-5.4
2D: Partial—Combined	-6.2
3D: Full—Combined	-7.3
3C: Full—Banks + Rocky	-8.1

Findings and Conclusions

Based on feasibility-level engineering and design, all of the eight action alternatives are technically viable.

The purpose of the Odessa Special Study is to assess the effects of potential replacement of groundwater currently used for irrigation in the Odessa Subarea Special Study Area (Study Area) with CBP surface water.

The Study responds to four specific needs in the study area:

- Address declining groundwater supply for agriculture and other uses in the Study Area,
- Avoid significant economic loss to the region's agricultural sector because of decline of groundwater,
- Address environmental concerns and interests, and
- Fulfill commitments by Reclamation, the State, and CBP irrigation districts to conduct the Study.

Water Supply

The Full-Replacement Alternatives supply approximately 102,600 acres with surface water supply. The Partial-Replacement Alternatives supply surface water to about 57,000 of the approximate 102,600 eligible acres.

Groundwater wells are also used to support municipal, industrial, and domestic uses in the Study Area. More than 80 percent of the public and domestic drinking water in the mid-Columbia Basin comes from groundwater. Similar to irrigation wells, the wells for municipal, industrial, and domestic uses also are at risk from dropping aquifer levels. Converting from 57,000 to 102,600 plus irrigated acres from groundwater to surface water within the study area could alleviate groundwater level declines thereby aiding municipal, industrial, and domestic uses.

Agricultural Production

As discussed in the Odessa DEIS, Gross Farm Income was calculated by multiplying the number of acres of representative crops by yield per acre and the price received for each unit of yield. This amount was then used as an input for the RED analysis presented in this Special Study Report. Following are the findings from this analysis:

- Under current 2010 conditions, the average annual gross farm income for the Study Area is $110.9 million. The average annual gross farm income for the surrounding four-county region is $1.6 billion. Thus, the Study Area's gross farm income accounts for 6.9 percent of the gross farm income generated in the four-county region.
- Under the No Action Alternative, about 50,000 acres of the currently irrigated acres in the Study Area would revert to dryland by 2025 (as irrigation wells continue to decline in usability). Annual gross farm income for the Study Area would decline from the current level of $110.9 million to $42.7 million by 2025, a 60-percent decrease. The gross farm income for the Study Area of $42.7 million would be less than 3 percent of the $1.6 billion gross farm income for the surrounding four-county region in 2025.
- Under any of the four partial-replacement alternatives, about 50 percent fewer acres would revert to dryland by 2025 (at the end of all construction phases) compared to the No Action Alternative. By 2025, partial-replacement alternatives would provide $36.5 million more in gross farm income than the No Action Alternative. The change in gross farm income of $36.5 million would be less than 3 percent of the gross farm income for the surrounding four-county region in 2025.
- Under any of the four full-replacement alternatives, no currently irrigated acres in the Study Area would revert to dryland after the completion of the construction phases in 2025. The full-replacement alternatives each provided an increase of $65.7 million in gross farm income compared to the No Action Alternative. The change in gross farm income of $65.7 million would be less than 5 percent of the gross farm income ($1.6 billion) for the surrounding four-county region in 2025.

Environmental Considerations—Columbia River Flow Targets

None of the Study's eight action alternatives would result in a significant change in Columbia River flows. Current instream flow requirements intended to protect resource values would continue to be met as a first priority in all hydrologic conditions. Water management programs and requirements are in place that establish minimum flows and levels for the Columbia River to protect the resource values associated with the mainstem of the Columbia River, including ESA-listed fish species in the river.

Instead, providing CBP surface water to lands in the Study Area would require changing reservoir operations during and immediately after the irrigation season at Banks Lake for all action alternatives and at Lake Roosevelt for Alternatives 2B, 2D, 3B, and 3D, as shown on Table 2-1. At both reservoirs, these changes would mean increased drawdowns—and therefore lower pool levels—when compared with the No Action Alternative. In all cases, the increased drawdowns would reach their minimum elevations at the end of August. The Rocky Coulee Reservoir proposed in Alternatives 2C, 2D, 3C, and 3D would be a working reservoir, filled and emptied each year exclusively to provide irrigation water supply.

Four-Account Analysis

National Economic Development (NED) Account

Benefit-cost comparisons of alternatives were made by dividing total project benefits by total project costs—resulting in the benefit-cost ratio (BCR). For benefits to exceed costs, a BCR greater than one is required. Before comparison, all benefits and costs were converted to a common point in time across all alternatives – that is, the year 2025, which is assumed as the end of the construction period for any of the action alternatives.

- The highest BCR of 0.917 was calculated for two of the partial-replacement alternatives—Alternatives 2A and 2B. These two alternatives would utilize existing facilities for water supply (that is, Banks Lake for Alternative 2A, and Banks Lake and Lake Roosevelt for Alternative 2B), and are therefore less costly (for the same level of benefits) then Alternatives 2C and 2D, which would both include a new water supply (Rocky Coulee Reservoir). A BCR of 0.678 was calculated for each of Alternatives 2C and 2D.

- Lower BCRs were calculated for full-replacement alternatives compared to the partial-replacement alternatives. A BCR of 0.439 was calculated for Alternatives 3A and 3B, and a BCR of 0.396 was calculated for Alternatives 3C and 3D. Although the full-replacement alternatives would provide about $650 million more in benefits than the partial-replacement alternatives, the full-replacement alternatives would cost at least $2.4 billion more for

construction and operation of delivery and storage facilities, including a new 80-mile East High Canal.

Regional Economic Development (RED) Account

This account evaluates the beneficial and adverse impacts of each alternative on the economy of the affected region, with particular emphasis on income and employment measures. The affected region reflects the geographic area where significant impacts are expected to occur. The No Action Alternative would have minimal adverse impacts from a regional perspective. The four-county analysis area would see a small (less than 1 percent) net decrease in jobs, labor income, and sales. The partial-replacement alternatives would have minimal beneficial effects. There would be a less than 2-percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative. The full-replacement alternatives would have minimal beneficial effects. There would be a less than 6-percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative.

Environmental Quality (EQ) Account

This account displays the effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources which cannot be adequately measured in monetary terms within the NED and RED accounts. Impacts were compared using indicators, a characteristic of an EQ resource that serves as a direct or indirect means of measuring or otherwise describing changes in the quantity and/or quality of an EQ resource. Scores within each impact indicator were assigned on a simple scale of 0 (No Impact) through +4 (most beneficial) or -4 (most adverse). The EQ score for No Action was -2.0. EQ scores for the partial replacement alternatives ranged from -2.8 to -5.1 whiles scores for the full replacement alternatives ranged from -10.9 to -16.9.

Other Social Effects (OSE) Account

This account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. The same methodology and scale was used for the OSE account as for the EQ account. The OSE score for No Action was 0. The OSE scores for the partial replacement alternatives ranged from -1.3 to -4.7, while scores for the full replacement alternatives ranged from -5.4 to -8.1.

Conclusions

Reclamation and Ecology will carefully consider all comments received on the DEIS during the public comment period. Substantive comments will be addressed in the final EIS by modifying alternatives, supplementing the analyses, or making factual corrections as appropriate. Based on feedback from the public on the DEIS and in consultation with study partners, Reclamation and Ecology will choose a preferred alternative for inclusion in the final EIS and Special Study Report.

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Chapter 1: Location, Purpose, and Authority

This chapter provides an introduction and background and describes the location; purpose, scope, and objectives; and the study authority.

The Bureau of Reclamation (Reclamation), Washington State Department of Ecology (Ecology), and Columbia Basin Project (CBP) irrigation districts are conducting the Odessa Subarea Special Study (Study) to investigate the continued phased development of the CBP to replace groundwater currently used for irrigation in the Odessa Ground Water Management Subarea (Odessa Subarea) with CBP surface water.

This feasibility-level Special Study Report is prepared in compliance with the requirements of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies* (U.S. Water Resources Council, 1983) (P&Gs). The P&Gs represent the main set of project evaluation guidelines for Federal water management agencies. This report presents a discussion of the formulation of alternatives, a description of the alternatives considered, and the results of the P&Gs-specific analyses.

Information in this Special Study Report is based on a variety of sources, including the Odessa Subarea Special Study Draft Environmental Impact Statement (Odessa DEIS).

Technical reports containing the feasibility-level drawings and cost estimates are available at http://www.usbr.gov/pn/programs/ucao_misc/odessa/

Further background information is available at the following websites:

- Washington State Department of Ecology Office of Columbia River, Odessa Subarea Special Study: http://www.ecy.wa.gov/programs/wr/cwp/cr_odessa.html

- Reclamation's Pacific Northwest Region, Columbia-Cascades Area Office, Odessa Subarea Special Study: http://www.usbr.gov/pn/programs/ucao_misc/odessa/

1.1. Location

1.1.1 Columbia Basin Project

The CBP is a multipurpose water development project in the central part of the State of Washington (State), east of the Cascade Range. The key structure, Grand Coulee Dam, is on the mainstem of the Columbia River about 90 miles west of

Spokane. The CBP currently serves a total of about 671,000 acres in Grant, Adams, Walla Walla, and Franklin Counties, with some northern facilities located in Douglas County.

Principal project features include Grand Coulee Dam, Franklin D. Roosevelt Lake, Grand Coulee Powerplant Complex, switchyards, and the John W. Keys III Pump-Generating Plant. Primary irrigation facilities are the Feeder Canal, Banks Lake, the Main, West, East High (as part of future phased development), and East Low Canals, O`Sullivan Dam, Potholes Reservoir, and Potholes Canal. There are over 300 miles of main canals, about 2,000 miles of laterals, and 3,500 miles of drains and wasteways on the project. The irrigation portion of the CBP begins at the head of the Grand Coulee and extends 152 miles to the confluence of the Snake and Columbia Rivers. The Columbia River forms the western boundary of the CBP near the City of Quincy and the project extends east 60 miles to near the Cities of Odessa and Lind.

The CPB irrigates about 671,000 acres with an average annual diversion of 2.65 million acre-feet as measured at the Main Canal from 2000 to 2004. Up to 67 different crops are grown, with more than a half billion dollars of crop value each year, including alfalfa, potatoes, apples, and vegetables. In addition to irrigation, the CBP provides power production, flood control, municipal water supply, recreation, and fish and wildlife benefits. Irrigation return flows from the CBP are discharged into the Columbia River through wasteways, creeks, and groundwater seepage.

Three irrigation districts and other miscellaneous lands receive CBP water:

- Quincy-Columbia Basin Irrigation District (QCBID): serves 247,122 acres
- East Columbia Basin Irrigation District (ECBID): serves 152,000 acres
- South Columbia Basin Irrigation District (SCBID): serves 232,000 acres
- Miscellaneous parcels: 39,878 acres

1.1.2 Odessa Subarea

The Odessa Subarea is in the eastern part of the CBP and overlaps the CBP boundaries. In 1967, the Washington Legislature designated the Odessa Subarea as a ground water management area because of groundwater level declines resulting from pumping (Washington Administrative Code [WAC] 173-128A, *Odessa Ground Water Management Subarea*). Lands within the Odessa Subarea which are eligible for surface water from the CBP form the Odessa Subarea Special Study Area (Study Area) for this Special Study Report. Figure 1- 1 shows these relationships. Map 1-1 shows a map of the study area and its environs.

1.2. Purpose, Scope, and Objectives

The purpose of the Study is to evaluate alternatives that would deliver surface water from the CBP to replace declining groundwater supply currently used for irrigation in the Study Area. This surface water would be provided as part of the continued phased development of the CBP and would come from existing surface water rights in the Columbia River system.

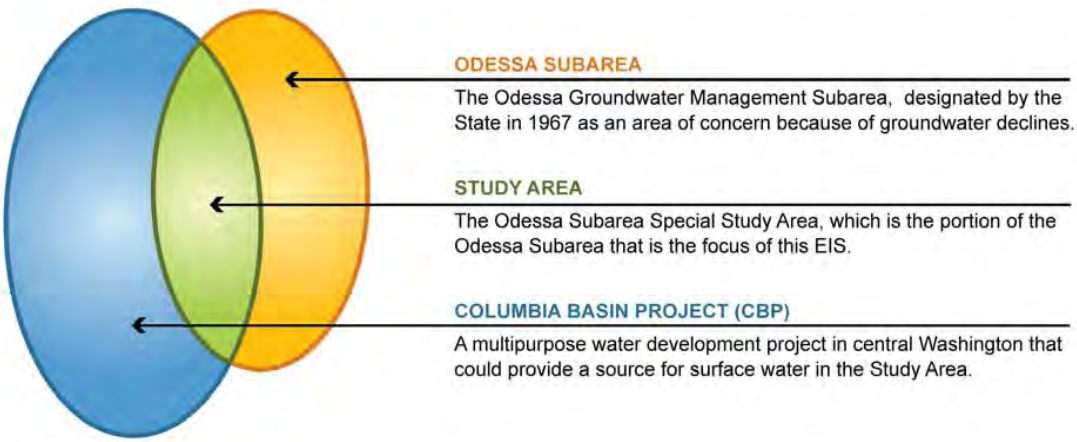


Figure 1- 1. Common Location Terms Used in this Special Study

The Study is evaluating alternatives to replace groundwater supply with surface water to irrigate existing groundwater-irrigated acres. Reclamation can only deliver water to lands authorized to receive CBP water. As such, approximately 102,600 groundwater-irrigated acres in the study area are eligible to receive CBP surface water.

1.3. Authority

The Grand Coulee Dam Project was authorized for construction by the Act of August 30, 1935, and reauthorized and renamed in the Columbia Basin Project Act of March 10, 1943. Congress authorized the CBP to irrigate a total of 1,029,000 acres.

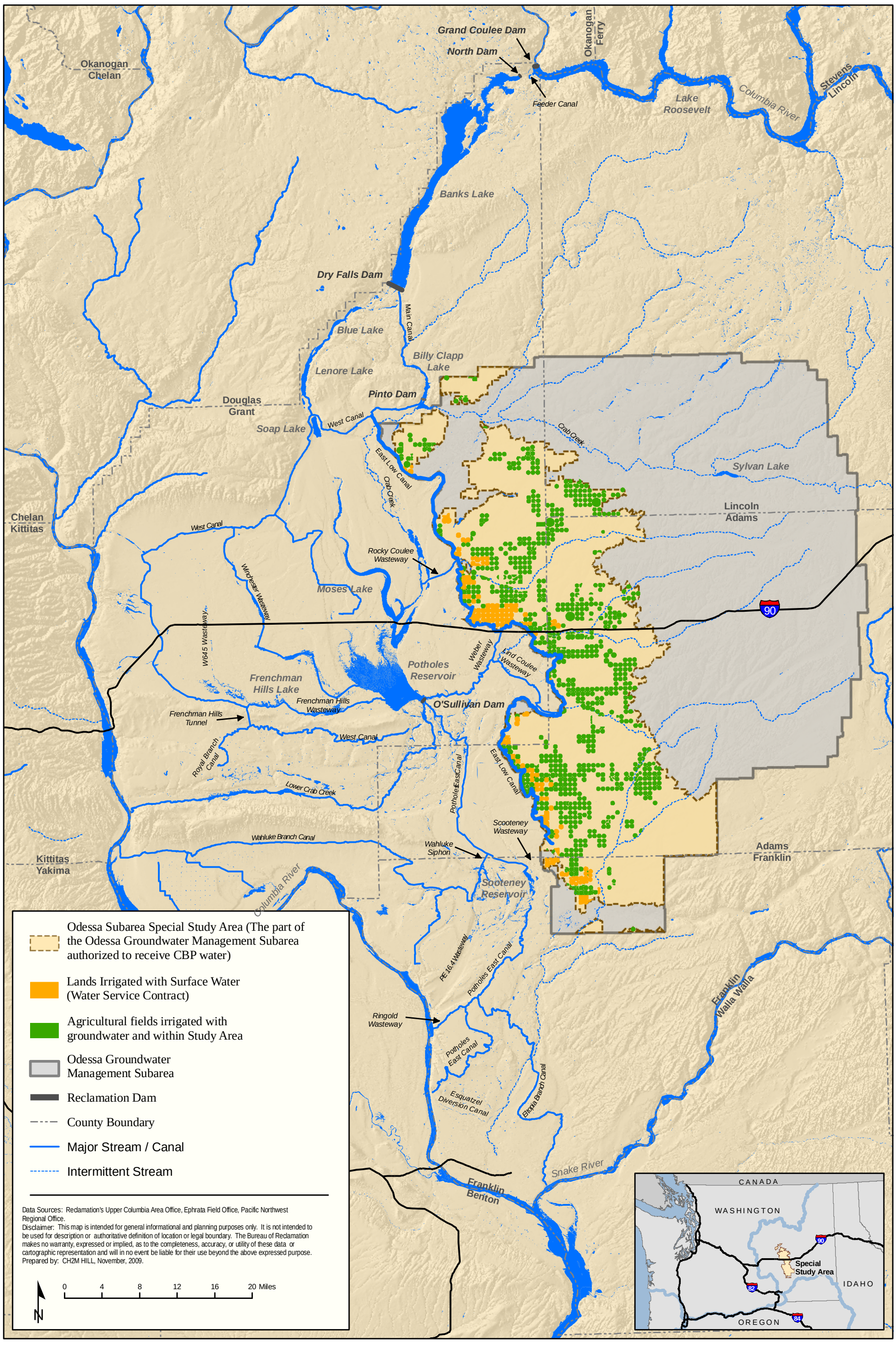
The 1943 Columbia Basin Project Act subjected the CBP to the requirements of the Reclamation Project Act of 1939. Section 9(a) of the Act of 1939 gave authority to the Secretary of the Interior (Secretary) to approve a finding of feasibility and thereby authorize construction of a project upon submitting a report to the President and the Congress. The Secretary approved a plan of development for the Columbia Basin Project (Reclamation, 1944), which was then transmitted as a joint report known as House Document No. 172 to the President and to the House Irrigation and Reclamation Committee in 1945,

thereby satisfying these requirements (referred to in this document as "1945 feasibility report"). (When the Secretary recommended a project to Congress, the feasibility report and Reclamation's Regional Director's report were customarily printed as a House Document.) The Odessa Subarea Special Study is conducted under the authority of this Act, as amended, and the Reclamation Act of 1939.

Acting for the Secretary, Reclamation is authorized to implement additional development phases of the CBP as long as the Secretary finds it to be economically justified and financially feasible. In response to the public's concern about the declining groundwater supply in areas of the CBP and associated economic and other effects, Congress funded Reclamation to investigate the problem. The State is partnering with Reclamation by providing substantial funding and collaborating on interagency relationships, public outreach, and various technical studies.

Following the signing of the Columbia River Initiative MOU, the State legislature passed the Columbia River Water Resource Management Act (Management Act; Engrossed Substitute House Bill [ESHB] 2860) in February 2006. The Management Act directs Ecology to aggressively pursue development of water benefiting both instream and out-of-stream uses through storage, conservation, and voluntary regional water management agreements. Among the activities identified in the legislation, Ecology is directed to focus on "development of alternatives to groundwater for agricultural users in the Odessa subarea aquifer." The Management Act also created a Columbia River Basin development account. Ecology's participation in this Special Study is part of that program.

Ecology has been further directed by the State legislature to aggressively pursue new water supplies for instream and out-of-stream use. The Odessa Subarea is a high priority for the State, as it occurs first on the list of projects in the legislation concerning the allocation and development of water supplies (RCW 90.90.020, *Allocation and Development of Water Supplies*). In addition, Ecology is participating in this Special Study to provide support for State and local agency permitting decisions that will likely be necessary to implement a water delivery project.



Map 1-1. Location Map

Chapter 2: Need for Action

This chapter defines the problems, needs, and opportunities for plan formulation. The potential for alleviating problems and opportunities was determined during inventorying and forecasting water and related land resource conditions.

2.1. Problems and Opportunities

The Study is needed to evaluate and implement actions to avoid significant economic loss, in the near term, to the region's agricultural sector because of resource conditions associated with continued decline of groundwater supply in the Odessa Subarea.

2.1.1 Address Declining Groundwater Supply for Agriculture and Other Uses

Groundwater in the Odessa Subarea is currently being depleted to such an extent that water must be pumped from great depths. Most of the groundwater wells in the area currently are drilled to a depth of 800 to 1,000 feet, with maximum well depths as great as 2,100 feet. In addition, the groundwater level in wells continues to decline steadily. In nearly half of the production wells in the Odessa Subarea, groundwater levels have dropped by more than 100 feet and as much as 200 feet since 1981.

Figure 2- 1 shows a continuous declining trend in measurements of groundwater levels in three representative wells of up to 180 feet over the past 30 years (with best available data). While not all wells have shown declines, the overall area of decline has spread and deepened over the past 30 years as wells have been drilled deeper. Public concern about the declining aquifers and associated economic and other effects has resulted in funding for Reclamation by Congress and funding for Washington State by the State legislature to investigate the problem. Figure 2- 2 shows a map of these declines.

Pumping water from such great depths has resulted in water quality concerns such as high water temperatures and sodium concentrations. Pumping water from these depths has also resulted in expensive power costs. As a result of this groundwater decline, the ability of farmers to irrigate their crops is at risk. Domestic, commercial, municipal, and industrial uses, as well as water quality, are also affected. Those irrigating with wells, even of lesser (shallower) depth, live with uncertainty about future well production. In the near term, the pumping efficiency of—and groundwater output from—production wells in the Odessa Subarea will continue to steadily decrease.

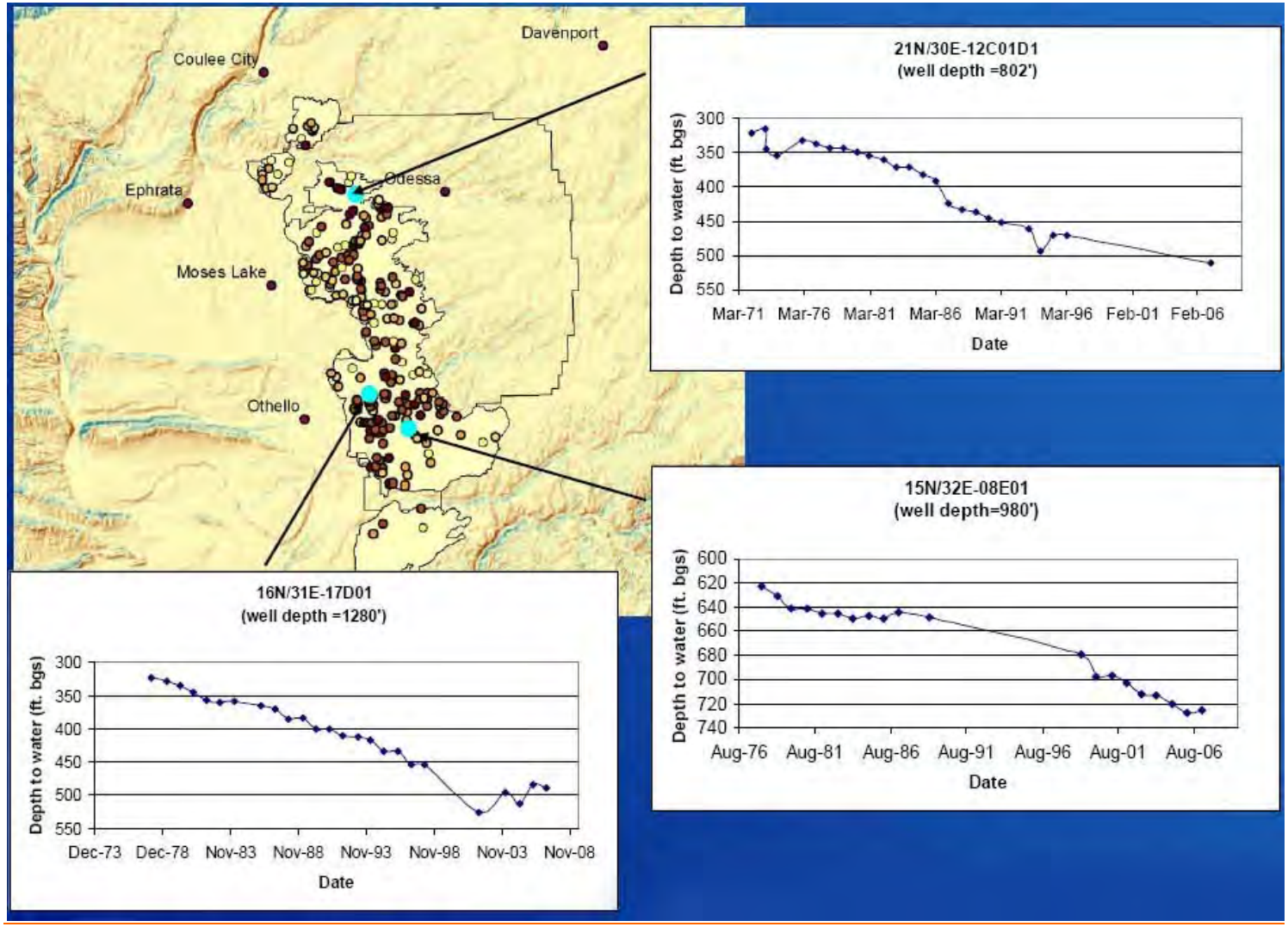


Figure 2- 1. Declining trend in measurements of groundwater levels in three example wells with best available data

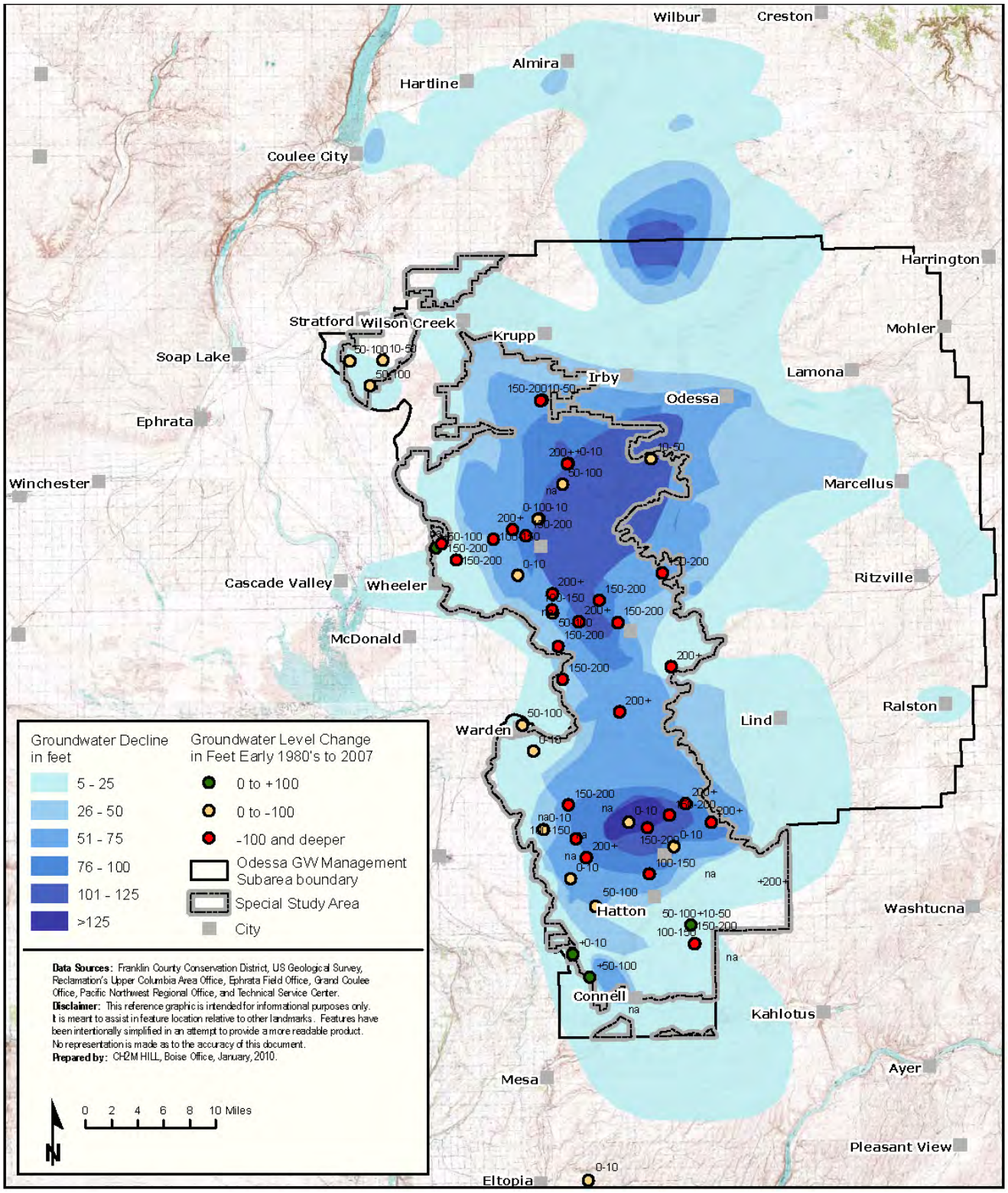


Figure 2- 2. Groundwater Level Decline in Aquifers of the Odessa Subarea (1981-2007)

Based on current trends, it is estimated that declining conditions will result in failure of the groundwater supply for most currently groundwater-irrigated lands in the study area within 10 years.

2.1.1.1. Irrigation Uses

The Columbia Basin Ground Water Management Area (GWMA) estimated that about 600 groundwater wells for irrigation exist in the Study Area. These wells have been classified into five levels that rank the wells from most dependable to least dependable. Level 1 (5 percent of all wells) and Level 2 wells (30 percent of all wells) are suitable for meeting the irrigation requirements of high water-use crops such as potatoes for an entire irrigation season. Level 3 and Level 4 wells (together, 60 percent of all wells) may be able to meet irrigation requirements for part of the year, but would not be able to meet the irrigation requirements for high-water-use crops for an entire irrigation season. Level 5 wells (5 percent of all wells) are assumed to have been abandoned. Acres previously irrigated with these wells typically go into a dryland wheat rotation (GWMA, 2010 [Conditions]).

The Level 2, 3, and 4 wells in the study area have been declining in dependability over time. Aquifer levels have been dropping and farmers have been forced to deepen wells in order to sustain irrigated crop practices. These groundwater wells are expected to continue declining in dependability into the future, and farmers would progressively discontinue pumping altogether due to pumping costs and water quality concerns.

2.1.1.2. Municipal, Industrial, and Domestic Uses

Groundwater wells also are used to support municipal, industrial, and domestic uses in the Study Area. More than 80 percent of the public and domestic drinking water in the mid-Columbia Basin comes from groundwater. Similar to irrigation wells, the wells for municipal, industrial, and domestic uses are also at risk from dropping aquifer levels. For example, based on historical groundwater level data, water levels in some of the municipal and industrial wells have declined more than 100 feet in the past 30 years.

The municipalities in the area that use groundwater for public supply include Moses Lake, Warden, Othello, Ritzville, Connell, Odessa, Lind, Hatton, and Wilson Creek. According to the Ecology database of well logs <http://apps.ecy.wa.gov/welllog/>, there are a total of 18 wells in the study area that serve these municipalities (Ecology, 2010). These municipal wells range from about 700 to 1,000 feet in depth, and have yields ranging from 400 to 2,000 gallons per minute (gpm). Industrial users of groundwater in the study area include primarily food processing plants to produce frozen foods such as potatoes and beans. These facilities are located primarily in Othello, Warden, and Moses Lake. The Ecology database of well logs includes 19 wells in the study area that serve these industrial users. The wells used by these facilities range in size and

depth, and are based on the water needs of the facilities. The wells range in depth from 100 to more than 1,000 feet. Several of the smaller wells produce around 100 gpm, but the larger, deeper wells produce up to 2,000 gpm.

Several hundred domestic wells have been drilled in the study area and are used for household water supply. These wells are typically completed in either the overburden sediments or the Wanapum Basalt unit, and are usually less than about 400 feet deep. As with the larger wells for irrigation, municipal, and industrial uses, the shallow domestic wells are also experiencing declining water levels in some areas. In these domestic wells, the shallow groundwater seeps downward through fractures and open boreholes into the declining deeper aquifers.

2.1.2 Avoid Significant Economic Loss

Washington State University conducted a regional economic impact study assessing the effects of lost potato production and processing in Adams, Franklin, Grant, and Lincoln counties from continued groundwater decline. Assuming that all potato production and processing is lost from the region, the analysis estimated the regional economic impact would be a loss of about $630 million dollars annually in regional sales, a loss of 3,600 jobs, and a loss of $211 million in regional income (Bhattacharjee and Holland, 2005).

Since the publication of the purpose and need statement in the Federal Notice of Intent initiating the process for preparing the Draft EIS (published August 2008), additional economic studies have been conducted that convey differing results. Depending upon the study assumptions, geographic scope, and sectors of the economy included in each analysis, the level of projected economic impact varies. These studies capture a range of perspectives on economic impact and are described in the Draft EIS, Chapter 4, Section 4.15, “Irrigated Agriculture and Socioeconomics.”

2.1.3 Address Environmental Concerns and Interests

The Study is needed to address environmental concerns and interests, including Endangered Species Act (ESA) matters. For example, important objectives of the Study include ensuring that alternatives are consistent with the 2008 National Marine Fisheries Service (NMFS) Biological Opinion for salmon and steelhead, and that potential impacts are avoided or minimized to habitats of importance to other sensitive species (see Section 2.2.1).

2.1.4 Fulfill Reclamation’s and Ecology’s Obligations in the Columbia River Initiative

The Study is needed to fulfill the commitment by Reclamation, the State, and CBP irrigation districts to cooperatively conduct the Study as stipulated in the Columbia River Initiative Memorandum of Understanding (MOU) in December

2004 (Ecology, 2004). The MOU promotes a cooperative process for implementing activities to improve water management within the CBP. The Study implements Section 15 of the MOU, which states in part that, "[t]he parties will cooperate to explore opportunities for delivery of water to additional existing agricultural lands within the Odessa Subarea."

2.2. Study Constraints

Legal influences, regulations, authorities, the goals and missions of all participants, and the overall purpose of the action must be considered in the planning process. Operational requirements at Grand Coulee Dam and Lake Roosevelt that affect the timing of water withdrawals are constraints in this study and discussed in this section.

2.2.1 Federal Columbia River Power System 2008 NMFS Biological Opinion and 2010 Supplemental Biological Opinion

The action agencies (U.S. Army Corps of Engineers [Corps], Bonneville Power Administration [BPA], and Reclamation) operate the Federal Columbia River Power System (FCRPS) in accordance with the 2008 NMFS Biological Opinion[1] and the 2010 NMFS Supplemental Biological Opinion. Operating criteria under the biological opinions affect the timing and amount of water that is available for the Odessa Subarea.

Table 2- 1 lists some of the mitigation measures and associated constraints under the biological opinions that are particularly applicable to the Odessa Study Area.

Table 2- 1. Mitigation Measures and Associated Constraints on the Odessa Subarea Special Study by the 2008 FCRPS NMFS Biological Opinion and Fish Accords

Agreement	Summary Description	Constraints on Odessa Study
Actions 1 and 4[1]	Dictates storage project operations for all types of water years. CBP operations at Grand Coulee Dam and Lake Roosevelt include drafting the reservoir to support salmon flow objectives during July and August with a variable draft limit of elevation 1,278 to 1,280 feet by August 31, based on the water supply forecast. Currently, the lower draft of elevation 1,278 feet is to be limited to	Numerous other operational requirements are in place at Lake Roosevelt: Operate to be at the April 10 Upper Rule Curve. Refill to elevation 1,290 feet by July 4 (Reclamation cannot implement actions that would prevent the reservoir from being full on July 4).

[1] Whenever a Federal action may adversely affect listed species, the ESA requires that the action agency (the Corps, BPA, and Reclamation) formally consult with a consulting agency (in this case, NMFS) that evaluates the effects of the proposed action on the listed species. The evaluation is contained in a biological opinion.

Table 2- 1. Mitigation Measures and Associated Constraints on the Odessa Subarea Special Study by the 2008 FCRPS NMFS Biological Opinion and Fish Accords

Agreement	Summary Description	Constraints on Odessa Study
	those years when the April-to-August runoff volume is less than 92 million acre-feet (approximately 50 percent of the years of record) (Graves, et al., 2007). This element of reasonable and prudent alternative Action 4 is subject to future evaluation and modeling (NMFS, 2008).	Operate for chum salmon flows (at times, Reclamation must draft Lake Roosevelt to provide flows below Bonneville Dam from November through April 10). Provide flows for Priest Rapids from April through June. Refill to elevation 1,283 feet by the end of September. Draft an additional 1 to 1.8 feet by the end of August for the Lake Roosevelt Incremental Storage Releases Project.
Action 14*	Reasonable and prudent alternative Action 14 is for dry-water-year operations. Two of the specific elements within Action 14 call for the action agencies to convene a technical workshop to scope and investigate alternative strategies for dry water year operations, and to consider annual and future long-term agreements between the U.S. and Canada (NMFS, 2008).	The dry-year study would look at shaping the Lake Roosevelt Incremental Storage Releases Project water in April, May, and June in the 20-percent driest water years. This may impact Reclamation's ability to refill Lake Roosevelt.
Columbia Basin Fish Accords	On May 2, 2008, several Memoranda of Agreement (MOA), referred to as the Columbia Basin Fish Accords, were signed by the action agencies (Reclamation, Corps, and BPA) and the following: • The Confederated Tribes of the Colville Reservation • Three of the Treaty Tribes (the Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation, and the Confederated Tribes and Bands of the Yakama Nation) • The Columbia River Inter-Tribal Fish Commission • The State of Idaho • The State of Montana	The goal of these agreements is to acknowledge the substantive role of Tribes and States as managers of the fish resource, provide greater long-term certainty for fish restoration funding, support and enhance the actions contemplated in the NMFS Biological Opinions for listed salmon and steelhead and improve their prospects for recovery, foster a partnership toward our mutual goal of protecting and recovering fish and wildlife, and provide for the parties to work together to assure the agencies' responsibilities under the ESA, Northwest Power Act, and Clean Water Act are satisfied. Additional MOAs are under negotiation between other northwest Tribes and States, and an MOA was signed between the

Table 2- 1. Mitigation Measures and Associated Constraints on the Odessa Subarea Special Study by the 2008 FCRPS NMFS Biological Opinion and Fish Accords

Agreement	Summary Description	Constraints on Odessa Study
		action agencies and the Shoshone-Bannock Tribes on November 7, 2008. An MOA for Estuary Habitat was signed between the Action Agencies and the State of Washington on September 16, 2009.

[1]Actions are from the 2008 Biological Opinion (NMFS, 2008)

2.2.2 Columbia River Regulation

The construction and operation of dams and reservoirs on the river's mainstem and tributary streams, as well as system operations, have significantly impacted the annual flow patterns (hydrograph) of the Columbia River. Regulation of the system through the use of dams has compressed the river's annual discharge patterns as original high-season flows have decreased and low-season flows have increased.

Lake Roosevelt fluctuates seasonally and daily in response to a complex set of demands from irrigation and flood control to fish flows and hydropower. Within these constraints, Reclamation also strives to support recreational use by minimizing drawdowns during the recreation season. Figure 2- 3 illustrates historical drawdown in Lake Roosevelt. The deep drawdowns shown in 1969 and 1974 are due to construction of the third powerplant associated with the Grand Coulee Powerplant Complex.

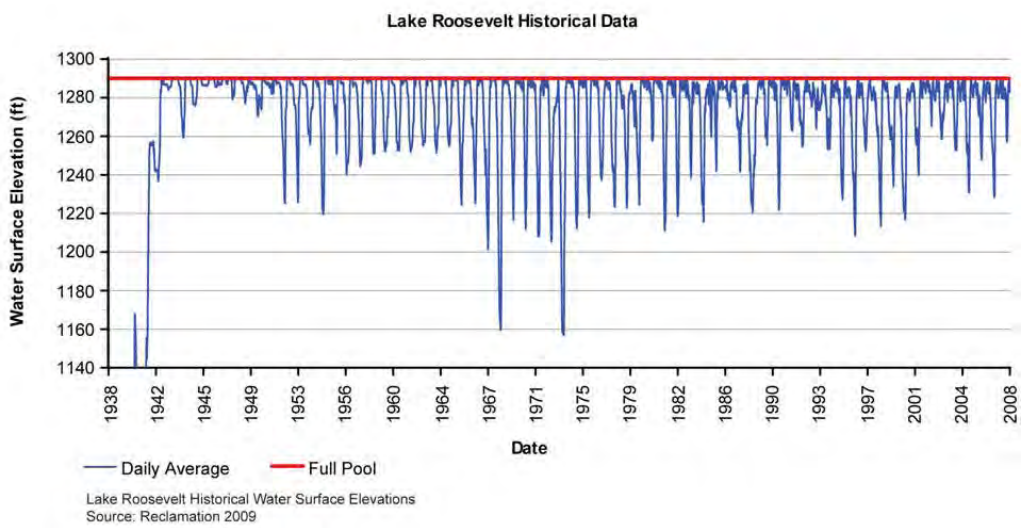


Figure 2- 3. Lake Roosevelt historical water surface elevations (Source: Reclamation, 2009)

Similarly, Banks Lake operates within established constraints to meet water delivery contractual obligations, ensure public safety, and protect property, while striving to allow for recreational use (see Figure 2- 4). Banks Lake drawdowns generally begin approximately August 1. The irrigation season typically extends from mid-March through October. Since 2000, the reservoir has been drawn down 5 feet (to elevation 1,565 feet above mean sea level [amsl]) to provide fish flow augmentation in the Columbia River through reduced pumping from the river. Larger drawdowns typically correspond with maintenance or weed control efforts.

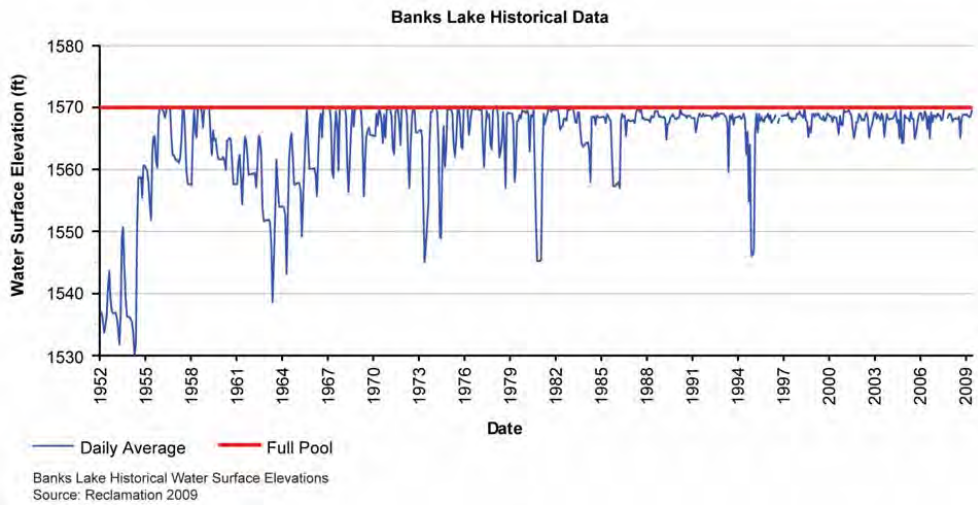


Figure 2- 4. Banks Lake Historical Water Surface Elevations (Source: Reclamation, 2009)

Reclamation will need to divert more water from the Columbia River than current CBP diversions to provide a replacement water supply for the action alternatives. Table 2- 2 lists the acres to be served and the additional water needed.

Table 2- 2. Groundwater replacement range considered in this Special Study Report and associated surface water diversion

Groundwater Replacement Range	Groundwater Acres to be Replaced with Surface Water	Additional CBP Surface Water Diversion Needed (acre-feet)
Partial Replacement (based on enlarging and extending East Low Canal system south of Interstate-90)	Approximately 57,000	176,343
Full Replacement (based on enlarging and extending East Low Canal system south of Interstate-90, and constructing a new East High canal system north of Interstate-90)	Approximately 102,600	347,137

The Study assumed that water from the Columbia River would not be diverted unless flows exceeded the ESA flow objectives from the 2008 FCRPS NMFS Biological Opinion (NMFS, 2008). These flow objectives are primarily to aid downstream passage of juveniles and chum spawning and incubation and to accommodate returning adult salmon and steelhead listed under the ESA. In addition, the State of Washington has recently enacted a law that does not allow new Columbia River diversions in July and August without a replacement water supply.

Reclamation's analysis concluded that no water is available for diversion from the Columbia River the months of April through August. However, water is available for diversion during September and October. In some years, water may also be available in January, December, and May.

To determine when water could be diverted from the Columbia River, hydrologic model analysis was updated. The model analysis is based on the output data from BPA's HYDSIM model for the 2008 NMFS FCRPS BiOp, which includes all major dams on the mainstem Columbia River and its major tributaries.

Hydrologic modeling of alternatives assumed that water from the Columbia River would not be diverted unless flows exceeded ESA flow objectives for anadromous fish identified by NMFS (NMFS, 2008) and that no new diversions would occur in July and August without a replacement water supply. Diversions were limited to 1,000 cfs in September and 2,200 cfs in October through March, if water were available in excess of flow objectives; this was based on discussions with NMFS during consultation of the 2008 FCRPS NMFS BiOp.

To calculate when Columbia River flows would exceed ESA flow objectives, HYDSIM model output was compared to the ESA flow objectives on the Columbia River at Priest Rapids, McNary, and Bonneville Dams. Columbia River water available for diversion to the CBP was then calculated as the average monthly flow in excess of ESA flow objectives.

Chapter 3: Plan Formulation

This chapter discusses the project background and subarea to demonstrate that the alternatives for the Odessa Subarea Special Study were developed in a systematic manner to ensure that all reasonable alternatives are evaluated via processes that conform to the P&Gs.

3.1. Background/Previous Investigations

The first half of CBP lands were developed primarily in the 1950s and 1960s, with some acres added sporadically until 1985. The 1945 feasibility report (Reclamation, 1944) anticipated a 70-year period of incremental development to complete the CBP to irrigate a total of 1,029,000 acres. It was anticipated that further incremental development of the CBP would depend on future needs and any irrigation of additional lands would use water from the Columbia River already reserved for the CBP.

To date, about 671,000 acres of currently irrigated lands in the CBP have been developed. Prior studies examined the merits of continuing the incremental development of irrigated acreage in the CBP. However, for various reasons, additional development has not yet occurred. The State issued irrigation groundwater permits in the 1960s and 1970s in the Odessa Subarea as a temporary measure to provide surface water to these lands until the CBP was further developed. Local constituents have advocated that Reclamation investigate CBP development to replace groundwater with CBP water as a possible solution for issues associated with the declining aquifer.

Reclamation formally initiated the environmental process to consider the continued, orderly development of the CBP when it published a Notice of Intent to Prepare an EIS in the *Federal Register* in December 1983. A *Draft Environmental Impact Statement—Continued Development of the Columbia Basin Project, Washington (*Reclamation, 1989) was prepared.

The alternatives considered ranged from full development of the second half of the Project to a phased approach. Besides a No Action Alternative, two alternatives for continued development were analyzed and discussed:

- Complete the CBP as originally envisioned by providing irrigation service to an additional 538,600 acres; and
- Expand the CBP on a more limited scale by providing irrigation service to approximately 87,000 acres along the east bank of the East Low Canal.

In addition, a *Supplement to the Draft Environmental Impact Statement—Continued Development of the Columbia Basin Project, Washington* (Reclamation, 1993) was prepared to examine new information or analyze issues

in more detail, including an anadromous fish plan, a fish and wildlife plan, and water withdrawal effects to Lake Roosevelt. The preferred alternative was to provide Project water to 87,000 acres near or adjacent to the East Low Canal within ECBID and SCBID. Of these lands, 41 percent (35,700 acres) were lands currently irrigated using groundwater or with interruptible service and 59 percent (51,300 acres) were dryland farmed. Numerous reports and documents supporting the technical studies and economic analyses were also prepared. Because of the ESA and the decline in salmon stocks, both Reclamation and Ecology put a moratorium on any additional withdrawals from the Columbia River in June 1993. Therefore, the DEIS was suspended.

Prior studies on the merits of continued development of the CBP have occurred. As described above, Reclamation completed a DEIS in 1989 and a Supplement to the DEIS in 1993. In 1994, Reclamation placed this study on hold. Around the same time, Reclamation placed a self-imposed moratorium on additional water withdrawals from the Columbia River because it was purchasing and leasing Snake River water to augment Snake and Columbia River flows to aid migrating anadromous fish. Reclamation lifted the moratorium in 2003 after a biological opinion addressing operations of the Federal Columbia River Power System, which includes the CBP, was issued. Table 3- 1 briefly lists the other actions within the area.

Table 3- 1. Relationship of the proposed action to other projects or activities

Activity	Summary Description	Relationship to the Odessa Study
Priest Rapids Hydroelectric Project Relicensing	The Federal Energy Regulatory Commission (FERC) issued a new 44-year license on April 17, 2008, for the operation of Priest Rapids and Wanapum hydroelectric dams. The license outlines operational requirements that cover a range of resources, including aquatic resources such as resident and anadromous fish that inhabit Priest Rapids Lake or the Hanford reach, or that pass through the dam. Many of the requirements deal with the timing and magnitude of flows designed to protect anadromous fish.	ESA flow objectives, as defined in the 2008 Biological Opinion (NMFS, 2008), are set at Priest Rapids Dam downstream of Lake Roosevelt, from which water would be withdrawn for the Odessa Subarea. Any additional withdrawals of water from the Columbia River for the Odessa Subarea would need to address these downstream flow objectives.

Table 3- 1. Relationship of the proposed action to other projects or activities

Activity	Summary Description	Relationship to the Odessa Study
Federal Columbia River Power System 2008 Biological Assessment and Opinion (NMFS, 2008)	The CBP, which includes Grand Coulee Dam and Lake Roosevelt, is part of the 2008 consultation on the Federal Columbia River Power System (FCRPS). The FCRPS Biological Assessment included proposed reasonable and prudent alternatives to address impacts to ESA-listed species and thereby avoid jeopardy to the listed species. Additionally, the Action Agencies entered into new agreements with four northwest Tribes and two States for a 10-year commitment to benefit fish, particularly Columbia River Basin salmon and steelhead stocks.	The reasonable and prudent alternatives dictate numerous operational requirements at Grand Coulee Dam and Lake Roosevelt that affect the timing of water withdrawals considered in the Odessa Study.
DEIS—Continued Development of the Columbia Basin Project (Reclamation, 1989)	The DEIS described the potential beneficial and adverse impacts of the proposed continued development of the CBP. Two alternatives for continued development were analyzed and discussed: (1) complete the CBP as originally envisioned, by providing irrigation service to an additional 538,600 acres; and (2) expand the CBP on a more limited scale by providing irrigation service to approximately 87,000 acres along the east bank of the East Low Canal. A No Action Alternative was also included.	Provides a basis for understanding the potential effects of continued development of the CBP, as contemplated in this Special Study Report.
Supplemental DEIS (Fish Enhancement) (Reclamation, 1993)	A Supplemental DEIS was completed in September 1993 that mainly addressed fish and wildlife issues. Because of the ESA and the decline in salmon stocks, both Reclamation and Ecology put a moratorium on any additional withdrawals from the Columbia River in June 1993. Therefore, the DEIS was suspended.	Same as 1989 DEIS above.
Banks Lake Resource Management Plan (RMP) (Reclamation, 2001)	The Banks Lake RMP was developed in response to the growing demand for recreational opportunities and visitor facilities while balancing resource protection and conservation objectives. The plan is designed to conserve, protect, and manage land and water resources under Reclamation's jurisdiction. For further information, please see <http://www.usbr.gov/pn/programs/rmp/bankslake/index.html>.	Management guidance for Banks Lake determines, in part, the types of mitigation measures anticipated for Recreation resources.

Table 3- 1. Relationship of the proposed action to other projects or activities

Activity	Summary Description	Relationship to the Odessa Study
Banks Lake Drawdown Final EIS (Reclamation, 2004)	The Final Environmental Impact Statement (FEIS) describes and analyzes the environmental effects of lowering the August water surface elevation of Banks Lake annually to elevation 1,560 feet (10 feet below the full pool elevation of 1,570 feet).	This information was used to assess impacts on biological and recreation resources at Banks Lake.
Walla Walla River Storage and Pump Exchange Studies	The Corps, in conjunction with the Confederated Tribes of the Umatilla Indian Reservation, are focusing on the restoration and management of a viable ecosystem within the Walla Walla River Basin. Many factors have contributed to the decline and limited production of salmonids and lamprey in the Basin. To increase salmonid and lamprey production, several actions have been proposed for consideration, including ways to increase streamflows, improve water quality, and lower river water temperatures. Multiple measures were evaluated through the shallow aquifer. They include recharge, storage, and recovery, and recharge for protection purposes only. The measure that was carried forward is recharge for protection purposes.	Potential for applying CBP surface water for other uses. This is a cumulative impact that is analyzed along with the Odessa Study alternatives in the Odessa DEIS.
Umatilla Basin Aquifer Recovery (OWRD, 2003)	The agricultural economy of Umatilla and Morrow Counties is critically dependant on availability of water for irrigation. Because of overdraft of the groundwater aquifers in the area, the Oregon Water Resources Department (OWRD) designated four groundwater aquifers within the Umatilla Basin as Critical Groundwater Areas in the Umatilla Basin. To increase water availability in the Critical Groundwater Areas, OWRD has begun a technical assessment of the feasibility of storing water from the Columbia River and other surface water sources, during high-flow periods in shallow sediment and deep basalt aquifers for later recovery and use during the irrigation season. Surface water withdrawals from the Columbia and Umatilla Rivers that would occur during times that avoid impacts to listed fish species, and that would deliver water for storage in groundwater aquifers, are key to addressing the long-term water supply needs in the Umatilla Basin.	Illustrates the widespread nature of groundwater management issues and that surface water is considered for other areas beyond the Odessa Subarea. This is a cumulative impact that is analyzed along with the Odessa Study alternatives in the Odessa DEIS.

3.2. Public and Agency Participation

To be responsive to State and local concerns, Reclamation contacted State agencies before initiating studies and provided opportunities for State, local, and public participation. Formulating alternatives that are responsive to the needs and desires of the American public requires direct public participation. Reclamation established a coordinated public participation program with willing agencies and groups and pursued public participation. Several agencies, entities, organizations, and groups participated in the Study. The degree of participation ranged from providing viewpoints and general observations to direct contributions to plan formulation. Specific input into the plan formulation is discussed in Section 3.3. , Alternative Formulation. The following paragraphs identify agencies and their contributions.

The State, Reclamation, and the CBP irrigation districts signed the Columbia River Initiative (MOU) in December 2004, to promote a cooperative process for implementing activities to improve Columbia River water management and water management within the CBP. The Odessa Subarea Special Study implements Section 15 of the MOU, which states, in part, "The parties will cooperate to explore opportunities for delivery of water to additional existing agricultural lands within the Odessa Subarea." The State provided a cost-share through an Intergovernmental Agreement between Washington Department of Ecology and Reclamation in December 2005 to fund this Study. Congress provided funding to Reclamation beginning in fiscal year 2005 to investigate opportunities to provide CBP water to replace groundwater use in the Odessa Subarea.

In February 2006, the Washington State Legislature passed the Columbia River Water Resource Management Act (Management Act). In its enactment, the legislature established that "a key priority of water resource management in the Columbia River Basin is the development of new water supplies to meet economic and community development needs concurrent with instream flow needs." The Management Act authorizes Ecology to aggressively pursue development of water benefiting both instream and out-of-stream uses through storage, conservation, and voluntary regional water management agreements. Among the activities identified in the legislation, Ecology is directed to focus on "development of alternatives to groundwater for agricultural users in the Odessa subarea aquifer." The Odessa Subarea is a high priority for the State, as it occurs first on the list of projects in the legislation (Revised Code of Washington [RCW] 90.90.020, Allocation and Development of Water Supplies).

BPA, a cooperating agency in the preparation of the Odessa DEIS, provided the basis for the energy analysis in the Odessa DEIS. BPA evaluated and summarized the regional supply and demand for energy in the Pacific Northwest in an annual (BPA, 2007) 10-year forecast document called the *Pacific Northwest Loads and Resources Study* (commonly called the White Book).

GWMA interviewed well operators in the Odessa Subarea concerning the current status of well use and performance from September to December 2009 (GWMA, 2010 [Conditions]). In January 2010, GWMA (2010 [Survey]) conducted an additional survey asking well operators in the Odessa Subarea to characterize the current status of their wells relative to the five status levels.

Reclamation contacted and solicited participation of other Federal, State, and local agencies; Indian Tribes; national, regional and local groups; other affected groups; and individuals. Table 3- 2 lists legal requirements for consultation and/or actions taken to date. If an action alternative is selected for implementation, consultation will be completed prior to seeking construction authorization.

Table 3- 2. Consultation with/participation by other agencies and Tribes

Agency	Legal Requirements and Actions
NMFS	Section 7(a)(2) of the ESA requires Federal agencies to consult with NMFS when a Federal action may affect a listed marine and anadromous endangered or threatened species or its critical habitat. Reclamation obtained a listing of the threatened and endangered species that reside within the Study Area from the NMFS website.
State Historic Preservation Officer	The National Historic Preservation Act of 1966, as amended in 1992, requires that Federal agencies consider the effects that their projects have on historic properties.
U.S. Army Corps of Engineers (Corps)	Reclamation has ongoing coordination activities with the Corps in conjunction with their interests and responsibilities for wetlands. Reclamation will apply to the Corps or petition them for an exemption under Section 404 of the Clean Water Act.
U.S. Department of Agriculture	The Farmland Protection Policy Act of 1981 is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. The project does not change the use of land from farmland to an agricultural noncompatible use. Special siting of delivery pipes, canals, pumping facilities, and reservoirs were designed to limit impacts to on-farm improvements and protected soils.
U.S. Fish and Wildlife Service (Service)	Section 7 (a)(2) of the ESA (16 U.S.C. Section 1536), requires all Federal agencies to consult with the Service when a Federal action may affect a listed freshwater and/or threatened or endangered wildlife species or its critical habitat. The Fish and Wildlife Coordination Act (16 United States Code 661-667e, as amended) requires Federal agencies to coordinate with the Service when planning a new project or modifying existing projects so that wildlife resources receive equal consideration and are coordinated with other project objectives and features. The recommendations (Section IV) are contained in the U.S. Fish and Wildlife Service Coordination Act Report, which is available online at http://www.usbr.gov/pn/programs/ucao_misc/odessa.

Table 3- 2. Consultation with/participation by other agencies and Tribes

Washington Department of Fish and Wildlife (WDFW)	WDFW is conducting a series of biological studies to determine the effects of the Odessa action alternatives on wildlife throughout the analysis area and on the fishery in Banks Lake. Results of the studies completed in 2009 are summarized in the Odessa DEIS. Results of additional studies conducted by WDFW in 2010 will be included in the FEIS.
Tribal Consultation and Coordination, and Government-to-Government Consultation	Executive Order 13175 establishes "regular and meaningful consultation and collaboration with Tribal officials in the development of Federal policies that have Tribal implications, to strengthen the United States Government-to-Government relationships with Indian Tribes, and to reduce the imposition of unfunded mandates upon Indian Tribes." Government-to-Government consultation between Reclamation and the Spokane Tribe of Indians, the Yakama Nation, and the Confederated Tribes of the Colville Reservation is ongoing. This consultation encompasses coordination related to all relevant laws, regulations and Executive orders described in this chapter.
Agency	**Participation by Other Agencies**
Natural Resource Conservation Service	Originally established by Congress in 1935 as the Soil Conservation Service (SCS), NRCS has expanded to become a conservation leader for all natural resources, ensuring private lands are conserved, restored, and more resilient to environmental challenges, like climate change.
East Columbia Basin Irrigation District	The East Columbia Basin Irrigation District is a non-profit quasi-municipality located in North Central Washington State that operates and maintains a portion of the Columbia Basin Irrigation Project. The primary function of the Irrigation District is to deliver irrigation water to farm land located in the Columbia River Basin.
South Columbia Basin Irrigation District	The South Columbia Basin Irrigation District is a non-profit quasi-municipality located in North Central Washington State that operates and maintains a portion of the Columbia Basin Irrigation Project. The primary function of the Irrigation District is to deliver irrigation water to farm land located in the Columbia River Basin.
Quincy Irrigation District	The Quincy-Columbia Basin Irrigation District is a non-profit quasi-municipality located in North Central Washington State that operates and maintains a portion of the Columbia Basin Irrigation Project. The primary function of the Irrigation District is to deliver irrigation water to farm land located in the Columbia River Basin.
Groundwater Management Area (GWMA)	The Columbia Basin Ground Water Management Area or GWMA is a grassroots, pro-active, voluntary, local planning effort to reduce nitrate in groundwater, and is intended to lessen the need for mandated control measures through the creation of a groundwater management plan to reduce nitrate levels in the groundwater of the GWMA.

Table 3- 2. Consultation with/participation by other agencies and Tribes

Washington State Water Resources Association	Washington State Water Resources Association is the coordinating agency for the irrigation districts in Washington State. The association has 35 irrigation district members covering 1.1 million irrigation agricultural acres. The association is active in State and federal water policy and legislative issues and affiliated with National Water Resources Association.
Washington State Department of Health	The Department of Health works with its federal, state and local partners to help people in Washington stay healthier and safer. Our programs and services help prevent illness and injury, promote healthy places to live and work, provide education to help people make good health decisions and ensure our state is prepared for emergencies.
Washington State Potato Commission	The mission of the Washington State Potato Commission is to serve the potato growers of Washington State by facilitating the awareness and value of Washington State potatoes. The main functions of the Commission are to enhance trade opportunities, to advance environmentally sound production and cultural practices through research, and to represent the growers' interests in areas and issue relating to education, trade barriers, irrigation, transportation, and crop protection.

3.2.1 Appraisal-Level Public Participation

During the appraisal-level investigation, Reclamation held public information meetings and distributed mailings in October and November 2007 to individuals on its mailing list to present information and request comments. Reclamation received 84 written comments from State agencies; environmental, conservation, and nongovernmental organizations; State residents; and representatives for agriculture and recreation interests. Table 3- 3 lists meetings with publics and stakeholder groups.

Table 3- 3. Meetings held with interested parties during the appraisal-level investigation

Date of Meeting	Meeting With	Location
February 22, 2006	Public	Big Bend Community College, Moses Lake, Washington
October 11, 2006	Public	Big Bend Community College, Moses Lake, Washington
June 6, 2007	Columbia River Policy Advisory Group	Yakima, Washington
October 4, 2007	Colville Business Council, Colville River Water Management Program	Omak, Washington
October 23, 2007	Public	Big Bend Community College, Moses Lake, Washington
November 15, 2007	Washington Department of Fish and Wildlife	Ephrata, Washington

Table 3- 3. Meetings held with interested parties during the appraisal-level investigation

Date of Meeting	Meeting With	Location
December 4, 2007	Confederated Tribes of the Colville Reservation	Nespelem, Washington

Many noted that partial development, which would rely on the existing CBP canal system, could not deliver a replacement water supply to sufficient acres to address the issues associated with the declining aquifer and would not be able to deliver water to lands south of Interstate 90 (I-90), an area where significant aquifer decline is occurring. Many suggested that Reclamation examine less expensive alternatives such as water conservation, water measurement, water markets, conversion to dryland farming, and reconstruction of wells, given the significant economic costs associated with constructing the water delivery alternatives. Others noted that construction costs were not significant when considering the current economic benefits of sustaining current agricultural production in the Odessa Subarea.

Most of the comments that were received opposed construction of a Lower Crab Creek reservoir because of concerns about possible impacts to fish, wildlife, recreation, infrastructure, and private property. Many advocated modifying operations at existing CBP reservoirs as the best approach to provide a replacement water supply because it would be more cost effective and would result in fewer environmental issues than constructing new dams and reservoirs.

3.2.2 Feasibility-Level and Odessa DEIS Public Participation

In addition to providing information to the public regarding the Study and EIS, Reclamation and Ecology also solicited responses regarding the public's needs, values, and evaluations of the proposed alternatives. Both formal and informal input has been encouraged and used in plan formulation.

3.2.2.1. Scoping Process

The public scoping process in support of the plan formulation was conducted in August and September 2008. The purpose of scoping includes:

- Identifying the significant issues relevant to the proposed action,
- Identifying those elements of the environment that could be affected by the proposed action,
- Formulating alternatives for the proposed action, and
- Determining the environmental documents to be prepared.

The scoping was conducted to seek comments and information from the public to identify potential issues related to planned Study actions and to help formulate the scope of the EIS analysis.

On August 21, 2008, a Federal Notice of Intent to Prepare an EIS and to conduct public scoping meetings was published in the *Federal Register*, Ecology issued a Determination of Significance and a request for comments on the scope of the EIS, and Reclamation sent an e-mail message to 190 mailing list recipients announcing that the Study Update was available on the Study Website, http://www.usbr.gov/pn/programs/ucao_misc/odessa/.

On August 25, 2008, Ecology provided notice of scheduled public scoping meetings to subscribers of its e-mail list for the Columbia River Basin Water Management Program (Management Program). On August 26, 2008, Reclamation mailed copies of the Study Update, which included notification of the scoping process and meetings, to 243 mailing list recipients. Reclamation issued a news release to local media on September 2, 2008. On September 4, 2008, Ecology provided a reminder notice to subscribers of its e-mail lists, including those for the Columbia River Basin Water Management Program and the Reclamation Yakima Water Storage Feasibility Study. The Notice of Intent, Determination of Significance, news releases, and meeting notice are attached to the Scoping Summary Report (Reclamation, 2008 [Scoping]). The Scoping Summary Report is available upon request or can be accessed from the Odessa Special Study Web site: <http://www.usbr.gov/pn/programs/ucao_misc/odessa/>.

3.2.2.1.1 ***Public Scoping Meetings***

Reclamation and Ecology hosted two evening public scoping meetings, one at the Town of Coulee Dam Town Hall, Coulee Dam, Washington, on September 10, 2008, and one at the Advanced Technologies Education Center, Big Bend Community College, Moses Lake, Washington, on September 11, 2008. About 55 people attended the two scoping meetings. At the public meetings, Reclamation and Ecology presented the proposed alternatives and an overview of the National Environmental Policy Act (NEPA)/State Environmental Policy Act (SEPA) process, and provided opportunities for the public to identify issues and concerns associated with the Study.

3.2.2.1.2 ***Comments and Other Information Received from the Public***

In addition to comments received at the scoping meetings, written comments were accepted through September 19, 2008. Including those from the scoping meetings, 33 written comment documents were received. The documents included two requests to be added to the mailing list (no comments included) and one request to be removed from the mailing list for this Study. Substantive input ranged from brief comments or questions to detailed statements. Comments about how each of the resources should be analyzed led to the development of the indicators used to evaluate the effects of the alternatives on the resources. Many comments were quite broad and overlapped these categories.

Comments and questions focused on the following:

- **Facilities and Operation:** Effects of water withdrawal on Columbia River flows and reservoir operations; potential for water conservation measures and use of reclaimed water and conversion to dryland farming as alternatives; options for off-channel storage; hydropower losses because of additional water withdrawals; and use of a phased approach to implementation.
- **Natural Resources:** Effects of changes in Columbia River flows and reservoir operations on fish and wildlife, loss of wildlife habitat, and blockage of wildlife migration and local movements.
- **Recreation and Tourism:** Effects of changes in reservoir operations on recreation, tourism, and boater safety at Banks Lake.
- **Socioeconomics:** Exploration of various repayment options, preparing a thorough benefit-cost analysis, and exploring the economic effects of reduced tourism at Banks Lake.
- **Tribal Concerns and Environmental Justice:** Role of the Tribes in the project and Tribal influence; impacts on environmental justice.

3.2.3 Feasibility-Level Meetings Held with Interested Parties

Meetings held to provide information and answer questions about the Odessa Subarea Special Study, both prior to and during the NEPA/SEPA process, are listed in Table 3- 4.

Table 3- 4. Meetings held with interested parties during the feasibility-level investigation

Date of Meeting	Meeting With	Location
March 1, 2008	Public	Coulee Corridor Big Event
March 26, 2008	Grand Coulee History and Columbia River Management Program	Coulee City, Washington
September 2, 2008	Ephrata Lions Club	Ephrata, Washington
September 10, 2008	Public Scoping Meeting	Coulee Dam, Washington
September 11, 2008	Public Scoping Meeting	Moses Lake, Washington
October 3, 2008	American Society of Farm Managers and Rural Appraisers	Moses Lake, Washington
October 7, 2008	Confederated Tribes of the Colville Reservation, Colville Indian Agency	Nespelem, Washington
October 28, 2008	WSU Tri-Cities ES/RP590 Class	Richland, Washington
November 6, 2008	Columbia Basin Development League	Moses Lake, Washington

Table 3- 4. Meetings held with interested parties during the feasibility-level investigation

Date of Meeting	Meeting With	Location
January 22, 2009	Columbia Basin Crop Consultants Association	Ephrata, Washington
January 22, 2009	Columbia Basin Railroad	Yakima, Washington
February 12, 2009	Public	Coulee City Fire Hall, Coulee City, Washington
February 18, 2009	Columbia Basin Development League	Moses Lake, Washington
February 19, 2009	Columbia Basin Development League	Moses Lake, Washington
March 3, 2009	Employee Presentation Columbia River Management Program	Bureau of Reclamation Field Office, Ephrata, Washington
March 5, 2009	Columbia River Policy Advisory Group	Yakima, Washington
March 13, 2009	Lake Roosevelt Forum	Colville, Washington
March 16, 2009	Othello Rotary Club	Othello, Washington
March 18, 2009	Columbia Basin Development League	Moses Lake Fire Hall, Moses Lake, Washington
March 31, 2009	East Columbia Basin irrigation District	Ephrata, Washington
April 15, 2009	Columbia Basin Development League	Moses Lake, Washington
May 5, 2009	Audubon Society, Central Columbia Basin Chapter	Moses Lake, Washington
July 7, 2009	East Columbia Basin irrigation District	Bureau of Reclamation Field Office, Ephrata, Washington
September 2, 2009	East Columbia Basin irrigation District	Ephrata, Washington
July 10, 2009	U.S. Fish and Wildlife Service	Wenatchee, Washington
October 29, 2009	Columbia Basin Development League	Moses Lake, Washington
May 17, 2010	Washington Department of Fish and Wildlife	Ephrata, Washington
May 19, 2010	Columbia Basin Development League	Othello, Washington
June 16, 2010	Columbia Basin Development League	Moses Lake, Washington
June 29, 2010	U.S. and Washington Department of Fish and Wildlife	Yakima, Washington
July 15 & 16, 2010	U.S. and Washington Department of Fish and Wildlife	Yakima, Washington
August 10, 2010	CBP Irrigation Districts	Pasco, Washington
October 5, 2010	Colville Tribe	Nespelem, Washington

3.2.4 Draft Environmental Impact Statement Comments

Reclamation and Ecology will publish and distribute the Odessa DEIS and will begin a 60-day public review and comment period. Written comments may be

submitted to Reclamation and Ecology throughout this period. Also during this period, Reclamation and Ecology will hold two public meetings to receive oral and written comments.

Upon completion of the review period and as part of preparing a Final EIS, Reclamation and Ecology will respond to comments received. No Reclamation or Ecology decision will be made on the proposed action until a minimum of 30 days after release of the FEIS. Following this 30-day period, Reclamation will complete its Record of Decision (ROD). Ecology's requirements state that an action may be taken 7 days after issuance of the FEIS.

3.3. Alternative Formulation

3.3.1 Plan of Study

Reclamation began the Study in 2005. Reclamation, through the Odessa Plan of Study (Reclamation, 2006 [POS]) (POS) provided the study background and purpose, described potential issues, outlined study steps and requirements, and identified required resources in the Odessa Subarea.

3.3.2 Project Alternatives Solution Study

Reclamation completed a pre-appraisal-level investigation through the Project Alternative Solutions Study (PASS) in late in 2006. The investigation is documented in a report entitled, *Initial Alternative Development and Evaluation, Odessa Subarea Special Study* (Reclamation, 2006 [PASS]). The POS and the PASS provided the basis for the Odessa Special Study, and cover the same Study Area.

The Objectives Team and the Technical Team conducted the PASS together. The Objectives Team was comprised of various stakeholders in the Study area, including Federal and State agencies, local governments, Tribes, CBP irrigation districts, and groundwater irrigators. The Objectives Team developed study objectives that were used to rank alternative concepts.

The Technical Team was comprised of engineers, a hydrogeologist, a watermaster, and irrigation district managers from Reclamation, Ecology, and the CBP irrigation districts. The Technical Team developed preliminary alternative concepts suggested by the public and examined in previous investigations, and ranked them using the study objectives developed by the Objectives Team. The Technical Team then recommended water delivery alternatives and water supply options for further study based on Study objectives. Table 3- 5 shows that these study objectives fall under the P&Gs tests of viability; alternatives that met the PASS study objectives would also meet these tests of viability:

- **Completeness** – The extent to which the alternative provides and accounts for all necessary investments and actions to implement the plan.
- **Effectiveness** – The extent to which the alternative alleviates the problems and accomplishes the objectives.
- **Efficiency** – The extent to which the alternative is cost effective in accomplishing the project objectives.
- **Acceptability** – The workability and viability of the plan in terms of acceptance by Federal, State, and local governments and the public and compatibility with existing laws, regulations, and public policies.

Table 3- 5. Comparison of PASS study objectives with P&Gs tests of viability

PASS Study Objectives	P&Gs Tests of Viability
Retain the possibility of full CBP development in the future.	**Completeness –** The extent to which the alternative provides and accounts for all necessary investments and actions to implement the plan.
Replace all or a portion of current groundwater withdrawals for irrigation within the CBP portion of the Odessa Subarea with CBP water. Provide environmental and recreational mitigation and enhancements.	**Effectiveness –** The extent to which the alternative alleviates the problems and accomplishes the objectives.
Maximize use of existing infrastructure. Minimize potential delay in the Study schedule. Be conducive to development in phases for early and efficient implementation based on funding expectations, physical and operational constraints, and rate of groundwater decline.	**Efficiency –** The extent to which the alternative is cost effective in accomplishing the project objectives.
Address environmental concerns and interests, including NMFS Columbia River seasonal flow objectives and impacts to ESA-listed and other sensitive species. Address the potential impact to shrub-steppe habitat for ESA-listed species.	**Acceptability –** The workability and viability of the plan in terms of acceptance by Federal, State, and local governments and the public and compatibility with existing laws, regulations, and public policies.

Using input received from the public at a February 2006 public meeting and through written correspondence, as well as the information from previous related investigations, the PASS defined and evaluated alternative concepts and solutions to resolve problems posed by groundwater decline in aquifers of the Odessa Subarea.

The PASS identified four broadly-defined alternatives that combined various options for supply and delivery of surface water to replace groundwater for

irrigation use in the Study area. These met the criteria in Table 3- 5 and were carried forward through an appraisal-level investigation.

3.3.3 Appraisal-Level Investigation

In March 2008, Reclamation completed the *Appraisal-Level Investigation Summary of Findings, Odessa Subarea Special Study* (Reclamation, 2008 [Appraisal]) of water delivery alternatives and water supply options that could provide a replacement surface water supply.

3.3.3.1. Alternative Formulation

The investigation examined the engineering viability, developed preliminary cost estimates, and identified potential environmental and social issues. Four water delivery alternatives and six water supply options were evaluated. The appraisal-level alternatives were divided into alternatives for delivering water and options for storing a replacement water supply. Table 3- 6 lists the alternatives considered in the appraisal-level investigation.

Table 3- 6. Alternatives identified through the 2006 PASS process and considered in the 2008 appraisal investigation

Delivery Alternatives	
A	Full replacement of groundwater with a CBP surface-water supply for irrigation. Construct an East High Canal System reaching 140,000 eligible acres both north and south of I-90.
B	Full replacement by developing an East High Canal system to serve lands north of I-90, and expanding the capacity of the existing East Low Canal to serve 127,300 acres south of I-90.
C	Partial replacement to serve 70,100 acres using only the existing East Low Canal. North of I-90, lands would be served from available capacity in the existing canal without major modification. South of I-90, lands would be served by expanding the capacity of the canal system.
D	Partial replacement to serve 40,700 acres through existing capacity in the East Low Canal system without major modification.
Supply Options	
Banks Lake Drawdown	Draw down the existing reservoir to levels lower than current operations.
Banks Lake Raise	Raise the operational water surface of the reservoir by 2 feet by raising the crest of the two dams and allowing more storage.
Potholes Reservoir Reoperation	Adjust the timing of water storage in the reservoir by feeding some water in the fall, rather than in the spring, thus freeing up available water in the spring for use in the Study Area. Some modifications of the dam may also be required.

Table 3- 6. Alternatives identified through the 2006 PASS process and considered in the 2008 appraisal investigation

Delivery Alternatives	
New Reservoirs	Build new reservoirs at Dry Coulee, Lower Crab Creek, and Rocky Coulee.

Refinements to the alternatives developed in the PASS included developing appraisal-level engineering designs and cost estimates, identifying specific groundwater-irrigated land areas to receive a replacement surface water supply, and calculating the number of groundwater-irrigated acres served and replacement water supply volumes for each alternative.

The appraisal-level investigation predominantly relied on existing data and included additional limited engineering, geologic, hydrologic, and hydrogeologic analyses to assess the technical feasibility of water delivery alternatives and water supply options and to develop preliminary cost estimates to allow comparison among alternatives. Engineering designs and cost estimates were based on previous studies and limited design data, including investigations of the East High canal system conducted in the 1960s and 1970s, construction drawings and geology logs from previous investigations, and drawings from construction of existing CBP facilities such as the East Low Canal. Limited additional data were developed (e.g., hydrologic modeling to simulate operations to help determine the sizing of canals and pumping plants). Reclamation, with the assistance of the Service, WDFW, and Confederated Tribes of the Colville Reservation, conducted a preliminary inventory of potential environmental and cultural issues and concerns.

The alternatives formulation process was conducted in three stages. Each successive stage is more detailed than the last to refine potential alternatives, assess their relative engineering and economic feasibility, and compare their relative performance in addressing the problems and opportunities described in Chapter 2.

The water delivery system for the partial-replacement alternatives examined in the feasibility-level investigations was refined from the appraisal-level investigation's Water Delivery Alternatives C and D. The water delivery system for the full-replacement alternatives examined in the feasibility-level investigations was refined from Water Delivery Alternatives A and B.

Reclamation reviewed the information developed during the appraisal-level investigation and considered public feedback to compare and evaluate the water delivery alternatives and water supply options. As mentioned above, completeness, effectiveness, efficiency, and acceptability were the basis for the selection of alternatives and options for future investigation.

After the appraisal-level investigation and during the early work on the current feasibility-level studies, three adjustments were made to the range of supply options being considered. These included eliminating the Banks Lake Raise and the Potholes Reoperation options, and adding use of storage in Lake Roosevelt as an option.

The two sections below summarize the delivery alternatives and supply options that were considered but eliminated from further study.

3.3.3.2. Alternatives Considered But Eliminated From Further Study

3.3.3.2.1 ***Appraisal Alternative A***

Although it would provide full replacement, Alternative A as originally formulated was eliminated because it would involve substantially higher cost, longer implementation times, and greater potential for environmental impact when compared with Alternative B. These disadvantages arise from the fact that Alternative A would require development of a new East High Canal system to serve lands south of I-90; whereas, Alternative B would serve this area by expanding the existing East Low Canal. Expanding the East Low Canal would cost considerably less than a new canal system, could allow earlier implementation because it would not rely on completion of the East High Canal system north of the highway, and would involve less land acquisition and other effects involved with developing new canals.

3.3.3.2.2 ***Appraisal Alternative C***

Alternative C as originally formulated was eliminated from consideration because it would use all available capacity in the East Low Canal to serve groundwater-irrigated lands in the Study Area. Thus, SCBID could not receive water for additional lands as originally planned. Further, this alternative did not include the potential to provide full replacement of groundwater with CBP surface water for all eligible acreage in the Study Area. Alternative C would offer significantly less potential than Alternative B to meet the fundamental Purpose and Need of the project. It would not substantially address the challenge of the groundwater decline in aquifers of the Odessa Subarea, and would not avoid significant economic loss.

3.3.3.2.3 ***Appraisal Alternative D***

Alternative D as originally formulated was eliminated from consideration for the same reasons as Alternative C. This option would serve the least amount (less than half) of irrigated acreage in the Subarea, especially when compared with Alternative B.

3.3.3.3. Water Supply Options Considered But Eliminated From Further Study

3.3.3.3.1 ***Banks Lake Raise***

This supply option would raise the two dams that create Banks Lake by 2 feet, resulting in an increase of 2 feet in the reservoir full pool level and a gain of 50,000 acre-feet of additional storage. This option was eliminated from consideration because of high cost and the potential for significant impact to lands, facilities, and environmental resources. Potential problems associated with raising the Banks Lake pool level include:

- Public controversy due to unavoidable and potentially immitigable recreational impacts,
- Major relocations and modifications of infrastructure required, such as the feeder canal and State Route 155,
- Potentially significant adverse impacts to existing developed land uses around the reservoir, such as Coulee Playland, Sunbanks Resort, Steamboat Rock State Park, and Coulee City Park; and
- Adverse impacts to the environment, such as increased acres of vegetation lost to inundation, resulting in increased erosion, wave action higher on the shoreline, and impacts to cultural resources around the reservoir.

3.3.3.3.2 ***Potholes Reservoir Reoperation***

Use of storage in Potholes Reservoir is not a feasible option for providing CBP water to the Study Area for a number of reasons. Primary among these are:

- This reservoir is physically located below the CBP system; and
- The reservoir's role in providing flood storage and release is generally not compatible with reliably retaining water in storage at the time of year required to meet the additional irrigation needs in the Study Area.

3.3.3.3.3 ***Lake Roosevelt Sole Supply***

This supply option would use storage from Lake Roosevelt by drawing it down when Columbia River flows are not available as the sole water supply option for the Study Area. This option was eliminated from consideration because it would result in summer drawdown levels that conflict with other water management requirements at Grand Coulee Dam and Lake Roosevelt, and it would result in adverse impacts to recreation and shoreline environmental resources managed by the National Park Service and the Tribes.

3.3.3.3.4 ***Dry Coulee and Lower Crab Creek Reservoirs***

Both of these potential locations for new reservoirs were eliminated from consideration as supply options because of substantial cost and environmental impact concerns. Each of these reservoir options would involve substantially

higher cost and greater potential for adverse environmental impact than the Rocky Coulee option.

3.4. Relationship of Other Water and Related Resources Activities to Study

The Study is conducted within the framework of the Columbia River Basin Water Management Program, which derived from the Management Act. In particular, the Management Program directs Ecology to seek alternatives to groundwater pumping in the Odessa Subarea for agricultural use.

The major components of the Management Program include storage, conservation, voluntary regional agreements, and other measures intended to meet the legislative mandate. The Management Program also includes administrative functions such as development of a project inventory, a water supply and demand forecast, and a data management system. Funding and management of a number of major projects have resulted from the Management Program. The Management Program directs Ecology to focus efforts to develop water supplies for the Columbia River Basin to meet the following needs:

- Alternatives to groundwater pumping for agricultural users in the Odessa Subarea aquifer,
- Sources of water supply for pending water rights applications,
- A new uninterruptible supply of water for the holders of interruptible (junior) water rights on the Columbia River mainstem that are subject to instream flows or other mitigation conditions to protect streamflows, and
- New municipal, domestic, industrial, and irrigation water needs within the Columbia River Basin.

Ecology developed the *Final Programmatic Environmental Impact Statement for the Columbia River Water Management Program* (Ecology, 2007) (Management Program FEIS) under SEPA to assist in evaluating conceptual approaches to developing the Management Program and in describing the potential impacts that could be associated with components of the Management Program. Components evaluated included storage, conservation, voluntary regional agreements, instream resources, and policy alternatives for implementing requirements of the Management Act.

The study also evaluated potential impacts associated with implementation of the following three actions:

- Storage releases from Lake Roosevelt;
- A supplemental feed route to supply Potholes Reservoir; and

- The proposed Columbia-Snake River Irrigators Association Voluntary Regional Agreement.

Key components of the Management Program are summarized below, with more detailed descriptions available in the Management Program FEIS.

Reclamation is considering potential storage projects that may be approved for study and funding. One primary example is the ongoing Columbia River Mainstem Off-Channel Storage Options evaluation. These projects range from new large storage facilities (more than 1 million acre-feet), new small storage facilities (less than 1 million acre-feet), modification of existing storage facilities, and groundwater storage.

Ecology has developed an inventory of more than 500 conservation projects and is currently developing, screening, and ranking criteria to determine which projects best meet the goals of the Management Program. Potential projects may address issues such as incentive payments to reduce water use and full or partial water banking, improvements to municipal water infrastructure, use of reclaimed water, improved water delivery efficiency at the irrigation district level and on-farm conservation, improved industrial infrastructure, and pump exchanges. Ecology would manage the use of conserved water.

A voluntary regional agreement (VRA) is a legal agreement between the State and one or more Columbia River water users "for the purpose of providing new water for out-of stream use, streamlining the application process, and protecting instream flow" (RCW 90.90.030, *Voluntary Regional Agreements*). Under this component, groups would be able to enter VRAs with Ecology to exchange a package of water projects for new water rights. All existing legislation governing new water rights would remain in place, and VRAs must meet minimum requirements to be approved by Ecology. Ecology and the Columbia-Snake River Irrigators Association (CSRIA) have entered into a VRA as provided for in RCW 90.90.030. The purpose of this VRA is to provide new water for the issuance of drought permits to existing interruptible water rights holders and new water rights on the Columbia and Snake Rivers. This VRA provides that the issuance of these new water rights cannot reduce or negatively impact streamflows in the months of July and August (April through August for the Snake River). To meet this standard of protection, Ecology and CSRIA would pursue conservation, storage, acquisition, and other opportunities to provide new water to offset new withdrawals during the summer.

Ecology is pursuing a full range of options for augmenting instream resources. The Management Act provides that one-third of the active storage in any new storage facility made possible with Management Program funding would be available for instream flows. Water for allocation to instream uses could be provided by a number of projects that Ecology is considering under the Management Program, including any new storage within the Study alternatives being addressed in this Special Study Report.

The Management Act directs Ecology to develop a water supply inventory and a long-term water supply and demand forecast that is updated every 5 years. The first inventory and long-term water supply and demand forecast was released in November 2006. The inventory and forecast include conservation and water storage projects, a water rights inventory, a water use inventory, a long-term water supply forecast, and a long-term demand forecast. Ecology has begun to implement the three early actions included in the Management Program as shown in Table 3- 7.

Table 3- 7. Early Actions Under the Management Program

Early Action	Description
Incremental Storage Releases from Lake Roosevelt	The Lake Roosevelt Incremental Storage Releases Project involves releasing flows from Lake Roosevelt to improve municipal and industrial water supply, replace some groundwater use in the Odessa Subarea, enhance stream-flows in the Columbia River to benefit fish, and provide water to interruptible water rights holders in drought years. Ecology issued the *Final Supplemental Environmental Impact Statement for the Lake Roosevelt Incremental Storage Releases Program* in August 2008 (Ecology, 2008), and Reclamation issued the *Lake Roosevelt Incremental Storage Releases Project Draft Environmental Assessment and Finding of No Significant Impact* (Reclamation, 2009) for the project in June 2009. Reclamation and Ecology began implementing the flow releases in September 2009. This activity is a cumulative impact that is analyzed along with the Study alternatives addressed in the Odessa EIS.
Supplemental feed route for Potholes Reservoir	The purpose of the supplemental feed route project is to increase the reliability of transporting water from Banks Lake to Potholes Reservoir. This activity has been identified as a cumulative impact that is analyzed along with the Study alternatives addressed in this Special Study Report (see Section 1.8.1, Actions within the Geographic Scope, of the Odessa DEIS). Currently, the existing feed route transports water through the Main Canal, south through the East Low Canal to Rocky Coulee Wasteway, and then into Upper Crab Creek near the north end of Moses Lake and Potholes Reservoir. Feeding is done early and late in the irrigation season when demand for irrigation water is low. At these times, the "unused" capacity in the East Low Canal is used to carry feed water to Potholes Reservoir. Changes in irrigation practices and demand have reduced the effectiveness of the existing feed route. The demand on Potholes is greater, and the amount of "unused" capacity in the East Low Canal has declined. Reclamation prepared an EA and identified Alternative 2—Crab Creek and Frenchman Hills Wasteway—as the preferred alternative for a supplemental feed route (Reclamation, 2007). This would release feed water from Billy Clapp Reservoir through the Crab Creek channel, then into Moses Lake and Potholes Reservoir. The supplemental feed route lies outside of the Odessa Ground Water Management Area and beyond the boundaries of the Study Area. The existing feed route in the Study Area would continue to be used as well. Reclamation received funding under the American Recovery and Reinvestment Act for the feed route. Work was initiated in 2009 and will be completed in 2011.

Chapter 4: Alternatives

4.1. Introduction

This chapter presents a description and summary comparison of the alternatives being considered to address the Problems and Opportunities discussed in Chapter 2. Alternative formulation is discussed in Chapter 3. This chapter is organized as follows:

Section 4.2: Summary of alternative descriptions, including related water resource management programs and activities.

Sections 4.3 through 4.5: More detailed alternative descriptions, including how CBP water would be supplied (that is, which reservoirs would be involved), and the facilities required to deliver that water to groundwater-irrigated lands in the Study Area. Included with the description of required facilities is an overview of related construction timeframes and activities and how reservoirs would operate.

Sections 4.6 and 4.7: Summary of potential environmental consequences (details are presented in the Odessa DEIS and in the four-account analysis in Chapter 5 of this Special Study Report).

Note that findings from the economic and financial analyses are in Chapter 5, "Four-Account Analysis."

4.2. Alternatives and Feasibility-Level Design and Cost Estimates Overview and Water Management

Nine alternatives are considered for the Odessa Study, including the No Action Alternative, as required under the P&Gs. Because these alternatives must adhere to the same framework of management programs described in Chapter 3, this section explains the general approach of each alternative and the features common to all.

Section 4.2.1, "Overview of Alternatives," describes the components for water delivery and water supply, and indicates how those components were grouped into the nine alternatives analyzed. Then, Section 4.2.3, "River and Reservoir Operational Changes under the Action Alternatives," describes what would change and how those changes are measured under different watershed conditions, such as average, wet, dry, and drought years.

A number of existing, interrelated water management programs, actions, and activities in the study region would be a part of all alternatives. Section 4.2.2, "Action Alternatives—Delivery and Supply Combinations," describes common elements for all action alternatives.

Alternatives in the Odessa Special Study Draft EIS

The DEIS for the Odessa Subarea Special Study analyzes eight action alternatives that meet the Study's Purpose and Need to varying degrees, as well as a No Action Alternative. The eight action alternatives for the Odessa Study Area include two components:

Delivery Component—How much water is delivered to the Odessa Subarea; which lands would receive the water; and what are the conveyance facilities that would be used to provide that water.

Water Supply Component—The combination of existing and/or new reservoirs that would provide stored water from the Columbia River.

Half of the action alternatives would provide water to partially replace the groundwater supply in the Study Area and the other half would fully replace the groundwater irrigation supply. Within each of these two broad delivery categories of partial and full replacement, four different water supply combinations are analyzed, as described in Section 4.2.1, "Overview of Alternatives."

4.2.1 Overview of Alternatives

Nine alternatives are evaluated in the Odessa DEIS, including one No Action Alternative, four partial groundwater irrigation replacement alternatives, and four full groundwater irrigation replacement alternatives. The replacement alternatives differ in which reservoir provides the main water supply:

1. No Action Alternative

2. Partial-Replacement Alternatives:
   2A. Partial—Banks
   2B. Partial—Banks + FDR
   2C. Partial—Banks + Rocky
   2D. Partial—Combined

3. Full-Replacement Alternatives:
   3A. Full—Banks
   3B. Full—Banks + FDR
   3C. Full—Banks + Rocky
   3D. Full—Combined

4.2.1.1. Delivery Categories

In addition to the No Action Alternative, the eight action alternatives fall into two categories of alternatives based on how much surface water is delivered and where it would be delivered to replace groundwater-irrigated acreage in the Study Area. The three categories of alternatives are listed below:

4.2.1.1.1 *Alternative 1—No Action*

No additional surface water supply would be provided from the CBP to replace groundwater-irrigated acreage in the Study Area. No new facilities would be built, and no existing facilities would be expanded. The only existing programs or activities that would address the declining groundwater conditions in the Study Area would be the incremental release from Lake Roosevelt (30,000 acre-feet to

agriculture in the Study Area), which is part of the Management Program MOU and the Coordinated Conservation Program.

4.2.1.1.2 *Alternative 2—Partial Groundwater Irrigation Replacement*

This category of alternatives focuses on enlarging the existing East Low Canal and providing CBP surface water to approximately 57,000 acres currently using groundwater south of I-90 (Map 4-1). No surface water replacement would be provided to most of the remaining groundwater-irrigated acres in the Study Area north of I-90. The total CBP surface water supply needed for the partial-replacement alternatives would be 176,343 acre-feet.

Major facility development necessary for the partial-replacement alternatives would include expanding the capacity of 43.3 miles of the existing East Low Canal south of I-90, extending the canal by 2.1 miles, and developing a pressurized pipeline system to distribute water from the canal to the farmlands.

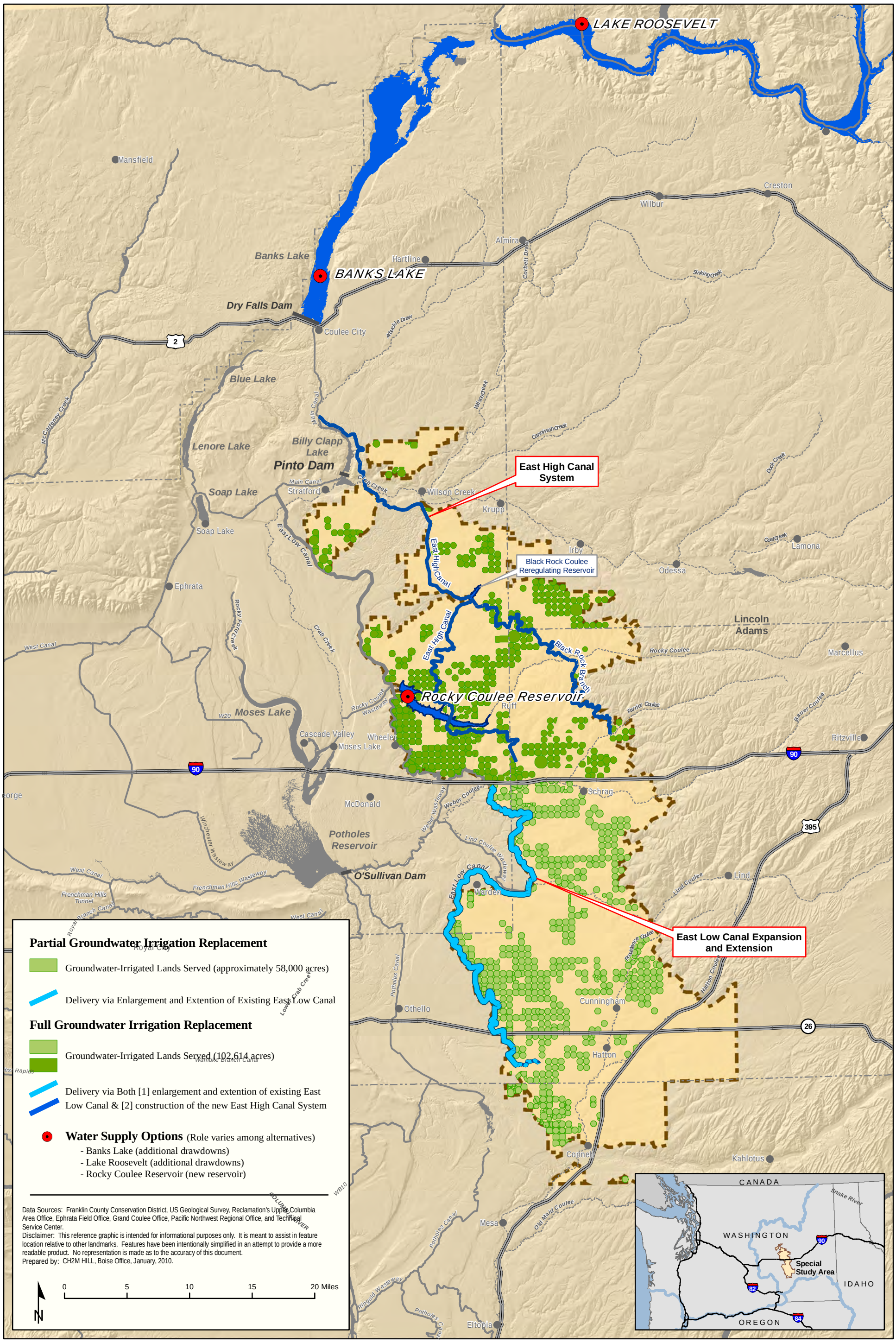
4.2.1.1.3 *Alternative 3—Full Groundwater Irrigation Replacement*

This category of alternatives would provide CBP surface water to most groundwater-irrigated acreage in the Study Area (approximately 102,600 acres). Lands south of I-90 would be served by enlarging the East Low Canal as described for the partial-replacement alternatives. Lands north of I-90 would be served by construction of the East High Canal system, as shown on Map 4-1. The total CBP surface water supply needed for the full-replacement alternatives would be 347,137 acre-feet.

In addition to the facilities described for the partial-replacement alternatives, the full-replacement alternatives would require construction of 71.6 miles of new canal, plus associated siphons, tunnels, wasteways, and a small reregulating reservoir, as well as a pressurized pipeline distribution system.

4.2.1.2. Water Supply Options

All surface water supplies for the action alternatives ultimately would come from the Columbia River using existing CBP water rights, but storage of that water in existing or new reservoirs would be needed. This allows water to be used from the reservoirs during the irrigation season, when less river flow is available. The reservoirs are then refilled during the fall and winter, when more river flow is available. Banks Lake and Lake Roosevelt could both be used for this storage. A new reservoir on Rocky Coulee in the Study Area is also possible. The locations of these three reservoirs are shown on Map 4-1. Four water supply components are considered for both the partial-replacement and full-replacement alternatives. These use storage from Banks Lake, Lake Roosevelt, or the proposed Rocky Coulee Reservoir, either individually or in combination, to provide the necessary CBP water supply:



Map 4-1. Overview of Action Alternatives: Major Delivery and Supply Elements

4.2.1.2.1 ***Water Supply Option A: Partial—Banks.***

This water supply option would use existing storage in Banks Lake, exclusively.

4.2.1.2.2 ***Water Supply Option B: Partial—Banks + FDR.***

This water supply option would result in drawdowns from both Banks Lake and Lake Roosevelt.

4.2.1.2.3 ***Water Supply Option C: Partial—Banks + Rocky.***

This water supply option would use existing storage in Banks Lake, plus a new Rocky Coulee Reservoir.

4.2.1.2.4 ***Water Supply Option D: Partial—Combined.***

This water supply option would use a combination of all three facilities.

4.2.2 Action Alternatives—Delivery and Supply Combinations

Within each of the two broad delivery categories of partial and full replacement described above, the four different supply combinations are analyzed to create the action alternatives. These eight action alternatives are listed on Table 4- 1 along with the No Action Alternative.

Alternative 1 is the No Action Alternative, which would not deliver additional CBP water to the Study Area and does not involve any facility construction.

Alternatives 2A through 2D would each deliver CBP surface water to replace groundwater to approximately 57,000 currently irrigated acres south of I-90 through an enlarged East Low Canal. The alternatives differ only in which of the four supply options would be used.

Similarly, Alternatives 3A through 3D evaluate four different supply options that would each provide CBP replacement water to approximately 102,600 acres of land currently irrigated with groundwater, both north and south of I-90. These alternatives would use both an enlarged East Low Canal and a new East High Canal system.

4.2.3 River and Reservoir Operational Changes and Hydrology under the Action Alternatives

The Columbia River system would provide the surface water supply that would replace groundwater irrigation in the Study Area. Hydrologic modeling has been conducted to determine the potential changes in river flows and reservoir operations (drawdown and refill patterns) that would accompany implementation of the partial-replacement alternatives (Alternatives 2A through 2D), the full-replacement alternatives (Alternatives 3A through 3D), and the No Action Alternative.

Modeling for this Study used four representative water year scenarios, or hydrologic conditions, within the watershed:

- Wet condition: Approximately 10 percent of years would be this wet or wetter.
- Average condition: Half of years would be wetter and half drier.
- Dry condition: Approximately 15 percent of years would be this dry or drier.
- Drought condition: Approximately 5 percent of years would be this dry or drier.

Using historical data to evaluate likely future hydrologic and system operation patterns assumes that future hydrologic conditions would be similar to those observed in the 1929 to 1998 period of record that was used as the basis for modeling. However, other wet, average, dry, and drought water years would not be identical to these four representative years. Section 4.2, "Surface Water Quantity," in the Odessa DEIS, describes the hydrologic record used for modeling, and the specific years within that record selected as representative.

How Would the Columbia River System Be Changed by the Alternatives?

None of the Study's eight action alternatives would result in a significant change in Columbia River flows. Current instream flow requirements intended to protect resource values would continue to be met as a first priority in all hydrologic conditions. Water management programs and requirements are in place that establish minimum flows and levels for the Columbia River to protect the resource values associated with the mainstem of the Columbia River, including ESA-listed fish species in the river.

Instead, providing CBP surface water to lands in the Study Area would require changing reservoir operations during and immediately after the irrigation season at Banks Lake for all action alternatives and at Lake Roosevelt for Alternatives 2B, 2D, 3B, and 3D, as shown on Table 4-1. At both reservoirs, these changes would mean increased drawdowns—and therefore lower pool levels—when compared with the No Action Alternative. In all cases, the increased drawdowns would reach their maximum points at the end of August. The Rocky Coulee Reservoir proposed in Alternatives 2C, 2D, 3C, and 3D would be a working reservoir, filled and emptied each year exclusively to provide irrigation water supply.

In all water year conditions, the most demand for surface water in the Study Area and, therefore, the greatest drawdown of reservoirs, would occur at the end of August during the height of the irrigation season. Figure 4- 1 shows the end-of-August drawdowns and associated pool elevations projected for Banks Lake for the No Action Alternative and the eight action alternatives under wet, average, dry, and drought conditions.

Table 4- 1. Alternatives Overview

Delivery Alternative (see also Map 4-1)		Supply alternative: Additional drawdowns of existing reservoirs				
		Letter and symbol*		Banks Lake	Lake Roosevelt (FDR)	New Rocky Coulee Reservoir
1 – No Action						
	• No CBP surface water provided to any additional groundwater-irrigated lands in the Odessa Subarea • No facility construction required • Current and ongoing Columbia River and CBP programs, commitments, and operations continue	Not Applicable				
2 – Partial Groundwater Irrigation Replacement						
	• Approximately 57,000 acres of groundwater-irrigated lands provided with CBP surface water • All lands supplied with surface water replacement would be south of I-90 • Water delivered by enlargement and extension of the existing East Low Canal and construction of a pressurized pipeline system • Current and ongoing Columbia River and CBP programs, commitments, and operations continue	**2A**		Yes	No	No
		2B		Yes	Yes	No
		2C		Yes	No	Yes
		2D		Yes	Yes	Yes
3 – Full Groundwater Irrigation Replacement						
	• Most groundwater-irrigated lands in the Study Area (approx. 102,600 acres) provided with CBP surface water (both north and south of I-90) • Water delivered south of I-90 by enlargement and extension of the existing East Low Canal and construction of a pressurized pipeline system • Water delivered north of I-90 by construction of a new East High Canal system, with an associated pressurized pipeline system • Current and ongoing Columbia River and CBP programs, commitments, and operations continue	**3A**		Yes	No	No
		3B		Yes	Yes	No
		3C		Yes	No	Yes
		3D		Yes	Yes	Yes

*The symbol system shown on this table is used to help identify the alternatives. The center area shows the delivery alternative—partially or fully shaded to indicate partial or full replacement. The band surrounding the center shows the supply option—black with white text is included in that alternative, white with grayed-out text is not included.

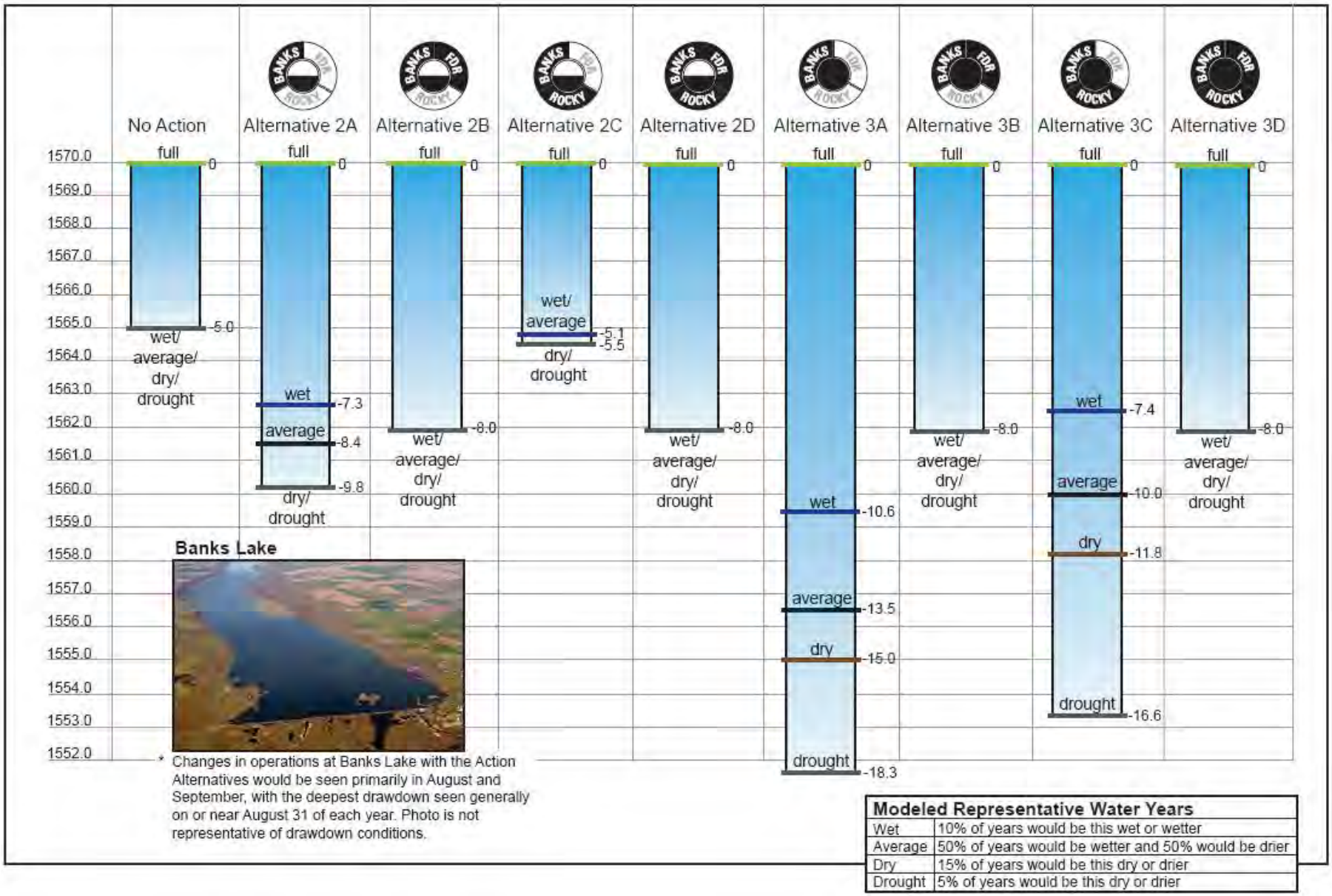


Figure 4- 1. Banks Lake End of August Drawdown

Figure 4- 2 provides this same information at Lake Roosevelt for the four action alternatives that use Lake Roosevelt storage. For example, as shown on Figure 4- 1, the maximum irrigation-season drawdown of Banks Lake under Alternative 2A: Partial—Banks in a drought year (up to 5 percent of years) would be 9.8 feet. In more typical, average years, the end-of- August drawdown under this alternative would be 8.4 feet. For Alternative 2A: Partial—Banks, this would mean an additional drawdown beyond No Action conditions of 3.4 feet in an average year and 4.8 feet in a drought year.

Full-year depictions of the modeling results for Banks Lake and Lake Roosevelt for all alternatives are presented in the Odessa DEIS Section 4.2, Surface Water Quantity.

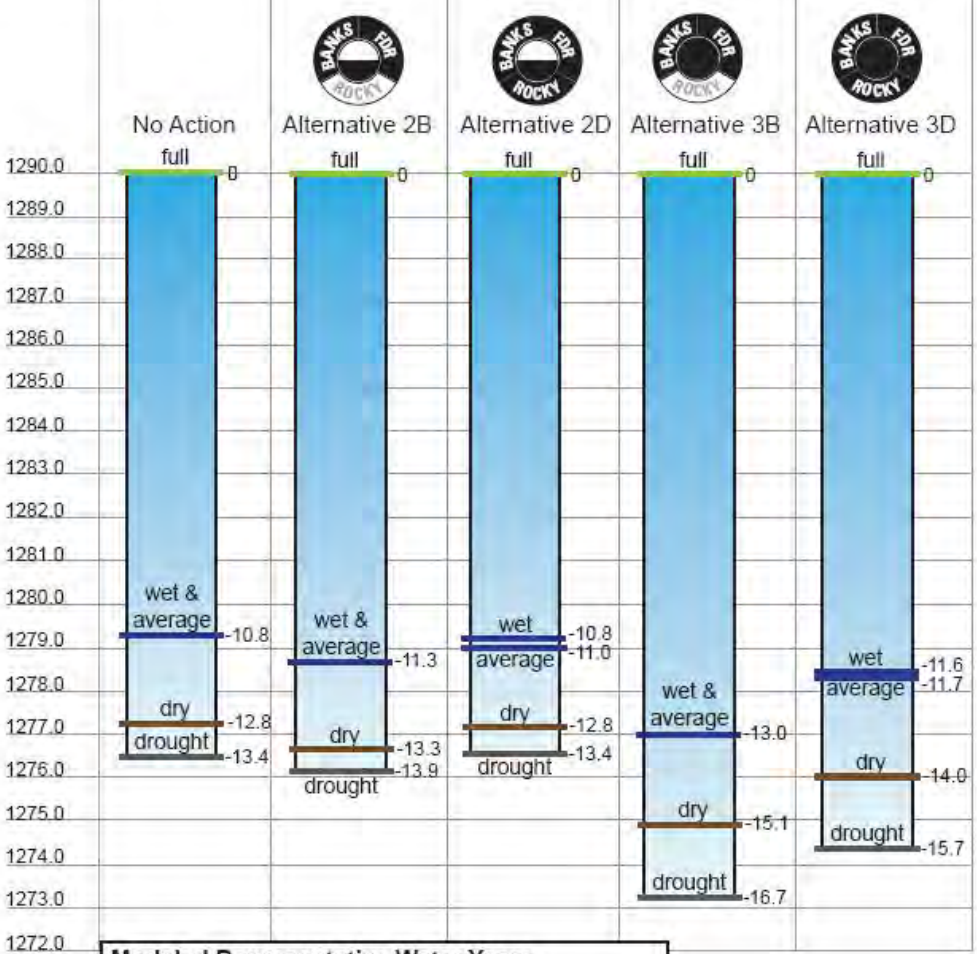
For the proposed new Rocky Coulee Reservoir that would accompany Alternatives 2C, 2D, 3C, and 3D, no modeling data is provided. This reservoir would be a working reservoir, completely filled and emptied each year to provide required irrigation water supply.

4.2.4 Water Management Programs and Requirements Common to All Alternatives

Water management within the Columbia River Basin is complex and is reflected in all of the alternatives, including the No Action Alternative. Delivery of irrigation water, supply of flows in the Columbia River to support fish and environmental objectives and meet water rights, and flood control operations are all carefully timed throughout the year to meet numerous, interrelated water demands and priorities in the region.

A number of programs and requirements of this water management system relate directly or indirectly to the alternatives being considered for groundwater-irrigated lands in the Study Area and would be common to all of the alternatives, including No Action. The most relevant of these programs and requirements are listed below, with brief descriptions of each provided in the paragraphs following:

- Operations at Lake Roosevelt and Banks Lake
- CBP irrigation water supply, including master water service contracts in the Study Area
- Columbia River Basin Water Management Program
- Coordinated Conservation Program.



Modeled Representative Water Years	
Wet	10% of years would be this wet or wetter
Average	50% of years would be wetter and 50% would be drier
Dry	15% of years would be this dry or drier
Drought	5% of years would be this dry or drier

Lake Roosevelt

* Changes in operations at Lake Roosevelt due to the Action Alternatives would be focused in August and September of each year, with the deepest drawdown resulting from the alternatives seen generally on or near August 31 of each year. Deeper drawdowns occur annually at this reservoir in April for flood control purposes. Photo is not representative of drawdown conditions.

Figure 4- 2. Lake Roosevelt - end of August drawdown

4.2.4.1. Operations at Lake Roosevelt and Banks Lake

The water supply for the CBP is stored behind Grand Coulee Dam in Lake Roosevelt. Congress originally authorized the Grand Coulee project for irrigation, navigation, flood control, and hydropower. Since the original authorization, recreation and fish management have been added to the authorized purposes of the dam and reservoir. Storage and delivery of water to meet irrigation, municipal, and industrial uses are authorized CBP purposes.

To supply the CBP, water from Lake Roosevelt is lifted to the Grand Coulee Feeder Canal, which flows 1.6 miles to Banks Lake (Figure 4- 3). Banks Lake is a storage facility formed by two dams: North and Dry Falls Dam (Figure 4-4 and Figure 4-5). Banks Lake is designed to serve as a re-regulation reservoir for the irrigation portion of the CBP, as well as the forebay for a pumped storage plant. Water is delivered to CBP lands through a low-head powerplant and outlet works at Dry Falls Dam at the southern end of Banks Lake through the Main Canal (Figure 4-6).

Figure 4- 3. Grand Coulee Feeder Canal with Lake Roosevelt in background and Banks Lake in foreground

Figure 4- 4. Banks Lake at North Dam

Figure 4- 5. Banks Lake at Dry Falls Dam

Figure 4- 6. Main Canal Headworks and Powerplant at Dry Falls Dam

4.2.4.1.1 ***Lake Roosevelt***

Reclamation currently operates Grand Coulee Dam and Lake Roosevelt for flood control, hydropower generation, irrigation, municipal and industrial supply, fish and wildlife, and recreation. Operations are coordinated directly with the Army Corps of Engineers (Corps) for flood control; State and Federal fish and wildlife agencies for management and protection of fish resources; and BPA for power production.

At full pool, the surface elevation of Lake Roosevelt is 1290 feet amsl and has an active capacity of 5.23 million acre-feet. Lake Roosevelt receives large amounts of runoff from its tributaries with enough runoff to fill the reservoir several times in an average year. The minimum operating pool elevation of Lake Roosevelt is 1208 feet amsl.

Lake Roosevelt is typically drafted and refilled twice during the year—a deeper draft occurs in winter and early spring for system flood control, and a shallower draft occurs in July and August to provide flow augmentation water for ESA-listed fish in the river downstream. Operations under current conditions and the No Action Alternative are included in the description of the No Action Alternative (see Section 4.3). The primary considerations that shape these operations are summarized in Table 4- 2. Except where noted, these existing operations would continue unchanged under all Study alternatives.

Table 4- 2. Lake Roosevelt Operations Common to All Alternatives

Operational Goal	Description
Flood Control	Lake Roosevelt is operated under a series of "rule curves" that regulate the amount of drawdown and fill. In late winter and early spring, flows are released from the reservoir to allow room to store upstream runoff and prevent downstream flooding. In an average year with normal precipitation, the reservoir can be drawn down 50 feet or more. The level of drawdown is based on the volume water supply forecast and other factors. The reservoir typically refills by the Fourth of July holiday.
ESA-Listed Fish	Grand Coulee Dam is operated to help shape streamflows downstream to support ESA-listed fish. In the Columbia River system, 13 anadromous fish species and 2 resident fish species are listed as threatened or endangered. NMFS and the Service have developed biological opinions that include objectives for Columbia River operations to benefit and protect these species. The two agencies review annual water management plans developed by Reclamation, the Corps, and BPA to assist in meeting fish objectives. Grand Coulee is operated to help with chum salmon flows from November 1 to April 10 and for other listed salmon and steelhead from April 10 to August 31. Under the Lake Roosevelt Incremental Storage Releases Program, operation of Grand Coulee Dam is being modified to include additional instream flow augmentation. These releases would draw down Lake Roosevelt by an additional 1 foot in non-drought years and 1.8 feet during drought years by the end of August.
CBP Irrigation Supply	About 2.65 million acre-feet is currently pumped annually from Lake Roosevelt to Banks Lake to supply irrigation water, generally from March through October. All irrigation-related operations are conducted to comply with downstream flow objectives to avoid impacting ESA-listed species.
Hydropower	In addition to seasonal fluctuations, Lake Roosevelt fluctuates daily because of releases for hydropower production. Grand Coulee Dam has four powerplants, including the pump/generation plant, and 33 turbines with a maximum generating capacity of 6,809 megawatts (MW).
Lake Roosevelt Incremental Storage Releases Program	The most recent substantive set of changes to operations at Grand Coulee Dam and Lake Roosevelt result from this component of the Management Program. Releases are being made to benefit agriculture, municipal and industrial users, Columbia River mainstem interruptible water right holders, and instream flows. Each year, 30,000 acre-feet will go to the Study Area, 25,000 acre-feet to meet municipal and industrial needs, and 27,500 acre-feet to augment instream flows (82,500 acre-feet total). An additional 50,000 acre-feet will be released during drought years, with 33,000 acre-feet of that release providing relief for interruptible water right holders and 17,000 acre-feet supplementing instream flows. Within the Study Area, reconstruction of the Weber Siphon is the primary facility modification necessary to deliver the 30,000 acre-feet of supply.
Secondary Considerations	Within these limitations, Reclamation strives to operate Lake Roosevelt to make boat launches and marinas accessible, and beaches and campgrounds usable. Lake levels at or above 1280 feet amsl are maintained during the summer recreation season as much as possible. Management for non-listed fish is also a secondary consideration for the overall operation of the reservoir. For example, operations coordinated with involved fish and wildlife agencies are shaped to benefit and protect non-listed mid-Columbia Chinook salmon from November through June.

4.2.4.1.2 ***Banks Lake***

Since its construction in the early 1950s, Banks Lake has been operated and maintained to store and deliver irrigation water to CBP lands. The lake has an active storage volume of 715,000 acre-feet between elevations 1570 feet (full pool) and 1537 feet amsl.

Reclamation operates Banks Lake within established constraints on water surface elevation to meet contractual obligations, ensure public safety, and protect property. This facility was sized to provide water for the ultimate development of the CBP. However, since its construction, the facility has not been operated at its maximum capabilities.

For the most part, the Banks Lake water surface level has fluctuated in a narrow 2-foot range, from about elevation 1570 feet amsl to elevation 1568 feet amsl. Exceptions to this, historically, have included periodic drawdowns of up to 35 feet (to surface elevation of approximately 1535 feet amsl) for facility maintenance or to address other water management issues. For example, in September 1993, the water surface elevation was lowered 5 feet, to approximately 1565 feet amsl, for maintenance of canal gates at the dams. In late 1994 and early 1995, the reservoir level was drawn down about 25 feet (to elevation 1545 feet) to perform maintenance on constructed facilities and to reduce an infestation of Eurasian milfoil.

Since 2000, adjustments have been made in Banks Lake operations to leave more water in the Columbia River during the summer for fish flow augmentation. Pumping to Banks Lake has been, and will continue to be, reduced in August to provide 133,600 acre-feet for summer fish flow augmentation. This results in a 5-foot drawdown of the reservoir level by the end of August. Refill occurs in September at rates subject to operational requirements and commitments at Grand Coulee Dam and Lake Roosevelt.

Beyond this planned annual drawdown, withdrawals from Banks Lake for CBP irrigation and refill of the reservoir from Columbia River flows and Lake Roosevelt are generally balanced to result in little water-level fluctuation under current conditions and the No Action Alternative.

4.2.4.2. CBP Irrigation Water Supply, Including Water Service Contracts in the Study Area

Currently, the CBP provides irrigation water supply to more than 550,000 acres in the Columbia Basin. CBP facilities include over 330 miles of main canals, approximately 2,000 miles of laterals, and over 3,500 miles of drains and wasteways. Other purposes of the CBP include power production, flood control, and recreation.

All of Reclamation’s current water supply obligations related to the CBP would continue to be met in all Study alternatives. Specific to the Study Area, CBP water would continue to be provided to 16,864 acres under existing water service

contracts through the ECBID. The locations of these lands are shown on Map 4-2 as "Lands Irrigated with Surface Water." About 11,700 of these acres are located north of I-90, and 5,164 are located south of I-90.

4.2.4.3. Columbia River Basin Water Management Program

Ecology was directed through the Management Act to aggressively pursue the development of water supplies to benefit both instream and out-of-stream uses. Ecology is currently in the process of developing the Management Program to facilitate implementation of the legislation. The Management Program includes administration of the Columbia River Basin Water Supply Development Account that the legislation created to fund storage, conservation, and other projects to provide new water supplies for the Columbia River Basin (Ecology, 2007).

As part of this program, the State, Reclamation, ECBID, the SCBID, and the QCBID are implementing an MOU that the parties entered into December 2004. The purpose of the MOU is to establish collaboration to secure economic and environmental benefits from improved water management within the CBP and along the mainstem Columbia River. Specific to the Study Area, the MOU includes three provisions (MOU Sections 14 to 16):

- Cooperate to support and pursue the diversion and delivery of an additional 30,000 acre-feet of water from Lake Roosevelt to the Odessa Special Study Area. Water use is limited to existing agricultural lands, with priority for lands currently irrigated under State groundwater permits.
- Cooperate to explore opportunities for water delivery to additional existing agricultural lands within the Odessa Subarea.
- Conduct an appraisal-level assessment of the potential to store additional water from the Columbia River mainstem in the Odessa Aquifer.

The State would continue to pursue the Management Program, including the MOU with Reclamation and the irrigation districts, under all of the Study alternatives. The first provision of the MOU is already being implemented as the Lake Roosevelt Incremental Storage Releases Program. Action on the second provision, however, may not proceed further under the No Action Alternative, since this Study is the direct response to this provision.

4.2.4.4. Coordinated Conservation Program

Under the broad umbrella of the Management Program, the ECBID, SCBID, QCBID, Ecology, and Reclamation are collaborating on a Coordinated Conservation Program to determine the potential for conservation efforts to create water savings in all three districts. This basinwide conservation program would continue under all Special Study alternatives.

For example, in 2005 ECBID was contracted to deliver water to 2,361 acres of land (6,274 acre-feet of water) to replace groundwater supplies in the Study Area.

This water was available as a result of water conservation associated with Ecology's Referendum 38 funded pipeline and canal lining projects. The conservation also produced over 4,200 acre-feet of M&I and fish and wildlife water in the District. Water conservation has been achieved through such actions as lining ditches, improving control structures, and more efficient operational controls.

Some of the water conserved through the Coordinated Conservation Program could eventually be allocated to groundwater-irrigated lands in the Study Area. However, there are many issues and perspectives related to ownership and use of conserved water. Conserved water cannot be directly translated into reduced demand for groundwater irrigation. Primary considerations include impacts on streamflows, initiatives by those conserving water to irrigate new land that is not currently irrigated, and the fact that the SCBID system relies on return flows from irrigation in the ECBID and QCBID for part of its water supply.

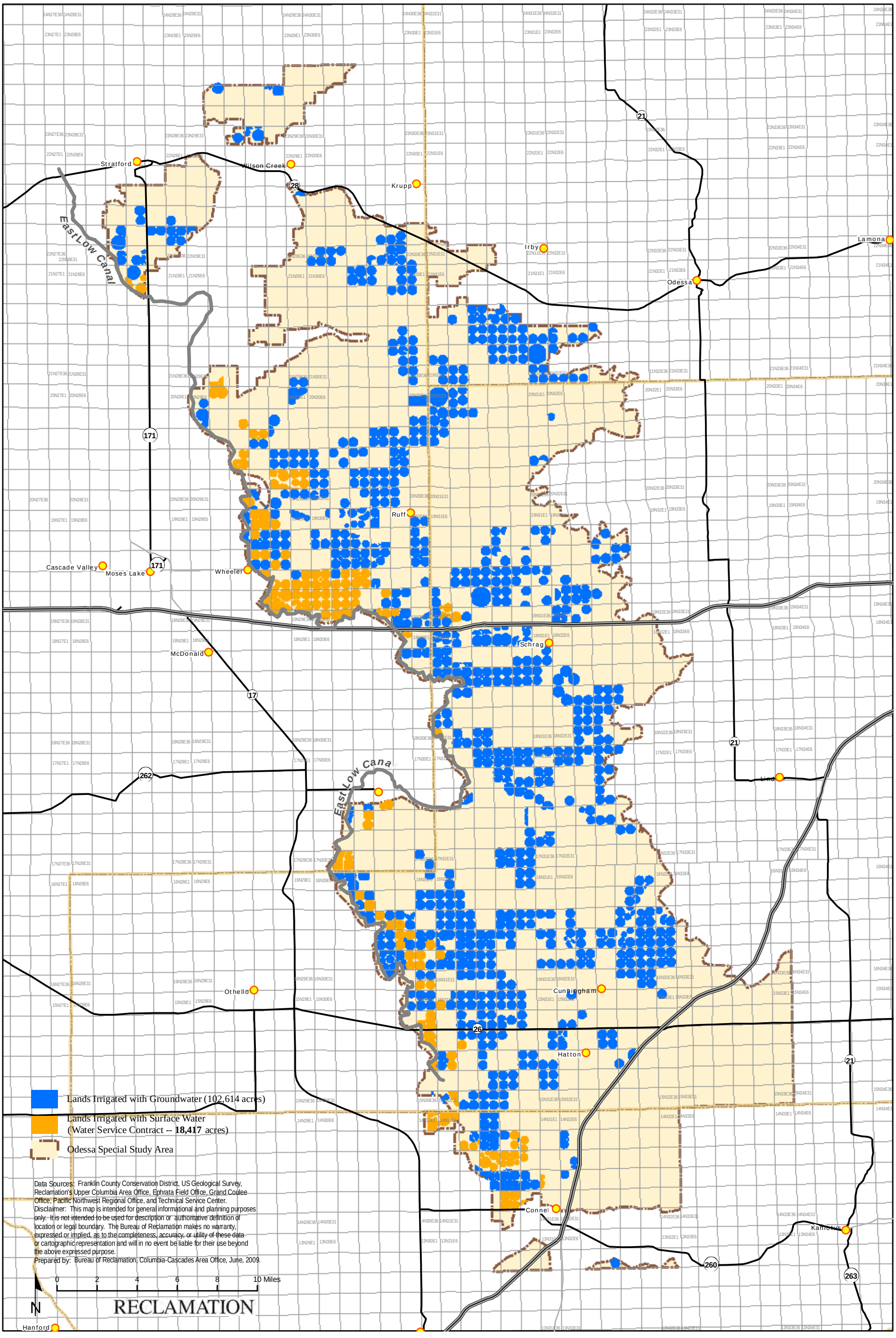
4.3. Alternative 1: No Action Alternative

In this Special Study Report, "no action" means that the proposed Federal action would not take place, and the resulting environmental effects from taking no action are compared with the effects of moving forward with an action alternative. Under the No Action Alternative, Reclamation and Ecology would not replace existing groundwater supplies with CBP surface water. Currently, farmers use groundwater to irrigate about 102,600 farmland acres in the Study Area, as shown on Map 4-2.

The No Action Alterative represents the foreseeable future if the proposed action is not implemented and groundwater levels continue declining in the Study Area aquifers. Under the No Action Alternative, irrigated agriculture in the Study Area that currently relies on groundwater would continue using that source of water. With continued dependence on groundwater, aquifers would further decline in quantity and quality. As groundwater declines, well yield and irrigation capability would progressively diminish in the study area.

4.3.1 Status of Groundwater Wells in the Odessa Subarea

Drilling groundwater wells within the Odessa Subarea, including the Study Area, began in the early 1960s, but drilling new wells essentially ended in the late 1980s. Groundwater levels in wells of the Odessa Subarea have steadily declined since substantive pumping began in the 1960s. Since the early 1980s, groundwater levels have dropped by 100 to 200 feet in nearly half of the production wells (see Figure 2-2, "Map of groundwater level declines in aquifers of the Odessa Subarea, 1981–2007," and discussion in Chapter 2 of this Special Study Report), at an average decline rate of 6 to 8 feet per year. In many cases, wells have been drilled deeper to access water, or use of wells has been



Map 4-2. Irrigated Agriculture in the Odessa Subarea

discontinued. Most of the current groundwater wells are 800 to 1,000 feet deep, but some are as deep as 2,100 feet.

During the period from September to December 2009, the Columbia Basin Ground Water Management Area (GWMA) interviewed well operators in the Odessa Subarea concerning the current status of well use and performance (GWMA, 2010 [Conditions]). Using this information, GWMA characterized wells into five status levels, ranging from full delivery of permitted flow rates (Status Level 1) to failure and discontinued use (Status Level 5).

The five status levels represent the life cycle of production wells in the Odessa Subarea. Wells were originally constructed for full permit delivery (Status Level 1). Over time as groundwater declines, well yield and irrigation capability progressively diminish. Typically, wells drop from Status Level 1 to Status Level 2, or Status Level 2 to Status Level 3, after the less-expensive well changes have been implemented. Well changes include any or all of the following measures:

- Reducing irrigated acreage
- Rotating to a shorter irrigation season crop
- Lowering the level of in-well pump intakes (such as pump bowls) to offset groundwater declines through the irrigation season
- Implementing water conservation measures to increase efficiency

If these changes do not suffice and, if feasible and affordable, a well could be drilled deeper to reach additional groundwater resources. GWMA considers wells entering Status Level 5 to have discontinued use permanently.

In January 2010, GWMA (2010 [Survey]) conducted an additional survey asking well operators in the Odessa Subarea to characterize the current status of their wells relative to the five status levels (see box, below). This survey also asked

GWMA Status Levels:
Describing Well Performance in the Odessa Subarea

Status Level 1: Full Permit Delivery. The well operates within its original permitted delivery levels and specifications, and has never been deepened. The well performs within acceptable levels and irrigates high water use crops (such as potatoes) through a full season without unplanned interruption.

Status Level 2: Full Permit Delivery, But Requiring Modifications. The well supports full permit delivery but either has been substantially reconstructed or has had conservation measures implemented since construction. Reconstruction has deepened the well shaft, lowered pump intakes, or otherwise increased efficiency to irrigate high water use crops through a full season without unplanned interruption.

Status Level 3: Partial Permit Delivery, But Still Supports Some High Water Crop Use. The well cannot support full permit delivery, but can sustain a high water use crop through part of a season. Although functioning, the well either fails to supply the original permit volume or cannot continue that volume for an entire season.

Status Level 4: Low Permit Delivery and No Support of High Water Crop Use. The well has a low yield through the full season and cannot support high water use crops, even on reduced acreage. It can supply shorter season crops (such as wheat or peas), because these crops do not require irrigation after July 1.

Status Level 5: Discontinued Use. The owner has discontinued use of a well, will not use it for any reason, and has chosen to not reconstruct or drill deeper.

well operators whether they would drill deeper if it were the only solution to water level decline, or if they would reduce water use through a shorter season or supplemental use only. Finally, the survey asked well operators to estimate what year current well use would be reduced to shorter season or supplemental use only.

GWMA estimates that only 5 percent of the wells in the Odessa Subarea currently operate within original permitted delivery levels and well specifications (Status Level 1), as shown on Table 4- 3. GWMA estimates that about 30 percent of the wells deliver full permit capacity after implementation of substantial well reconstruction or conservation measures (Status Level 2). On the other end of the spectrum, GWMA estimates that 5 percent of wells have had their use discontinued (Status Level 5), with the remaining 60 percent of wells operating at less-than-permitted levels and providing limited, if any, support to high water use crops (Status Levels 3 and 4).

Table 4- 3. Estimated Status of Wells in the Odessa Subarea Under Current Conditions and in the Future Under the No Action Alternative

Well Status Levels	Percent of Wells By Status Level	
	Current Conditions[1]	Future—10 Years (about 2020)[2]
Status Level 1: Full Permit Delivery	5	5
Status Level 2: Full Permit Delivery, But Requiring Modifications	30	10
Status Level 3: Partial Permit Delivery, But Still Supports Some High Water Crop Use	30	15
Status Level 4: Low Permit Delivery and No Support of High Water Crop Use	30	15
Status Level 5: Discontinued Use	5	55

[1] Based on GWMA (2010 [Survey]) survey results.
[2] Estimated by Reclamation's Economics and Resource Planning Group based on GWMA (2010 [Survey]) survey results.

GWMA's assessment of well decline is generally supported by observations of groundwater decline based on measured data obtained from known, reliable well records (see further discussion in the Odessa DEIS Sections 3.3 and 4.3, Groundwater Resources).

4.3.2 Future Risks Posed by Groundwater Conditions in the Odessa Subarea

As a result of the current conditions of groundwater decline in the Odessa Subarea, including the Study Area, the ability of farmers to irrigate their crops is at risk. Domestic, commercial, municipal, and industrial uses, as well as water quality, are also affected. Farmers irrigating with wells live with uncertainty about future well production. If no action is taken, GWMA estimates that wells would drop into lower status levels at a rate of 10 percent per year (GWMA, 2010 [Survey]). Using current well status levels and the estimated rate of decline from GWMA (2010 [Survey]), along with other local information on agricultural trends and practices, Reclamation's Economics and Resource Planning Team conducted an analysis of future conditions of well status and associated cropping patterns in the Study Area under a No Action Alternative. The methods and results of this analysis are described in the Odessa DEIS, Chapter 4, "Environmental Consequences," Section 4.15.

The results of this analysis indicate that the proportion of the production wells in the Study Area that support high-water-use crops would decline from 35 percent to 15 percent in the next 10 years (Status Levels 1 and 2; Table 4- 3). Further, at the current rates of decline, 55 percent of the production wells in the Study Area would cease groundwater output and use of these wells would be permanently discontinued in 10 years. The remaining 30 percent of wells would operate at lower-than-permitted water delivery levels that would provide limited or no support for high-water-use crops (Status Levels 3 and 4; Table 4-3).

Under the No Action Alternative, several factors would continue to cause disincentive for, or the inability of, most well owners and operators to deepen their wells. As a result, these factors would lead to a continuing trend of wells dropping into lower-than-permitted water delivery levels (Status Levels 3 and 4) or discontinued use (Status Level 5) as estimated by GWMA. These factors include the following:

- **Unreliable Groundwater Quantity from Deeper Zones**. Some of the recently-deepened wells have failed to deliver sufficient quantities of water, while others are performing but declining in static water level each season. The deeper zones consist of older water that has resided in these zones for a very long time (thousands of years), indicating little or no active recharge. Therefore, the prospect of deepening to low or no-recharge zones discourages investment in deeper wells.
- **Impaired Water Quality in Deeper Zones.** Deep groundwater is older water with undesirable qualities, such as high pH, high salinity, high mineral content, and warm temperature. Sustained use of such water risks damaging irrigated crops and soils.
- **Uneconomical Pumping Limits Reached.** Most of the wells in the Odessa Subarea have lowered their in-well pump intakes as low as possible to achieve effective pumping. Pump intakes set below 900 feet are less effective because the pressure required to bring the water to the surface is beyond the performance capability of current economical pump equipment. Additionally, the electrical power required for 900-foot lifts is substantial (GWMA, 2010 [Conditions]).
- **High Cost of Well Deepening.** At present, drilling deeper means drilling down 2,500 to 3,000 feet to reach additional groundwater resources. This is estimated to cost $700,000 to $1,000,000 per well (GWMA, 2010 [Conditions]).

Drilling new groundwater wells is not a feasible solution to augment or replace existing irrigation water needs. New wells would be subject to the same future uncertainties as existing wells with declining groundwater levels in Study Area aquifers. In addition, the State is not issuing new water rights that would be required for new wells.[2]

4.3.3 Other Uses of Groundwater in the Study Area

Groundwater wells also are used to support municipal, industrial, and domestic uses in the Study Area. More than 80 percent of the public and domestic drinking water in the mid-Columbia Basin comes from groundwater. Similar to irrigation wells, the wells for municipal, industrial, and domestic uses are also at risk from

[2] New wells may be drilled and operated using the State's groundwater exemption provisions, but the exemption only applies for livestock watering, noncommercial lawn and gardens up to 0.5 acre in size, and domestic uses up to 5,000 gallons per day.

dropping aquifer levels. For example, based on historical groundwater level data, water levels in some of the municipal and industrial wells have declined more than 100 feet in the past 30 years.

The municipalities in the area that use groundwater for public supply include Moses Lake, Warden, Othello, Ritzville, Connell, Odessa, Lind, Hatton, and Wilson Creek. According to the Ecology database of well logs (http://apps.ecy.wa.gov/welllog/), there are a total of 18 wells in the Study Area that serve these municipalities. These municipal wells range from about 700 to 1,000 feet in depth, and have yields ranging from 400 to 2,000 gallons per minute.

In addition, recent surveys conducted by GWMA provide a history of impacts to municipalities due to declining water levels (GWMA, 2010 [Survey]). The towns of Odessa, Warden, Ritzville, and Connell have all been forced to deepen or abandon wells due to declines in deep groundwater. Some of the wells cannot pump adequately during summer irrigation periods because of the seasonal drop in groundwater levels while irrigation pumps are running. The City of Ritzville had proposed drilling a new supply well but was forced to abandon the project because of the high costs involved.

Industrial users of groundwater in the Study Area include primarily food processing plants to produce frozen foods such as potatoes and beans. These facilities are located primarily in Othello, Warden, and Moses Lake. The Ecology database of well logs includes 19 wells in the Study Area that serve these industrial users. The wells used by these facilities range in size and depth, and are based on the water needs of the facilities. The wells range in depth from 100 to more than 1,000 feet. Several of the smaller wells produce around 100 gallons per minute, but the larger, deeper wells produce up to 2,000 gallons per minute.

Several hundred domestic wells have been drilled in the Study Area and are used for household water supply. These wells are typically completed in either the overburden sediments or the Wanapum Basalt unit, and are usually less than about 400 feet deep. As with the larger wells for irrigation, municipal, and industrial uses, the shallow domestic wells are also experiencing declining water levels in some areas. In these domestic wells, the shallow groundwater seeps downward through fractures and open boreholes into the declining deeper aquifers.

4.3.4 Other Water Management Programs and Requirements

Under the No Action Alternative, operations at Lake Roosevelt and Banks Lake would continue as they now occur. Lake Roosevelt would continue to provide water supply to meet authorized CBP purposes, including water delivery for irrigation, municipal, and industrial uses, and recreation and fish management. Water from Lake Roosevelt to the CBP would continue to be lifted via the Grand Coulee Feeder Canal to Banks Lake. Banks Lake would continue to serve as a

reregulation reservoir for the irrigation portion of the CBP and water would be delivered to CBP lands through the Dry Falls Dam outlet works at the southern end of Banks Lake.

Since 2000, adjustments have been made in Banks Lake operations to leave more water in the Columbia River during the summer for fish flow augmentation. Under the No Action Alternative, this adjustment would continue, whereby pumping from Lake Roosevelt to Banks Lake would be reduced in August to provide 133,600 acre-feet for summer fish flow augmentation in the Columbia River below Grand Coulee Dam.

Under the No Action Alternative, Reclamation's current water supply obligations related to the CBP would continue. Specific to the Study Area, CBP water would continue to be provided to 16,864 acres under existing water service contracts through the ECBID. For existing water service contracts in the Odessa Subarea, contract holders pump directly out of the East Low Canal at 34 locations. This condition, characterized by individual, unscheduled starts and stops of pumps, decreases system efficiency and can adversely affect ECBID's ability to meet delivery commitments downstream. The No Action Alternative would not address this condition.

A specific provision of the Columbia River Basin Water Resource Management Program (as described in Section 4.2.4.3), being implemented by Ecology, is to aggressively pursue the development of water supply alternatives to groundwater for agricultural users in the Odessa Subarea, among other priorities (Sec. 90.90.020 of Chapter 90.90 RCW–Columbia River Water Management Act). Action on this specific provision, however, would not proceed further under the No Action Alternative, since this Study is the direct response to this particular provision. As a result, the No Action Alternative would fail to meet this specific provision of Chapter 90.90 RCW.

Under the No Action Alternative, two other specific activities of the Management Program would occur within the Study Area:

- The Coordinated Conservation Program (as described in Section 4.2.4.4. of this report) would continue to implement conservation efforts to create water savings in the Study Area to reduce the use of groundwater for existing irrigation. Such actions and water savings would continue under the No Action Alternative.
- The Lake Roosevelt Incremental Storage Releases Program would continue to implement incremental storage releases from Lake Roosevelt to supplement water supplies to benefit both instream and out-of-stream uses. Each year, 82,500 acre-feet would be released, of which 30,000 acre-feet would go to the Study Area, 25,000 acre-feet to meet municipal and industrial needs, and 27,500 acre-feet to augment instream flows. The additional 30,000 acre-feet to the Study Area would remain limited to existing agricultural lands, with priority for lands irrigated under existing

State groundwater permits. An additional 50,000 acre-feet would be released during drought years, with 33,000 acre-feet of that release directed at relief for interruptible water right holders and 17,000 acre-feet used for augmenting instream flows.

4.4. Partial Groundwater Irrigation Replacement Alternatives

The group of partial-replacement alternatives would provide CBP surface water supply to approximately 57,000 acres of lands in the Study Area south of I-90 (Map 4-1 and Map 4-2). The total volume of water associated with partial groundwater replacement is estimated at 176,343 acre-feet. A small portion of currently groundwater-irrigated lands north of I-90, nearest the East Low Canal, may also be included in the partial-replacement alternatives. As the surface water supply system is brought online and this water becomes available to eligible lands, the intent would be to cease operation of associated irrigation wells. Under current State regulations, the irrigation wells would not be decommissioned or abandoned. Instead, the wells would be placed in standby status, remaining operational for use in an emergency (such as an interruption of the Federal surface water delivery system). However, the State is exploring the option of conducting a rulemaking process to require that these wells be fully decommissioned, at least in some areas or circumstances. Such rulemaking may be part of authorizing legislation for construction of an action alternative.

As part of these alternatives, the 16,864 acres of existing water service contracts that pump out of the East Low Canal at 34 locations would be incorporated into the delivery system. This action would increase system operational efficiency and improve ECBID's ability to meet scheduled deliveries.

Each of the four partial-replacement alternatives would involve the same water delivery system facilities and the same quantity of water. The delivery system would involve enlarging and extending the East Low Canal and constructing a pressurized pipeline system. The alternatives vary only in the option used to store and supply CBP water.

The four partial-replacement alternatives are:

- **Alternative 2A:** Partial replacement using the Banks Lake supply option (2A: Partial—Banks)
- **Alternative 2B:** Partial replacement using the Banks Lake and Lake Roosevelt (FDR) supply options (2B: Partial—Banks + FDR)
- **Alternative 2C:** Partial replacement using the Banks Lake and Rocky Coulee supply options (2C: Partial— Banks + Rocky)

- **Alternative 2D.** Partial replacement using the Banks Lake, FDR, and Rocky Coulee supply options combined (2D: Partial—Combined)

Each of these partial-replacement alternatives is described below, including summaries of water supply aspects and more detailed information about required facility development.

4.4.1 Alternative 2A: Partial—Banks

The main aspects of Alternative 2A: Partial—Banks are illustrated on Figure 4- 7. As shown on the diagram, these aspects include providing water supply from Banks Lake (1), and delivered through the East Low Canal (2) to currently groundwater-irrigated lands south of I-90. Major facility development associated with this alternative would be limited to enlargement of the East Low Canal south of I-90 and installation of a pressurized pipeline system to deliver the water from the canal to farmlands.

4.4.1.1. Water Supply

Water supply for this alternative comes from available Columbia River flows and additional drawdown of Banks Lake. Banks Lake water would be released into the Main Canal from Dry Falls Dam and diverted to the East Low Canal. The additional drawdown of Banks Lake would be 3.4 feet in an average year, beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown would be 8.4 feet at the end of August (see Figure 4- 1).

Banks Lake would be refilled as soon as practicable after the irrigation season, subject to any constraints imposed by Columbia River instream flow or other operational requirements.

No construction or modification of facilities is required at Banks Lake under Alternative 2A: Partial—Banks.

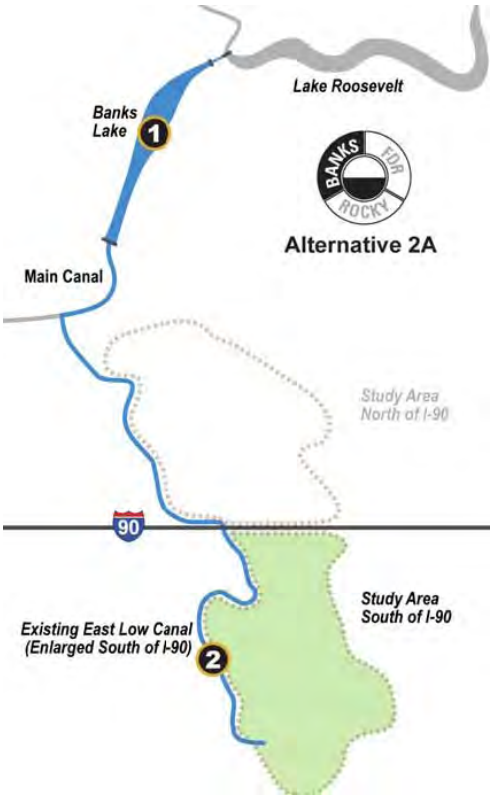


Figure 4- 7. Diagram of Alternative 2A: Partial—Banks

4.4.1.2. Delivery System

4.4.1.2.1 ***Facility Descriptions***

The water delivery system necessary for Alternative 2A: Partial—Banks and all of the other partial-replacement alternatives is shown on Map 4-3. Facility development would include the following:

- Enlarging the capacity of the 43.3 miles of the East Low Canal south of I-90, including adding a second barrel to all five existing siphons.
- Extending the East Low Canal about 2.1 miles at its southern end.
- Constructing a pipeline distribution system fed by pumping plants along the canal and a gravity-feed turnout at mile 89. This system would require numerous meter and equipment stations along the pipeline routes, primarily at farm delivery points.

Other related requirements include the following:

- Potential reconstruction of some existing road bridges over the East Low Canal
- Crossing of one local road by the East Low Canal extension
- A new O&M facility (see Map 4-3)
- Additional easement width along the existing Weber wasteway
- New electric transmission lines to each pumping plant and the O&M facility.

Each of these facilities is described below. Table 4- 4 provides a summary listing, including information on facility quantities and land requirements.

Table 4- 4. Partial Replacement Alternatives—Delivery System Facility Requirements

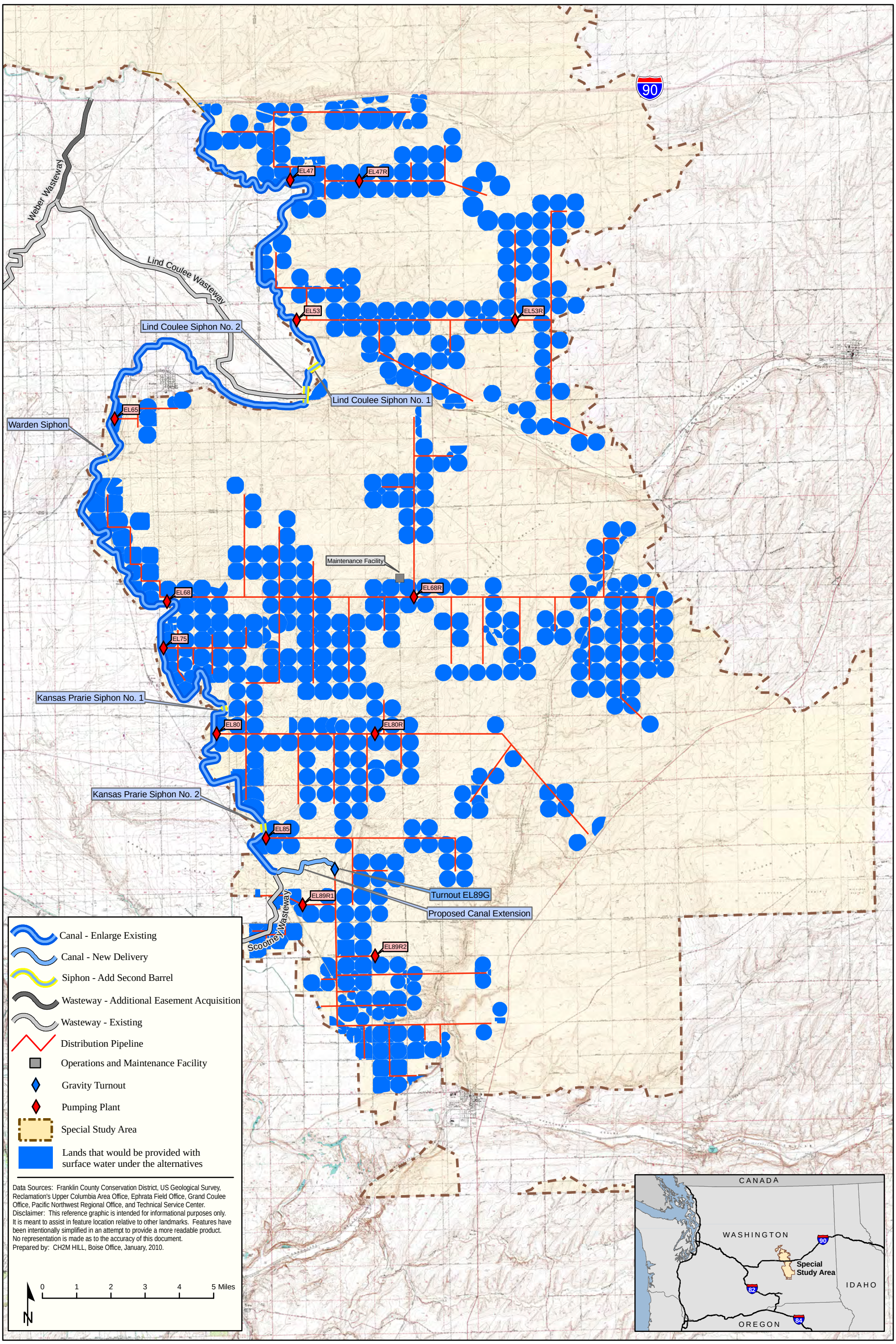
Facility/Action*	Quantity	Land Interest Acquisition Required	
		Type	Quantity
East Low Canal (ELC) (3,650 cfs)			
Enlargement	43.3 miles	N/A--Within existing easement	
Extension	2.1 miles	Easement	600 feet wide
Siphons--Add second barrel to all 5 existing	1.5 miles	N/A--Within existing easement	
Weber Wasteway—Additional Easement Acquisition	3.0 miles	Easement	350 feet wide[1]
Pumping Plants			
Canal-side Plants (along ELC) (EL47, 53, 68, 75, 80 & 85) (345 cfs – 13 cfs)	6 Sites	Fee	7 acres each
Relift Plants (EL47R, 53R, 68R, 80R, & 89R2)	5 sites	Fee	7 acres each
Gravity Turnout (EL89G)	1 site	Fee	2 acres
Distribution Pipeline	161.3 miles	Easement	200 feet wide
Pipeline Meter/Equipment Sites	TBD[2]	N/A—2500 square feet within pipeline easement	
Electric Transmission Lines[3]	84 miles	Easement	100 feet wide
Road Crossings			
Existing bridges over ELC—Reconstruct	N/A[4]	N/A—Within road easement and canal easement	
Road Crossings By New Canal[5]	1 location		
Operation and Maintenance Facility	1 site	Fee	7 acres each

[1] Existing Weber Wasteway easement width varies, but averages 250 feet (125 feet on each side of the channel); Reclamation would acquire an additional 175 feet on each side, to bring total easement width to 600 feet.
[2] To Be Determined: Number and location not determined at this level of planning; all would be within pipeline easements.
[3] Electric power supply would be needed at each pumping plant and the operations and maintenance facility. Supplying this power would require construction of new transmission lines. For the Partial Replacement alternatives, it is expected that power would be brought to facilities from the Moses Lake area. Given this projected source, total distance of new transmission lines required is estimated to be 84 miles. The locations and routes for these new transmission lines would be determined during future design phases.
[4] Some existing road bridges across the ELC canal may need to be lengthened/reconstructed to accommodate ELC enlargement. Any such requirements would be defined during more detailed planning (see "Transportation" discussion in section 4.16 of the Odessa DEIS).
[5] The ELC extension would cross one existing road. Through traffic on this road would be closed.

*Note: Some refinements in project facility design are occurring as part of engineering feasibility work. These refinements generally include limited adjustments to pumping plant locations and pipeline alignments (see Engineering Technical Report, available for review at http://www.usbr.gov/pn/programs/ucao_misc/odessa/). As of the public distribution date of the Odessa DEIS and Special Study Report, these refinements would not result in meaningful changes in the Odessa DEIS or Special Study Report analysis or conclusions.

4.4.1.2.2 *East Low Canal Enlargement*

The existing earth-lined, 43.3-mile section of the East Low Canal south of I-90 to the Scootney Wasteway was constructed at 23- to 46-percent of design capacity; design capacity was determined based on potential full development of the CBP as described in the 1989 *DEIS for Continued Phased Development of the CBP* (Reclamation, 1989). The five siphons along this reach of canal are also below design capacity, as they were constructed with one barrel (pipe), rather than the two barrels necessary to achieve full capacity.



Map 4-3. Partial Groundwater Irrigation Replacement Alternatives: Delivery System Facility Development & Modification

Beyond these limitations, many aspects of East Low Canal development anticipated the potential for future expansion in their design and construction. Sufficient easement width was acquired to allow for canal expansion and addition of the second siphon barrels. Siphon transitions, check structures, drainage inlets, cross-drainage facilities, and many of the roadway and other bridge crossings were built to accommodate full capacity.

Actions required along the East Low Canal south of I-90 for Alternative 2A: Partial—Banks (and the other partial-replacement alternatives) include the following:

- Widening the canal to increase its capacity. Figure 4- 8 presents a typical cross-section of this widening work, which would be accomplished within the existing canal easement. All excavated material would be placed within the existing easement, and the existing O&M access along the canal would be maintained similar to the approach used for initial canal construction. Concrete lining would also be added to short sections of the canal at 29 locations.
- Adding a second barrel to each of the five existing siphons (Lind Coulee 1 and 2, Warden, and Kansas Prairie 1 and 2), as illustrated in Figure 4- 9.

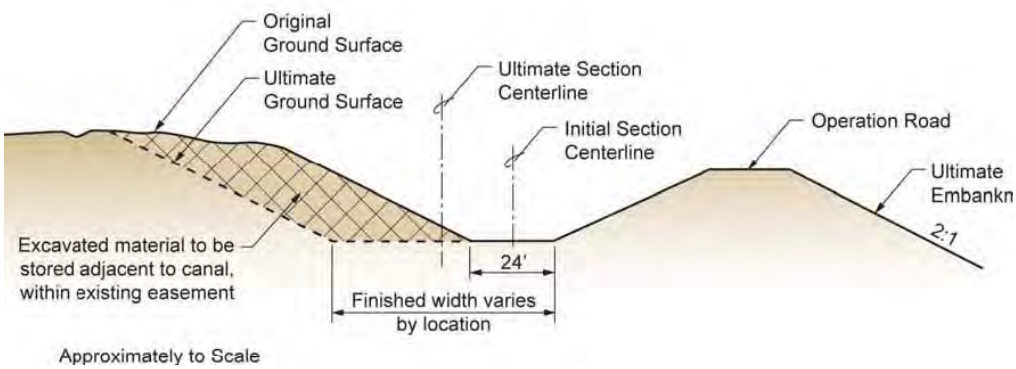


Figure 4- 8. East Low Canal Enlargement—Typical Cross Section

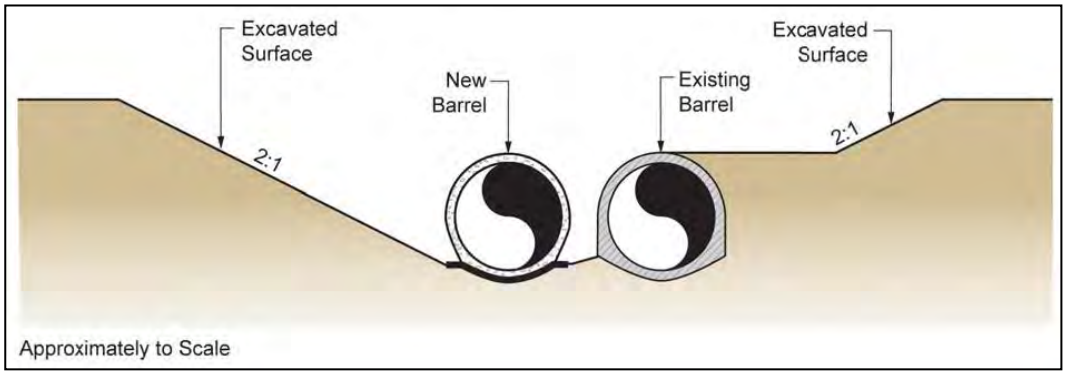


Figure 4- 9. Siphon Second Barrel Addition—Typical Cross-Section

4.4.1.2.3 ***East Low Canal Extension***

The East Low Canal would be extended approximately 2.1 miles beyond its current end. The general alignment of the extension is illustrated on Map 4-3, and a typical cross-section of the new canal is shown in Figure 4- 10. Reclamation would acquire a 600-foot-wide easement to accommodate canal construction, operation, and maintenance. As with the existing East Low Canal, all excavated material would be placed within the canal easement and an access road would be developed and maintained along the full length of the new canal. This canal would be built only to the capacity needed for the proposed groundwater irrigation replacement. No new siphons, tunnels, or other major facilities would be required.

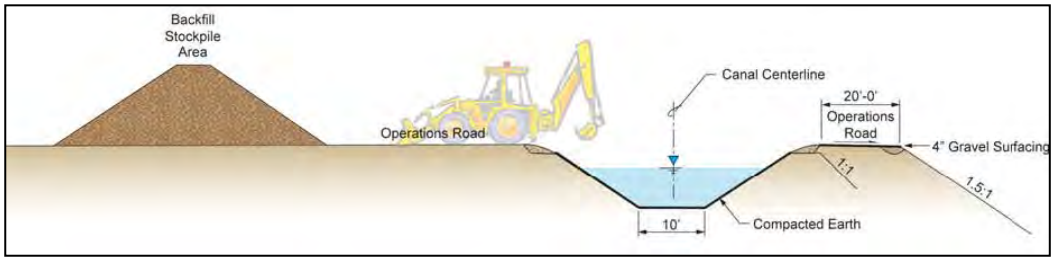


Figure 4- 10. Existing East Low Canal—Typical Cross-Section

4.4.1.2.4 ***Distribution Pipeline System***

CBP water from the East Low Canal would be provided by a pressurized pipeline distribution system to the groundwater-irrigated and water service contract lands south of I-90 that would be served in this alternative. The system would be pressurized by six canal-side pumping plants, five relift pumping plants, and one gravity-feed turnout to achieve 5 pounds per square inch (psi) at the highest delivery point. Metering stations would be located at numerous locations along the pipeline routes to record water deliveries. The following facilities would be included:

Distribution Pipelines: The distribution system would require approximately 161.3 miles of buried pipeline. In general, as illustrated on Map 4-3, the system is designed to locate the pipelines along section and half-section lines and deliver water to typical quarter sections. Reclamation would acquire a 200-foot-wide easement for pipeline installation and would need to retain long-term access to and within the easement for any necessary repairs or replacements. These requirements would preclude any future structure development within the easement. However, except for the locations of relift pumping plants and equipment sites described below, agriculture or other nonstructural uses could generally continue once the pipeline is installed and operational.

Canal-Side Pumping Plants: The six canal-side pumping plants that would feed the pipeline distribution system would be located on the east side of the East Low Canal, at canal miles 47, 53, 68, 75, 80, and 85. Each plant would require about 7 acres to accommodate the pumping plant equipment (no building or structure would be involved), a 6- to 35-foot-tall air chamber, and an electric power substation. The entire facility would be fenced for security using chain-link topped with barbed wire. A 50- to 205-foot-tall regulating tank would also be necessary with each of these pumping plants; this tank would be located along the pipeline up to 2 miles from the pumping plant site. Figure 4- 11 and Figure 4- 12 provide a conceptual site plan and elevation, respectively, of these pumping plants.

Relift Pumping Plants: Five relift pumping plants would be required to boost pipeline pressure in the central parts of the service area to reach the easternmost lands. The approximate locations of these plants are shown on Map 4-3; Figure 4- 13 provides a conceptual site plan. Each plant would require about 7 acres to accommodate the pumping plant equipment (as with the canal-side plants, no building would be involved), a 6- to 35-foot-tall air chamber, a 50- to 205-foot-tall regulating tank, and an electric power substation.

Gravity Feed Turnout: A turnout would be constructed at East Low Canal Mile 89 to deliver gravity-fed water to the pipelines serving lands at the southern end of the project area. This facility would require a 2-acre site.

Meter Equipment Sites: Metering equipment would be installed at numerous locations in the water distribution pipeline system. Most of these metering sites would be located where landowners tap into the system. These sites would total approximately 2,500 square feet, all within the pipeline easement, and would be sited specifically not to interfere with existing irrigation equipment or other infrastructure. They would be placed near existing roads as much as possible.

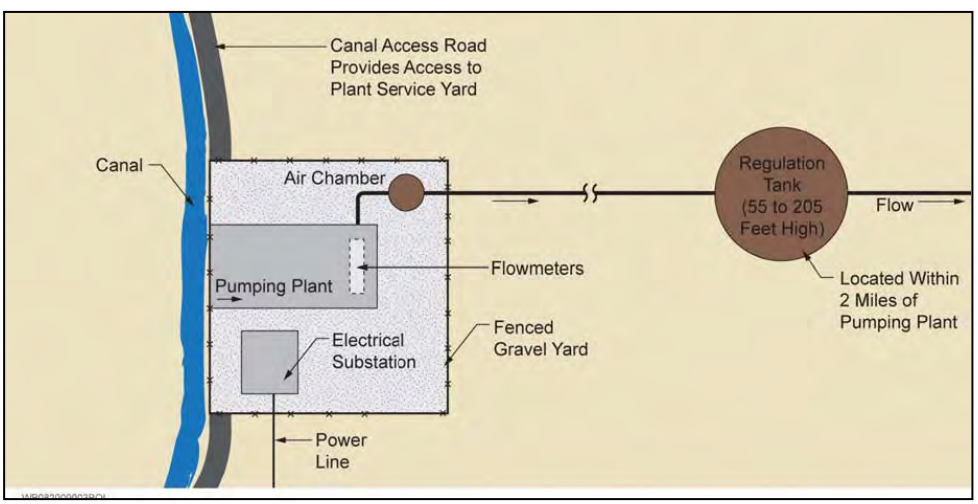


Figure 4- 11. Canal-side pumping plant conceptual site plan

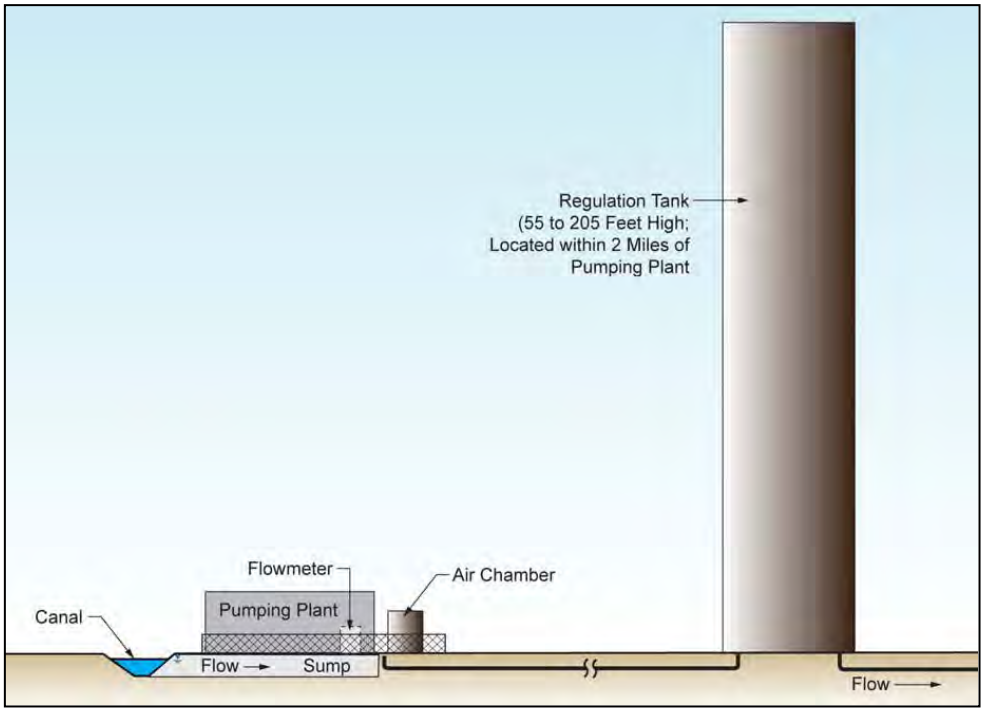


Figure 4- 12. Canal-side pumping plant conceptual elevation

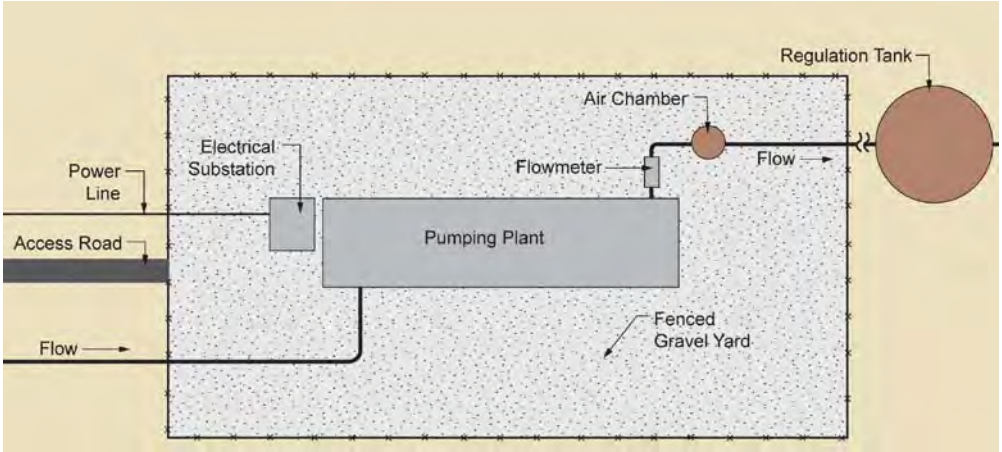


Figure 4- 13. Relift pumping plant conceptual site plan

4.4.1.3. Other Facility Requirements

4.4.1.3.1 ***Roadway Crossings of the East Low Canal***

Some of the existing road bridges over the East Low Canal may need to be modified to accommodate canal widening. A full review of the need for such work would be conducted during more detailed project design. In any case, it is

expected that necessary modifications would remain within the existing canal and road easements.

4.4.1.3.2 *The East Low Canal Extension*

This extension involves one new crossing of a county road. No bridge or realignment is proposed for this road. Through traffic would be rerouted to other nearby facilities.

4.4.1.3.3 *O&M Facility*

An O&M facility would be built to provide support services. This facility would be approximately 7 acres in size, and it would be located at the northeast corner of South Johnson Road and West Herman Road, approximately 20 miles northeast of Othello, Washington. The main building would be 63 feet wide, 243 feet long, and 26 feet high, and would house office space, parts storage, a large maintenance shop, a welding shop, a garage area for large maintenance vehicles, and a covered outdoor storage area. Other features of the site would include two above-ground bullet-resistant double walled tanks for storage of diesel and gasoline fuel, a propane tank surrounded by concrete masonry walls, and an uncovered outdoor storage area. Much of the site would serve as a service yard for vehicle access and parking. Electrical service would need to be extended to the site. Water supply would be from a new well, and wastewater would be managed with a septic system. The entire facility would be fenced for security, using chain-link topped with barbed wire. A conceptual site plan of the facility is shown in Figure 4- 14.

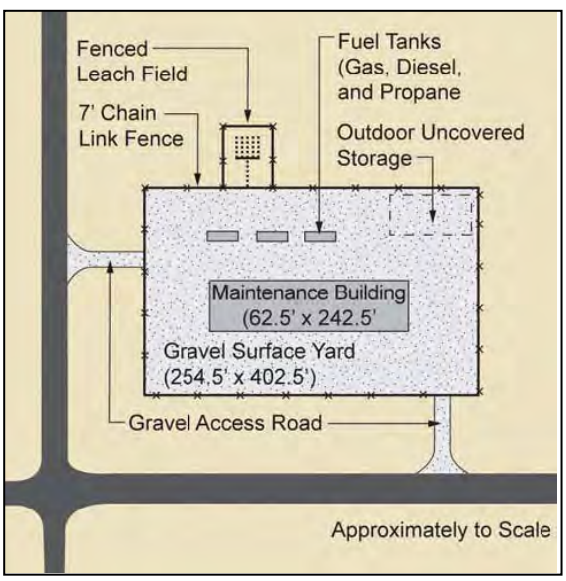


Figure 4- 14. Operation and Maintenance Facility Conceptual Site Plan

4.4.1.3.4 *Additional Easement Width—Weber Wasteway*

The 3-mile-long constructed channel of the existing Weber Wasteway (shown on Map 4-3) has deteriorated over time. Rather than reconstruct the channel, Reclamation proposes to acquire additional easement width to accommodate continued operation. Currently, the Reclamation easement along the wasteway averages 250 feet in width (125 feet from the channel centerline on each side). An additional (average) 175-foot easement would be acquired on each side of the channel, expanding total easement width to 600 feet. This acquisition would occur along the full 3 miles of the constructed channel alignment.

4.4.1.3.5 ***Electric Transmission Lines***

High voltage (currently estimated at 34.5 kilovolts) electric power would need to be provided at each of the canal side and relift pumping stations, as well as at the O&M facility. New transmission lines would be needed to supply most, if not all, of these facilities. The lines would be wood pole facilities, constructed in a 100-foot-wide easement. At the present stage of project planning, specific electric system tie-in points and routes for necessary transmission lines have not been determined. However, it is expected that power would be brought from the Moses Lake area, with the requirement for new transmission lines estimated at 84 miles. During more detailed planning, these lines would be routed to reduce creation of new corridors in the landscape and to minimize impact on existing land uses by following existing powerlines, roadways, railroads, or other existing linear infrastructure wherever possible. If needed, additional NEPA documentation would be provided to address transmission line development impacts as details of routing are defined.

4.4.1.3.6 ***Access Roads***

Few, if any, new permanent access roads would be required outside of the existing and facility easements and acquisition areas associated with this alternative. Existing operation and maintenance roads along the East Low Canal would be retained and similar roads would be built along the East Low Canal extension; these roads would be used to access the canal-side pumping plants and the gravity turnout facility. For the relift pumping plants and the O&M facility, locations with existing road access would be selected to the extent feasible. However, short distances of new access road may be needed for some relift plants and additional NEPA documentation would be provided if needed to address these roads. Access to distribution pipeline and powerline alignments would be with existing roads or along the facility easements, as necessary. For pipeline and powerline alignments, regular access would be necessary only during construction. There may be some need to use existing farm field roadways (trails) occasionally to access pipelines for appurtenant structure (air valve or blowoff) repair; any such use would be coordinated with the involved landowners.

4.4.1.4. Construction

4.4.1.4.1 *Duration and Phasing*

Development of the delivery system for Alternative 2A: Partial—Banks (and the other partial-replacement alternatives) would be divided into four segments, spanning a total of approximately 10 years, as shown on Map 4-4. Each construction segment would last 3-4 years, with work on two or more segments overlapping at times. Construction would be conducted in segments to spread the work as evenly as possible throughout the 10-year construction period and to bring the delivery system online in stages, as early as possible.

4.4.1.4.2 *Construction Workforce, Activities, Equipment, and Other Requirements*

The total workforce requirement for construction of the delivery system for Alternative 2A: Partial—Banks (and the other partial-replacement alternatives) is expected to be approximately 120 to 130 personnel at the peak level of activity,

which would occur in the latter half of the construction period concurrent with work on multiple segments.

Construction activity, and thus deployment of the workforce, would occur at multiple locations simultaneously in each segment, and move progressively through the segment area. Worksites would include the following:

- Along the East Low Canal (widening or extension)
- Existing siphons (adding a second barrel)
- Pumping plant(s), including associated electric substations
- Distribution pipeline alignments
- Transmission line alignments
- O&M facility

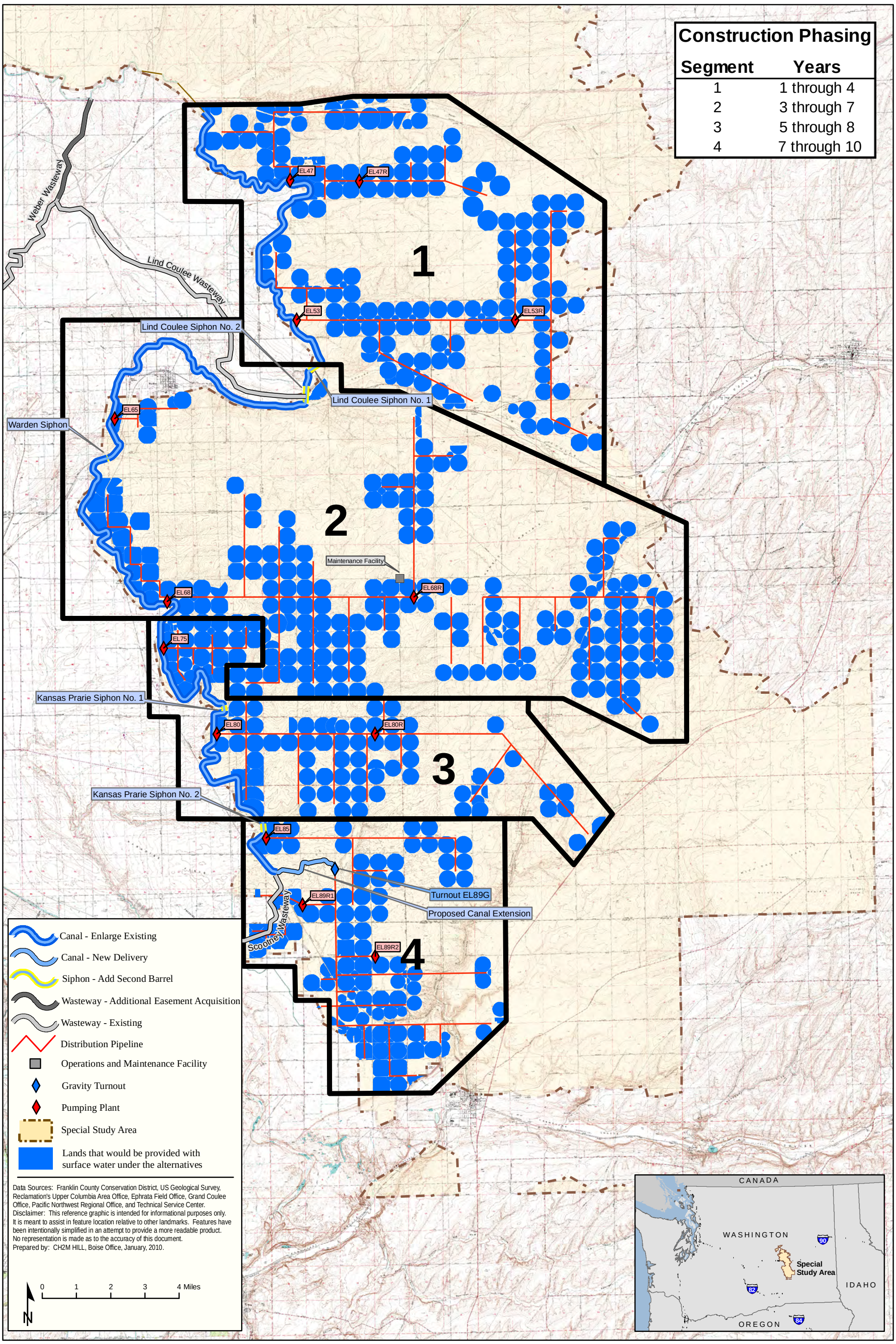
Major construction in any given area is not expected to extend beyond a year and, in many cases, would be of substantially shorter duration. Work on the existing East Low Canal would be outside of the irrigation season to avoid disruption of existing water operations.

Access for facility construction would be primarily from existing public roads, Reclamation operations, and maintenance roads along the East Low Canal or temporary roads along distribution pipelines within the pipeline easements. Powerlines would be installed along existing roads to the extent practical; where this is not feasible, temporary access roads would be needed along the powerline easement.

Construction of the delivery system, especially canal widening and extension, would require use of heavy equipment including hydraulic excavators, large dozers, scrapers, cranes, and compaction equipment. Other equipment normally involved with major construction would also be employed, such as dump trucks, loaders, and delivery trucks (for concrete and other materials).

Staging areas would generally be located within canal, pipeline, and transmission line easements and at the sites of pumping plants and the operation and maintenance facility. To the extent possible, staging areas would be located at least 500 feet from a residence.

No disposal sites for excavated material are expected to be needed. All material excavated for canal enlargement and extension, or for installation of pipelines and transmission lines, would be stockpiled within the facility easements or backfilled, as appropriate.



Map 4-4. Partial Groundwater Irrigation Replacement Alternatives: Delivery System Construction Phasing

4.4.1.5. Operation and Maintenance

Numerous activities are required to maintain irrigation system infrastructure and equipment, provide for efficient operation, and minimize unplanned outages in service. These activities include regular inspections, debris removal, cleaning, painting, resurfacing, and equipment maintenance, repair, and replacement. Collectively, these activities would not require a large workforce and only infrequent use of heavy equipment. All such activities would be carried out by involved irrigation districts.

4.4.1.6. Costs

Construction cost estimates (field cost estimates plus noncontract cost estimates) were prepared for the eight action alternatives associated with this Study. These cost estimates were based on the feasibility-level designs for each alternative. In addition, estimates of the annual operation, maintenance, replacement, and power (OMR&P) costs were prepared for each alternative. These cost estimates are in October 2009 price-levels.

A brief description of these cost estimate components follow, along with the cost estimates for Alternative 2A: Partial—Banks.

Estimates for field cost, noncontract cost, and OMR&P costs are noted for each of the action alternatives that follow in this Chapter.

4.4.1.6.1 *Field Cost Estimates*

Field cost estimates for the Study include itemized pay items, mobilization, design contingencies, procurement strategies, and construction contingencies.

The field cost estimates for Alternative 2A: Partial—Banks are $587.6 million.

4.4.1.6.2 *Noncontract Cost Estimates*

Noncontract costs include environmental studies, site investigations, design, construction management, contract administration, legal, security, land acquisition, relocation, and right-of-way costs that may be significant and are required for construction of the project features.

Noncontract cost estimates for Alternative 2A: Partial—Banks are $140.7 million.

4.4.1.6.3 *OMR&P Costs*

OMR&P costs were prepared for all the action alternatives for this Study. The operation and maintenance costs are based on historical data for project lands currently served by the ECBID and represent anticipated annual O&M costs expected for the proposed new features. Annual replacement costs are based on the most probable field cost estimates developed for this Study for the proposed project features with appropriate depreciation rates applied. Annual power costs

are based on estimates of power usage for the various pumping plants, buildings, canal structures, and dam facilities that comprise the proposed project features.

OMR&P cost estimates for Alternative 2A: Partial—Banks are $6.9 million.

4.4.2 Alternative 2B: Partial—Banks + FDR

The primary elements of Alternative 2B: Partial—Banks + FDR are illustrated on Figure 4- 15. As shown on the diagram, these aspects include providing water supply from Lake Roosevelt (1) and Banks Lake (2), delivered through the East Low Canal (3), to currently groundwater-irrigated lands south of I-90. As with Alternative 2A: Partial—Banks, major facility development would be limited to enlargement of the East Low Canal south of I-90 and installation of a pressurized pipeline system to deliver the water from the canal to farmlands.

4.4.2.1. Water Supply

Water for this alternative would be provided from available Columbia River flows and additional drawdown of both Lake Roosevelt and Banks Lake. Water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East Low Canal.

The additional drawdown of Banks Lake under this alternative would be 3 feet in an average year beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown at Banks Lake would be 8 feet at the end of August (see Figure 4- 1).

The additional drawdown in an average year at Lake Roosevelt would be 0.5 feet at the end of August beyond the 11.0 feet with the No Action Alternative, bringing the total end-of-August drawdown to 11.5 feet (see Figure 4- 2).

Reservoir refill would occur first for Lake Roosevelt, which is required to be at water surface elevation 1283 feet amsl by the end September. Banks Lake would then be refilled as soon as practicable subject to any constraints imposed by Columbia River instream flow or other operational requirements.

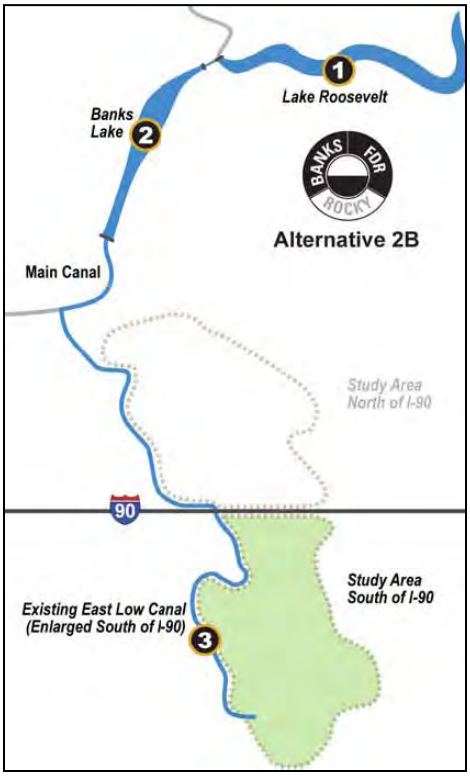


Figure 4- 15. Diagram of Alternative 2B: Partial—Banks + FDR

No construction or modification of facilities is required at either Lake Roosevelt or Banks Lake under Alternative 2B: Partial—Banks + FDR.

4.4.2.2. Delivery System

Delivery system, other facility requirements, construction, and O&M for this alternative would be the same as those described in Section 4.4.1.2 for Alternative 2A: Partial—Banks.

4.4.2.3. Costs

Construction cost estimates were prepared for the eight action alternatives associated with this Study (see Section 4.4.1.6).

The cost estimates for Alternative 2B: Partial—Banks + FDR are the same as for Alternative 2A: Partial—Banks.

4.4.3 Alternative 2C: Partial—Banks + Rocky

The main aspects of Alternative 2C: Partial—Banks + Rocky are illustrated on Figure 4- 16. As shown on the diagram, these aspects include providing water supply from Banks Lake (1) and a new Rocky Coulee Reservoir (2), delivered through the East Low Canal (3), to currently groundwater-irrigated lands south of I-90. Major facility development would include Rocky Coulee Reservoir as well as the same East Low Canal enlargement and pressurized pipeline system described for Alternative 2A: Partial—Banks.

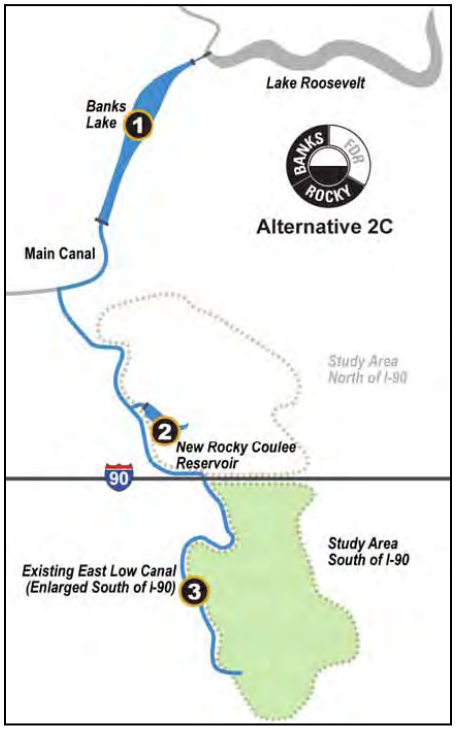


Figure 4- 16. Diagram of Alternative 2C: Partial—Banks + Rocky

4.4.3.1. Water Supply

Water supply for Alternative 2C: Partial—Banks + Rocky would be provided from available Columbia River flows, minor additional drawdowns at Banks Lake, and storage in a new Rocky Coulee Reservoir. When Columbia River flows or Banks Lake storage is being used, water would be released from Banks Lake into the Main Canal from Dry Falls Dam and diverted to the East Low Canal. Water from Rocky Coulee Reservoir would enter the East Low Canal directly though an inlet/outlet channel, as described and illustrated below.

Reservoir operation under this alternative would cause very little additional drawdown of Banks Lake. The additional drawdown at Banks Lake would be 0.1 foot in an average year beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total drawdown would average 5.1 feet at the end of August.

Rocky Coulee Reservoir would be nearly or fully emptied each year, with no continuing recreational or fish and wildlife values.

In terms of refill, water would be released from Banks Lake to fill Rocky Coulee Reservoir by the end of October each year, followed by any necessary refill of Banks Lake. Rocky Coulee Reservoir would need to be refilled first because of icing conditions in the Main and East Low Canals after November 1. Refill rates for the two reservoirs, in turn, would be subject to any constraints imposed by adherence to Columbia River instream flow or other operational requirements.

No construction or modification of facilities is required at Banks Lake under Alternative 2C: Partial—Banks + Rocky. Required facility development for Rocky Coulee Reservoir is described below.

Rocky Coulee Reservoir would be formed by an earth-filled dam in Rocky Coulee, approximately 8 miles from the town of Moses Lake, Washington. The location of the reservoir is shown on Map 4-1, and the reservoir site plan is shown on Map 4-5. Data describing facility types, sizes, and capacities are shown on Table 4- 5.

Table 4- 5. Rocky Coulee Reservoir Data

Facility/Characteristic	Size/Quantity
Land Acquisition Requirement	8,960 acres
Reservoir	
Surface area at full pool	2,812 acres
Length at full pool	9 miles along center line
Active storage capacity	109,315 acre-feet
Maximum water surface elevation	1,300.5 feet
Elevation top of active storage	1,291 feet
Dam (height 100 feet)	
Type	Zoned earthfill embankment
Crest elevation	1,305 feet
Crest width	30 feet
Crest length	3,100 feet
Inlet/outlet canal length and capacity	1.27 mile; 1,060 cfs. 600-foot easement outside of acquisition area
Pumping Plant	
Unit type	91.9 cfs horizontal split case centrifugal
Plant design flow capacity	735.4 cfs
Pump lift	88 feet

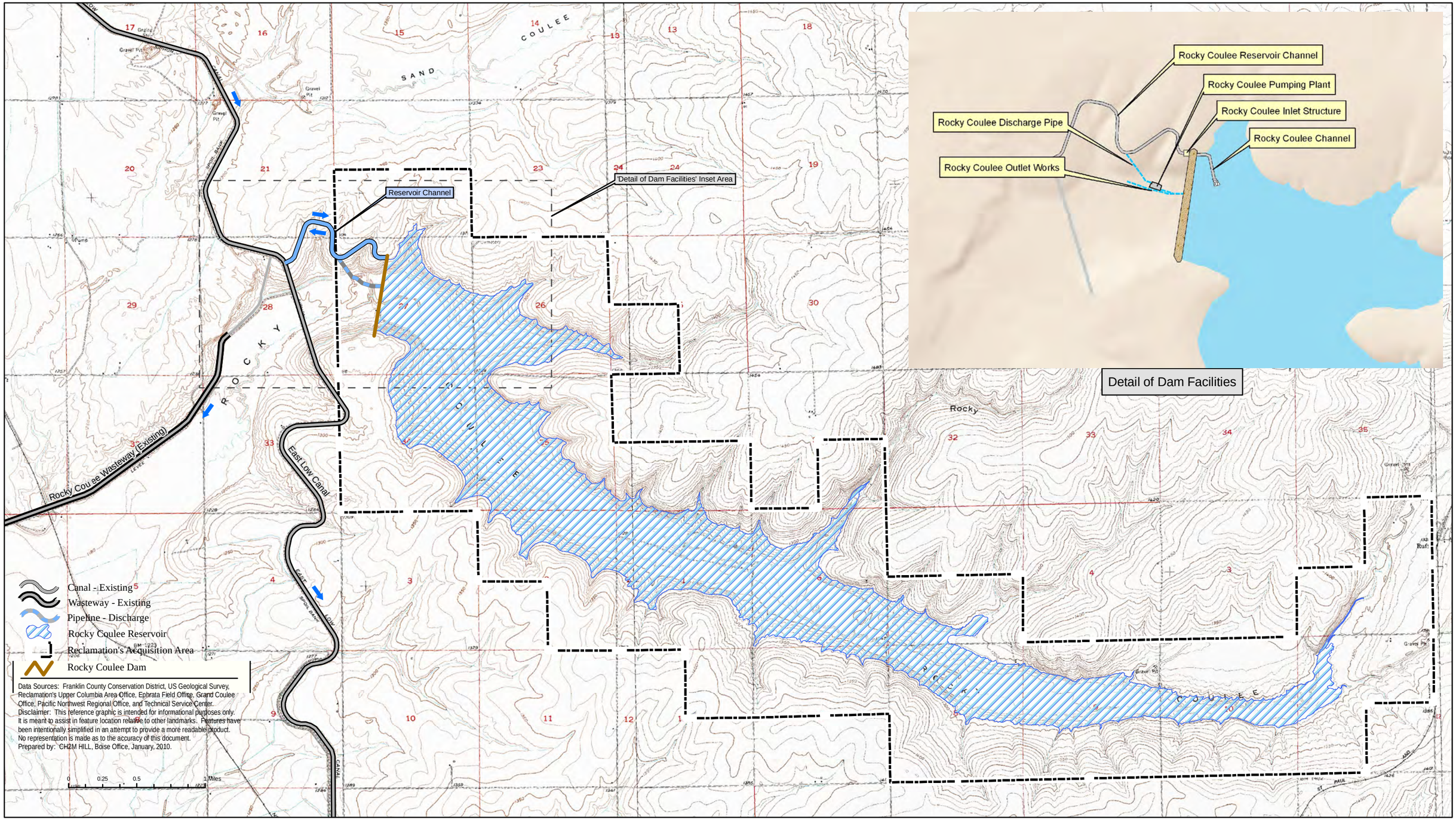
To fill the new Rocky Coulee Reservoir, water would flow by gravity through a newly constructed concrete-lined inlet/outlet channel from the existing East Low Canal to the right abutment of the proposed dam. The channel would tie into the existing East Low Canal immediately upstream of the existing Rocky Coulee Siphon. When needed to meet irrigation needs, water would be pumped back into the East Low Canal through a pumping plant located at the downstream toe of the dam. A lower outlet structure would also be constructed at the dam to evacuate the reservoir, if needed.

4.4.3.2. Delivery System

Delivery system and other facility requirements for Alternative 2C: Partial—Banks + Rocky would be the same as those described in Section 4.4.1.2 for Alternative 2A: Partial—Banks.

4.4.3.3. Construction

Rocky Coulee Reservoir, including all related facilities, would be constructed over a 4-year period. A workforce of approximately 120 personnel would be employed during construction. Access to the reservoir site for construction personnel, materials, and equipment would be from existing public roads, and any necessary material or equipment staging areas would be located within the Reclamation acquisition area illustrated on Map 4-5.



Map 4-5. Rocky Coulee Reservoir

Construction would require use of heavy equipment, including hydraulic excavators, large dozers, scrapers, graders, and compaction equipment. Other equipment normally involved with major construction would also be employed, such as dump trucks, loaders, and delivery trucks for concrete and other materials.

Based on preliminary geologic investigations, it is expected that all earth and rock material necessary for construction of the dam can be derived from within the reservoir inundation area or nearby, within the Reclamation acquisition area. As a result, all major material hauling activity would occur within the reservoir site.

No disposal sites for excavated material are expected to be needed. All material excavated for the inlet/outlet channel or other facilities would be used in dam construction or stockpiled onsite.

4.4.3.4. Operation and Maintenance

The dam and related facilities would require periodic maintenance, inspection, monitoring, and debris removal. Major maintenance of pumping plant equipment would take place on a 5-year cycle, with replacement of pumps and associated equipment occurring on a 20-year cycle. Collectively, these activities would not require a large workforce and only infrequent use of heavy equipment.

4.4.3.5. Costs

Construction cost estimates were prepared for the eight action alternatives associated with this Study (see Section 4.4.1.6).

4.4.3.5.1 ***Field Cost Estimates***

The field cost estimates for Alternative 2C: Partial—Banks + Rocky are $777.6 million.

4.4.3.5.2 ***Noncontract Cost Estimates***

Noncontract cost estimates for Alternative 2C: Partial—Banks + Rocky are $226.9 million.

4.4.3.5.3 ***OMR&P Costs***

OMR&P cost estimates for Alternative 2C: Partial—Banks + Rocky are $7.9 million.

4.4.4 Alternative 2D: Partial—Combined

The primary elements of Alternative 2D: Partial—Combined are illustrated on Figure 4- 17. As shown on the diagram, these include providing water supply from Lake Roosevelt (1), Banks Lake (2) and a new Rocky Coulee Reservoir (3), delivered through the East Low Canal (4), to currently groundwater-irrigated lands south of I-90. Major facility development would include Rocky Coulee Reservoir (as described for Alternative 2C: Partial—Banks + Rocky), as well as the same East Low Canal enlargement and pressurized pipeline system described for Alternative 2A: Partial—Banks.

4.4.4.1. Water Supply

Water for this alternative would come from available Columbia River flows, additional drawdowns at Banks Lake and Lake Roosevelt, and storage in a new Rocky Coulee Reservoir. When Columbia River flows or storage in Banks Lake and Lake Roosevelt are being used, water would be released from Banks Lake into the Main Canal from Dry Falls Dam and diverted to the East Low Canal. Water from Rocky Coulee Reservoir would enter the East Low Canal directly though an inlet/outlet channel, as described and illustrated for Alternative 2C: Partial—Banks + Rocky (Section 4.4.3).

The average additional drawdown at Banks Lake under this alternative would be 3 feet beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total drawdown would be 8 feet at the end of August (see Figure 4- 1).

In an average year, drawdown at Lake Roosevelt in August would reach 11.2 feet, compared with 11.0 feet under the No Action Alternative (that is, an increase in August drawdown of 0.2 feet) (see Figure 4- 2).

Rocky Coulee Reservoir would generally fill and empty each year.

Refill of the reservoirs would proceed as follows:

1. Water would be released from Banks Lake to fill Rocky Coulee Reservoir by the end of October each year because of icing conditions in the Main and East Low Canals during the winter.
2. Lake Roosevelt would be refilled to meet the requirement that it be at water surface elevation 1283 feet amsl by the end of September.

3. Refill of Banks Lake would occur subject to these priorities and any other constraints imposed by Columbia River instream flow or other operational requirements.

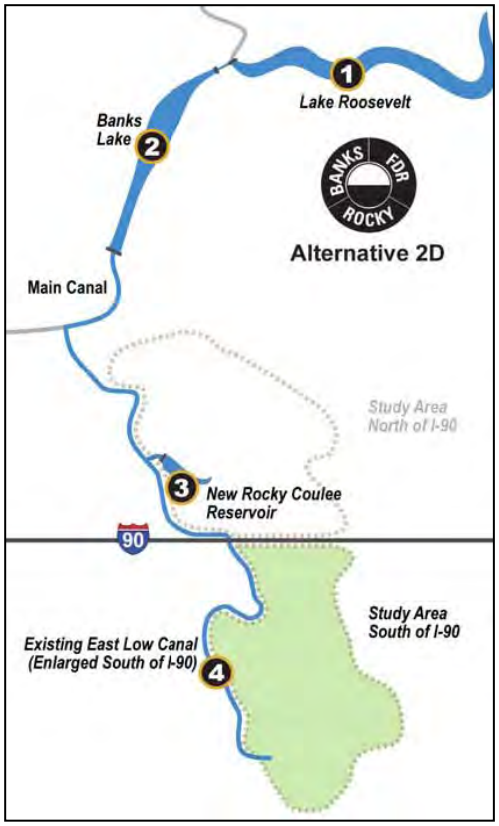


Figure 4- 17. Diagram of Alternative 2D: Partial—Combined

No construction or modification of facilities is required at Lake Roosevelt or Banks Lake under Alternative 2D: Partial—Combined. Required facility development for Rocky Coulee Reservoir is described under Alternative 2C: Partial—Banks + Rocky, above.

4.4.4.2. Delivery System

Delivery system, other facility requirements, construction, and O&M for Alternative 2D: Partial—Combined would be the same as described in Section 4.4.1.2 for Alternative 2A: Partial—Banks.

4.4.4.3. Costs

Construction cost estimates were prepared for the eight action alternatives associated with this Study (see Section 4.4.1.6).

The cost estimates for Alternative 2D: Partial—Combined are the same as for Alternative 2C: Partial—Banks + Rocky.

4.5. Full Groundwater Irrigation Replacement Alternatives

Full-replacement alternatives would provide CBP surface water supply to replace existing groundwater supply for most lands in the Study Area now irrigated with groundwater (102,600 acres), both north and south of I-90. The total volume of water would be 347,137 acre-feet. As the surface water supply system would be brought online and this water would become available to eligible lands, the intent would be to cease operation of associated irrigation wells. Under current State regulations, the irrigation wells would not be decommissioned or abandoned; instead, the wells would be placed in standby status, remaining operational for use in an emergency (such as an interruption of the Federal surface water delivery

system). However, the State is exploring the option of conducting a rulemaking process to require that these wells be fully decommissioned, at least in some areas or circumstances. Such rulemaking may be part of authorizing legislation for construction of an Odessa Subarea Special Study action alternative.

As part of these alternatives, the 16,864 acres of existing water service contracts that pump out of the East Low Canal at 34 locations would also be incorporated into the delivery system. Incorporating this acreage would increase system efficiency and improve ECBID's ability to meet scheduled deliveries.

Each of the four full-replacement alternatives would involve the same water delivery system facilities and the same quantity of water. Delivery would require all facilities described for the partial-replacement alternatives, plus development of the East High Canal System north of I-90 (see Map 4-1). Each of the full-replacement alternatives vary only in the option used to store and supply CBP water.

The four full-replacement alternatives include the following:

- Alternative 3A: Full replacement using the Banks Lake Supply option (3A: Full—Banks)
- Alternative 3B: Full replacement using the Banks Lake and Lake Roosevelt (FDR) supply options (3B: Full— Banks + FDR)
- Alternative 3C: Full replacement using the Banks Lake and Rocky Coulee supply options (3C: Full—Banks + Rocky)
- Alternative 3D: Full replacement using the Banks Lake, FDR, and Rocky Coulee supply options combined (3D: Full—Combined)

Each of these full-replacement alternatives is described below, including summaries of water supply aspects and more detailed information about required facility development.

4.5.1 Alternative 3A: Full—Banks

The primary elements of Alternative 3A: Full—Banks are illustrated on Figure 4- 18. As shown on the diagram, these include providing water supply from Banks Lake (1), delivered through the existing East Low Canal (2) and a new East High Canal system (3), to groundwater-irrigated lands north and south of I-90. Major facility development would include:

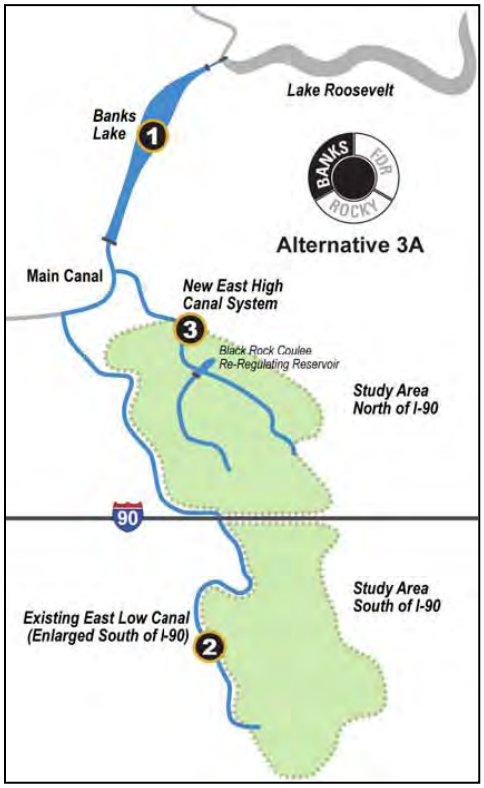


Figure 4- 18. Diagram of Alternative 3A: Full—Banks

- The same East Low Canal enlargement and pressurized pipeline system south of I-90 described for partial-replacement alternatives, and
- The new East High Canal system, a small reregulating reservoir, and an associated pressurized pipeline distribution network.

4.5.1.1. Water Supply

Water for this alternative would come from available Columbia River flows and from additional drawdown of Banks Lake. Water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East High and East Low Canals.

The additional drawdown of Banks Lake would be 8.4 feet in an average year, beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown would be 13.5 feet at the end of August (see Figure 4- 1).

Banks Lake would be refilled as soon as practicable after the irrigation season, subject to any constraints imposed by Columbia River instream flow or other operational requirements.

No construction or modification of facilities at Banks Lake would be required.

4.5.1.2. Delivery System

The water delivery system for Alternative 3A: Full—Banks would require development of all facilities described for the partial-replacement alternatives under Alternative 2A: Partial—Banks (Section 4.4.1) to serve acreage south of I-90 (see Map 4-6).

To serve acreage north of I-90, the following additional facilities would be developed (see Map 4-6):

- 78.4 miles of new canal (including associated siphons and tunnels), comprised of the 44.8-mile East High Canal and the 26.8-mile Black Rock Branch Canal,

- Four new wasteway channels, 2.8 miles long, to manage canal flow,
- A reregulating reservoir in Black Rock Coulee (Black Rock Coulee Reregulating Reservoir), including a pumping plant to lift water from the reservoir to the Black Rock Branch Canal,
- A pipeline distribution system involving 187.3 miles of pipeline fed by 15 pumping plants and 3 gravity turnout facilities along the East High and Black Rock Branch Canals, and 3 relift pumping plants (2 associated with the East High Canal and 1 associated with the Black Rock Branch Canal).

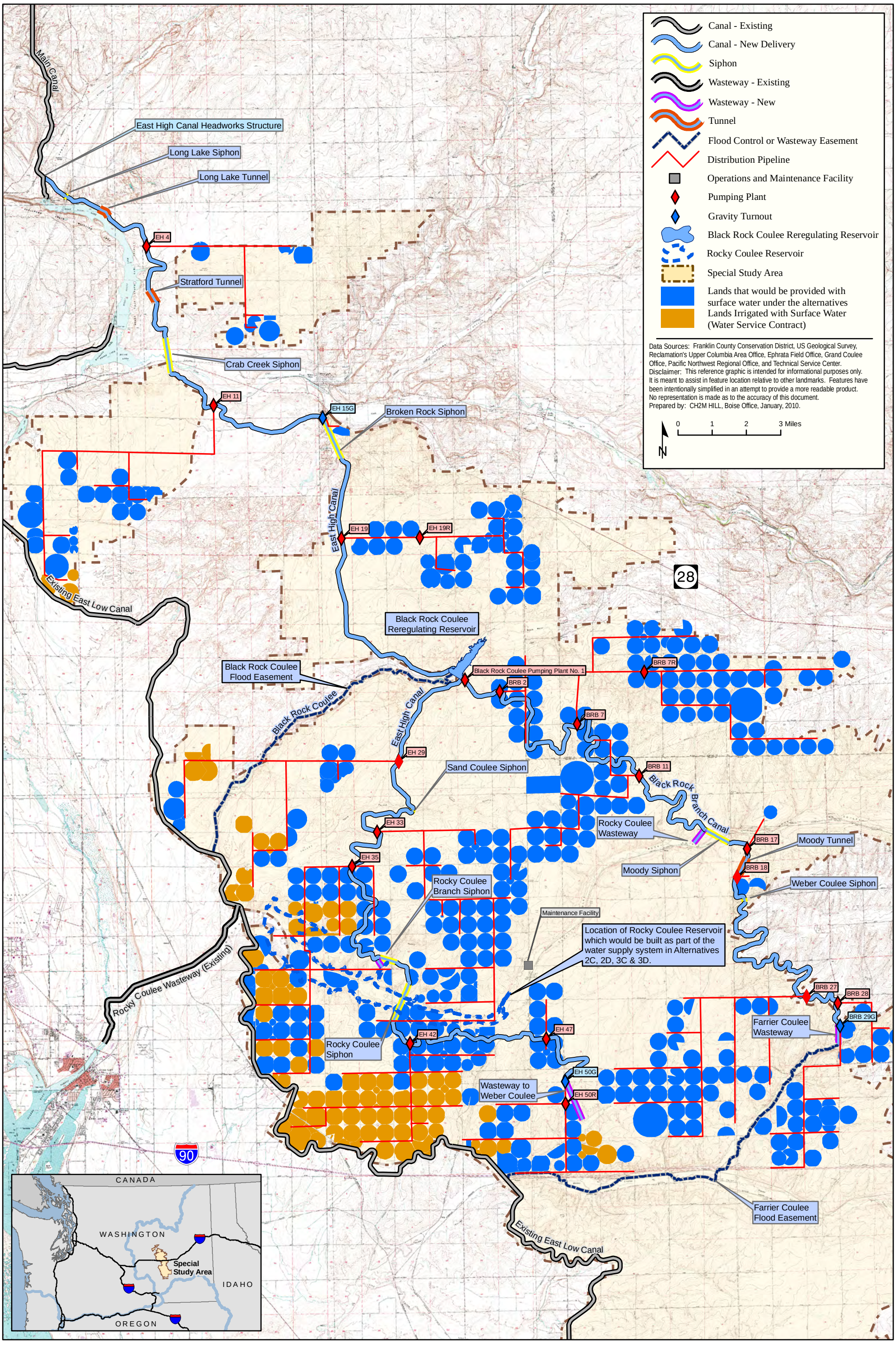
Other related requirements include the following:

- Approximately 60 crossings of existing roadways and one crossing of an existing railroad by new canal,
- Limited instances and lengths of new, long-term access roads,
- Eleven wildlife crossings,
- Wildlife escape ramps at each canal check structure, at all siphon and tunnel portals, and along concrete lined canal reaches,
- A new O&M facility (see Map 4-6).
- New electric transmission lines to each pumping plant and the O&M facility.

Each of these facilities is described below. Table 4- 6 lists the facilities, including information on quantities and land requirements.

Table 4- 6. Full-Replacement Alternatives—Delivery System Facility Requirements

Facility/Action	South of I-90 (See Map 4-3)	North of I-90 (See Map 4-6)	Total	Land Interest Acquisition Required	
				Type	Quantity
Canals					
East Low Canal (primarily enlargement) (3,650 cfs @Station 1640+00)					
Enlargement	43.3 miles	-	43.3 miles	N/A—Within existing easement	
Extension	2.1 miles	-	2.1 miles	Easement	600 feet wide
Siphons--Add second barrel to all 5 existing	1.5 miles	-	1.5 miles	N/A—Within existing easement	
East High Canal System (new facilities)					
Headworks Structure	-	1 site	1 site	N/A—Within canal easements	
New Canal	-	74.6 miles	74.6 miles	Easement	600 feet wide
East High Canal North Reach (1,100 cfs @Station 1+00)	-	21.4 miles			
East High Canal South Reach (520 cfs @Station 1333+00)	-	23.4 miles			
Black Rock Branch Canal (420 cfs @Station 1+00)	-	26.8 miles			



Map 4-6. Full Groundwater Irrigation Replacement Alternatives: Delivery System Facility Development & Modification

Table 4- 6. Full-Replacement Alternatives—Delivery System Facility Requirements

Facility/Action	South of I-90 (See Map 4-3)	North of I-90 (See Map 4-6)	Total	Land Interest Acquisition Required	
				Type	Quantity
New Siphons (8)	-	5.5 miles	5.5 miles	Easement	600 feet wide
New Tunnels (3)	-	1.3 miles	1.3 miles	Easement	600 feet wide
Wasteways-Constructed Channels					
Existing (Weber)—Additional Easement Acquisition	3.0 miles		3.0 miles	Easement	350 feet wide[1]
New		2.8 miles	2.8 miles	Easement	600 feet wide
To Weber Coulee from EHC		1.3 miles			
To Rocky Coulee from EHC		0.3 miles			
To Rocky Coulee from BRBC		0.5 miles			
To Farrier Coulee from BRBC		0.6 miles			
Drainage/Flowage Easements					
Black Rock Coulee		6.0 miles	6 miles	Easement	1,200 feet wide
Farrier Coulee		13.2 miles	13.2 miles	Easement	1,200 feet wide
Reservoir					
Black Rock Coulee Reregulating Reservoir	-	1300 acres	1,300 acres	Fee	1,300 acres
Pumping Plants					
Black Rock Coulee Pumping Plant 1 (water from reregulating reservoir to BRBC) (425 cfs)	-	1 site	1 site	NA—Within reregulating reservoir acquisition area	
Canalside Pumping Plants (distribution system)	6 sites	15 sites	21 sites	Fee	7 acres each
East Low Canal (EL47, 53, 68, 75, 80 & 85) (355 to 13 cfs)	6 sites	-	6 sites		
East High Canal (EH4, 11, 19, 29, 33, 35, 42, & 47) (116 cfs to 22 cfs)	-	8 sites	8 sites		
Black Rock Branch Canal (BRB2, 7, 11, 17, 18, 27, 28) (95 cfs to 2 cfs)	-	7 sites	7 sites		
Relift Pumping Plants	5 sites	3 sites-	8 sites	Fee	7 acres each
East Low Canal (EL47, 53, 68, 75, 80 & 85) (180 cfs to 3 cfs)	5 sites		5 sites		
East High Canal (EH19R, 50R) (652 cfs and 7 cfs)	-	2 sites	2 sites		
Black Rock Branch Canal (BRB7R) (72 cfs)	-	1 site	1 site		
Gravity Turnout (EL89G)	1 site	3 sites	4 sites	Fee	2 acres
East Low Canal (EL89G)	1 site	-	1 site		
East High Canal (EH15G & EH50G)	-	2 sites	2 sites		
Black Rock Branch Canal (BRB29G)	-	1 site	1 site		

Table 4- 6. Full-Replacement Alternatives—Delivery System Facility Requirements

Facility/Action	South of I-90 (See Map 4-3)	North of I-90 (See Map 4-6)	Total	Land Interest Acquisition Required	
				Type	Quantity
Distribution Pipeline	161.3 miles	187.3 miles	348.6 miles	Easement	200 feet wide
East Low Canal	161.3 miles		161.3 miles		
East High Canal and Black Rock Branch Canal (BRBC)		187.3 miles	187.3 miles		
Pipeline Meter/Equipment Sites	TBD[2]	TBD[2]	TBD[2]	N/A—2500 square feet within pipeline easement	
Electric Transmission Lines[3]	28 miles	40	68 miles	Easement	100 feet wide
Road and Railroad Crossings					
Existing bridges over ELC--Reconstruct	TBD[4]	TBD[4]	TBD[4]	N/A—Within road easement and canal easement	
Road Crossings By New Canal[5]	1 location	~60 locations	~61 locations	N/A—Within road easement and canal easement	
Railroad Crossings By New Canal[6]	-	1 location	1 location	N/A—Within road easement and canal easement	
Wildlife Bridges	TBD[6]	11 locations	11 locations	N/A—Within canal easements	
New Access Roads	TBD[6]	TBD[6]	TBD[6]	Easement	TBD[6]
Operation and Maintenance Facility	1 site	1 site	2 sites	Fee	7 acres each

[1] Existing Weber Wasteway easement width varies but averages 250 feet (125 feet on each side of the channel); Reclamation would acquire an additional 175 feet on each side, to bring total easement width to 600 feet.
[2] To Be Determined: Number and location not determined at this level of planning; all would be within pipeline easements.
[3] Electric power supply would be needed at each pumping plant and the operations and maintenance facilities. Supplying this power would require construction of new transmission lines. As noted above for the Partial Replacement alternatives, it is expected that power would be brought to facilities south of I-90 from the Moses Lake area, requiring an estimated 84 miles of new transmission lines. For facilities north of I-90, power would be brought from Grand Coulee, with a requirement for new transmission lines estimated at 127 miles. The locations and routes for these new transmission lines would be determined during future design phases.
[4] To Be Determined: Some existing road bridges along the ELC canal may need to be lengthened/reconstructed to accommodate ELC expansion. Any such requirements would be defined during more detailed planning (See Transportation discussion in the Odessa DEIS).
[5] New canal alignments cross existing roads at one location under the partial-replacement alternatives and an estimated additional 60 locations under the full-replacement alternatives. The full-replacement alternatives would also involve one crossing of an existing railroad line. See Section 4.16 for discussion of how these crossings would be addressed.
[6] To Be Determined: For partial-replacement alternatives, all construction and long term access would be from existing roads, O&M roads along canals, and/or temporary roads along pipeline and transmission line easements. For full-replacement alternatives, need for new roads is undetermined at this level of planning; both construction and long term access would be predominantly from existing roads, O&M roads along canals, and temporary roads along pipeline and transmission line easements.

*Note: Some refinements in project facility design are occurring as part of engineering feasibility work. These refinements generally include limited adjustments to pumping plant locations and pipeline alignments (see Engineering Report, available for review at http://www.usbr.gov/pn/programs/ucao_misc/odessa/). As of the public distribution date of the Odessa DEIS and Special Study Report, these refinements would not result in meaningful changes in the Odessa DEIS or Special Study Report analysis or conclusions.

4.5.1.2.1 ***Canals***

Under Alternative 3A: Full−Banks, 71.6 miles of new canal would be required serve groundwater-irrigated and water service contract lands north of I-90. This canal would be constructed in three main reaches: East High Canal north of the reregulating reservoir (21.4 miles), East High Canal south of the reregulating reservoir (23.4 miles), and Black Rock Branch Canal originating at the

reregulating reservoir (26.8 miles). These distances do not include associated siphons and tunnel reaches along the canal alignments.

The East High Canal would be concrete-lined. Most of the Black Rock Branch Canal would be earth-lined because the native soils along the canal alignment can be compacted to serve as canal lining with minimal seepage. In the limited instances where this is not the case, concrete lining would be installed. This new canal would be constructed within a 600-foot easement, with all material excavated for the canal deposited within the easement. A typical cross-section of the canal is shown in Figure 4- 19 .

The new canal would not be constructed to the full capacity that would be needed to serve full development of the CBP if a decision is made in the future to pursue full project development. Instead, the canal would be built to approximately 15 percent of full capacity, which is the size necessary to serve groundwater-irrigated and existing water service contract lands in the Study Area.

As part of East High Canal and Black Rock Branch Canal development, a bifurcation along the Main Canal (the East High Canal Headworks Structure) would be needed, as well as eight siphon and three tunnel sections. The locations of these facilities along the canals are shown on Map 4-6, with additional information provided below and on Table 4- 6.

4.5.1.2.2 ***East High Canal Headworks Structure***

This bifurcation is where water from the CBP Main Canal would be diverted to the East High Canal for delivery to all lands to be served north of I-90. This structure would include a radial gate at the upstream end of the East High Canal. A conceptual site plan of the structure is provided in Figure 4- 20. This facility would be constructed entirely within the existing easement of the existing Main Canal and the new 600-foot easement acquired for the East High Canal. All soil and rock material excavated for development of the bifurcation structure would be deposited within the easements.

4.5.1.2.3 ***Siphons***

Three siphons would be constructed along the East High Canal north of the re-regulating reservoir. Three would be required along the East High Canal south of the reservoir and two would be needed along the Black Rock Branch Canal. The locations of these facilities are shown on Map 4-6, with the estimated length of each specified on Table 4- 6. All siphons would be constructed within a 600-foot easement with all material excavated for siphon installation deposited within this easement. Figure 4- 21 illustrates a typical siphon cross-section.

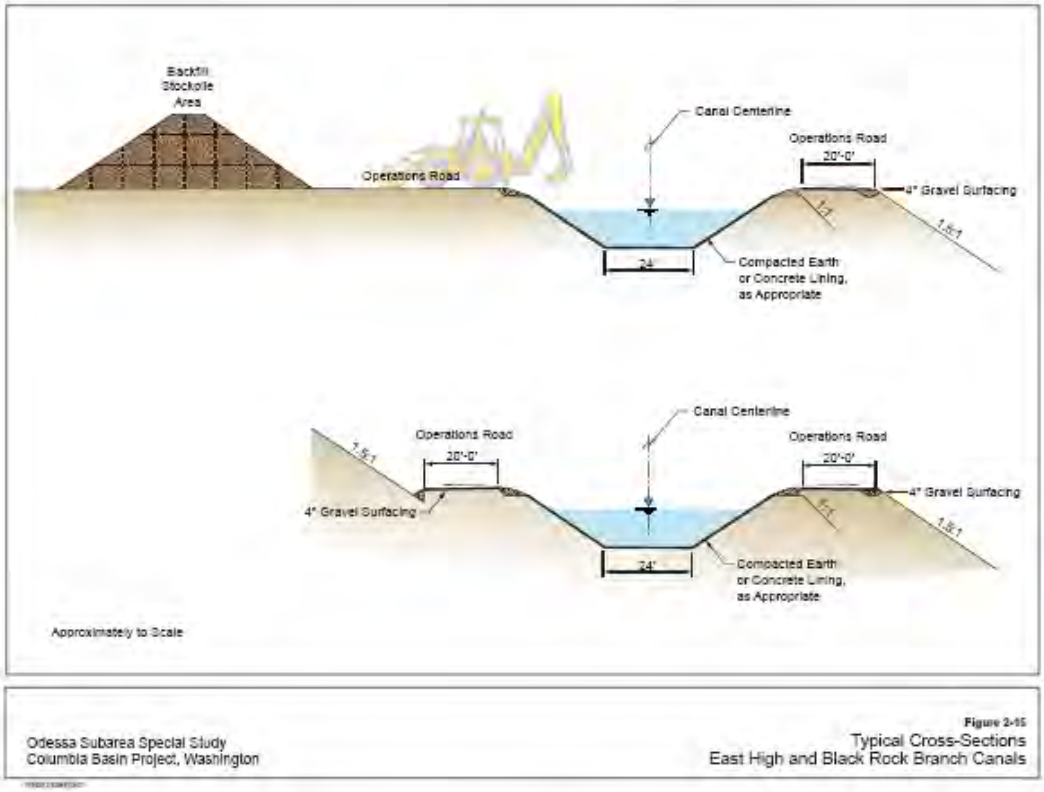


Figure 4- 19. Typical cross-sections—East High and Black Rock Branch Canals

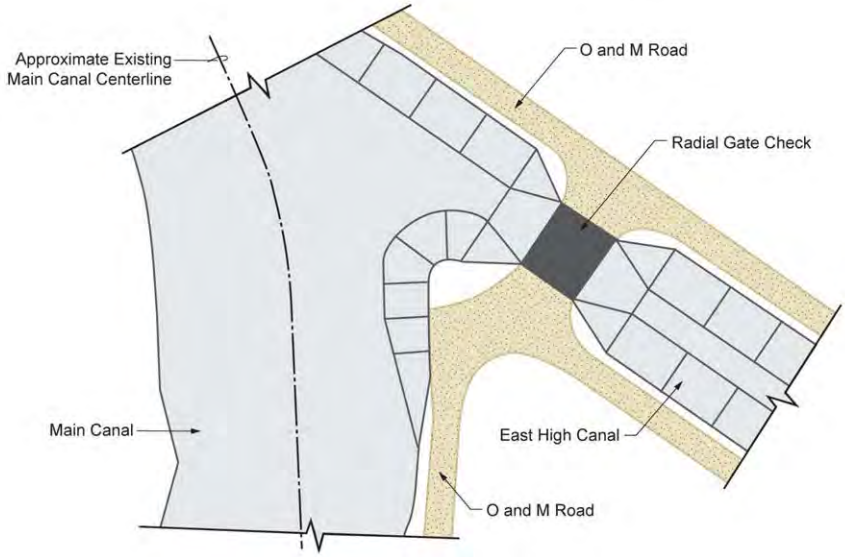


Figure 4- 20. East High Canal Headworks Structure: Conceptual Site Plan

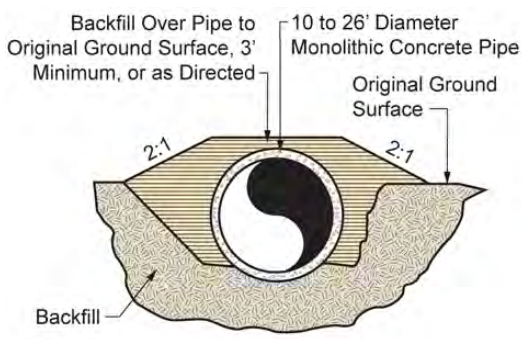


Figure 4- 21. Typical siphon cross-section

4.5.1.2.4 ***Tunnels***

Two tunnel sections would be constructed as part of the East High Canal north of the re-regulating reservoir and one would be located along the Black Rock Branch Canal. The locations of these tunnels are shown on Map 4-6, with the estimated length of each specified on Table 4-6. The tunnel portals would be constructed within the 600-foot canal easement, and a 600-foot surface easement would be acquired along the tunnel alignments. Material excavated for tunnel development would be deposited within the canal easement at or near the tunnel portals.

4.5.1.2.5 *Wasteways*

Wasteways provide outlets from canals that are needed to manage water flow as demand changes, to receive return flows from irrigated lands and drains, and in case of pump equipment failure. Four wasteways would be constructed along the new canal: two along the southern portion of the East High Canal, and two along the Black Rock Branch Canal. The locations of these wasteways are illustrated on Map 4-6. The wasteways along the East High Canal would discharge to Rocky and Weber Coulees. Those along the Black Rock Branch Canal would discharge to Rocky and Farrier Coulees. The lengths of each of these are noted on Table 4- 6. Each of these wasteways would be constructed within a 600-foot-wide easement.

For the Farrier Coulee wasteway, Reclamation would also acquire a 1,200-foot-wide easement along approximately 13 miles of the natural coulee downstream of the constructed channel. This easement acquisition would be for the purposes of project operation and maintenance; additional uses of the easement land would be for fish and wildlife purposes.

4.5.1.2.6 ***Black Rock Coulee Reregulating Reservoir***

A reregulating reservoir would be constructed in Black Rock Coulee to manage water delivery and distribute water to both the southern portion of the East High Canal and the Black Rock Branch Canal. The reservoir would have a storage capacity of 4,800 acre-feet, an active storage of 600 acre-feet, and a surface area of 225 acres at full pool. The reservoir dike would be a zoned earthfill

embankment, approximately 57 feet high, 2,500 feet long, and 24 feet wide at its crest. Fill material for dike construction would be obtained from within the reservoir acquisition area. A conceptual site plan of the reservoir and related facilities is shown on Map 4-7.

In its role as a reregulating reservoir, this facility would not be significantly drawn down at any point during the year. Water levels would be relatively stable near full pool, fluctuating in a narrow range.

In addition to the dike and reservoir, the site would include a pumping plant to lift water from the reservoir into the Black Rock Branch Canal (see Map 4-7).

Reclamation would also acquire a 1,200-foot-wide easement along the channel of Black Rock Coulee downstream of the reregulating reservoir dike. Similar to the easement along the Farrier Coulee channel downstream of the constructed wasteway, this easement acquisition would be for the purposes of project O&M. Additional uses of the land would be for fish and wildlife purposes.

4.5.1.2.7 ***Distribution Pipeline System***

CBP water from the East High Canal and Black Rock Branch Canal would be provided by a pressurized pipeline distribution system to the groundwater-irrigated and water service contract lands north of I-90. The pipeline system would be fed by 15 canal-side pumping plants, 3 relift pumping plants, and 3 gravity turnouts, and would be pressurized to provide a minimum of 5 psi at the highest delivery points. At numerous locations along the pipeline routes, metering stations would be located to record water deliveries. Map 4-6 illustrates the preliminary layout of the pipeline system and locations of the pumping plants and gravity turnouts. Additional information on these facilities is provided below and summarized on Table 4- 6.

Distribution Pipelines: The distribution system from the East High Canal and Black Rock Branch Canal would consist of approximately 187.3 miles of buried pipeline. In general, as illustrated on Map 4-6, the system is designed to locate the pipelines along half-section lines and deliver water to quarter-sections. Reclamation would acquire a 200-foot-wide easement for pipeline installation and retain long-term access for any necessary repairs or replacements. These requirements would preclude any future structure development within the long-term easement. However, agriculture or other nonstructural uses could generally continue once the pipeline is installed and operational.

Canal-Side Pumping Plants: As shown on Map 4-6, three canal-side pumping plants would be located along the East High Canal north of Black Rock Coulee Reregulating Reservoir (at canal miles 4, 11, and 19); five would be along the East High Canal south of the reservoir (at canal miles 29, 33, 35, 42, and 47); and seven would be along the Black Rock Branch Canal (at canal miles 2, 7, 11, 17, 18, 27, and 28). The site requirements and facilities at each of these stations

would be the same as described for the plants south of I-90 in Section 4.4.1.2, and illustrated in Figure 4- 11 and Figure 4- 12.

- Re-lift Pumping Plants: Three re-lift pumping plants (two associated with the East High Canal and one associated with the Black Rock Branch Canal) would be required to boost pipeline pressure in the central parts of the service area to reach higher-elevation lands. The approximate locations of these plants are shown on Map 4-6. The site requirements and facilities at each of these stations would be the same as described for the plants south of I-90 in Section 4.4.1.1, and illustrated on Figure 4-13.
- Gravity Feed Turnout: Two turnouts would be constructed at East High Canal Mile 15 and 50 and one turnout would be constructed at Black Rock Branch Canal Mile 29 to deliver gravity-fed water to the pipelines serving lands in these areas (see Map 4-6 for the locations of these turnouts). Each facility would require a 2-acre site.
- Meter Equipment Sites: Metering equipment would be installed at numerous locations in the water distribution pipeline system. Most of these metering sites would be associated with the locations where landowners tap into the system. These sites would be approximately 2,500 square feet, be within the pipeline easement, and be sited specifically to not interfere with existing irrigation equipment or other infrastructure.

4.5.1.3. Other Facility Requirements.

4.5.1.3.1 *Road and Railroad Crossings*

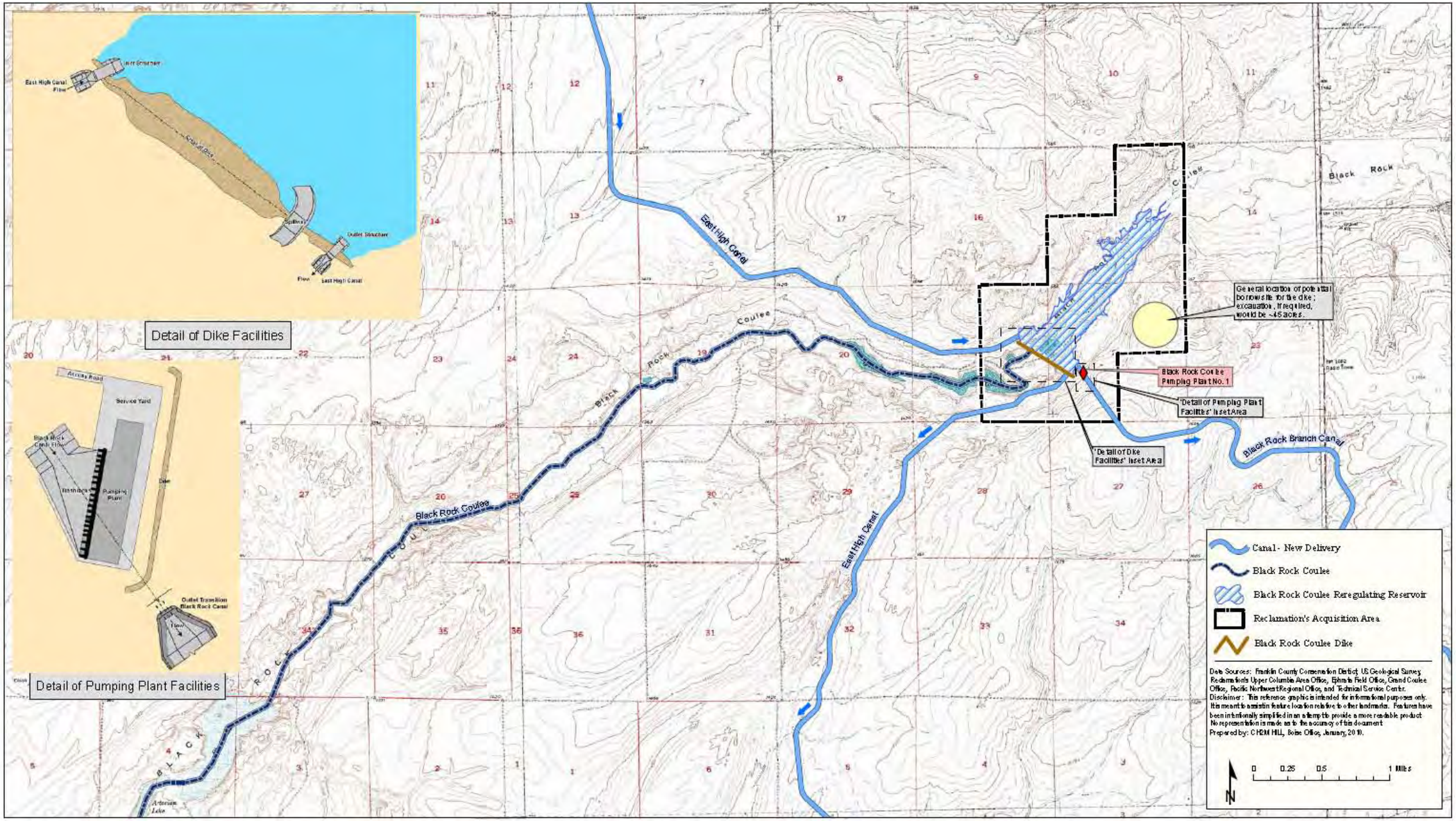
The new canal would cross existing roads at an estimated 60 locations. The exact treatment of these crossings would be defined in collaboration with involved jurisdictions during more detailed design work for the project. Bridges over the canal or pipelines under the road would be constructed at important through and all-weather roads and at the crossing of State Route 28. At other locations, road realignments or closures with local re-routes may be implemented.

The East High Canal also intersects one railroad line located along Crab Creek west of the town of Wilson Creek. At this location, the canal alignment would be piped under the railroad.

No additional easements are expected to be needed for bridges at road and railroad crossings. All construction would occur within the combination of existing road or railroad easement and the easement would be acquired by Reclamation for the new canal. In cases where road realignments would be needed, additional easements would need to be acquired.

4.5.1.3.2 *Access Roads*

With minor exceptions, no new access roads outside of Reclamation easements and acquisition areas would be required for O&M or facility development. O&M roads would be built within the Reclamation easement along all new canals,



Map 4-7. Black Rock Coulee Reregulating Reservoir

siphons, and wasteways. To the extent that distribution pipelines and powerlines cannot be aligned along existing roads, temporary access roads would be built within the Reclamation easements for construction of these facilities. A new road connection outside of Reclamation lands would be required for the Black Rock Coulee Reregulating Reservoir, where access from the reservoir eastward to County Road W NE is proposed. The alignment of this road has not been determined. Other possible access road locations are not known. NEPA documentation would be provided for new roads if needed.

4.5.1.3.3 *Wildlife Crossings and Escape Ramps*

As part of East High Canal development, 11 wildlife crossings would be installed over the East High Canal, nine along the reach north of Black Rock Coulee Reregulating Reservoir, and two along the reach south of Black Rock Coulee Reregulating Reservoir. The canal would present a barrier to wildlife movement in the area, and the crossings are intended to mitigate the extent of those effects. The conceptual design of these crossings is illustrated on Figure 4- 22. Each would also include a road surface planted with low grasses and would be used for general O&M vehicle circulation along the canal. These features may change to better accommodate wildlife use during final design.

Animal escape ramps would be located upstream of each structure (such as checks, siphons, and tunnel portals) in the canal alignment and along concrete-lined reaches. Figure 4- 23 illustrates these ramps, each of which would be concrete lined and placed perpendicular to the canal centerline. Overall design and placement of the ramps would be coordinated with the WDFW.

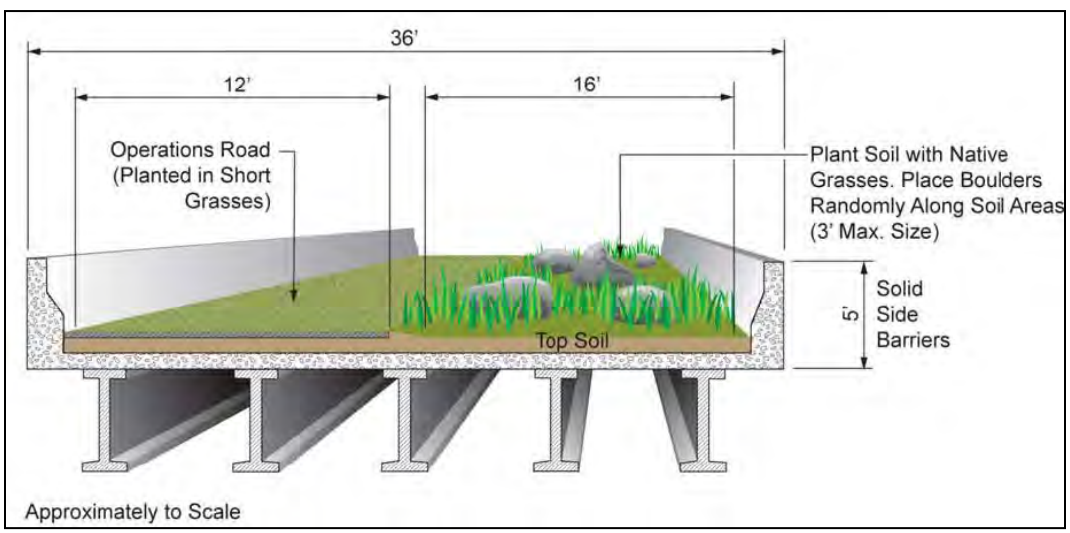


Figure 4- 22. Wildlife and O&M bridge typical cross-sections

4.5.1.3.4 *Operation and maintenance*

A second O&M facility (in addition to the one described in Section 4.4.1.1) would be built at the northeast corner of the intersection of Road 6 NE and Road W NE, approximately 0.25 mile north of Ruff, Washington. This facility would be the same as that described for location south of I-90 in Section 4.4.1.2 and illustrated in Figure 4- 14.

4.5.1.3.5 *Electric Transmission Lines*

High voltage electric power supply would be needed at each pumping plant and the operation and maintenance facilities. Supplying this power would require construction of new transmission lines. As noted above for the Partial-Replacement alternatives, it is expected that power would be brought to facilities south of I-90 from the Moses Lake area, requiring an estimated 84 miles of new transmission lines. For facilities north of I-90, power would be brought from Grand Coulee, with a requirement for new transmission lines estimated at 127 miles. The locations and routes for these new transmission lines have not been determined. During more detailed planning, the goal would be to route these lines to reduce creation of new corridors in the landscape and to minimize impact on existing land uses by following existing power lines, roadways, railroads, or other existing linear infrastructure wherever possible. If needed, additional NEPA documentation would be provided as the details of transmission line development are defined.

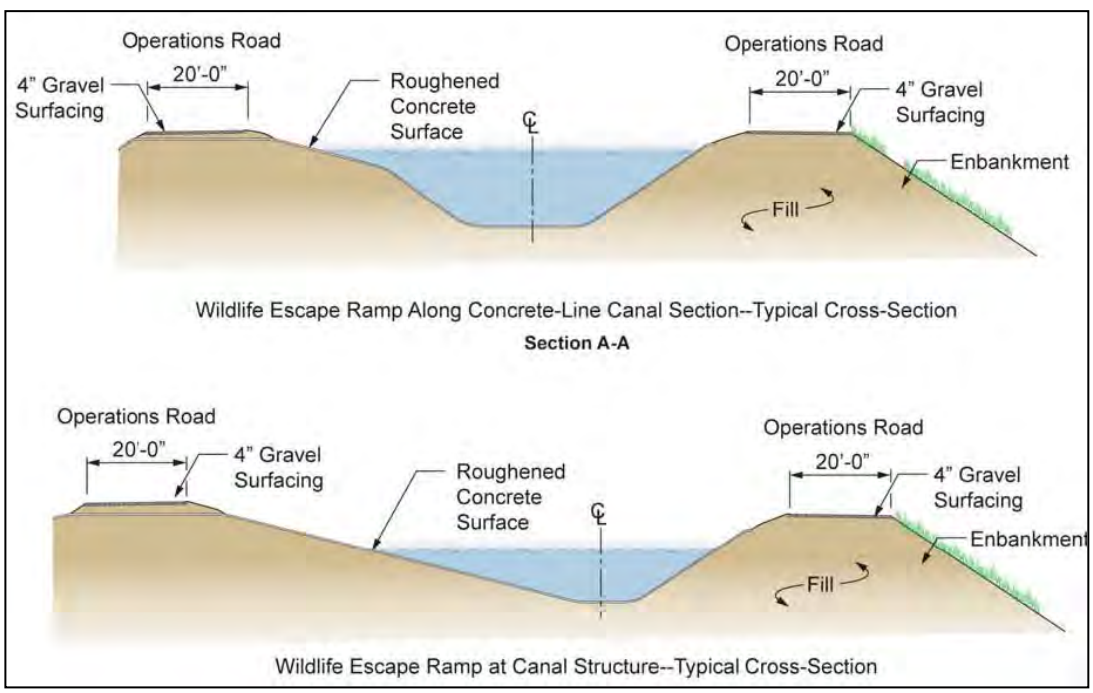


Figure 4- 23. Wildlife escape ramps typical cross-section

4.5.1.4. Construction

4.5.1.4.1 ***Duration and Phasing***

Development of the delivery system for the full-replacement alternatives would be divided into nine segments, as shown on Map 4-4 and Map 4-8 (showing phasing of facilities south and north of I-90, respectively). The total construction period is projected to be approximately 10 years, with segments being built simultaneously north and south of I-90. Construction within each segment would last 3 to 4 years. Construction would be conducted in segments to spread the work as evenly as possible throughout the 10-year construction period, and bring the delivery system online in stages as early as possible.

4.5.1.4.2 ***Construction Workforce, Activities, Equipment, and Other Requirements.***

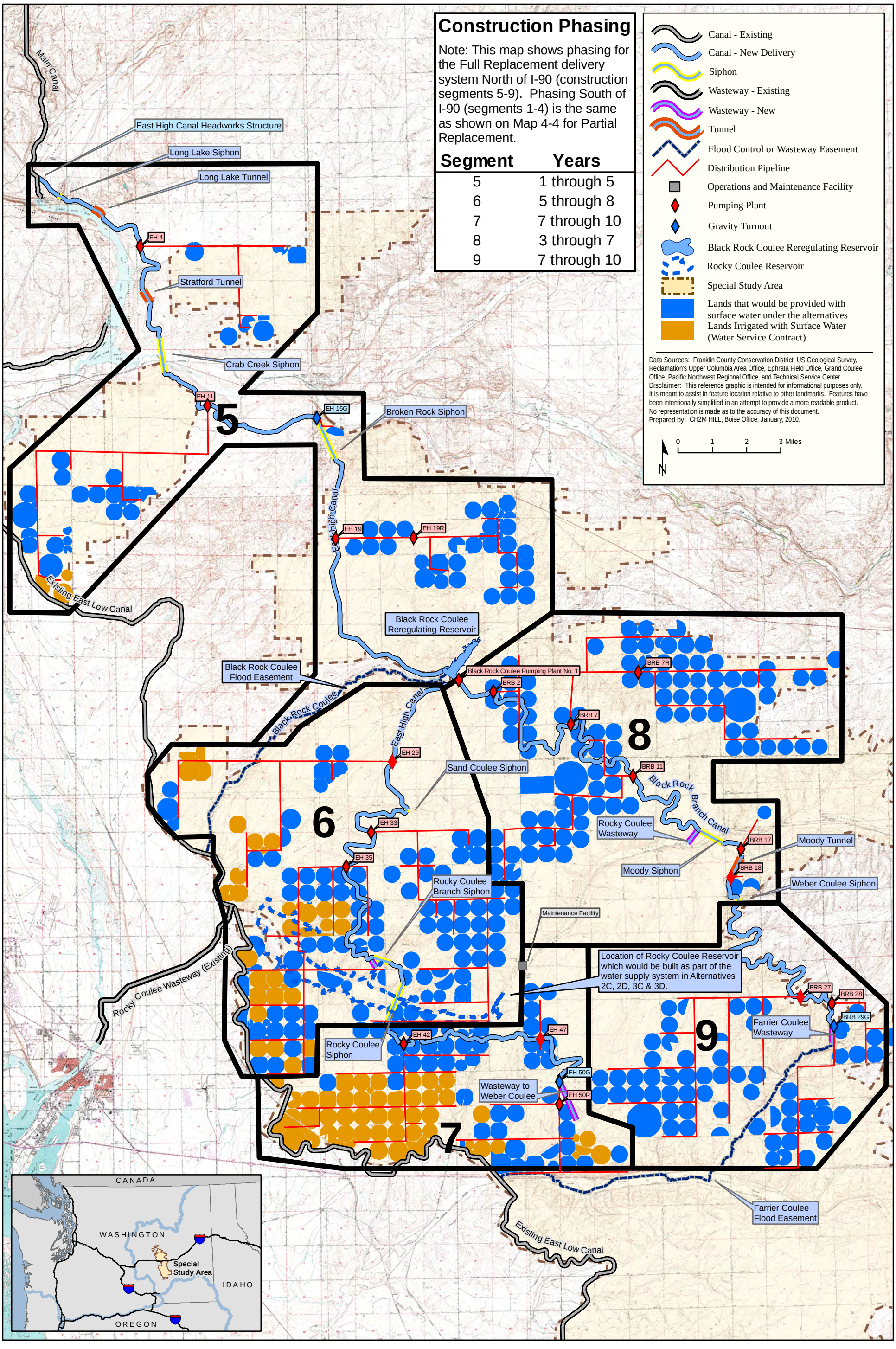
The total workforce requirement for construction of the delivery system for the full-replacement alternatives is expected to be 410 to 420 personnel on facilities north of I-90, and 120 to 130 personnel on facilities south of I-90. This would total 530 to 550 personnel at the peak level of activity during the latter half of the construction period, when work on several segments is occurring simultaneously.

Construction activity, and thus deployment of the workforce, would occur at multiple locations simultaneously in each segment and move progressively through the segment area. Primary work locations for facilities south of I-90 were listed in discussion of the partial-replacement alternatives (Section 4.4.1.2). Primary work locations for facilities north of I-90 would include:

- East High Canal Headworks structure (Segment 5 only)
- Black Rock Coulee Reregulating Reservoir (Segment 5 only)
- New canal alignments (East High or Black Rock Branch)
- New siphons, tunnels, and wasteways
- Pumping plant(s), including associated electric substations
- Distribution pipeline alignments
- Transmission line alignments
- Operation and maintenance facility

With the exception of Black Rock Coulee Reregulating Reservoir, major construction in any given area is not expected to extend beyond a year and, in many cases, would be of substantially shorter duration. Wherever possible, work would be planned and scheduled to avoid or minimize disruption of existing irrigation operations or other land uses.

Access for facility construction within Reclamation easements and acquisition areas would be primarily from existing public roads. In the case of canal alignments, long-term operation and maintenance roads would remain after construction is complete. Permanent access would also be required along



Map 4-8. Full Groundwater Irrigation Replacement Alternatives: Delivery System Construction Phasing

powerline and pipeline easements, although developed roads would generally not be necessary after construction is completed.

Construction of the delivery system, especially the canals and reregulating reservoir dike, would require use of heavy equipment including hydraulic excavators, large dozers, scrapers, cranes, and compaction equipment. Other equipment normally involved with major construction would also be employed, such as dump trucks, loaders, and delivery trucks (for concrete and other materials). Blasting may be necessary during construction of the tunnels north of I-90, along some reaches of the new canals, and at the site of the reregulating reservoir dike.

Staging areas would generally be located within canal, pipeline, and transmission line easements and within facility acquisition areas including the reregulating reservoir, pumping plants, and O&M facilities. To the extent possible, staging areas would be located at least 500 feet from a residence.

No offsite disposal sites for excavated material, borrow sites, or construction material processing facilities are expected to be needed. All material excavated for canal development and installation of pipelines and transmission lines would be stockpiled within the facility easements or backfilled, as appropriate. All material necessary for the reregulating reservoir dike is expected to be available from within the reservoir acquisition area, primarily from within the inundation zone. All construction materials would be acquired through available existing local and regional sources.

4.5.1.5. Operation and Maintenance

O&M activities for Alternative 3A: Full−Banks would be generally the same as described for O&M of the partial replacement facilities in Section 4.4.1.2.

4.5.1.6. Costs

Construction cost estimates were prepared for the eight action alternatives associated with this Study (see Section 4.4.1.6).

4.5.1.6.1 ***Field Cost Estimates***

The field cost estimates for Alternative 3A: Full—Banks are $2,071.7 million.

4.5.1.6.2 ***Noncontract Cost Estimates***

Noncontract cost estimates for Alternative 3A: Full—Banks are $510.7 million.

4.5.1.6.3 ***OMR&P Costs***

OMR&P cost estimates for Alternative 3A: Full—Banks are $15.9 million.

4.5.2 Alternative 3B: Full—Banks + FDR

The main aspects of Alternative 3B: Full−Banks + FDR are illustrated on Figure 4- 24. As shown on the diagram, these include providing water supply from Lake Roosevelt (1) and Banks Lake (2), delivered through the East Low Canal (3) and East High Canal system (4), to currently groundwater-irrigated lands north and south of I-90. Major facility development would include enlargement of the East Low Canal south of I-90 and construction of a new East High Canal system north of I-90. Water would be delivered to farmlands from both canals by a pressurized pipeline system.

4.5.2.1. Water Supply

Water for this alternative would come from available Columbia River flows and additional drawdown of both Lake Roosevelt and Banks Lake. Water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East High and East Low Canals.

The additional drawdown of Banks Lake under this alternative would be 3 feet in an average year, in addition to the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown at Banks Lake would be 8 feet at the end of August (see Figure 4- 1).

The additional drawdown in an average year at Lake Roosevelt would be 2.2 feet at the end of August beyond the 11.0 feet with the No Action Alternative, bringing the total end-of-August drawdown to 13.2 feet (see Figure 4- 2).

Reservoir refill would occur first for Lake Roosevelt, which is required to be at water surface elevation 1283 feet amsl by the end of September. Banks Lake would then be refilled as soon as practicable subject to any constraints imposed by Columbia River instream flow or other operational require-ments. Under this alternative, Banks Lake would not be expected to completely refill in approximately 6 percent of years. Operations modeling indicates that Banks Lake would not refill in 4 out of 70 years under this alternative.

No construction or modification of facilities is required at either Lake Roosevelt or Banks Lake under Alternative 3B: Full−Banks + FDR.

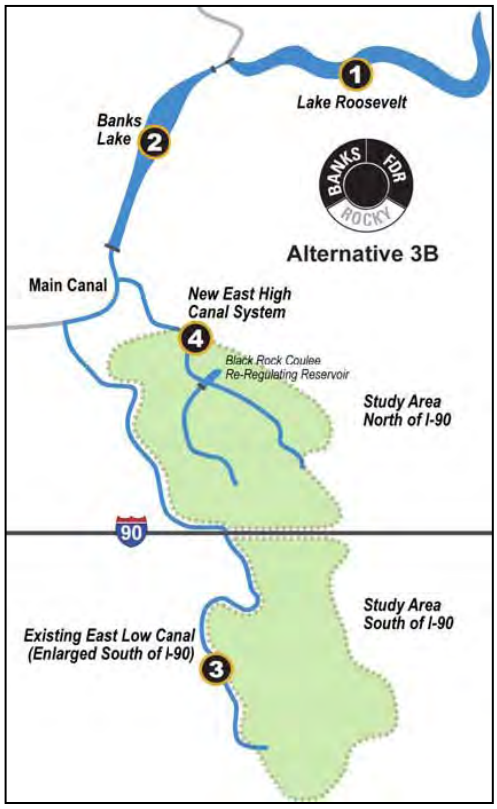


Figure 4- 24. Diagram of Alternative 3B: Full—Banks + FDR

4.5.2.2. Delivery System

Delivery system, other facility requirements, construction, and O&M for Alternative 3B: Full−Banks + FDR would be the same as those described in Section 4.5.1.2 for Alternative 3A: Full−Banks.

4.5.2.3. Costs

Construction cost estimates were prepared for the eight action alternatives associated with this Study (see Section 4.4.1.6).

The cost estimates for Alternative 3B: Full—Banks + FDR are the same as for Alternative 3A: Full—Banks.

4.5.3 Alternative 3C: Full—Banks + Rocky

The primary elements of Alternative 3C: Full−Banks + Rocky are illustrated on Figure 4- 25. As shown on the diagram, these include providing water supply from Banks Lake (1) and a new Rocky Coulee Reservoir (2), delivered through the East Low Canal (3) and a new East High Canal system (4), to currently groundwater-irrigated lands north and south of I-90. Major facility development would include Rocky Coulee Reservoir as well as the same East Low Canal enlargement, East High Canal system, and pressurized pipeline networks described for Alternative 3A: Full—Banks.

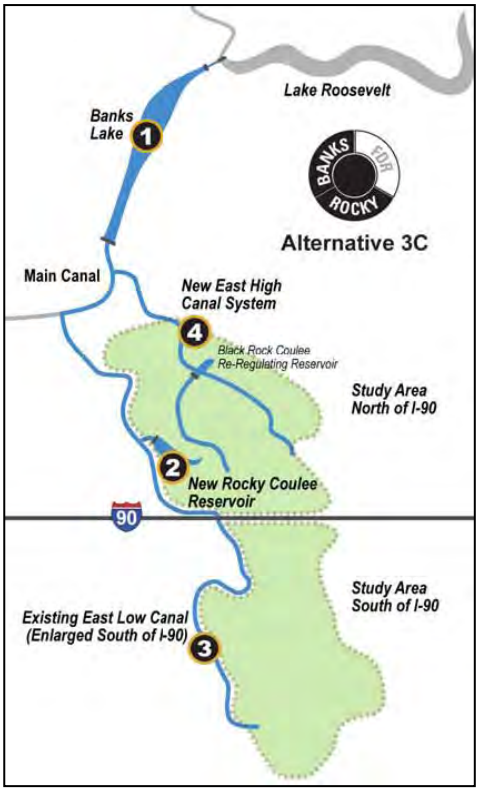


Figure 4- 25. Diagram of Alternative 3C: Full—Banks + Rocky

4.5.3.1. Water Supply

Water supply for Alternative 3C: Full−Banks + Rocky would come from available Columbia River flows, additional drawdowns at Banks Lake, and storage in a new Rocky Coulee Reservoir. When Columbia River flows or storage in Banks Lake are being used, water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East High and East Low Canals. Water from Rocky Coulee Reservoir would enter the East Low Canal directly though an inlet/outlet channel.

The additional drawdown at Banks Lake would be 5 feet in an average year, beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total drawdown would average 10 feet at the end of August.

Rocky Coulee Reservoir would be nearly or fully emptied each year, with no continuing recreational or fish and wildlife values.

In terms of refill, water would be released from Banks Lake to fill Rocky Coulee Reservoir by the end of October each year, followed by any necessary refill of Banks Lake. Rocky Coulee Reservoir would need to be refilled first because of icing conditions in the Main and East Low Canals after November 1. Refill rates for the two reservoirs, in turn, would be subject to any constraints imposed by adherence to Columbia River instream flow or other operational requirements.

No construction or modification of facilities would be required at Banks Lake under this alternative. Required facility development for Rocky Coulee Reservoir would be the same as described for Alternative 2C: Partial—Banks + Rocky.

4.5.3.2. Delivery System

Delivery system, other facility requirements, construction, and O&M for Alternative 3C: Full−Banks + Rocky would be the same as described in Section 4.5.1.2 for Alternative 3A: Full−Banks.

4.5.3.3. Costs

Construction cost estimates were prepared for the eight action alternatives associated with this Study (see Section 4.4.1.6).

4.5.3.3.1 ***Field Cost Estimates***

The field cost estimates for Alternative 3C: Full—Banks + Rocky are 2,261.7 million.

4.5.3.3.2 ***Noncontract Cost Estimates***

Noncontract cost estimates for Alternative 3C: Full—Banks + Rocky are $596.9 million.

4.5.3.3.3 ***OMR&P Costs***

OMR&P cost estimates for Alternative 3C: Full—Banks + Rocky are $17 million.

4.5.4 Alternative 3D: Full—Combined

The primary elements of Alternative 3D: Full−Combined are illustrated on Figure 4- 26. As shown on the diagram, these include providing water supply from Lake Roosevelt (1), Banks Lake (2) and a new Rocky Coulee Reservoir (3), delivered through the East Low Canal (4) and a new East High Canal system (5),

to groundwater-irrigated lands north and south of I-90. Major facility development would include Rocky Coulee Reservoir (as described for Alternative 2C: Partial− Banks + Rocky), as well as the same East Low Canal enlargement, East High Canal facilities, and associated pressurized pipeline systems described for Alternative 3A: Full−Banks.

4.5.4.1. Water Supply

Water supply for Alternative 3D: Full−Combined would come from available Columbia River flows, additional drawdowns at Banks Lake and Lake Roosevelt, and storage in a new Rocky Coulee Reservoir. When Columbia River flows or storage in Banks Lake and Lake Roosevelt are being used, water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East Low and East High Canals. Water from Rocky Coulee Reservoir would enter the East Low Canal directly though an inlet/outlet channel, as described and illustrated for Alternative 2C: Partial−Banks + Rocky (Section 4.4.3).

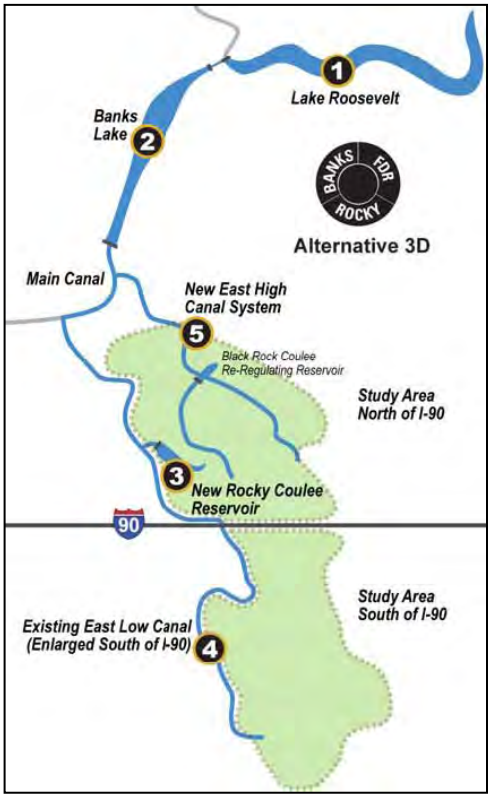


Figure 4- 26. Diagram of Alternative 3D: Full—Combined

The average additional drawdown at Banks Lake under this alternative would be 3 feet beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total drawdown would be 8 feet at the end of August (see Figure 4- 1).

At Lake Roosevelt in an average year, the additional drawdown would be 0.9 feet beyond the No Action Alternative drawdown of 11.0 feet, bringing the total end-of-August drawdown to 11.9 feet (see Figure 4- 2).

Rocky Coulee Reservoir would generally be filled and emptied each year.

Refill of the reservoirs would proceed as follows:

- Water would be released from Banks Lake to fill Rocky Coulee Reservoir by the end of October each year because of icing conditions in the Main and East Low Canals during the winter.

- Lake Roosevelt would be refilled to meet the requirement that it be at water surface elevation 1283 feet amsl by the end of September.
- Refill of Banks would occur subject to these priorities and any other constraints imposed by Columbia River instream flow or other operational requirements.

Under Alternative 3D: Full−Combined, it is projected that Banks Lake would not completely refill approximately 7 percent of years (operations modeling indicates that Banks Lake would not refill in 5 out of 70 years under this alternative).

No construction or modification of facilities is required at Lake Roosevelt or Banks Lake under Alternative 3D: Full−Combined. Required facility development for Rocky Coulee Reservoir is described under Alternative 2C: Partial−Banks + Rocky, above.

4.5.4.2. Delivery System

Delivery system, other facility requirements, construction, and O&M for Alternative 3D: Full−Combined would be the same as those described in Section 4.5.1.2 for Alternative 3A: Full−Banks.

4.5.4.3. Costs

Construction cost estimates were prepared for the eight action alternatives associated with this Study (see Section 4.4.1.6).

The cost estimates for Alternative 3D: Full—Combined are the same as for Alternative 3C: Full—Banks + Rocky.

4.6. Summary of Costs

The following table (Table 4- 7) provides a summary of the estimated feasibility-level costs for the alternatives. These cost estimates should only be used to compare alternatives. All the alternatives used the same assumptions and unit prices, so they are directly comparable from a cost standpoint. “Construction Costs” includes field costs—the costs to construct the facilities, plus noncontract costs. “Noncontract costs” include land acquisition, engineering and design, permitting, and other costs. “OMR&P” refers to Operation, Maintenance, Replacement, and Power. See Section 5.1.1.5 for the cost analysis used for Economic analysis.

Table 4- 7. Summary of alternative feasibility-level cost estimates ($ millions)

Alternative	Field Cost	Noncontract Costs	Construction Costs	Maximum Annual OMR&P Costs (Year 2045+)*
1: No Action	--	--	--	$3.3
2A: Partial—Banks	$587.6	$140.7	$728.3	$6.9
2B: Partial—Banks + FDR	$587.6	$140.7	$728.3	$6.9
2C: Partial—Banks + Rocky	$777.6	$226.9	$1,004.5	$7.9
2D: Partial—Combined	$777.6	$226.9	$1,004.5	$7.9
3A: Full—Banks	$2,071.7	$510.7	$2,582.4	$15.9
3B: Full—Banks + FDR	$2,071.7	$510.7	$2,582.4	$15.9
3C: Full—Banks + Rocky	$2,261.7	$596.9	$2,858.6	$17.0
3D: Full—Combined	$2,261.7	$596.9	$2,858.6	$17.0

* Since the construction periods vary by phase, this maximum annual OMR&P cost does not occur until year 2045 after all construction phases are completed.

4.7. Consequences of No Action

The consequences of the No Action Alternative over the next 10 years–by approximately the year 2020–would include the following:

- Only 15 percent of the production wells in the Study Area would continue to support irrigation for valuable high-water-use crops, such as potatoes.
- About 55 percent of the production wells in the Study Area would cease groundwater output and use of these wells would be permanently discontinued.
- The remaining 30 percent of the production wells in the Study Area would no longer support high-water-use crops, even on reduced acreage.

The consequences of the No Action Alternative to various environmental and socioeconomic resources are discussed further in the Odessa DEIS, Chapter 4, “Environmental Consequences.”

Under the No Action Alternative, the following would occur related to other water management programs:

- Operations at Lake Roosevelt and Banks Lake would continue as they do currently, providing water supply to meet authorized CBP purposes, including water delivery for irrigation, fish management, municipal and industrial uses, and recreation.
- Actions by the Management Program to pursue the development of water supply alternatives to groundwater for agricultural users in the Odessa Subarea would not proceed further under the No Action Alternative, since this Study is the direct response to this specific provision of Chapter 90.90 RCW−Columbia River Water Management Act.
- The No Action Alternative would not address existing East Low Canal system inefficiencies that affect ECBID's ability to meet delivery commitments to existing water service contract holders in the Study Area (as described in Section 4.2.3).
- The Coordinated Conservation Program (as described in Section 4.2.4.4.) would continue to implement conservation efforts to create water savings in the Study Area to reduce the use of groundwater for existing irrigation.
- The Lake Roosevelt Incremental Storage Releases Program (as described in Section 4.2.3) would continue to implement additional incremental storage releases from Lake Roosevelt to supplement water supplies for instream flows, existing agricultural lands in the Study Area, and municipal and industrial needs.

4.8. Summary of Impacts

The Odessa DEIS provides a detailed analysis of the impacts (direct, indirect, and cumulative) and associated mitigation measures of the alternatives. This summary of impacts provides a brief explanation of the resources analyzed and their context.

Both the adverse impacts and beneficial effects of the alternatives are directly related to how much land is provided with CBP surface water to replace failing groundwater supplies. For the No Action Alternative, the same beneficial effects and adverse impacts generally apply across the entire Study Area because none of the lands would receive a replacement water supply. Similarly, the full replacement alternatives typically deliver the same types of impacts and effects across the entire Study Area because CBP water would be delivered throughout the Study Area. For the partial-replacement alternatives, effects and impacts tend to be the same as expected for the No Action Alternative on lands north of I-90 because these lands would not receive a replacement water supply. Effects and impacts on lands south of I-90 tend to be similar to those expected for the full-replacement alternative in that portion of the Study Area.

4.8.1 Surface Water Quantity

Potential changes in surface water quantity were evaluated for the Columbia River, Lake Roosevelt, and Banks Lake, and other surface water features. The No Action Alternative would have no impact on Lake Roosevelt, Banks Lake, or the Columbia River downstream of Grand Coulee Dam because no additional water would be withdrawn. Changes in reservoir drawdowns under some of the action alternatives would affect surface water quantity. Changes to the Columbia River and Lake Roosevelt would be minor under the partial and full-replacement alternatives. Reductions in water surface elevation at Banks Lake would generally be smaller and of shorter duration under the partial-replacement alternatives than under the full-replacement alternatives. There are no significant impacts or effects associated with surface water resources.

4.8.2 Groundwater Resources

The shallow and deep aquifer systems beneath the Study Area are the area's primary source of municipal, industrial, domestic, and irrigation water. The deep aquifers are being depleted within and beyond the Study Area as a result of large-scale pumping. Consequently, groundwater users must pump from greater and greater depths as wells dry up and require deepening. This may impact all groundwater users, potentially those in nearby towns.

The No Action Alternative would have long-term significant impacts. These impacts would include continued decline of water levels in the Study Area which would result in some existing wells going dry, possible pump replacement, and increased pumping head and costs. At some point, using groundwater to grow high-water-demand crops would become uneconomical. In the partial replacement alternatives, groundwater levels in the Study Area south of I-90 are anticipated to stabilize, which would be an important beneficial effect for all users. Groundwater levels north of I-90 would continue to decline and be significantly impacted. In the full-replacement alternatives, groundwater levels both south and north of I-90 are anticipated to stabilize.

4.8.3 Surface Water Quality

Surface water quality issues associated with the Odessa Subarea Special Study alternatives consist of potential changes to temperature, dissolved oxygen, total dissolved gas, pH, nutrients, and heavy metals at Lake Roosevelt, Banks Lake, the Columbia River downstream of Grand Coulee Dam, and in the Study Area irrigation network.

The No Action Alternative would have no impact on water quality in Lake Roosevelt, Banks Lake, or the Columbia River. The Study Area irrigation network would experience a minor beneficial effect because of decreased delivery of pesticides and fertilizers to the canal and drain system. Lake Roosevelt water quality would generally experience only a minimal impact from any of the action

alternatives. Additional drawdown of Lake Roosevelt would be greatest in Alternative 3B: Full—Banks + FDR.

Banks Lake water quality, particularly temperature and dissolved oxygen, would be significantly impacted under all of the partial and full-replacement alternatives except Alternative 2C: Partial—Banks + Rocky. The impacts of additional drawdown of Banks Lake on temperature and dissolved oxygen would be greatest with Alternative 3A: Full—Banks and Alternative 3C: Full—Banks + Rocky. Water quality in the Columbia River downstream of Grand Coulee Dam, particularly temperature and total dissolved gas, would experience only a minimal impact from any of the action alternatives. Either no impacts or minimal beneficial effects to water quality in the irrigation network would be expected.

4.8.4 Water Rights

Water rights considered included those within the Study Area, plus downstream rights associated with the Columbia River. The analysis focused primarily on Lake Roosevelt because minimal impacts would occur to downstream water rights. With the need to meet minimum flow requirements and ESA target flows built into the alternatives, no impacts to water rights are anticipated for any of the alternatives.

4.8.5 Geology

The geologic setting of the Study Area has a major influence on the topography, groundwater occurrence, erosion potential, and availability of resources in constructing the proposed facilities. The No Action Alternative would have no impact on geologic resources because no new facilities would be constructed. Some geologic resources would be committed to build the facilities proposed under the action alternatives, with the greatest amount of material required for the full-replacement alternatives with both dams. Construction of the Rocky Coulee Reservoir dam or the Black Rock Coulee Reregulating Reservoir dam would require earthen materials; borrow materials are anticipated to come from within the reservoir inundation areas. Impacts associated with the depletion of geologic resources are anticipated to be minimal for all of the partial and full-replacement alternatives. There are no significant impacts or effects associated with geology.

4.8.6 Soils

Soil productivity can be reduced when ground-disturbing activities increase erosion or soil compaction. Impacts would result from new facilities that would take current land out of production, or construction activities that increase erosion and compaction. A long-term reduction in soil productivity would occur under the No Action Alternative as irrigated farmland shifts to dryland farming.

Short-term impacts to soils from construction activities would occur under all of the action alternatives. The extent of these impacts would be greater under the full-replacement alternatives because of the larger construction footprint.

Erosion control legal requirements, best management practices (BMPs), and mitigation measures would minimize offsite movement of sediment until new vegetation becomes established on temporarily disturbed lands. These lands would be put back into production following construction. Long-term impacts to soils would occur under all alternatives.

State-important unique farmland would be permanently taken out of production under all of the action alternatives, which is significant in terms of the Farmland Protection Policy Act. The extent of this impact would vary, with more impact occurring under the full-replacement alternatives. Significant impacts or effects associated with soils would be addressed through legal requirements for mitigation.

4.8.7 Vegetation and Wetlands

The action alternatives would impact both native upland vegetation and wetlands. No impacts are expected at Lake Roosevelt under any of the alternatives.

South of I-90, there would be loss of shrub-steppe vegetation and wetlands adjacent to the East Low Canal. Impacts to wetlands surrounding Banks Lake would primarily shift the plant community composition and would not be significant. Additional long-term significant impacts to upland vegetation would occur with the construction of Rocky Coulee Reservoir under action alternatives that include this component. Long-term impacts under the full-replacement alternatives would be similar to the partial-replacement alternatives, but would impact substantially larger areas.

Impacts to native plant communities would be significant and include the area of the proposed Black Rock Coulee Reregulating Reservoir and the East High and Black Rock Branch Canals. There would be significant impacts to Washington-listed rare or sensitive plant species under all of the full-replacement alternatives.

Significant wetland impacts would occur near the East Low and East High canals, and the area of the proposed Black Rock Coulee Reregulating Reservoir. Primary impacts to wetlands around Banks Lake would range from shifts in community composition to reduced area of wetlands, which constitute adverse to significant impacts.

4.8.8 Wildlife and Wildlife Habitat

Both native and nonnative wildlife habitats would be impacted by the action alternatives. The extent of shrub-steppe habitat in eastern Washington has

declined dramatically, largely because of conversion to agriculture. Any further losses would be significant.

The wildlife analysis is based on changes in the amount of available habitat identified in the vegetation studies, WDFW studies at the sites of major proposed facilities, and the effect of habitat fragmentation and movement barriers on wildlife. A shift from irrigated agriculture to dryland farming under the No Action Alternative would cause adverse impacts to wildlife that use irrigated croplands. Under all of the action alternatives, long-term significant impacts to wildlife would occur as a result of lost shrub-steppe habitat. Additional long-term significant impacts would occur to special status species and migratory birds under all of the action alternatives as a result of drawdowns at Banks Lake and reduced nesting habitat. The extent of these impacts would be greater in duration and area under the full-replacement alternatives. The East High Canal and Black Rock Branch Canal would result in significant impacts to wildlife under all of the full-replacement alternatives. The canals would create barriers to animal movements and fragment native shrub-steppe habitat, thereby isolating some segments of animal populations.

4.8.9 Fisheries

Potential impacts of the action alternatives on fisheries and aquatic resources that provide essential habitat for anadromous salmonids were assessed in Lake Roosevelt, Banks Lake, and the Columbia River downstream of Grand Coulee Dam.

Under the No Action Alternative, no short- or long-term impacts on fisheries and aquatic resources would occur. Since changes in the reservoir pool at Lake Roosevelt would not differ greatly from current conditions, impacts are expected to be minimal, if any, on the fishery in that reservoir.

For the Columbia River, the greatest reduction in flows would occur in September and October when adult fall Chinook salmon and steelhead trout are migrating up the lower and mid-Columbia River. However, no impacts to these adult migrating fish are anticipated. Similarly, spawning success of fall Chinook in the free-flowing Hanford Reach of the Columbia River and chum salmon that spawn below Bonneville Dam would not be impacted. During the salmonid smolt downstream migration season from mid-April through August, flows would either not change or the changes would be so small that no or nonmeasurable minimal impacts are expected. Minimal impacts on salmonid smolt survival during the spring months would be expected in some years for the four alternatives that would not use Lake Roosevelt storage. Projected summer water surface elevations in Banks Lake would be lower and would last for longer periods under the action alternatives compared to the No Action Alternative.

Impacts may include the potential for reduced habitat availability for various life stages of fish, shifts in zooplankton production, and increased fish and

zooplankton entrainment. Under the partial-replacement alternatives, impacts to fisheries and aquatic resources would be little to none. Under the full-replacement alternatives, however, significant impacts would be expected for fish and some other aquatic species because of the greater extent and duration of drawdowns, especially in dry years.

4.8.10 Threatened and Endangered Species

No short-term impacts to threatened and endangered species would occur under the No Action Alternative or any of the action alternatives.

There would be no long-term impacts to terrestrial threatened and endangered species under any of the action alternatives. Potential long-term impacts to aquatic threatened and endangered species would be related to changes in Columbia River streamflows. Only minimal impacts would occur to some downstream smolt migrants under the four alternatives that would not use Lake Roosevelt storage. Very minor beneficial effects might occur downstream on the Columbia River because of slightly increased flows during some months of the driest years.

No impacts would occur for upstream adult migrants or spawning under any of the action alternatives.

4.8.11 Air Quality

Non-road engine exhaust emissions have been identified by the U.S. Environmental Protection Agency (EPA) as a significant contributor to air pollution throughout the country. Short- and long-term minimal impacts from construction vehicle exhaust, release of fugitive dust, and greenhouse gasses would occur under all of the action alternatives, but would be greater under the full-replacement alternatives. There are no significant impacts or effects associated with air quality.

4.8.12 Land Use and Shoreline Resources

Concerns related to land use and shoreline resources focus on changes in land ownership, changes in existing land uses, and consistency with relevant plans, programs, and policies. No significant impacts to water bodies under the State Shoreline Management Act would occur with any of the alternatives.

4.8.12.1. Land Ownership

The No Action Alternative would not involve major changes in land ownership in the Study Area. The action alternatives would require significant acquisition of land interests by Reclamation for water delivery systems. Land interests that would need to be acquired include easements for linear facilities such as canals,

wasteways, pipelines, and transmission lines, and fee title to sites for pumping plants, operation and maintenance facilities, and reservoirs.

Easement and fee title requirements for the full replacement delivery system would be much greater than those for the partial-replacement alternatives. Also, fee title acquisition requirements are greater for alternatives that include Rocky Coulee Reservoir. Most of the land involved in these acquisitions is private. The majority of public land involved is State Trust land administered by the Washington Department of Natural Resources (WDNR), with minor holdings by other state and local jurisdictions.

4.8.12.2. Land and Shoreline Use

The No Action Alternative would result in a significant change in land use as irrigated agriculture transitions to dryland farming. This same change would occur on groundwater-irrigated lands north of I-90 under all partial-replacement alternatives. Beyond these broad changes, land use impacts would center on development of the facilities needed for the action alternatives. The categories of existing land use that would be significantly impacted include residences, center pivot irrigation systems, and irrigated agriculture in general. Other impacted land uses would include dryland agriculture and open space and habitat lands.

Impacts of the full-replacement alternatives would be substantially higher in all categories than those under the partial-replacement alternatives. Also, for both the partial and full-replacement alternatives, impacts would be much higher for alternatives that include Rocky Coulee Reservoir.

4.8.12.3. Relevant Plans, Programs and Policies

All involved counties designate land in the Study Area as agriculture and emphasize the importance of irrigated agriculture. Also, many of the State lands in the Study Area are leased for irrigated agriculture as a revenue source for State Trust beneficiaries. The No Action Alternative would be broadly inconsistent with this plan and program framework throughout the Study Area. The partial-replacement alternatives reflect the same inconsistency north of I-90. Only the full-replacement alternatives support this framework throughout the Study Area.

4.8.13 Recreation Resources

The action alternatives would generally have minimal impact on recreation resources at Lake Roosevelt.

All action alternatives would have some degree of significant impact on water-oriented recreation facilities and uses at Banks Lake unless mitigation measures are implemented.

No significant impact would occur to recreational resources at Lake Roosevelt or in the Study Area with any of the alternatives. Impacts at Banks Lake would be

due to the additional drawdowns of the reservoir pool beyond the No Action Alternative necessary to provide irrigation water supply to the Study Area. These drawdowns would cause some boat ramps and most developed swimming sites to become unusable for a period time each year under all alternatives. Developed and dispersed day use and camping sites would be adversely impacted in two ways:

- The loss of adjacent boat launches and swimming site capacity
- The additional distance to water caused by the lower pool elevation.

These impacts would center on the end of August each year when drawdowns reach their maximum depth. Generally, impacts at Banks Lake would be more widespread, impact more facilities, and last longer under the full-replacement alternatives than under the partial-replacement alternatives. Alternative 3A: Full—Banks and Alternative 3C: Full—Banks + Rocky would have the most widespread impacts, with use limitations averaging 2 months. Alternative 2C: Partial—Banks + Rocky would have the least widespread and shortest duration impacts. Impacts related to loss of boat ramp and swimming area availability could be mitigated by developing replacement facilities or redeveloping existing facilities. Impacts related to increased distance to the water's edge could not be mitigated.

4.8.14 Irrigated Agriculture and Socioeconomics

Washington's Adams, Grant, Franklin, and Lincoln Counties make up the analysis area. In the four-county area, adverse impacts to gross farm income under the No Action Alternative would represent less than 3 percent of the regional gross farm income. The partial-replacement alternatives would represent a beneficial effect of less than 3 percent of the total gross farm income for the four-county analysis area. Under the full-replacement alternatives, a beneficial effect of less than 5 percent of total gross farm income would be realized. The effects of the action alternatives, compared to No Action, are shown on Figure 4- 27.

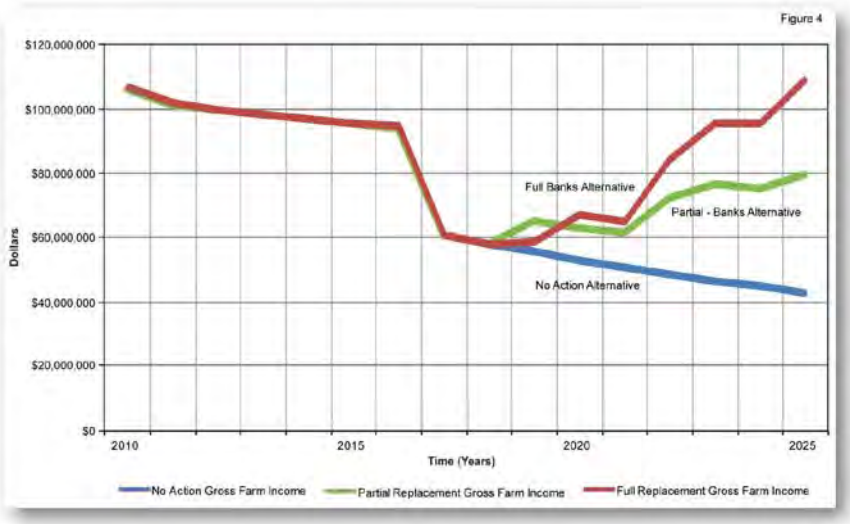


Figure 4- 27. Comparison of gross farm income under the No Action Alternative to the Action Alternatives

With respect to jobs, labor income, and sales in the four-county area, the analysis indicates that a minimal adverse impact would occur under the No Action Alternative. The net decrease would be less than 1 percent. Under the action alternatives, however, minimal beneficial effects would be expected, with a less than 1 percent increase in jobs, labor income, and sales in the four-county area.

4.8.15 Transportation

Transportation concerns focus on impacts to roads, highways, and railroads in the Study Area caused when proposed facilities intersect these routes. No such concerns exist for the No Action Alternative, and no air or navigable waterway transportation systems would be affected by any of the alternatives.

For all action alternatives, Reclamation and Ecology are committed to preparing a Transportation Management Plan in collaboration with affected counties and other agencies. The planning process would create a blueprint for avoiding short-term, construction-related impacts, and for assessing the best solution for resolving long-term impacts where facilities obstruct current routes. Development of the delivery system for the partial-replacement alternatives would not involve significant potential for short- or long-term transportation impacts.

The full replacement delivery system north of I-90 would involve more than 60 new crossings of existing roadways, including one state highway and one crossing of an active rail line by surface water conveyance facilities like canals. Through the transportation planning process, requirements for maintaining adequate transportation service would be defined and programmed, including bridges over

the new conveyances or placing the facilities underground. For action alternatives that include construction of Rocky Coulee Reservoir, locally significant long-term impacts to vehicular circulation would be unavoidable. This reservoir would inundate portions of local north-south through travel routes, including S Road NE and U Road NE.

4.8.16 Energy

Energy issues associated with the Study alternatives include the potential to alter regional and local energy balances. Additional withdrawals from the Columbia River would lead to lost hydroelectric generation potential and a possible reduction in regional energy supply and availability. Additional pumping requirements to deliver water through new or modified canal systems would increase the burden on local energy providers responsible for supplying energy resources and could affect regional energy demand.

Under the No Action Alternative, irrigators would require more energy to pump groundwater from greater depths, but local energy providers would experience minimal impacts because they would have sufficient capacity to supply all customers.

Regional energy availability would be impacted to some extent by all of the action alternatives. In the short term, even under critical water conditions, impacts to the regional energy surplus would be minimal. However, projecting the energy surplus out to a 10-year horizon, the reduction in regional energy availability would have an adverse impact for the partial-replacement alternatives and a significant adverse impact for the full-replacement alternatives.

The net reduction in available energy relative to the projected regional surplus would range from 11 percent for Alternative 2A: Partial—Banks and Alternative 2B: Partial—Banks + FDR, to 31 percent for Alternative 3C: Full—Banks + Rocky and Alternative 3D: Full—Combined. Current projections for the Critical Water year case indicate that there could be a regional system deficit by 2018.

4.8.17 Public Services and Utilities

Public services in the Study Area include law enforcement, fire protection, and emergency medical services. Utilities providers include electricity, natural gas, water supply, telecommunications, and wastewater management.

There would be no significant adverse impact on any public service or utilities in the Study Area with any of the alternatives. However, the No Action Alternative and, to a lesser extent, the partial-replacement alternatives, do have the potential to cause a downsizing impact on public service capacity in the area because of the drop in the regional economy as land use changes.

4.8.18 Noise

Localized, short-term noise impacts would occur during construction of facilities associated with the action alternatives. Construction noise is exempt from state noise regulations. Nonetheless, BMPs would be employed to control and minimize construction noise to the extent practical, and no significant adverse short-term noise impacts are anticipated. In the long term, ambient noise levels would increase near the pumping plants and operation and maintenance facilities associated with the action alternatives. These impacts would not be significant, and there are no significant impacts or effects associated with noise.

4.8.19 Public Health

Public health considerations related to the Special Study alternatives include potential exposure to hazardous materials and mosquito-borne illnesses. No impacts are expected under the No Action Alternative.

With the action alternatives, development of delivery system facilities and additional drawdown at reservoirs would create the potential for exposure to hazardous materials such as fuels and chemicals or contaminated sediments, and for short- and long-term increases in mosquito habitat. However, existing regulations and BMPs would ensure that any such impacts are either avoided or minimized. There are no significant impacts or effects associated with public health.

4.8.20 Visual Resources

Changes in visual character or quality would occur in the Study Area with all alternatives, including the No Action Alternative. Additional drawdowns at Banks Lake and Lake Roosevelt under the action alternatives also have the potential to result in adverse visual resource impacts.

In the Study Area, the No Action Alternative and the portion of the partial-replacement alternatives north of I-90 would result in significant, broad-scale impacts caused by the transition from irrigated agriculture to dryland. Where lands would receive replacement water supply for irrigation under the action alternatives, broad-scale visual character would not be changed.

However, development of water delivery system facilities would result in significant localized visual impacts associated with introduction of major new infrastructure. Some of the new facilities, such as canals, would be compatible with the irrigated agriculture environment. However, facilities such as regulating tanks up to 200 feet high would likely be seen as an adverse impact on visual quality.

Additional drawdowns at Banks Lake and Lake Roosevelt under the action alternatives would generally not result in significant adverse impacts on visual quality. The exceptions to this are Alternative 3A: Full—Banks, where

drawdowns would be more than 8 feet lower than the No Action Alternative in average years and Alternative 3C: Full— Banks + Rocky, where similar, deep drawdowns would occur in dry and drought years. This extent of additional drawdown would have a significant adverse impact on visual quality at the reservoir for a period of time each year, creating a much larger "bathtub ring" effect where open, unvegetated shoreline is exposed around the reservoir.

4.8.21 Cultural and Historic Resources

Cultural resources encompass a wide range of historic and prehistoric resources defined by State and Federal regulations.

The No Action Alternatives would not impact such resources. At the current level of project planning, assessment of potential for impact under the action alternative uses a predictive model to estimate the likelihood of significant resources being encountered for the sake of comparison among the alternatives. No surveys of potential facility sites have been conducted because of the scale and complexity of the alternatives. All action alternatives involve development and operation of delivery system facilities in areas with high potential to contain significant cultural resources. These alternatives would also involve additional drawdowns at Banks Lake each year, exposing more shoreline with potential to contain significant resources. Generally, the partial-replacement alternatives would have considerably less potential for adverse impact than the full-replacement alternatives because fewer facilities would be built and these facilities would be located in less sensitive areas, and because additional drawdowns at Banks Lake are generally less. For alternatives that include Rocky Coulee Reservoir, another large site with high potential for significant resources would be added. Full field surveys to identify cultural and historic resources would be completed and all necessary consultation with the State Historic Preservation Officer and involved Tribes would be carried out if a decision is made to proceed with one of the action alternatives. Through this effort, impact avoidance and mitigation measures would be defined.

4.8.22 Indian Trust Assets

Government-to-Government consultation has been initiated with involved Tribes related to Indian Trust Assets. To date, no Indian Trust Assets have been identified in or near the project area. If a decision is made to proceed with development of one of the action alternatives, Reclamation would continue consultation, consistent with existing regulations and policies.

Project activities would be conducted to protect these resources, promote Tribal access to resource sites, and avoid adverse effects whenever possible. There are no significant impacts or effects associated with Indian Trust Assets

4.8.23 Sacred Sites

Government-to-Government consultation has been initiated with involved Tribes related to Sacred Sites. To date, no Sacred Sites have been identified in or near the project area. If a decision is made to proceed with development of one of the action alternatives, Reclamation would continue consultation consistent with existing regulations and policies. Project activities would be conducted to protect these resources, promote Tribal access to resource sites, and avoid adverse effects whenever possible. There are no significant impacts or effects associated with Sacred Sites.

4.8.24 Environmental Justice

The environmental justice analysis area is generally comprised of Adams, Franklin, Grant, and Lincoln Counties. The area is primarily rural, supporting agricultural land uses with few towns. Minority and low-income populations reside in the area, but no disproportionate economic, land use, construction-related, or other impacts to these populations would occur with any of the alternatives. There are no significant impacts or effects associated with environmental justice.

4.8.25 Comparison Table of Impacts

Table 4- 8, Overview of the Benefits and Impacts from the Alternatives on All Resource Topics and Areas Assessed, displays the results of the Study alternatives for all resource topics. For each resource topic, one or more impact indicators are listed in the left-hand column. These indicators identify how changes to the environment are measured. A short description of the benefit or adverse impact for each of these impact indicators is listed under the alternatives, and is colored to show the relative magnitude of the effects of the alternatives. The Odessa DEIS provides criteria for significance, applicable mitigation measures, and details of these impacts.

For all of the resource topics, the expected impacts shown are those that would remain after all regulatory requirements and best management practices are met. This impact analysis does not account for application of any mitigation measures. These impact categories are defined and color-coded as noted below:

Important Beneficial Effect	Beneficial Effect	No Impact to Minimal Impact	Adverse Impact	Important Adverse Impact
A substantial beneficial effect	A minor beneficial effect	No impact; or influences the resource to a barely measurable degree	A negative impact to the resource	A substantial negative impact

Table 4- 8 provides a comparison overview of impacts to these resources.

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Impacts assume that all legal requirements are followed and all BMPs are successfully implemented. Mitigation measures are not considered. Impact categories are defined as follows:

Important Beneficial Effect	Beneficial Effect	No Impact to Minimal Impact	Adverse Impact	Important Adverse Impact
A substantial beneficial effect	A minor beneficial effect	No impact; or influences the resource to a barely measurable degree	A negative impact to the resource	A substantial negative impact

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Surface Water Resources									
Instream flow requirements	No impact	Compliance achieved. No impact.	Compliance achieved. No impact.	Compliance achieved. No impact.	Compliance achieved. No impact.	Compliance achieved. No impact.	Compliance achieved. No impact.	Compliance achieved. No impact.	Compliance achieved. No impact.
Reduction of surface water elevations in Lake Roosevelt	No impact	No impact	Minimal additional drawdown in late August/early September. Minimal hydrologic impact.	No impact	Minimal additional drawdown in late August/early September. Minimal hydrologic impact.	No impact	Minimal additional drawdown in late August/early September. Minimal hydrologic impact.	No impact	Minimal additional drawdown in late August/early September. Minimal hydrologic impact.
Reduction of surface water elevations in Banks Lake	No impact	Additional drawdown in August and September. Minimal hydrologic impact.	Additional drawdown in August and September. Minimal hydrologic impact.	Additional drawdown in August and September. Minimal hydrologic impact.	Additional drawdown in August and September. Minimal hydrologic impact.	Additional drawdown in August and September. Minimal hydrologic impact.	Additional drawdown in August and September. Minimal hydrologic impact.	Additional drawdown in August and September. Minimal hydrologic impact.	Additional drawdown in August and September. Minimal hydrologic impact.
Changes to flows, geomorphology, or connectivity from inundation under a planned reservoir or spillway flow from a reservoir	No impact	No impact	No impact	Inundation by Rocky Coulee. Minimal impact.	Inundation by Rocky Coulee. Minimal impact.	Inundation by Black Rock Coulee Reregulating Reservoir. Minimal impact.	Inundation by Black Rock Coulee Reregulating Reservoir. Minimal impact.	Inundation by Black Rock Coulee Reregulating Reservoir and Rocky Coulee Reservoir. Minimal impact.	Inundation by Black Rock Coulee Reregulating Reservoir and Rocky Coulee Reservoir. Minimal impact.
Changes to areas that receive water from the wasteways	No impact	Minimal impact	Minimal impact	Minimal impact in Rocky Coulee	Minimal impact in Rocky Coulee	Minimal impact in Black Rock Coulee	Minimal impact in Black Rock Coulee	Minimal impact in Black Rock Coulee and Rocky Coulee	Minimal impact in Black Rock Coulee and Rocky Coulee
Groundwater Resources									
Groundwater level declines	102,614 acres would still be irrigated by groundwater; declines continue	48,416 acres would still be irrigated by groundwater; declines continue	48,416 acres would still be irrigated by groundwater; declines continue	48,416 acres would still be irrigated by groundwater; declines continue	48,416 acres would still be irrigated by groundwater; declines continue	Full surface water replacement supply; groundwater not used	Full surface water replacement supply; groundwater not used	Full surface water replacement supply; groundwater not used	Full surface water replacement supply; groundwater not used
Recharge or seepage in Rocky Coulee	No impact	No impact	No impact	Local recharge to shallow groundwater from reservoir	Local recharge to shallow groundwater from reservoir	No impact	No impact	Local recharge to shallow groundwater from reservoir	Local recharge to shallow groundwater from reservoir
Recharge or seepage in Black Rock Coulee	No impact	No impact	No impact	No impact	No impact	Local recharge to shallow groundwater from reservoir	Local recharge to shallow groundwater from reservoir	Local recharge to shallow groundwater from reservoir	Local recharge to shallow groundwater from reservoir
Municipal and industrial users	No impact	Minimal beneficial effect south of I-90	Minimal beneficial effect south of I-90	Minimal beneficial effect south of I-90	Minimal beneficial effect south of I-90	Minimal beneficial effect throughout Study Area	Minimal beneficial effect throughout Study Area	Minimal beneficial effect throughout Study Area	Minimal beneficial effect throughout Study Area
Water Quality									
Temperature (FDR)	No impact	No impact	Minimal impact	No impact	Minimal impact	No impact	Adverse impact	No impact	Minimal impact
Dissolved oxygen (FDR)	No impact	No impact	Minimal impact	No impact	Minimal impact	No impact	Adverse impact	No impact	Minimal impact
Heavy metals (FDR)	No impact	No impact	Minimal impact	No impact	Minimal impact	No impact	Minimal impact	No impact	Minimal impact
Temperature (Banks)	No impact	Significant impact	Significant impact	Minimal impact	Significant impact	Significant impact but greater than 2A	Significant impact	Significant impact but greater than 2A	Significant impact
Dissolved oxygen (Banks)	No impact	Significant impact	Significant impact	Minimal impact	Significant impact	Significant impact but greater than 2A	Significant impact	Significant impact but greater than 2A	Significant impact
Turbidity (Banks)	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Impacts assume that all legal requirements are followed and all BMPs are successfully implemented. Mitigation measures are not considered. Impact categories are defined as follows:

Important Beneficial Effect	Beneficial Effect	No Impact to Minimal Impact	Adverse Impact	Important Adverse Impact
A substantial beneficial effect	A minor beneficial effect	No impact; or influences the resource to a barely measurable degree	A negative impact to the resource	A substantial negative impact

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Temperature (Columbia)	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Total dissolved gas (Columbia)	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Temperature (Analysis)	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
pH (Analysis Area)	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Salinity (Analysis Area)	No impact	Minor beneficial effect	Minor beneficial effect	Minor beneficial effect	Minor beneficial effect	Minor beneficial effect	Minor beneficial effect	Minor beneficial effect	Minor beneficial effect
Nutrients (Analysis Area)	Potential minor beneficial effect	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Water Rights									
Loss or curtailment of groundwater rights	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Columbia River and Lake Roosevelt Tribal water rights	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Geology									
Commitment of geologic resources	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact
Geologic hazards	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Unique geologic features	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Soils									
Farmland Protection Policy Act	No impact	Significant impact, but would be addressed through legal requirements	Significant impact, but would be addressed through legal requirements	Significant impact, but would be addressed through legal requirements	Significant impact, but would be addressed through legal requirements	Significant impact, but would be addressed through legal requirements	Significant impact, but would be addressed through legal requirements	Significant impact, but would be addressed through legal requirements	Significant impact, but would be addressed through legal requirements
Soil salinity and sodicity *Note: This is not a significance criteria in Chapter 4, but it is provided here to illustrate consequences of No Action*	The need to apply soil amendments to maintain land in production would become more widespread if continued pumping of declining groundwater increases use of deeper, older groundwater of higher salinity and sodium content.	The impact described under No Action would continue for lands north of I-90.	The impact described under No Action would continue for lands north of I-90.	The impact described under No Action would continue for lands north of I-90.	The impact described under No Action would continue for lands north of I-90.	No impact	No impact	No impact	No impact
Vegetation and Wetlands									

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Impacts assume that all legal requirements are followed and all BMPs are successfully implemented. Mitigation measures are not considered. Impact categories are defined as follows:

Important Beneficial Effect	Beneficial Effect	No Impact to Minimal Impact	Adverse Impact	Important Adverse Impact
A substantial beneficial effect	A minor beneficial effect	No impact; or influences the resource to a barely measurable degree	A negative impact to the resource	A substantial negative impact

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Impact on native plant communities	No impact	Significant impact on native plant communities.	Significant impact on native plant communities.	Significant impact on native plant communities, but greater impact on native plant communities from Rocky Coulee Reservoir.	Significant impact on native plant communities, but greater impact on native plant communities from Rocky Coulee Reservoir.	Significant impact over a large area of native communities, including Black Rock Coulee Reregulating Reservoir	Significant impact over a large area of native communities, including Black Rock Coulee Reregulating Reservoir	Significant impact over a large area of native communities, including Black Rock Coulee Reregulating Reservoir and Rocky Coulee Reservoir	Significant impact over a large area of native communities, including Black Rock Coulee Reregulating Reservoir and Rocky Coulee Reservoir
Fragmentation of native plant communities	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Significant impact due to construction of new canals	Significant impact due to construction of new canals	Significant impact due to construction of new canals	Significant impact due to construction of new canals
Impact on special status plants	No impact	No impact	No impact	No impact	No impact	Impact on rare plants would be significant	Impact on rare plants would be significant	Impact on rare plants would be significant	Impact on rare plants would be significant
Habitat restoration	No impact	Minimal impact	Minimal impact	Significant requirement for restoration of disturbed habitat over large areas	Significant requirement for restoration of disturbed habitat over large areas	Significant requirement for restoration of disturbed habitat over large areas	Significant requirement for restoration of disturbed habitat over large areas	Significant requirement for restoration of disturbed habitat over large areas	Significant requirement for restoration of disturbed habitat over large areas
Long-term loss of wetland area	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Significant impact at Banks Lake	Significant impact at Banks Lake	Significant impact at Banks Lake	Significant impact at Banks Lake
Long-term loss or degradation of wetland function	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal to adverse impact at Banks Lake depending on the water year	Minimal to adverse impact at Banks Lake depending on the water year	Minimal to adverse impact at Banks Lake depending on the water year	Minimal to adverse impact at Banks Lake depending on the water year
Wildlife and Wildlife Habitat									
Impact on intact shrub-steppe habitat	Minimal impact on wildlife that use farm lands because wheat fields would be fallowed every other year	Significant impact	Significant impact	Significant impact	Significant impact	Significant impact over substantially larger area than under Alternatives 2A-2D	Significant impact over substantially larger area than under Alternatives 2A-2D	Significant impact over substantially larger area than under Alternatives 2A-2D	Significant impact over substantially larger area than under Alternatives 2A-2D
Barriers to unrestricted movement by wildlife	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	Significant impact from canal construction	Significant impact from canal construction	Significant impact from canal construction	Significant impact from canal construction
Impact on special status species, including migratory birds	No impact	Significant impact on multiple species	Significant impact on multiple species	Significant impact on multiple species, with increased area of effect due to Rocky Coulee Reservoir	Significant impact on multiple species, with increased area of effect due to Rocky Coulee Reservoir	Significant impact on multiple species, involving substantially larger area and a number of species than under Alternatives 2A-2D	Significant impact on multiple species, involving substantially larger area and a number of species than under Alternatives 2A-2D	Significant impact on multiple species, involving substantially larger area and a number of species than under Alternatives 2A-2D	Significant impact on multiple species, involving substantially larger area and a number of species than under Alternatives 2A-2D
Habitat fragmentation and population viability	No impact	No impact	No impact	No impact	No impact	Significant impact due to canal construction	Significant impact due to canal construction	Significant impact due to canal construction	Significant impact due to canal construction
Fisheries and Aquatic Resources									
Columbia River: Downstream migration of salmonid smolts	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact
Columbia River: Upstream migration of adult salmon and steelhead	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Impacts assume that all legal requirements are followed and all BMPs are successfully implemented. Mitigation measures are not considered. Impact categories are defined as follows:

Important Beneficial Effect	Beneficial Effect	No Impact to Minimal Impact	Adverse Impact	Important Adverse Impact
A substantial beneficial effect	A minor beneficial effect	No impact; or influences the resource to a barely measurable degree	A negative impact to the resource	A substantial negative impact

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Columbia River: Chum salmon spawning below Bonneville Dam	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact
FDR: Zooplankton production	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact
FDR: Rainbow trout net pen program	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact
FDR: Kokanee salmon spawner access to San Poil River	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact
Banks Lake: Fish and zooplankton entrainment	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact
Surface areas of littoral habitat temporarily exposed during drawdowns	No additional impact	Significant impact on invertebrate production from greater drawdown but no long-term impact on fish populations.	Significant impact on invertebrate production from greater drawdown but no long-term impact on fish populations.	Minimal additional impact on invertebrate production from greater drawdown.	Significant impact on invertebrate production from greater drawdown but no long-term impact on fish populations.	Significant impact on invertebrate production from greater drawdown but no long-term impact on fish populations.	Significant impact on invertebrate production from greater drawdown but no long-term impact on fish populations.	Significant impact on invertebrate production from greater drawdown but no long-term impact on fish populations.	Significant impact on invertebrate production from greater drawdown but no long-term impact on fish populations.
Banks Lake: Overall condition of the fishery	No impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	No impact to minimal impact	Significant impact in all water year conditions is likely	Significant impact in drought years. Minimal impact in wet, average, or dry years.	Significant impact in all water year conditions is likely, but less severe than 3A.	Significant impact in drought years. Minimal impact in wet, average, or dry years.
Threatened and Endangered Species									
Pygmy rabbits	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Downstream migration of salmonid smolts	No impact	Minimal impact	No impact	Minimal impact	No impact	Minimal impact	No impact	Potential minor beneficial effect	Minimal impact
Upstream migration of adult salmon, steelhead, and bull trout	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Chum salmon spawning below Bonneville Dam	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Air Quality									
Primary air quality standards	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Secondary air quality standards	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Attainment area classification	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Land Use and Shoreline Resources									
Changes in land ownership and land status	No acres acquired for facilities	5,294 acres acquired (easements and fee title)	5,294 acres acquired (easements and fee title)	14,232 acres acquired (easements and fee title)	14,232 acres acquired (easements and fee title)	21,214 acres acquired (easements and fee title)	21,214 acres acquired (easements and fee title)	30,252 acres acquired (easements and fee title)	30,252 acres acquired (easements and fee title)
Changes in land or shoreline uses: Protection of irrigated agriculture	Significant change from irrigated to dryland agriculture	57,000 acres of irrigated agriculture preserved	57,000 acres of irrigated agriculture preserved	57,000 acres of irrigated agriculture preserved	57,000 acres of irrigated agriculture preserved	102,600 acres of irrigated agriculture preserved	102,600 acres of irrigated agriculture preserved	102,600 acres of irrigated agriculture preserved	102,600 acres of irrigated agriculture preserved
Changes in land or shoreline uses: Occupied structures impacted	No structures impacted	5 structures impacted	5 structures impacted	20 structures impacted	20 structures impacted	17 structures impacted	17 structures impacted	32 structures impacted	32 structures impacted

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A substantial beneficial effect	A minor beneficial effect	No impact; or influences the resource to a barely measurable degree	A negative impact to the resource	A substantial negative impact

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Changes in land or shoreline uses: Center pivots impacted	No center pivots removed from operation	5 pivots removed from operation	5 pivots removed from operation	41 pivots removed from operation	41 pivots removed from operation	53 pivots removed from operation	53 pivots removed from operation	70 pivots removed from operation	70 pivots removed from operation
Changes in land or shoreline uses: Irrigated agriculture impacted	No acres removed from production	203 acres removed from production	203 acres removed from production	5,784 acres removed from production	5,784 acres removed from production	1,442 acres removed from production	1,442 acres removed from production	5,269 acres removed from production	5,269 acres removed from production
Consistency with relevant plans, policies and programs	Inconsistent with plans across 102,614 acres	Supports county comprehensive plans across 57,000 acres	Supports county comprehensive plans across 57,000 acres	Supports county comprehensive plans across 57,000 acres	Supports county comprehensive plans across 57,000 acres	Supports county comprehensive plans across 102,600 acres	Supports county comprehensive plans across 102,600 acres	Supports county comprehensive plans across 102,600 acres	Supports county comprehensive plans across 102,600 acres
Recreation Resources									
FDR: Loss of boating capacity	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
FDR: Exposure of boating hazards	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
FDR: Loss of fishing opportunities	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
FDR: Loss of usability at developed swimming areas	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
FDR: Decrease in usability or aesthetic quality at developed camping or day use facilities	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
FDR: Dispersed recreation	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
FDR: Loss of opportunity for hunting, wildlife viewing, hiking, etc. on lands surrounding the reservoirs	No impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact
Banks: Loss in boat launch capacity and related impacts on fishing access, camping, and day use	No impact	1 week in North and Steamboat sectors and 4 weeks in Middle and South sectors in an average year. Impact would be mitigated	5 weeks in Middle and South sectors in an average year. Impact would be mitigated	1 week in Middle and South sectors in an average year. Impact would be mitigated	6 weeks in Middle and South sectors in an average year. Impact would be mitigated	6 weeks in North and Steamboat sectors and 10 weeks in Middle and South sectors in an average year. Impact would be mitigated	5 weeks in Middle and South sectors in an average year. Impact would be mitigated	3 weeks in North and Steamboat sectors and 7 weeks in Middle and South sectors in an average year. Impact would be mitigated	6 weeks in Middle and South sectors in an average year. Impact would be mitigated
Banks: Exposure of boating hazards	Minimal impact	3.4 feet of drawdown beyond the No Action Alternative in an average year	3 feet of drawdown beyond No Action	0.1 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action	8.5 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action	5 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action
Banks: Loss of fishing opportunities (because of impact on fishery; impact on fishing access reflected in boating capacity indicator)	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Significant impact likely in all water year conditions	Significant impact in drought years. Minimal impact in wet, average or dry years.	Significant impact likely in all water year conditions	Significant impact in drought years. Minimal impact in wet, average or dry years.
Banks: Loss of usability at developed swimming areas	2 weeks of loss of use at most sites in average years	6 weeks of loss of use at most sites in average years. Impact would be mitigated	6 weeks of loss of use at most sites in average years. Impact would be mitigated	2 weeks of loss of use at most sites in average years. Impact would be mitigated	7 weeks of loss of use at most sites in average years. Impact would be mitigated	12 weeks of loss of use at most sites in average years. Impact would be mitigated	6 weeks of loss of use at most sites in average years. Impact would be mitigated	9 weeks of loss of use at most sites in average years. Impact would be mitigated	8 weeks of loss of use at most sites in average years. Impact would be mitigated

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Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Banks: Decrease in usability or aesthetic quality at developed camping or day use facilities	Minimal impact	3.4 feet of drawdown beyond the No Action Alternative in an average year	3 feet of drawdown beyond No Action	0.1 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action	8.5 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action	5 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action
Banks: Decrease in usability of aesthetic quality at dispersed recreation sites	Minimal impact	3.4 feet of drawdown beyond the No Action Alternative in an average year	3 feet of drawdown beyond No Action	0.1 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action	8.5 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action	5 feet of drawdown beyond No Action	3.4 feet of drawdown beyond No Action
Banks: Loss of opportunity for hunting, wildlife viewing, hiking, etc. on lands surrounding the reservoirs	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Loss of hunting and/or wildlife viewing opportunities in Odessa Special Study Area	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Irrigated Agriculture									
Gross Farm Income 2025 Study Area Compared to Four-County Analysis Area	Adverse long-term impact: less than three percent of analysis area Gross Farm Income	Beneficial long-term effect: less than three percent of analysis area Gross Farm Income	Beneficial long-term effect: less than three percent of analysis area Gross Farm Income	Beneficial long-term effect: less than three percent of analysis area Gross Farm Income	Beneficial long-term effect: less than three percent of analysis area Gross Farm Income	Beneficial long-term effect: less than five percent of analysis area Gross Farm Income	Beneficial long-term effect: less than five percent of analysis area Gross Farm Income	Beneficial long-term effect: less than five percent of analysis area Gross Farm Income	Beneficial long-term effect: less than five percent of analysis area Gross Farm Income
Socioeconomics									
Change in regional employment (number of jobs) within the four-county analysis area	Adverse long-term impact: less than one percent decrease in jobs	Short-term beneficial effects: less than one percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.	Short-term beneficial effects: less than one percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.	Short-term beneficial effects: less than two percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.	Short-term beneficial effects: less than two percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.	Short-term beneficial effects: less than four percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.	Short-term beneficial effects: less than four percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.	Short-term beneficial effects: less than four percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.	Short-term beneficial effects: less than four percent increase in jobs. Net long-term beneficial effects: less than one percent increase in jobs.
Change in regional labor income within the four-county analysis area	Adverse long-term impact: less than one-half of one percent decrease in labor income	Short-term beneficial effects: less than two percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.	Short-term beneficial effects: less than two percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.	Short-term beneficial effects: less than two percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.	Short-term beneficial effects: less than two percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.	Short-term beneficial effects: less than six percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.	Short-term beneficial effects: less than six percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.	Short-term beneficial effects: less than six percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.	Short-term beneficial effects: less than six percent increase in labor income. Net long-term beneficial effects: less than one percent increase in labor income.
Change in regional sales within the four-county analysis area	Adverse long-term impact: less than one-half of one percent decrease in sales	Short-term beneficial effects: less than one percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.	Short-term beneficial effects: less than one percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.	Short-term beneficial effects: less than one percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.	Short-term beneficial effects: less than one percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.	Short-term beneficial effects: less than four percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.	Short-term beneficial effects: less than four percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.	Short-term beneficial effects: less than four percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.	Short-term beneficial effects: less than four percent increase in sales. Net long-term beneficial effects: less than one percent increase in sales.

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Impacts assume that all legal requirements are followed and all BMPs are successfully implemented. Mitigation measures are not considered. Impact categories are defined as follows:

Important Beneficial Effect	Beneficial Effect	No Impact to Minimal Impact	Adverse Impact	Important Adverse Impact
A substantial beneficial effect	A minor beneficial effect	No impact; or influences the resource to a barely measurable degree	A negative impact to the resource	A substantial negative impact

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Transportation									
Short- or long-term increases in traffic (general average daily and peak hour) on regional or local roads	No impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact
Increases in large and/or heavy-load vehicle traffic on regional or local roads	No impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact	Minimal Impact
Existing roads and railroads: crossings by new surface facilities or inundation by new reservoirs	No impact	Minimal impact given committed Transportation Management Plan (TMP)	Minimal impact given committed TMP	Significant impact on local circulation from road closures necessary for Rocky Coulee reservoir	Significant impact on local circulation from road closures necessary for Rocky Coulee reservoir	Minimal impact given committed TMP	Minimal impact given committed TMP	Significant impact on local circulation from road closures necessary for Rocky Coulee reservoir	Significant impact on local circulation from road closures necessary for Rocky Coulee reservoir
Energy									
Change in net energy available in region	No impact	Adverse impact	Adverse impact	Adverse impact	Adverse impact	Significant impact	Significant impact	Significant impact	Significant impact
Capacity of local providers	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Public Services and Utilities									
Exceedance of service or utility capacity (long-term)	No impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact
Disruption of services or utilities for existing residents and landowners (short-term, construction-phase)	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Impact on emergency response times (short-term, construction-phase)	No impact	Minimal Impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Noise									
Short-term (construction) increases in noise levels	No impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact
Long-term increases in noise levels	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Public Health (Hazardous Materials)									
Hazardous sites	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Mosquito habitat	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Visual Resources									
Landscape-level change: conversion from irrigated agriculture to dryland or fallow	102,614 acres would convert to dryland or fallow	48,416 acres would convert to dryland or fallow	48,416 acres would convert to dryland or fallow	48,416 acres would convert to dryland or fallow	48,416 acres would convert to dryland or fallow	Landscape appearance does not change	Landscape appearance does not change	Landscape appearance does not change	Landscape appearance does not change
Introduction of new developed facilities	No impact	Delivery and distribution system south of I-90 only	Delivery and distribution system south of I-90 only	Delivery and distribution system south of I-90 and Rocky Coulee Reservoir north of I-90	Delivery and distribution system south of I-90 and Rocky Coulee Reservoir north of I-90	Delivery and distribution system north and south of I-90	Delivery and distribution system north and south of I-90	Delivery and distribution system north and south of I-90, plus Rocky Coulee Reservoir	Delivery and distribution system north and south of I-90, plus Rocky Coulee Reservoir

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Impacts assume that all legal requirements are followed and all BMPs are successfully implemented. Mitigation measures are not considered. Impact categories are defined as follows:

Important Beneficial Effect	Beneficial Effect	No Impact to Minimal Impact	Adverse Impact	Important Adverse Impact
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Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Changes in reservoir drawdown patterns at Banks Lake and Lake Roosevelt	Minimal Impact	Adverse impact at Banks Lake generally related to depth of additional drawdown	Adverse impact at Banks Lake generally related to depth of additional drawdown	Minimal Impact	Adverse impact at Banks Lake generally related to depth of additional drawdown	Significant impact at Banks Lake in August and September of average years	Adverse impact at Banks Lake generally related to depth of additional drawdown	Significant impact at Banks Lake in August and September of dry and drought years	Adverse impact at Banks Lake generally related to depth of additional drawdown
Cultural and Historic Resources *Potential for construction to encounter and impact significant cultural resources*									
Miles of new linear facilities	No impact	172 miles	172 miles	172 miles	172 miles	248 miles	248 miles	248 miles	248 miles
Acres of facility site acquisition	No impact	90 acres	90 acres	6,170 acres	6,170 acres	128 acres	128 acres	6,208 acres	6,208 acres
Additional acreage exposed by drawdowns at Banks Lake	No impact	780 acres	680 acres	30 acres	500 acres	2,310 acres	690 acres	1,170 acres	690 acres
Indian Sacred Sites									
Potential for facility development to impact known sacred sites	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Indian Trust Assets									
Potential for facility development to impact known ITAs	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Environmental Justice									
Disproportionate impact to minority or low-Income populations	No impact	No Impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact

Chapter 5: Four-Account Analysis

The alternatives were compared using the four accounts of the Principles and Guidelines defined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, March 10, 1983 (P&Gs) to facilitate evaluation and to display effects of the alternatives:

National Economic Development (NED): The Federal objective is to contribute to national economic development consistent with protecting the Nation's environment. The NED account measures the beneficial and adverse monetary effects of each alternative in terms of changes in the value of the national output of goods and services.

Regional Economic Development (RED): This account evaluates the beneficial and adverse impacts of each alternative on the economy of the affected region, with particular emphasis on income and employment measures. The affected region reflects the geographic area where significant impacts are expected to occur. Impacts can be measured in both monetary and nonmonetary terms.

Environmental Quality (EQ): This account displays the effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources which cannot be adequately measured in monetary terms within the NED and RED accounts.

Other Social Effects (OSE): This account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

The NED and RED accounts evaluate economic effects of proposed alternative plans. According to the P&Gs, a primary distinction between an NED benefit-cost analysis (BCA) and a RED regional economic impact analysis is geographic. The RED analysis focuses on economic impacts to the local region, whereas the NED analysis focuses on economic benefits to the entire Nation. The RED evaluation recognizes the NED benefits accruing to the local region plus the transfers of income into the region. However, since the RED analysis focuses purely on the local region, it does not take into account potential offsetting effects occurring outside the region, as does the NED analysis. As a Federal agency, Reclamation must analyze the NED effects so as not to favor one area of the country over another. Reclamation also analyzes the RED effects to the local economy to provide specific information on the primary impact area. However, economic justification is determined for each alternative solely based on the results of the NED BCA. In addition to the geographic differences between the economic analyses, the RED analysis includes not only the initial or direct impact on the primary affected industries (as does the NED analysis), but also the secondary or indirect effects on those industries providing inputs to the directly

affected industries (referred to as the multiplier effect). This multiplier effect is not included in the NED analysis.

For each of the four accounts, analyses were conducted on the alternatives considered in this Study. In addition to the No Action Alternative, eight proposed or "action" alternatives to replace groundwater with surface water within the Odessa Study Area were evaluated. The partial-replacement alternatives (2A, 2B, 2C, and 2D) would provide nearly 57,100 acres with CBP surface water, and the full-replacement alternatives (3A, 3B, 3C, and 3D) would provide CBP water to approximately 102,600 acres. The main difference between the range of partial- and full-replacement alternatives is the source of the water supply. Alternatives 2A and 3A assume the water supply would come from Banks Lake; Alternatives 2B and 3B assume the water supply would come from Banks Lake and Lake Roosevelt; Alternatives 2C and 3C assume the water supply would come from Banks Lake and a new Rocky Coulee Reservoir; and finally, Alternatives 2D and 3D assume the water supply would come from Banks Lake, Lake Roosevelt, and the new Rocky Coulee Reservoir.

5.1. National Economic Development Benefit-Cost Analysis and Financial Analysis

The purpose of an NED BCA is to compare the benefits of a proposed project to its costs. The total costs of the project are subtracted from the total benefits to measure net benefits. If the net benefits are positive, implying that benefits exceed costs, the project could be considered economically justified. In studies where multiple alternatives are being considered, the alternative with the greatest positive net benefit would be preferred from strictly an economics perspective. Another way of displaying this benefit-cost comparison involves dividing total project benefits by total project costs—resulting in the benefit-cost ratio (BCR). A BCR greater than one is analogous to a positive net benefit.

Before comparisons can be made between costs and benefits, they must be converted to the same dollar year and point in time. Since all the costs and benefits are measured in current dollars, no dollar year adjustment was necessary. However, the costs and benefits would occur at different times. As is typical in Reclamation studies, the decision was made to measure all the costs and benefits as of the end of the construction period. Since canal construction is divided into a series of phases, the end of the canal construction period is defined as the end of the last canal construction phase (year 2025).

Starting at the end of the canal construction period in year 2025, a standard 100-year analysis period was used, resulting in a period of analysis from 2026 to 2125. Costs and benefits incurred after year 2025 are discounted (reduced) back to the end of the construction period using the Federal 2009-2010 water project planning rate of 4.375 percent. Benefits associated with all phases prior to the last construction phase would begin at the end of each phase (not the end of the last

canal construction phase), and would end in year 2125. Thus, some of those benefits would accrue prior to the end of the canal construction period. This implies that those pre-2025 benefits would need to be compounded (increased) to the end of the canal construction period. These same discounting and compounding concepts are also applied to the costs incurred during the construction period and period of analysis so as to measure all costs and benefits as of the end of the canal construction period (year 2025). Due to the conversion of costs to year 2025, the costs presented in this NED BCA section will differ from the unadjusted costs by alternative presented in Chapter 4.

5.1.1 Methodology and Assumptions

This section briefly describes the methodology and assumptions associated with each benefit and cost component. For more detail on the NED methodology, see the Draft Economics Technical Report, Odessa Subarea Special Study, Columbia Basin Project, Washington (Reclamation, 2010 [Economics]) (Draft Economics Technical Report).

5.1.1.1. Benefit Analyses

The primary beneficiary of the proposed project to replace groundwater with surface water is irrigated agriculture. However, benefits were also estimated for municipal and industrial users. Municipal and industrial benefits were considered "other direct benefits" since they are "incidental to the purposes for which the water resources plan is being formulated" (U.S. Water Resources Council, 1983).

5.1.1.2. Agricultural Benefits

Benefit values for irrigated agriculture were estimated following the criteria for measuring National Economic Development (NED) benefits defined in the P&Gs. The P&Gs are the Federal guidelines by which Reclamation determines NED benefits of Federal actions or project implementation. A P&G analysis of NED agricultural benefits is based on a "with- and without-project" comparison.

The without-project condition is similar to the No Action Alternative described in an environmental impact statement prepared under National Environmental Policy Act (NEPA) requirements. The without-project condition was defined for the Odessa Subarea Special Study so that differences in the amounts of economic output generated could be quantitatively compared to the economic output of the formulated action alternatives (the with-project conditions). Generally speaking, the without-project condition assumed that groundwater pumping in the Study Area would continue as long as possible over a 100-year period. As well performance degraded over time and wells were eventually taken offline, those lands in the Odessa Subarea being irrigated with groundwater would revert to dryland farming. The with-project condition assumed that 3 acre-feet of irrigation water would be delivered to each of the groundwater-irrigated acres within the area, thus allowing irrigated agriculture to continue in the future.

Agricultural Irrigation benefit values are estimated using a farm budget application developed by Reclamation. The farm budget methodology is used to estimate how valuable an irrigation water supply is to the crops produced within a project. This is accomplished by estimating the residual net farm income of a representative farm expected to be found in the project area under with- and without-project conditions. A representative farm budget characterizes the production, management, and marketing strategies commonly used in producing the mix of crops expected to be produced on a farm considered to be typical of the project area. Each farm budget is sized to provide approximately full-time employment to the operator through the growing season. Additionally, each budget provides a fair return to land, labor, and capital, as specified by the P&Gs. Furthermore, the P&Gs specify the debt load to be carried by the farm and identify the prices and interest rates to be used in the analysis. Residual net farm income refers to the amount of farm income remaining after subtracting production costs and an allowance for management and labor from the gross farm income expected from the sale of crops. Agricultural benefits are calculated by estimating the residual net farm income for the with- and without-project farms. After estimating the residual net farm income for both conditions, the difference between the two residual net farm incomes is calculated; this difference is the agricultural benefit.

The agricultural benefits analysis for the Odessa Subarea Special Study are based on:

1. Changes in the crop mix expected to occur under the with- and without-project conditions,

2. On-farm savings (or decreased production costs) resulting from implementing the project, and

3. The subsequent differences in residual net farm income under the with- and without-project conditions.

Four representative farms were defined; the cropping pattern for each representative farm was based on the amount of groundwater pumped for irrigation purposes. The size of the multiple-crop representative farms and the associated cultural practices were chosen based on data obtained from the Census of Agriculture data and guidance from local farmers. The guidance from local farmers was reinforced by Reclamation's Columbia-Cascades Area Office (CCAO), which directed the agricultural benefit analysis be completed using a 1,400-acre farm size. Therefore, the representative farm size was set at 1,400 acres for all four representative farms. However, it is recognized that a wide variation in farm sizes exists within the Study Area. The consistent farm size was used to facilitate an analysis of one crop mix transitioning into another crop mix as well output and dependability declined. Each of the four representative farms was associated with acres irrigated with groundwater wells of varying capacity and dependability.

After determining the representative farm size, crop mix, average yields, and expected prices received, gross revenue for the farm was calculated. Variable and fixed production costs were subtracted from the gross revenue to find net farm revenue. Residual net farm income was derived by subtracting an allowance for a return to management and labor from net farm revenues. The residual net farm income was divided by the total number of irrigated acres in the farm budget to derive a per-acre value. The difference between the with-project residual net farm income and the without-project residual net farm income for each representative farm is the estimate of agricultural irrigation benefits.

The crops selected for the representative farms were based on the distribution of crops within the study area associated with each of five groundwater pumping levels. Production records related to the distribution of crops were collected by Reclamation from the U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) and the Columbia Basin Ground Water Management Area. Additionally, crop enterprise budgets published by Washington State University (WSU) were used to reflect typical production costs incurred in the study area.

Representative farm budgets were developed for with- and without-project conditions for each well level. A description of the five pumping levels is available in Chapter 2 of the Odessa DEIS and the National Economic Development (NED) section of the Draft Economics Technical Report (Reclamation, 2010 [Economics]).

The with-project condition assumed that pumping costs were minimized since surface water was delivered for irrigation purposes. The without-project condition was characterized by full pumping costs based on a 900-foot lift. The difference between the residual net farm incomes under the with- and without-project conditions is the benefit to irrigated agriculture.

In this analysis, the primary driver for agricultural benefits comes from a change in pumping costs. Reduced pumping costs lower farm cost, resulting in higher residual net farm incomes. A secondary driver for agricultural benefits comes from an incremental change in crop acres as wells become less dependable and the crop mix is changed. For example, if the performance of Level 2 wells is reduced and those wells become classified as Level 3 wells, there will be a change in the crops that can be grown on the acres served by those wells. Thus, a change in crop production will occur (different crops will be grown) along with a resultant change in residual net farm income.

After incorporating the effects on residual net farm income from reducing pumping costs and the incremental change in crop mix into the representative farm budget, a total benefit accruing to agriculture was estimated. Table 5- 1 shows the agricultural benefits attributable to each well pumping level. These

values were obtained from the with- and without-project residual net farm incomes (RNFI) for the representative farms developed for each well pumping level.

Table 5- 1. Residual net farm incomes from with- and without-project representative farm budgets and agricultural benefits

Well Level	Without-Project RNFI ($/acre)	With-Project RNFI ($/acre)	Agricultural Benefit Value Per Acre
1	-$52.97	$124.77	$177.74
2	$167.15	$439.29	$272.14
3 and 4	-$309.08	$110.24	$419.32
5	-$205.25	-$205.25	$0.00

5.1.1.3. Other Direct Benefits - Municipal

Municipal water supplies within the Study Area are obtained almost exclusively from groundwater sources. Like agricultural wells in the area, municipal wells are also experiencing difficulties as groundwater levels continue to decline. At first glance, it would appear that replacing agricultural groundwater pumping with surface water as proposed by the action alternatives could imply a significant benefit for municipal groundwater users. But the level of benefit to municipal groundwater users depends on what is expected to occur under the No Action Alternative.

Under the No Action Alternative, groundwater levels are expected to continue to decline as irrigators continue to pump. However, irrigators would not be able to maintain current levels of groundwater pumping indefinitely as aquifer levels decline. As can already be seen in the area, irrigators would continue to move to less water-intensive crops and ultimately convert to dryland agriculture. From a municipal groundwater use perspective, the conversion of irrigated acreage to dryland agriculture is equivalent to moving those acres off of groundwater and on to surface water.

The question becomes how quickly would irrigators convert to dryland agriculture under the No Action Alternative versus shifting to surface water under the action alternatives. Table 5- 2 displays estimates of the number of acres moved off of groundwater pumping and onto either surface water or dryland farming by alternative over time.

Table 5- 2. Total acres removed from groundwater pumping by year and alternative

Alternative	Source of Irrigated Acreage Reduction	Year 2025	Year 2030	Year 2040	Year 2050
No Action	Dryland Farming	49,126	60,844	77,862	87,693
Partial-Replacement	Surface Water and Dryland Farming	78,877	84,077	91,631	95,995
Full-Replacement	Surface Water	102,616	102,616	102,616	102,616

Reclamation estimates that over 49,100 acres within the study area would be converted to dryland farming under the No Action Alternative by the end of the canal construction period in year 2025. The combination of converted surface water irrigation and dryland farming was estimated at nearly 78,900 acres under the partial-replacement alternatives. Under the full-replacement alternatives, all 102,600+ acres would be converted to surface water irrigation. By year 2050, the difference between the alternatives tightens considerably, with nearly 87,700 acres converted to dryland farming under the No Action Alternative, approximately 96,000 acres converted to surface water or dryland farming under the partial-replacement alternatives, and the full 102,600+ acres switched to surface water for the full-replacement alternatives. The decision was made that the differences in acreage off of groundwater under the various alternatives were significant enough to warrant an evaluation of municipal pumping cost savings benefits.

Groundwater levels were estimated by the groundwater team for the No Action Alternative for each canal construction phase area. These estimates were developed by year through the end of the period of analysis in year 2125 (see Table 5- 3). The groundwater level projections were based on current groundwater level estimates and recent trends in average annual groundwater level declines within each canal construction phase area. These projections would likely be considered pessimistic given they did not take into account the expected movement of agriculture to dryland farming under the No Action Alternative and the associated reduction in agricultural pumping of the deep aquifer.

Annual groundwater level estimates were not developed for the proposed action alternatives, but the groundwater section in the Odessa DEIS does suggest that groundwater levels might stabilize within each phase after the irrigators are converted to surface water. If groundwater levels did indeed stabilize, then the assumption could be made that groundwater levels would remain fixed at the stabilization depths from the end of construction for each canal phase to the end of the period of analysis in 2125. Table 5- 3 also displays the stabilization levels associated with each phase under the action alternatives.

Table 5- 3. No Action and Action Alternatives groundwater level projection for selected years

Phase	Town(s)	Action Alternatives		No Action Alternative										
		Stabilization Levels	Stabilization Starts	2019	2020	2021	2022	2023	2024	2025	2050	2075	2100	2125
1	Lind	472	2019	539	545	551	557	563	569	575	725	875	1024	1174
2	Warden	600	2022				671	678	685	692	869	1047	1224	1402
3	Hatton & Othello	677	2023					750	757	764	947	1130	1313	1497
4	Connell	597	2025							669	855	1042	1228	1414
	None	431	2020		490	493	496	499	503	506	583	661	738	816
6	Moses Lake	536	2023					603	608	614	753	892	1032	1171
7	None	518	2025							584	722	859	997	1134
8	Odessa	595	2022				659	663	668	672	786	900	1013	1127
9	None	563	2025							632	782	933	1083	1233

Since only a few towns are actually located within the study area (Connell, Hatton, Warden) and groundwater level declines are occurring outside the study area, the decision was made to include towns close to the study area as well those within the study area. Wells operated by each town were assumed to experience the same groundwater levels under each alternative as the closest canal phase.

The water level estimates by alternative, phase, and year were entered into a pumping cost equation used for agriculture. While agricultural wells and pumps may be somewhat larger than municipal pumps, the difference was assumed to be insignificant. Furthermore, as groundwater level depths decline, it is likely that municipalities may need to expand the size of their systems to allow for deeper pumping.

To calculate the annual pumping costs by municipality and alternative, the alternative-specific costs of pumping 1 acre-foot (estimated in the model as a function of groundwater level depth) are applied to estimates of annual pumping for each municipality. The groundwater team gathered data from local water entities on 2010 estimates of annual water use by municipal well and by town. To focus on pumping from the deep aquifer, the groundwater team recommended removal of wells less than 400 feet deep. As a result, two wells from Moses Lake and both Wilson Creek wells were removed from the analysis.

Since the period of analysis stretches from the end of the first canal construction phase in 2019 until year 2125, deep aquifer water use by town had to be projected across this time period. Water use was projected to grow at the same rate as population. Water use for towns located within each county was assumed to grow at the same rate as county population. Since county population projections were only made to year 2030, an approach had to be developed to estimate water use beyond year 2030. The decision was made to use the rate of growth for the last year (2030) of the projection period across the remaining years of the projection (2031-2125). Applying these annual rates of population growth by county to the 2010 estimates of water use for each associated town provided the required estimates of water use by town over the 2019-2125 period of analysis.

The annual cost per acre-foot by alternative, phase/town, and year from the pumping cost equation was multiplied by the projected water use in acre-feet by town and year to estimate the pumping costs by alternative, town, and year. For each town and year, subtracting the lower pumping costs for the partial- and full-replacement alternatives from the higher pumping costs for the No Action Alternative provided an estimate of the pumping cost savings for the partial-and full-replacement alternatives for that town and year. Aggregating the pumping cost savings across towns/phases provides an estimate of the pumping cost savings by alternative and year. Finally, the pumping cost savings by alternative and year were compounded/discounted to the end of the canal construction period in year 2025.

This analysis focuses only on the pumping cost savings for the action alternatives as compared to the No Action Alternative. As noted above, this pumping cost savings benefit estimate may be overstated to the extent that No Action Alternative groundwater level estimates may be overly pessimistic. This analysis does not address other potential cost savings such as any differential in well extension costs between alternatives.

5.1.1.4. Other Direct Benefits – Industrial

Other direct benefits for industrial water have been identified for the Study. These benefits are associated with increased flexibility in the operation of water supply conveyance facilities under the action alternatives (or, with-project conditions) as compared to the No Action Alternative (or, the without-project condition).

There are several agricultural processing plants in the Study Area including those utilizing potatoes grown within the Study Area. The nutrient content of agricultural processing water is too high to be disposed of or used for other purposes without dilution. Under the direction of the processing plants, the processing water is diluted with clean water from other sources to meet discharge requirements and then applied to irrigated crops. Several processors have interruptible contracts with Reclamation totaling 4,700 acre-feet for industrial water to dilute their processing water. The water is delivered through East Columbia Basin Irrigation District (ECBID) facilities. However, under the No Action Alternative (without-project condition), the industrial deliveries are interrupted because even though adequate water supplies are available, there is not sufficient capacity within the canal for delivery to all users along the canal during the summer months. Under the partial- and full-replacement alternatives (with-project conditions), sufficient capacity would be provided to allow uninterrupted delivery of the 4,700 acre-feet of industrial water.

Since the 4,700 acre-feet of industrial water is diluted and applied to irrigated crops, the benefit for industrial water was based on the agricultural benefit per acre-foot of water, less the cost of industrial water.

5.1.1.5. Cost Analyses

Project costs are composed not only of construction, interest during construction (IDC), and annual operating, maintenance, replacement, and power (OMR&P) costs, but also lost project benefits related to hydropower.

5.1.1.5.1 ***Construction Costs and Interest During Construction***

Canal and reservoir construction costs were estimated by Reclamation cost engineers and include field costs of construction contracts and noncontract costs (lands purchases, construction facilities, studies/investigations/design data collection, engineering design, construction management and contract administration, etc.).

Since the majority of construction activities are associated with different canal segments, the construction period was broken down into a number of phases. Partial Replacement Alternatives 2A and 2B were broken down into four canal construction phases and Alternatives 2C and 2D were broken down into five phases (canal phases 1-4 and the Rocky Coulee Reservoir). The Full-Replacement Alternatives 3A and 3B were broken down into nine canal construction phases and Alternatives 3C and 3D were broken down into ten phases (canal phases 1-9 and the Rocky Coulee Reservoir). The canal and reservoir construction period runs from 2014 to 2025 across all phases.

IDC is charged on both field costs and noncontract costs, but only during the construction period. A significant portion of the noncontract costs are incurred prior to the start of the construction period. As a result, noncontract costs incurred prior to the start of the construction period for each phase were aggregated into the first year of the construction period for that phase before calculating IDC.

IDC was calculated on the canal and reservoir construction and noncontract costs incurred annually within each construction phase. Total IDC was added to the total construction and noncontract cost to estimate costs at the end of each phase. These phase-specific construction/ noncontract and IDC costs were then compounded to the end of the overall canal construction period in year 2025.

In addition to canal and reservoir construction, costs of constructing drainage systems were also estimated by Reclamation cost engineers for each canal phase. Drainage system construction was assumed to start 5 years after the end of each canal construction phase and last for 15 years. As a result, the drainage system construction period runs from 2024 to 2044 across all phases. As with canal and reservoir construction, IDC was calculated for each drainage system. Total IDC was added to drainage construction costs to estimate total drainage costs at the end of each phase. These phase-specific construction and IDC drainage costs were then discounted back to the end of the canal construction period in year 2025.

5.1.1.5.2 ***Annual Operating, Maintenance, Replacement, and Power (OMR&P) Costs***

Average annual OMR&P costs were also estimated by Reclamation cost engineers. Since the construction phases would be completed at different times and OMR&P costs were assumed to begin immediately after completion of each construction phase, the OMR&P costs were estimated separately for each construction phase.

Annual OMR&P costs were included for each year from the end of construction on each phase until the end of the 100-year period of analysis year in 2125. The canal and reservoir OMR&P costs incurred prior to the end of the canal construction period were compounded to the end of the canal construction period. The canal and reservoir OMR&P costs incurred during the period of analysis (2026-2125) were discounted back to the end of the canal construction period.

OMR&P costs were also estimated for the drainage systems. OMR&P costs associated with each drainage system would begin well into the future (starting in years 2039 through 2045 depending on the phase) and are therefore discounted back to the end of the canal construction period in year 2025.

5.1.1.5.3 ***Annual Lost Benefits***

Lost Hydropower Benefits: Losses in Columbia River system hydropower benefits were anticipated due to the increased pumping from the Columbia River to provide surface water supplies for agriculture. Bonneville Power Administration (BPA) ran their Columbia River System hydropower model based on operational/hydrologic changes (compared to the No Action Alternative) associated with each action alternative. Note that since each partial replacement alternative (2A-D) would imply the same level of additional pumping out of the Columbia River, there is no difference in terms of the downstream hydropower effects across the partial-replacement alternatives. The same holds true for the full-replacement alternatives. However, the partial- and full-replacement alternatives differ from each other (i.e., Alternatives 2A-2D are the same and Alternatives 3A-3D are the same, but Alternatives 2A-2D are different from Alternatives 3A-3D). BPA multiplied the changes in average monthly hydropower generation by Aurora Model-based average monthly power values to estimate losses in average annual hydropower benefits. In addition, the cost of pumping the additional water into Banks Lake was included in the BPA analysis and not the OMR&P costs. These benefit losses and increased pumping costs were assumed to begin after the end of the canal construction period in year 2025. To allow for comparison with project benefits, the lost hydropower benefits were discounted back to the end of the canal construction period.

Lost Recreation Benefits: The analysis presented in Section 4.14, “Recreation Resources” of the Odessa DEIS indicates boat ramps at Banks Lake will become unavailable more frequently under the action alternatives as compared to the No Action Alternative. This would likely lead to reductions in recreation visitation and adverse recreation economic effects. To address this potential adverse effect, Reclamation and Ecology have committed to necessary mitigation measures as described in Section 4.29.10, “Environmental Commitments-Recreation Resources” of the Odessa DEIS. This mitigation assumption results in the elimination of the majority of the anticipated adverse recreation economic effects. As a result, lost recreation benefits are not included in the BCA.

5.1.2 No Action Alternative

5.1.2.1. Benefit Analyses

5.1.2.1.1 ***Agricultural Benefits***

All agricultural irrigation benefits associated with the action alternatives were measured as changes from the No Action Alternative. To start the agricultural benefits calculation, annual residual net farm income was first calculated for each year under the No Action Alternative by taking the annual change in crop acres

for each pumping level and multiplying by the associated without-project residual net farm income (shown in Table 5- 1). This was done for each year of the 100-year period of analysis so that future projections of residual net farm income could be quantified.

Under the No Action Alternative, irrigated agriculture in the Study Area would be dramatically reduced because groundwater would not be replaced with surface water. As groundwater diminished, farmers would transition into growing dryland crops in rotation with fallow land. Ultimately, all but Level 1 acres would grow dryland crops under the No Action Alternative because no other source of irrigation water would be available to the acres associated with the other well levels.

After forecasting the future number of irrigated and dryland acres, residual net farm income was estimated. There are 102,616 acres in the Study Area currently irrigated with groundwater. The crops represented by the NED benefits budgets include irrigated potatoes, wheat, mixed crops, and a dryland rotation of wheat and fallow. As stipulated, the farm size was held at a constant 1,400 acres for all farm budgets used in estimating the residual net farm incomes.

Information about crops grown in the Study Area and the number and status of groundwater wells in the Study Area was obtained from GWMA (see NED section of the Draft Economics Technical Report). In addition to helping describe current conditions, GWMA also provided guidance and assumptions on the future status of groundwater wells and cropping patterns in the Study Area under the No Action Alternative.

Groundwater wells in the area were ranked by GWMA according to five status levels (Levels 1 to 5) based on output and dependability. Assumptions were made about how long wells would remain in use and what crops would be grown as wells declined in output and dependability. This information was used in a spreadsheet model to predict changes in irrigated acres in the future. Subsequent changes in residual net farm income were estimated by multiplying the number of acres in each well level by the associated residual net farm income for each well level.

The results for the No Action Alternative are presented in two tables. The first table (Table 5- 4) presents the change in groundwater- irrigated acres for the years 2019, 2020, 2023, 2025, 2050, 2075, 2100, and 2125. In each year of the analysis, a lagged transition of acres from one well level to the next lowest well level occurred. The lag was introduced into the analysis to show that even though a number of acres would be transitioned into the next lower well level each year, that transition would not occur instantaneously. Instead, the transition of acres from one well level to the next would occur at the beginning of the next year. Some of the acres that transitioned from one well level to another were assumed to be in the first year of a fallow rotation. These acres are identified in Table 5- 4 as acres not harvested.

The second table presenting No Action Alternative results, Table 5- 5, contains information about the estimated residual net farm income generated by each well level and the total residual net farm income for all well levels. The residual net farm income for each well level is estimated by multiplying the without-project per-acre benefit value for each well level by the number of groundwater-irrigated acres in the well level. It can be seen in the table that residual net farm income under without-project conditions continuously declines through 2025, and then rises slightly as the last of the Level 3 and Level 4 acres transition into Level 5 acres.

The crop mix for acres irrigated with Level 1 wells had irrigated potatoes and wheat on 5,131 acres (Table 5- 4). Since no Level 1 acres were taken out of irrigated production over the 100-year planning horizon, residual net farm income for Level 1 acres was a constant -$271,800 (Table 5- 5). The estimate of residual net farm income (-$52.97/acre) under the No Action Alternative came from a representative farm budget for Level 1 acres. The total residual net farm income for Level 1 acres was derived by multiplying -$52.97/ acre (without-project residual net farm income) by the 5,131 acres in Level 1.

In 2019, acres irrigated by Level 2 wells had irrigated potatoes, mixed crops, and wheat on 11,927 acres. Residual net farm income in 2019 was $1,993,500. By 2125, there were virtually no acres being served by Level 2 wells and the residual net farm income had dropped to $800. The Level 2 representative farm, with three crops, had a without-project per-acre residual net farm income of $167.15; multiplying $167.15/acre by the 11,927 acres (in 2019) being served by Level 2 wells gives a total residual net farm income of $1,993,500. The per-acre residual net farm income multiplied by the number of acres (5 acres) in 2125 gives $800. The drop in residual net farm income was $1,992,700, a 99.9 percent drop in residual net farm income for this level.

Acres associated with well Level 3 and well Level 4 had a crop mix of irrigated mixed crops and wheat. In 2019, residual net farm income was -$15,200,300 and by 2125 residual net farm income was -$5,500. There were 49,179 acres served by Levels 3 and 4 wells in 2019. The representative farm for these two well levels estimated a per-acre residual net farm income of -$309.08. By 2125, the number of acres served by Level 3 and 4 wells had dropped to 18 acres and the residual net farm income was -$5,500. There was a 99.9 percent loss of acres served by Level 3 and 4 wells.

Level 5 acres were all in a dryland wheat/fallow rotation. As more acres were transitioned into Level 5 acres, they were put into the dryland wheat/fallow rotation. In 2019, 32,551 acres were in Level 5; by 2125, Level 5 acres numbered 97,447. Residual net farm income went from -$6,681,100 in 2019 to -$20,000,900 in 2125. The per-acre benefit value was -$205.25. The number of acres classified as Level 5 was more than 3 times as large in 2125 as it was in 2019.

When the residual net farm incomes from each well level were added together, total residual net farm income remained fairly constant (-$20,159,600 in 2019 compared to -$20,277,400 in 2125) over the planning horizon but large changes in residual net farm income were seen in the different well levels. Specifically, residual net farm income from Levels 2, 3, and 4 basically went to zero. The residual net farm income from Level 5 kept increasing because more and more acres kept being added to the Level 5 category.

5.1.2.1.2 Other Direct Benefits – Municipal

The municipal benefits were estimated based on the change in pumping costs as compared to the No Action Alternative. No Action Alternative pumping costs from 2019-2125 across all seven towns were estimated at $215.8 million.

5.1.2.1.3 ***Other Direct Benefits – Industrial***

There are no industrial benefits under the No Action Alternative.

5.1.2.2. Cost Analyses

All construction costs, OMR&P costs, and lost hydropower benefits associated with the action alternatives were measured as changes from the No Action Alternative. Note that the No Action Alternative has no construction costs. While there are OMR&P costs and hydropower benefits associated with the No Action Alternative, those costs and benefits would not change over time with declining groundwater levels as would the agricultural benefits. As a result, it is not necessary to estimate OMR&P costs and hydropower benefits for the No Action Alternative.

Table 5- 4. No Action Alternative groundwater-irrigated acres under the without-project condition, by selected years

Acres by Well Level	2019	2020	2022	2023	2025	2050	2075	2100	2125
Level 1	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Level 2	11,927	10,734	8,695	7,825	6,338	456	33	5	5
Level 3 and 4	49,179	47,707	44,546	42,893	39,517	9,016	1,344	162	18
Level 5	32,551	35,467	41,132	43,869	49,126	87,998	96,093	97,303	97,447
Acres Not Harvested	3,828	3,577	3,112	2,898	2,504	69	15	15	15
Total Acres	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616

Table 5- 5. No Action Alternative residual net farm incomes by well level under a without-project condition, by selected years

Well Level	2019	2020	2022	2023	2025	2050	2075	2100	2125
Level 1	-$271,778	-$271,778	-$271,778	-$271,778	-$271,778	-$271,778	-$271,778	-$271,778	-$271,778
Level 2	$1,993,542	$1,794,187	$1,453,292	$1,307,963	$1,059,450	$76,172	$5,468	$788	$788
Level 3 & 4	-$15,200,269	-$14,745,171	-$13,768,304	-$13,257,383	-$12,213,812	-$2,786,637	-$415,375	-$50,043	-$5,535
Level 5	-$6,681,124	-$7,279,511	-$8,442,286	-$9,004,191	-$10,083,150	-$18,061,503	-$19,723,002	-$19,971,354	-$20,000,910
Total Residual Net Farm Income	-$20,159,629	-$20,502,273	-$21,029,076	-$21,225,289	-$21,509,291	-$21,043,746	-$20,404,688	-$20,292,388	-$20,277,436

5.1.3 Partial Replacement Alternatives

The NED BCA results for the four partial replacement alternatives based on the Federal 2009-2010 water project planning rate (4.375 percent) are presented in Table 5- 12. Total benefits for all four partial replacement alternatives were estimated at $1,170.2 million, of which agricultural benefits comprised $1,153.3 million and other direct benefits—municipal and industrial—comprised $5.1 and $11.8 million, respectively. Total costs, including lost hydropower benefits, vary by alternative and range from $1,276.7 million to $1,726.1 million. Therefore, all of the partial replacement alternatives result in negative net benefits (-$106.5 to -$555.9 million) and benefit-cost ratios of less than one (.917 to .678). While none of these alternatives would be considered economically justified, alternatives 2A/2B are getting close with a .917 benefit-cost ratio.

5.1.3.1. Benefit Analyses

5.1.3.1.1 ***Agricultural Benefits***

As explained in Chapter 6, "Alternatives," the Partial-Replacement Alternatives A – D only differ in which reservoir would provide the main water supply. All of the partial-replacement alternatives would provide CBP surface water to the same approximately 57,000 acres currently using groundwater south of I-90. Thus, the agricultural benefits are the same for each of the partial-replacement alternatives.

Agricultural benefits were estimated for the partial-replacement alternatives by comparing the residual net farm income under the No Action Alternative to the residual net farm income under the partial-replacement alternative.

All of the partial-replacement alternatives are based on completing four construction phases encompassing 57,070 acres between 2019 and 2025. The 100-year period of analysis for agricultural benefits begins in 2026 and ends in 2125. From 2010 until 2019, when the first construction phase ends, there are no agricultural benefits because there is no difference in residual net farm income between the No Action Alternative and the partial-replacement alternative. However, starting in 2019 when construction phase 1 ends, agricultural benefits begin to accrue on the acres served by the construction phase 1 canal(s) and laterals.

When construction phase 1 ends, 18,713 acres will accrue agricultural benefits because those acres will no longer be served by groundwater wells. Additionally, among the 18,713 acres, those acres most affected by well performance reductions will gain from the start of surface water deliveries. Each acre previously irrigated with groundwater would receive 3 acre-feet of surface water. Thus, the production losses (from the changes in crops grown) would be gained back.

Under construction phase 2, 22,003 acres will begin to receive surface water deliveries; phase 3, 8,933 acres; and phase 4, 7,423 acres. Thus, the cumulative

number of acres receiving agricultural irrigation benefits in 2019, 2022, 2023, and 2025 is 18,713, 40,716, 49,647, and 57,070 acres, respectively. As each construction phase is completed, the acres previously served by groundwater wells will begin to receive 3 acre-feet of surface water per acre.

The results for the partial-replacement alternatives are presented in two tables. The first table (Table 5- 6) presents the change in irrigated and dryland acres for the years 2019, 2020, 2023, 2025, 2050, 2075, 2100, and 2125. In each year of the analysis, a lagged transition of acres from one well level to the next lowest well level occurred. The lag was introduced into the analysis to show that even though a number of acres would be transitioned into the next lower well level each year, the transition would not occur instantaneously. Instead, the transition of acres from one well level to another would occur at the beginning of the next year. Some of the acres that transitioned from one well level to another were assumed to be in the first year of a fallow rotation. These acres are identified in Table 5- 6 as acres not harvested.

The second table presenting the partial-replacement alternative results, Table 5- 7, contains information about the estimated residual net farm income generated by each well level and the total residual net farm income for all well levels for the years 2019, 2020, 2023, 2025, 2050, 2075, 2100, and 2125. The residual net farm income for the surface water irrigated acres under the with-project condition for well levels 1and 2 are multiplied by the with-project residual net farm income. Groundwater-irrigated acres under the without project condition for well levels 1 thru 5 are multiplied by the without project residual net farm income.. The difference in residual net farm income between the No Action Alternative and the partial replacement alternative is the estimate of agricultural benefits arising because of the implementation of any one of the partial replacement alternatives. For use in the benefit-cost analysis, the annual agricultural benefits were compounded/discounted to the end of the canal construction period (year 2025) using the 2009-2010 water project planning rate of 4.375 percent. For all partial replacement alternatives, this compounded/discounted stream of agricultural benefits equates to $1,153.3 million in year 2025 dollars.

The crop mix for acres irrigated with Level 1 wells had irrigated potatoes and wheat on 5,131 acres (Table 5- 4). In 2019, construction phase 1 was completed and 936 acres were transitioned into receiving surface water. Those 936 acres became the with-project acres and the residual net farm income of $124.77 per acre was multiplied by 936 acres to arrive at a residual net farm income of $116,741. As more construction phases were completed, more Level 1 acres began receiving surface water deliveries and the residual net farm income for Level 1 acres rose until it reached its maximum amount of $356,031 in 2025 and beyond.

In 2019, acres irrigated by Level 2 wells had irrigated potatoes, mixed crops, and wheat on 17,777 acres. Residual net farm income in 2019 was $7,809,412 under the with-project condition. Four construction phases had been completed by 2025

and residual net farm income came to $23,816,766 (54,216 acres multiplied by $439.29/acre). The Level 2 representative farm, with three crops, had a with-project, per-acre residual net farm income of $439.29.

Acres associated with well Level 3 and well Level 4 had a crop mix of irrigated mixed crops and wheat. In 2019, the residual net farm income was $4,432,839 and by 2125 residual net farm income was $859. There were 49,179 acres served by Levels 3 and 4 wells in 2019. The representative farm for these two well levels estimated a per-acre residual net farm income of $110.24. By 2125, the number of acres served by Level 3 and 4 wells had dropped to 8 acres and the residual net farm income was $869. There was a 99.9 percent decrease in the number of acres served by Level 3 and 4 wells.

Level 5 acres were all in a dryland wheat/fallow rotation. As more acres were transitioned into Level 5 acres, they were put into the dryland wheat/fallow rotation. In 2019, 26,615 acres were in Level 5; by 2125, Level 5 acres numbered 43,261. Residual net farm income went from -$5,462,757 in 2019 to -$8,879,222 in 2125. The per-acre benefit value was -$205.25. Level 5 acres increased by 61.5 percent from 2019 to 2125.

5.1.3.1.2 ***Other Direct Benefits – Municipal***

Partial Replacement Alternative municipal pumping costs from 2019-2125 across all seven towns was estimated at $158.6 million. This reflects a decrease of $57.2 million as compared to the No Action Alternative. Compounding and discounting this pumping cost savings to year 2025 results in a pumping cost benefit of $5.1 million.

5.1.3.1.3 ***Other Direct Benefits – Industrial***

The benefit for industrial water was based on the agricultural benefit per acre foot of water less the cost of industrial water. This yields a benefit of $111 per acre foot for industrial water or an annual benefit of $521,700. For use in the benefit-cost analysis, the annual industrial benefit was discounted to the end of the canal construction period (year 2025) using the 2009-2010 water project planning rate of 4.375 percent. For all partial replacement alternatives, this discounted stream of industrial benefits equates to $11.8 million in year 2025 dollars.

Table 5- 6. Partial-Replacement Alternative: Groundwater-irrigated acres under the with-project condition, by selected years

Acres	Construction Phases Ending in Each Year				Selected Years After Construction Ends			
	Phase 1 2019	Phase 2 2022	Phase 3 2023	Phase 4 2025	2050	2075	2100	2125
Surface Water Irrigated Acres (With-Project Condition)								
Level 1	936	2,036	2,482	2,854	2,854	2,854	2,854	2,854
Level 2	17,777	38,680	47,165	54,216	54,216	54,216	54,216	54,216
Subtotal Surface Water Acres	18,713	40,716	49,647	57,070	57,070	57,070	57,070	57,070
Groundwater-Irrigated Acres (Without-Project Condition)								
Level 1	4,195	3,095	2,649	2,277	2,277	2,277	2,277	2,277
Level 2	9,752	5,245	4,039	2,813	202	14	1	1
Levels 3 and 4	40,211	26,871	22,141	17,539	4,002	596	73	8
Dryland Acres								
Level 5	26,615	24,811	22,645	21,805	38,923	42,643	43,193	43,261
Acres Not Harvested	3,130	1,878	1,495	1,112	142	16	2	0
Subtotal Groundwater, Dryland, and Not Harvested Acres	83,903	61,900	52,969	45,546	45,546	45,546	45,546	45,546
Total Acres	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616

Table 5- 7. Full-Replacement Alternative: Residual net farm incomes by well level under the with-project condition, by selected years

Residual Net Farm Income	Construction Phases Ending in Each Year				Selected Years After Construction Ends			
	Phase 1 2019	Phase 2 2022	Phase 3 2023	Phase 4 2025	2050	2075	2100	2125
Surface Water Irrigated Acres (With-Project Condition)								
Level 1	$116,741	$254,007	$309,723	$356,031	$356,031	$356,031	$356,031	$356,031
Level 2	$7,809,412	$16,991,825	$20,718,959	$23,816,766	$23,816,766	$23,816,766	$23,816,766	$23,816,766
Subtotal Surface Water Acres	$7,926,153	$17,245,832	$21,028,682	$24,172,797	$24,172,797	$24,172,797	$24,172,797	$24,172,797
Groundwater-Irrigated Acres (Without- Project Condition)								
Levels 3 and 4	$4,432,839	$2,962,268	$2,440,803	$1,933,547	$441,165	$65,710	$8,046	$859
Dryland Acres								
Level 5	-$5,462,757	-5,092,554	-$4,647,790	-$4,475,395	-$7,988,895	-$8,752,570	-$8,865,424	-$8,879,222
Acres Not Harvested	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Groundwater, Dryland, and Not Harvested Acres	-$1,029,918	-$2,130,286	-$2,206,987	-$2,541,848	-$7,547,730	-$8,686,860	-$8,857,378	-$8,878,327
Total Residual Net Farm Income	$6,896,235	$15,115,546	$18,821,695	$21,630,949	$16,625,067	$15,485,937	$15,315,419	$15,294,470
Difference from No Action Residual Net Farm Income = Annual Benefits	$27,055,864	$36,144,622	$40,046,984	$43,140,240	$37,668,813	$35,890,626	$35,607,808	$35,571,871

5.1.3.2. Cost Analyses

As described below, the combined canal, reservoir, and drainage system construction, noncontract, IDC, annual OMR&P costs, and lost benefits to hydropower total $1,276.7 million for partial-replacement alternatives 2A/2B and $1,726.1 million for alternatives 2C/2D.

Table 5- 8. Total costs for partial-replacement alternatives (measured in $ millions at the end of the canal construction period [2025])

Cost Components	2A	2B	2C	2D
Canal & Reservoir Construction, Noncontract, and IDC	908.0	908.0	1,326.0	1,326.0
Canal & Reservoir OMR&P	180.7	180.7	212.1	212.1
Drainage System Construction and IDC	28.5	28.5	28.5	28.5
Drainage System ORM&P	3.1	3.1	3.1	3.1
Cost Subtotal	1,120.3	1,120.3	1,569.7	1,569.7
Lost Hydropower	156.4	156.4	156.4	156.4
Total	1,276.7	1,276.7	1,726.1	1,726.1

5.1.3.2.1 ***Construction, IDC, and OMR&P Costs***

Table 5- 8 presents the canal, reservoir, and drainage system construction and noncontract costs, IDC, and annual OMR&P costs for the four partial-replacement alternatives. Note that the costs for these components are the same for Alternatives 2A/2B and 2C/2D.

For partial-replacement alternatives 2A and 2B, canal construction and noncontract costs were estimated by Reclamation engineers at $688.7 million. IDC in the amount of $98.1 million was calculated on the annual canal construction and noncontract costs. IDC by phase was added to the canal construction and noncontract cost totals by phase, and then compounded to the end of the canal construction period (year 2025) to obtain a total canal construction cost estimate of $908.0 million. Reclamation engineers also estimated the construction costs of the drainage system for alternatives 2A and 2B at $39.6 million. Recall that construction of the drainage system was assumed to start 5 years after the end of each canal construction phase and last for 15 years. Calculating IDC and discounting back to the end of the canal construction period results in a drainage system construction cost estimate of $28.5 million.

For alternatives 2A and 2B, annual OMR&P costs for the canals and drainage systems were assumed to start at the end of each canal and drainage system construction phase and continue through the end of the period of analysis in year

2125. Compounding and discounting these costs to the end of the canal construction period resulted in an estimate of $180.7 million for the canals and $3.1 million for the drainage systems. These construction, noncontract, IDC, and OMR&P costs, measured as of the end of the canal construction period, total $1,120.3 million for alternatives 2A and 2B.

For partial-replacement alternatives 2C and 2D, canal and reservoir construction and noncontract costs were estimated by Reclamation engineers at $964.9 million. IDC in the amount of $145.2 million was calculated on the annual canal and reservoir construction and noncontract costs. IDC by phase was added to canal and reservoir construction and noncontract cost totals by phase, and then compounded to the end of the canal construction period to obtain a total canal and reservoir construction cost estimate of $1,326.0 million. Reclamation engineers also estimated the construction costs of the drainage system for alternatives 2C and 2D at $39.6 million. Calculating IDC and discounting the combined construction and IDC based drainage system cost back to the end of the canal construction period results in a drainage system construction cost estimate of $28.5 million. Annual OMR&P costs for the canals/reservoir and drainage systems were assumed to start at the end of each construction phase and continue through the end of the period of analysis in year 2125. Compounding and discounting these costs to the end of the canal construction period resulted in an estimate of $212.1 million for the canals and reservoir and $3.1 million for the drainage systems. These construction, noncontract, IDC, and OMR&P costs total $1,569.7 million for alternatives 2C and 2D.

5.1.3.2.2 ***Annual Lost Benefits***

Lost Hydropower Benefits. BPA estimated the same $6.9 million of average annual losses in hydropower benefits for each of the four partial-replacement alternatives. Discounting the 100-year stream of average annual lost hydropower benefits to the end of the canal construction period results in an estimated total hydropower loss of $156.4 million for each partial-replacement alternative.

5.1.4 Full Replacement Alternative

The NED BCA results for the four full-replacement alternatives based on the Federal 2009-2010 water project planning rate (4.375 percent) are presented in Table 5- 12. Total benefits for all four full-replacement alternatives were estimated at $1,820.5 million, of which agricultural benefits comprised $1,800.7 million and other direct benefits—municipal and industrial—comprised $8.1 and $11.8 million, respectively. Total costs vary by alternative, ranging from $4,148.6 million to $4,597.9 million. Therefore, all of the alternatives result in negative net benefits (-$2,328.1 to -$2,777.4 million) and benefit-cost ratios of less than one (0.439 to 0.396). As a result, none of these alternatives would be considered economically justified.

5.1.4.1. Benefit Analyses

5.1.4.1.1 ***Agricultural Benefits***

As explained in Chapter 6, "Alternatives," the full-replacement alternatives A–D differ only in which reservoir provides the main water supply. All of the full-replacement alternatives would provide CBP surface water to the same approximately 102,600 acres currently using groundwater in the Study Area. Thus, the agricultural benefits are the same for each of the full-replacement alternatives.

Agricultural benefits were estimated for the full-replacement alternatives by comparing the residual net farm income under the No Action Alternative to the residual net farm income under the full-replacement alternative.

All of the full-replacement alternatives are based on completing nine construction phases, encompassing 102,616 acres, between 2019 and 2025. The 100-year period of analysis for agricultural benefits begins in 2026 and ends in 2125. From 2010 until 2019, when the first construction phase ends, there are no agricultural benefits because there is no difference in residual net farm income between the No Action Alternative and the Full-Banks Alternative. However, starting in 2019 when construction phase 1 ends, agricultural benefits begin to accrue on the acres served by the construction phase 1 canal(s) and laterals.

The results for the full-replacement alternative are presented in two tables. The first table (Table 5- 9) presents the change in groundwater irrigated acres. In each year of the analysis, a lagged transition of acres from one well level to the next lowest well level occurred. The lag was introduced into the analysis as a means of showing that even though a number of acres would be transitioned into the next lower well level each year, the transition would not occur instantaneously. Instead, the transition of acres from one well level to another would occur at the beginning of the next year. Some of the acres that transitioned from one well level to another were assumed to be in the first year of a fallow rotation. These acres are identified in Table 5- 9 as acres not harvested.

When construction phase 1 ended in 2019, 18,713 acres began to accrue agricultural benefits because those acres were no longer served by groundwater wells. Additionally, among the 18,713 acres, those acres that had suffered from well performance reductions gained benefits from the start of surface water deliveries because a higher profit crop mix could be planted.

The completion date for construction phase 5 was 2020; 7,085 additional acres of groundwater irrigated acres transitioned into surface water deliveries and a higher profit crop mix.

Construction phases 2 and 8 were completed in 2022; construction phase 2 had 22,003 acres receiving surface water deliveries and construction phase 8 had 12,756 acres receiving surface water deliveries.

Construction phase 3 had 8,931 acres, and construction phase 6 had 11,671 acres; these construction phases were completed in 2023.

Construction phase 4 had 7,423 acres, construction phase 7 had 6,147 acres, and construction phase 9 had 7,887 acres receiving surface water when construction was completed in 2025.

The cumulative number of acres receiving agricultural irrigation benefits in 2019, 2020, 2022, 2023, and 2025 was 18,713, 25,798, 60,557, 81,159 and 102,616 acres, respectively. As each construction phase was completed, the acres previously served by groundwater wells began to receive 3 acre-feet of surface water.

The second table presenting Full-Banks Alternative results, Table 5- 10, contains information about the estimated residual net farm income generated by each well level and the total residual net farm income for all well levels. The residual net farm income for the surface water irrigated acres under the with-project condition for well levels 1and 2 are multiplied by the with-project residual net farm income. Groundwater irrigated acres under the without-project condition for well levels 1 thru 5 are multiplied by the without-project residual net farm income. The difference in residual net farm income between the No Action Alternative and the partial-replacement alternative is the estimate of agricultural benefits arising because of the implementation of any one of the partial-replacement alternatives.

The crop mix for acres irrigated with Level 1 wells had irrigated potatoes and wheat on 5,131 acres (Table 5- 4). In 2019, construction phase 1 was completed and 936 acres were transitioned into receiving surface water. Those 936 acres became the with-project acres and the residual net farm income of $124.77 per acre was multiplied by 936 acres to arrive at a residual net farm income of $116,741. As more construction phases were completed, more Level 1 acres began receiving surface water deliveries and the residual net farm income for Level 1 acres rose until it reached its maximum amount of $356,031 in 2025 and beyond.

In 2019, acres irrigated by Level 2 wells had irrigated potatoes, mixed crops, and wheat on 17,777 acres. Residual net farm income in 2019 was $7,809,412 under the with-project condition. Nine construction phases had been completed by 2025 and residual net farm income came to $42,824,274 (102,616 acres multiplied by $439.29/acre). The Level 2 representative farm, with three crops, had a with-project per-acre residual net farm income of $439.29.

Acres associated with well Level 3 and well Level 4 had a crop mix of irrigated mixed crops and wheat. In 2019, the residual net farm income was $4,432,839 and by 2025 residual net farm income was $0 because all acres had transitioned into receiving surface water. The representative farm for these two well levels estimated a without-project per-acre residual net farm income of $110.24. The with-project residual net farm income was $439.29 per acre.

Level 5 acres were all in a dryland wheat/fallow rotation. As more acres were transitioned into Level 5 acres, they were put into the dryland wheat/fallow rotation. In 2019, 26,615 acres were in Level 5; by 2025, all Level 5 acres had been transitioned into receiving surface water and no dryland acres remained. Residual net farm income went from -$5,462,757 in 2019 to $0 by 2025. The per-acre benefit value was -$205.25.

Table 5- 9 shows the full-replacement alternative's change in irrigated and dryland acres for the years 2019, 2020, 2023, 2025, 2050, 2075, 2100, and 2125. Table 5- 10 presents the change in residual net farm income for the same years. The difference in residual net farm income between the No Action Alternative and the full-replacement alternative is the estimate of agricultural benefits arising because of the implementation of any one of the full-replacement alternatives. For use in the benefit-cost analysis, the annual agricultural benefits were compounded/ discounted to the end of the canal construction period (year 2025) using the 2009-2010 water project planning rate of 4.375 percent. For all full-replacement alternatives, this compounded/discounted stream of agricultural benefits equates to $1,800.7 million in year 2025 dollars.

5.1.4.1.2 ***Other Direct Benefits – Municipal***

Full Replacement Alternative pumping costs from 2019-2125 across all seven towns was estimated at $133.3 million. This reflects a decrease of $82.6 million as compared to the No Action Alternative. Compounding and discounting this pumping cost savings to year 2025 results in a pumping cost benefit of $8.1 million.

Table 5- 9. Full-Replacement Alternative: Groundwater-irrigated acres under the with-project condition, by selected years

Acres	Construction Phases Ending in Each Year					Selected Years After Construction Ends			
	Phase 1 2019	Phase 5 2020	Phases 2, 8 2022	Phases 3, 6 2023	Phases 4, 7, 9 2025	2050	2075	2100	2125
Surface Water Irrigated Acres (With-Project Condition)									
Level 1	936	1,290	3,028	4,058	5,131	5,131	5,131	5,131	5,131
Level 2	17,777	24,508	57,529	77,101	97,485	97,485	97,485	97,485	97,485
Subtotal Surface Water Acres	18,713	25,798	60,557	81,158	102,616	102,616	102,616	102,616	102,616
Groundwater-Irrigated Acres (Without-Project Condition)									
Level 1	4,195	3,841	2,103	1,073	0	0	0	0	0
Level 2	9,752	8,035	3,564	1,473	0	0	0	0	0
Level 3_4	40,211	35,713	18,258	8,969	0	0	0	0	0
Dryland Acres									
Level 5	26,615	26,550	16,859	9,173	0	0	0	0	0
Acres Not Harvested	3,130	2,679	1,275	770	0	0	0	0	0
Subtotal Groundwater, Dryland, and Not Harvested Acres	83,903	76,818	42,059	21,458	0	0	0	0	0
Total Acres	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616

Table 5- 10. Full-Replacement Alternative: Residual net farm incomes by well level under the with-project condition, by selected years

Residual Net Farm Income	Construction Phases Ending in Each Year					Selected Years After Construction Ends			
	Phase 1 2019	Phase 5 2020	Phases 2, 8 2022	Phases 3, 6 2023	Phases 4, 7, 9 2025	2050	2075	2100	2125
Surface Water Irrigated Acres (With-Project Condition)									
Level 1	$116,741	$160,941	$377,785	$506,310	$356,031	$356,031	$356,031	$356,031	$356,031
Level 2	$7,809,412	$10,766,163	$25,271,980	$33,869,720	$42,824,274	$42,824,274	$42,824,274	$42,824,274	$42,824,274
Subtotal with-project residual net farm income	$7,926,153	$10,927,104	$25,649,765	$34,376,030	$43,180,305	$43,180,305	$43,180,305	$43,180,305	$43,180,305
Groundwater-Irrigated Acres (Without-Project Condition)									
Level 3 & 4	$4,432,839	$3,937,006	$2,012,763	$988,735	$0	$0	$0	$0	$0
Dryland Acres									
Level 5	-$5,462,757	-$5,449,418	-$3,460,222	-$1,882,755	$0	$0	$0	$0	$0
Acres Not Harvested	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Groundwater, Dryland, and Not Harvested Acres	-$1,029,918	-$1,512,412	-$1,447,459	-$894,020	$0	$0	$0	$0	$0
Total with-project Residual Net Farm Income	$6,896,235	$9,414,692	$24,202,306	$33,482,010	$43,180,305	$43,180,305	$43,180,305	$43,180,305	$43,180,305
Difference From No Action Residual Net Farm Income = Annual Benefits	$27,055,864	$29,916,965	$45,231,382	$54,704,300	$64,973,734	$64,508,190	$63,869,131	$63,756,831	$63,741,880

5.1.4.1.3 ***Other Direct Benefits – Industrial***

The benefit for industrial water was based on the agricultural benefit per acre foot of water less the cost of industrial water. This yields a benefit of $111 per acre foot for industrial water or an annual benefit of $521,700. For use in the benefit-cost analysis, the annual industrial benefit was discounted to the end of the canal construction period (year 2025) using the 2009-2010 water project planning rate of 4.375 percent. For all full replacement alternatives, this discounted stream of industrial benefits equates to $11.8 million in year 2025 dollars.

5.1.4.2. Cost Analyses

As described below, the combined canal, reservoir, and drainage system construction, noncontract, IDC, annual OMR&P costs, and lost benefits to hydropower total $4,148.6 million for full-replacement alternatives 3A/3B and $4,597.9 million for alternatives 3C/3D.

Table 5- 11. Total costs for full-replacement alternatives (measured in $ millions at the end of the canal construction period [2025])

Cost Components	3A	3B	3C	3D
Canal and Reservoir Construction, Noncontract, and IDC	3,255.7	3,255.7	3,673.7	3,673.7
Canal and Reservoir OMR&P	401.5	401.5	432.8	432.8
Drainage System Construction and IDC	83.5	83.5	83.5	83.5
Drainage System OMR&P	10.4	10.4	10.4	10.4
Cost Subtotal:	3,751.0	3,751.0	4,200.3	4,200.3
Lost Hydropower	397.6	397.6	397.6	397.6
Total:	4,148.6	4,148.6	4,597.9	4,597.9

5.1.4.2.1 ***Construction, IDC, and OMR&P Costs***

Table 5- 11 presents the canal, reservoir, and drainage system construction and noncontract costs, IDC, and annual OMR&P costs for the four full-replacement alternatives. Note that the costs for these components are the same for alternatives 3A/3B and 3C/3D.

For full-replacement alternatives 3A and 3B, canal construction and noncontract costs were estimated by Reclamation engineers at $2,460.8 million. IDC in the amount of $362.1 million was calculated on the annual canal construction and noncontract costs. IDC by phase was added to the canal construction and noncontract cost totals by phase, and then compounded to the end of the canal construction period to obtain a total estimate of $3,225.7 million. Reclamation engineers also estimated the construction costs of the drainage system for alternative 3A and 3B at $121.6 million. Calculating IDC and discounting back to the end of the canal construction period results in a drainage system construction cost estimate of $83.5 million.

For alternatives 3A and 3B, annual OMR&P costs for the canals and drainage systems were assumed to start at the end of each canal and drainage system construction phase and continue through the end of the period of analysis in year 2125. Compounding and discounting these OMR&P costs to the end of the canal construction period resulted in an estimate of $401.5 million for the canals and $10.4 million for the drainage systems. These construction, noncontract, IDC, and OMR&P costs, measured as of the end of the canal construction period, total $3,751.0 million for alternatives 3A and 3B.

For full-replacement alternatives 3C and 3D, canal and reservoir construction and noncontract costs were estimated by Reclamation engineers at $2,737.0 million. IDC in the amount of $409.2 million was calculated on the annual canal and reservoir construction and noncontract costs. IDC by phase was added to canal and reservoir construction and noncontract cost totals by phase, and then compounded to the end of the canal construction period to obtain a total canal and reservoir construction cost estimate of $3,673.7 million. Reclamation engineers also estimated the construction costs of the drainage system for alternatives 3C and 3D at $121.6 million. Calculating IDC and discounting back to the end of the canal construction period results in a drainage system construction cost estimate of $83.5 million. Annual OMR&P costs for the canals/reservoir and drainage systems were assumed to start at the end of each construction phase and continue through the end of the period of analysis in year 2125. Compounding and discounting these costs to the end of the canal construction period resulted in an estimate of $432.8 million for the canals and reservoir and $10.4 million for the drainage systems. These construction, noncontract, IDC, and OMR&P costs total $4,200.3 million for alternatives 3C and 3D.

5.1.4.2.2 ***Annual Lost Benefits***

Lost Hydropower Benefits. The same $17.6 million of average annual losses in hydropower benefits was estimated by BPA for each of the four full replacement alternatives. Discounting the 100-year stream of average annual lost hydropower benefits to the end of the canal construction period results in an estimated total hydropower loss of $397.6 million for each full replacement alternative.

5.1.5 NED BCA Results

Table 5- 12 and Table 5- 13 present the results of the benefit-cost analyses for each alternative. The tables display total benefits (agriculture, municipal, industrial), total costs (canal, reservoir, and drainage system construction costs; IDC; OMR&P; lost hydropower benefits), net benefits, and benefit-cost ratios.

The results in Table 5- 12 were generated using the required Federal 2009-2010 water project planning rate of 4.375 percent. Total benefits were estimated at $1,170.2 million for the partial-replacement alternatives and $1,820.5 million for the full-replacement alternatives. Total costs vary by alternative and range from $1,276.7 million to $1,726.1 million for the partial-replacement alternatives and from $4,148.6 million to $4,597.9 million for the full-replacement alternatives.

Therefore, all of the alternatives result in negative net benefits (-$106.5 to -$555.9 million for partial replacement and -$2,328.1 to-$2,777.4 million for full replacement) and benefit-cost ratios less than one (.917 to .678 for partial replacement and .439 to .396 for full replacement). As a result, none of these alternatives would be considered economically justified, although partial-replacement alternatives 2A/2B are not far off.

Table 5- 12. Results of NED BCA based on current planning rate of 4.375% (in $ millions)

Alternatives:	Partial-Replacement Alternatives				Full-Replacement Alternatives			
	2A	2B	2C	2D	3A	3B	3C	3D
1) Total NED Benefits	1,170.2	1,170.2	1,170.2	1,170.2	1,820.5	1,820.5	1,820.5	1,820.5
a) Agriculture Benefits	1,153.3	1,153.3	1,153.3	1,153.3	1,800.7	1,800.7	1,800.7	1,800.7
b) Other Direct Benefits – Municipal	5.1	5.1	5.1	5.1	8.1	8.1	8.1	8.1
c) Other Direct Benefits – Industrial	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
2) Total NED Costs (including Lost Benefits)	1,276.7	1,276.7	1,726.1	1,726.1	4,148.6	4,148.6	4,597.9	4,597.9
a) Canal & Reservoir Construction & IDC Costs	908.0	908.0	1,326.0	1,326.0	3,255.7	3,255.7	3,673.7	3,673.7
b) Canal & Reservoir OMR&P Costs	180.7	180.7	212.1	212.1	401.5	401.5	432.8	432.8
c) Drainage System Construction & IDC Costs	28.5	28.5	28.5	28.5	83.5	83.5	83.5	83.5
d) Drainage System OMR&P Costs	3.1	3.1	3.1	3.1	10.4	10.4	10.4	10.4
e) Lost Hydropower Benefits	156.4	156.4	156.4	156.4	397.6	397.6	397.6	397.6
3) Net Benefits (row 1 minus row 2)	-106.5	-106.5	-555.9	-555.9	-2,328.1	-2,328.1	-2,777.4	-2,777.4
4) Benefit-Cost Ratio (row 1 divided by row 2)	.917	.917	.678	.678	.439	.439	.396	.396

The results in Table 5- 13 were generated using the planning rate in place when the CBP was first authorized (3.0 percent). Since the 4.375 percent rate presented in Table 5- 12 is required for planning purposes, the results presented in Table 5-13 are for informational purposes only. Total benefits were estimated at $1,504.5 million for the partial-replacement alternatives and $2,401.9 million for the full-replacement alternatives. Total costs vary by alternative and range from $1,328.3 million to $1,736.1 million for the partial-replacement alternatives and from $4,185.5 million to $4,593.2 million for the full-replacement alternatives. Alternatives 2A/2B result in a positive net benefit of $176.2 million and a 1.133 benefit-cost ratio. All of the other alternatives result in negative net benefits (-$231.5 million for partial-replacement alternative 2C/2D and -$1,783.6 to -$2,191.3 for the full-replacement alternatives) and benefit-cost ratios of less than one (.867 for partial-replacement alternative 2C/2D and .574 to .523 for the full-replacement alternatives).

Table 5- 13. Results of NED BCA based on historic planning rate of 3.0% (in $ millions)

Alternatives:	Partial Replacement Alternatives				Full Replacement Alternatives			
	2A	2B	2C	2D	3A	3B	3C	3D
1) Total NED Benefits	1,504.5	1,504.5	1,504.5	1,504.5	2,401.9	2,401.9	2,401.9	2,401.9
a) Agriculture Benefits	1,478.7	1,478.7	1,478.7	1,478.7	2,371.1	2,371.1	2,371.1	2,371.1
b) Other Direct Benefits – Municipal	9.3	9.3	9.3	9.3	14.3	14.3	14.3	14.3
c) Other Direct Benefits – Industrial	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
2) Total NED Costs (including Lost Benefits)	1,328.3	1,328.3	1,736.1	1,736.1	4,185.5	4,185.5	4,593.2	4,593.2
a) Canal & Reservoir Construction & IDC Costs	832.5	832.5	1,200.0	1,200.0	2,981.5	2,981.5	3,348.9	3,348.9
b) Canal & Reservoir OMR&P Costs	239.9	239.9	280.1	280.1	535.5	535.5	575.7	575.7
c) Drainage System Construction & IDC Costs	31.4	31.4	31.4	31.4	93.5	93.5	93.5	93.5
d) Drainage System OMR&P Costs	5.2	5.2	5.2	5.2	17.7	17.7	17.7	17.7
e) Lost Hydropower Benefits	219.3	219.3	219.3	219.3	557.3	557.3	557.3	557.3
3) Net Benefits (row 1 minus row 2)	+176.2	+176.2	-231.5	-231.5	-1,783.6	-1,783.6	-2,191.3	-2,191.3
4) Benefit-Cost Ratio (row 1 divided by row 2)	1.133	1.133	.867	.867	.574	.574	.523	.523

5.1.6 Financial Feasibility

After a project is found to be economically justified, analyses are undertaken to determine if the Federal project cost outlays are recoverable from the project beneficiaries. Financial feasibility is the process of analyses identifying reimbursable and nonreimbursable financial costs and the ability to recover reimbursable costs from project beneficiaries. The analyses consist of a cost allocation and subsequent repayment analyses.

5.1.6.1. Cost Allocation

Cost allocation is used as a transitional step leading from economic evaluation to repayment analysis. Allocation is not a means of justifying an alternative or project but follows the determination of economically feasible project alternatives.

The objective of cost allocation is to equitably distribute economically justified project costs of feasible alternatives among the purposes served. The purposes allocated to can be either reimbursable or nonreimbursable, based on existing legislative authority. Formulation of plans by incremental analysis normally assures that the cost of the plan increments is justifiable for each project purpose. Based on the assumptions that project formulation principles have been applied, equitable cost distribution may be obtained by preventing costs allocated to any

purpose from exceeding corresponding benefits. This establishes, for reimbursable project functions, the cost base from which repayment schedules are developed.

The principles of cost allocation are:

- Each purpose is allocated directly—as a minimum—the identifiable separable cost (costs omitted from total project costs if one purpose is excluded) of that purpose.

- Project purposes should not be assigned costs in excess of benefits, or the assigned costs should not be greater than the cost of a single purpose alternative that could likely be built as a Federal project. Thus, the lesser of either benefits or the most likely Federal alternative cost is the justifiable expenditure or maximum allocation for a purpose.

- The costs remaining, after separable costs are identified and deducted from the justifiable expenditure, are allocated to each purpose in the same ratio as the remaining benefits.

- All costs necessary to achieve benefits claimed are included.

Based on the benefit-cost results of this study, benefits do not equal or exceed the costs under each of the eight proposed alternatives; therefore, the alternatives are not economically justified. Because none of the alternatives are economically justified, a cost allocation to reimbursable and nonreimbursable purposes pursuant to acceptable methods cannot be made and repayment requirements cannot be determined. If benefits were used in an attempt to allocate annual operating costs to determine repayment requirements, a dysfunctional allocation would result because there are insufficient benefits to justify the annual operating costs, and the entire project construction cost would remain unallocated as a non-Federal investment.

5.1.6.1.1 ***Project Repayment***

A project repayment analysis usually follows the cost allocation; however, in this case, because a Federal alternative has not been justified and an equitable cost allocation was not achievable, repayment of project costs was not considered.

5.2. Regional Economic Development Impact Analysis

This section presents estimates of the regional economic impacts resulting from changes in construction expenditures, operation and maintenance expenditures, and gross farm income for each alternative compared to the No Action Alternative.

The RED account measures the effect of the alternatives on the region's local economy, while the NED account compares the alternatives from a national perspective. The RED analysis includes not only the initial or direct impact on the primary affected industries, but also the secondary impacts resulting from those industries providing inputs to the directly affected industries as well. This analysis also includes the changes in economic activity stemming from household spending of income earned by those employed in the sectors of the economy impacted either directly or indirectly. These secondary impacts are often referred to as "multiplier effects."

The NED economic benefits are not used directly in the RED analysis; only the physical changes are carried over from the NED analysis. For example, changes in agricultural water supply may result in a change in crop acreages, which subsequently results in a change in gross farm income. The change in gross farm income reflects the direct economic impact in the RED analysis which, after being run through the regional economic model, generates the secondary, or multiplier, effects. The NED benefits analysis uses net farm income as defined by the P&Gs as the estimate of agricultural benefits.

This section describes potential regional economic impacts associated with implementation of the alternatives to the four-county analysis area composed of Adams, Franklin, Grant, and Lincoln Counties. Socioeconomic impacts were measured as changes in regional employment, income, and output (sales) associated with implementation of the action alternatives compared to those associated with implementation of the No Action Alternative.

The regional economic analysis of the proposed alternatives focuses on economic impacts stemming from construction costs, annual O&M costs, and agricultural gross farm income. The change in agricultural income was estimated for each action alternative and compared to the No Action Alternative.

5.2.1 Economic Activity in the Analysis Area

Table 5- 14 summarizes the economy in Adams, Grant, Franklin, and Lincoln Counties. The sectors of the economy are aggregated in to eight industries to summarize the activity in the counties. Industry output or sales represent the value of goods and services produced by businesses within a sector of the economy. The manufacturing sector produces the greatest level of output in the analysis area, with 34.5 percent of the total output. A portion of the manufacturing output stems from activities in industries related to food

processing. Agriculture ranks second in total industry output at 20.3 percent. Ranking third is the service sector, which makes up 18.5 percent of total industry output.

Employment measures the number of jobs related to each of the industry sectors of the regional economy. In the analysis area, activities related to the service sector generate the largest number of jobs, with 27.6 percent of total regional employment. The agricultural sector ranks second in terms of overall number of jobs in the analysis area, with 23 percent of total regional employment. Government-related employment ranks third, making up 18 percent of total regional employment.

Labor income is the sum of employee compensation and proprietor income. The government-related sector generates the largest portion of labor income in the analysis area, at 23.9 percent of the total regional labor income. The service sector ranks second, with 21 percent of the total regional labor income. Ranking third is agriculture, at 15.9 percent of the total regional labor income.

Table 5- 14. 2008 Industry Output, Employment, And Labor Income For Adams, Grant, Franklin, And Lincoln Counties

Industry Sectors	Industry Output *	Percent of Total	Employment	Percent of Total	Labor Income*	Percent of Total
Agriculture	2,609	20.3	20,524	23.0	521	15.4
Mining	38	0.3	165.4	0.2	11	0.3
Construction	620	4.8	4,540.7	5.1	240	7.1
Manufacturing	4,435	34.5	8,753.50	9.8	482	14.2
Transportation, Information, and Public Utilities	544	4.2	3,646.9	4.1	192	5.7
Trade	1,040	8.1	10,907.1	12.2	419	12.4
Service	2,375	18.5	24,671.00	27.6	711	21.0
Government	1,200	9.3	16,046.7	18.0	808	23.9
Totals	12,862		89,255.3		3,385	

* Millions of Dollars
Source: 2008 IMPLAN data files

5.2.2 Methodology and Assumptions

5.2.2.1. Impact Analysis Methods

The modeling package used to assess the regional economic impacts stemming from the agricultural gross value of production, construction, and O&M expenditures for each alternative is IMPLAN (IMpact analysis for PLANning). IMPLAN is an economic input-output modeling system that estimates the effects of economic changes in a defined analysis area.

IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data. Therefore, it is difficult to address dynamic impacts such as a decline in gross farm income due to progressively failing wells using IMPLAN. As the wells become less productive, farmers may adapt by using new technology or planting new crop varieties. As the economy adapts to changing farm practices, labor and capital inputs would move to alternative uses. IMPLAN measures the initial impact to the economy but does not consider long-term adjustments as labor and capital move into alternative uses.

The analysis assumes that the structure of the economy remains static between 2010 and 2025. This approach is used to compare the alternatives. Realistically, the structure of the economy will adapt and change; therefore, these numbers only can be used to compare relative changes between the No Action Alternative and the action alternatives and cannot be used to predict or forecast employment, labor income, or output (sales).

Input-output models measure commodity flows from producers to intermediate and final consumers. Purchases for final use (final demand) drive the model. Industries produce goods and services for final demand and purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the analysis area (imports and value added) stop the cycle. These indirect and induced effects (the effects of household spending) can be mathematically derived using a set of multipliers. The multipliers describe the change in output for each regional industry caused by a 1-dollar change in final demand.

This analysis uses 2008 IMPLAN data for the four counties which encompass the Study Area. IMPLAN data files for the analysis area are compiled from a variety of sources including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau.

5.2.2.2. Construction

The construction costs associated with each alternative were divided into the construction phases described in Chapter 2 of the Odessa DEIS. The construction-related expenditures for each phase were divided into expenditures that would be made inside the analysis area. The construction expenditures inside the analysis area were used in IMPLAN to estimate employment, labor income, and regional sales stemming from construction-related activities for each phase. Construction expenditures made outside the analysis area were considered “leakages” and would have no impact on the local economy.

Reclamation’s construction cost engineers allocated the costs associated with major construction activities to within-region expenditures according to the percentages shown in Table 5- 15. The construction costs by phase assumed to be spent within the analysis area are shown in the RED section of the Draft Economics Technical Report (Reclamation, 2010 [Economics]).

Table 5- 15. Allocations by construction activity within the analysis area

Construction Activity	In-Region Expenditures
Canal Enlargement and Linings	75%
Water Service Contracts	75%
Pump Station Modifications	75%
Wasteways	30%
Siphons	60%
Laterals	45%
Drains Subsurface	50%
Pumping Plants	35%
Switchyards and Transmission Lines	25%
Maintenance Buildings	40%
SCADA Systems	20%
Mobilization and Preparatory Work	60%

The analysis assumes that the onsite construction workforce would be hired from within the analysis area or would commute to the area from nearby communities. It is also assumed that most of the construction expenditures would be funded from sources outside the analysis area. Money from outside the analysis area spent on goods and services within the analysis area contributes to regional economic impacts, while money that originates from within the analysis area is much less likely to generate regional economic impacts. Spending from sources within the analysis area represents a redistribution of income and output rather than an increase in economic activity.

The impacts by phase would be spread over the length of the construction period and would vary year-by-year proportionate to actual expenditures. The regional impacts associated with each phase cannot be summed into a total construction impact for a particular alternative to avoid double counting.

5.2.2.3. O&M

Expenditures made inside the study region related to O&M generate positive economic impacts to the regional economy. For the purpose of this analysis, it is assumed that 80 percent of the O&M expenditures would be made inside the four-county area. As construction phases are completed, annual O&M expenditures would begin to accrue; however, this analysis measures annual O&M impacts after all the construction phases are implemented. The analysis does not quantify the positive impacts resulting from replacement costs given these are distributed over the entire study period. Like the construction related expenditures, O&M expenditures made inside the analysis area associated with each alternative were placed into categories related to the each sector of the economy and run through IMPLAN to estimate impacts to the regional economy.

5.2.2.4. Agriculture

Gross farm income estimates were used in IMPLAN to measure changes in regional impacts. The analysis also measures and includes regional economic impacts associated with potato processors within the four counties who receive potatoes from the Study Area.

The future number of irrigated and dryland acres and the associated gross farm income was estimated for each alternative using a spreadsheet model discussed in the NED agricultural section. The gross farm income for each alternative was used in IMPLAN to estimate the changes in regional economic impacts expected to occur if a partial or full replacement surface water supply was provided to lands currently irrigated with groundwater.

Potato processors in the four-county area rely on irrigated potatoes grown in the Study Area because the potatoes are high quality and have desirable storage characteristics. Local processors use all of the potatoes grown in the Study Area; therefore, the regional economy will be impacted by both changes in gross farm income and the availability of Odessa potatoes to the processing plants. This analysis measures regional economic impacts stemming from both of these changes.

The analysis measures the combined estimated employment, labor income, and output (sales) stemming from changes in gross farm income and the activities related to potato processing. Impacts were measured for year 2010, the beginning of construction, and year 2025 when all construction phases are completed for each alternative, including the No Action Alternative. Regional impacts were not estimated beyond the end of the construction phases, because of the uncertainties related to the re-employment of labor and capital.

5.2.3 Alternative 1: No Action Alternative

5.2.3.1. Construction and O&M

No regional economic impacts are anticipated because no new project facilities would be constructed under this alternative.

5.2.3.2. Agriculture

Table 5- 16 shows the change in acres and gross farm income associated with the No Action Alternative for years 2010 and 2025 assuming the current economy is static. These numbers were estimated using a spreadsheet model discussed in the NED agricultural section.

Table 5- 16. Comparison of 2010 and 2025 gross farm incomes for the No Action Alternative

Crop	2010 Acres by Crop	Year 2010 Gross Farm Income*	2025 Acres by Crop	Year 2025 Gross Farm Income
Potato	15,495	$59,020,857	3,044	$11,592,038
Wheat	38,481	$19,450,991	27,454	$13,877,444
Mixed Crops	43,509	$27,503,791	20,488	$12,951,198
Dryland Wheat Produced	2,565	$450,982	24,563	$4,318,044
Fallow Acres in Rotation	2,566	$0	24,563	$0
Acres of Lost Production	0	$0	2,504	$0
Total	102,616	$106,426,621	102,616	$42,738,724

* The agricultural impact model used 2010 as the base year and estimated changes in gross farm income for each year until 2025, when all construction would end.

Selecting the No Action Alternative would result in 1,107 jobs (1.24 percent of the employment with in the four-county area) in 2010 within the four-county area as shown in Table 5- 17. These jobs are the result of gross farm income from 102,416 acres of farmland and the jobs generated by activities related to processing of potatoes grown within the Study Area. Regional employment would decline from 1,107 jobs to 449 jobs between 2010 and 2025, or 0.50 percent within the four-county area. The job loss of 658 jobs in 2025 would be due to both losses in gross farm income and the Odessa potatoes supplied to local processors.

Table 5- 17. No Action Alternative—Regional impacts for 2010 And 2025 stemming from changes in gross farm income and associated potato processing

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area
Four-County Analysis Area	89,255		$3,385		$12,862	
2010 - No Action	1,107	1.24%	$16	0.48%	$99	0.77%
2025 - No Action	449	0.50%	$7	0.22%	$54	0.42%
Net Change	-658	-0.74%	-9.0	-0.26	-45.0	-0.35

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

Labor income as a result of implementation of the No Action Alternative would equal $16 million (0.48 percent of the four-county area) and would drop to $7 million (0.22 percent of the four-county area) in 2025. Implementation of the No Action Alternative would result in $99 million (0.77 percent of the four-

county area) of output. Output would decline to $54 million (0.42 percent of the four-county area) by 2025. The drop in both labor income and output also would be due to the loss of gross farm income and the Odessa potato supply to the local processors.

5.2.4 Alternative 2A: Partial—Banks

5.2.4.1. Construction

Construction expenditures spent within the analysis area would positively impact employment, labor income, and regional sales, as shown in Table 5- 18. These would be short-term impacts during construction phases proportional to expenditure levels during each construction year. Because construction phases would overlap, regional impacts associated with each phase cannot be summed into a total construction impact for this alternative to avoid double counting. The Tribal Employment Rights Ordinances (TEROs) of the Colville, Spokane, and Yakama Tribes may be applicable to construction of this alternative.

Table 5- 18. Total regional economic impacts stemming from Alternative 2A: Partial—Banks related to construction expenditures by phases

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area
Four-County Analysis Area	89,255		$3,385		$12,862	
Phase 1	735	0.82%	$38.1	1.13%	$107.5	0.84%
Phase 2	870	0.98%	$45.1	1.33%	$127.0	0.99%
Phase 3	307	0.34%	$15.9	0.47%	$44.9	0.35%
Phase 4	284	0.32%	$14.7	0.43%	$41.5	0.32%

a Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.4.2. O&M

Annual O&M expenditures required for this alternative would result in positive economic long-term impacts greater than with the No Action Alternative. Table 5- 19 summarizes the regional impacts stemming from annual O&M expenditures after all the construction phases have been implemented.

Table 5- 19. Total regional economic impacts stemming from Alternative 2A: Partial—Banks related to annual O&M expenditures

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area
Four-County Analysis Area	89,255		$3,385		$12,862	
Annual O&M impacts	33	Less than 1%	$2.06	Less than 1%	$4.09	Less than 1%

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.4.3. Agriculture

The change in gross farm income resulting from delivery of surface water to approximately 57,000 acres under Alternative 2A: Partial—Banks was evaluated using the spreadsheet model discussed in the NED agricultural section. It was assumed that all 57,000 acres would receive 3 acre-feet of irrigation water per acre, regardless of the existing pumping level. Estimates of gross farm income for the approximately 57,000 acres were calculated using a representative crop mix of irrigated potatoes, mixed crops, and wheat and are shown in Table 5- 20.

Table 5- 20. Comparison of 2010 and 2025 gross farm incomes for the No Action Alternative and Alternative 2A: Partial—Banks

Gross Farm Income by Crop	Year 2010	Year 2025
No Action Alternative Gross Farm Income		
Potato	$59,020,857	$11,592,038
Wheat	$19,901,973	$18,195,488
Mixed Crops	$27,503,791	$12,951,198
Total	$106,426,621	$42,738,724
Alternative 2A : Partial—Banks Gross Farm Income		
Potato	$59,020,857	$37,969,627
Wheat	$19,901,973	$21,416,085
Mixed Crops	$27,503,791	$19,862,922
Total	$106,426,621	$79,248,634
Difference in Income		
Potato	$0	+$26,377,589
Wheat	$0	+$3,220,597
Mixed Crops	$0	+$6,731,724
Total	$0	+$36,509,910

Using the gross farm income estimates, IMPLAN measured the regional impacts resulting from implementing a partial-replacement alternative. Implementing the partial-replacement alternative would result in 819 jobs (0.92 percent of total employment in the four-county area) compared to the No Action Alternative of 449 jobs in year 2025, as shown in Table 5- 21. Compared to the No Action Alternative, a partial-replacement alternative would result in a net change of 370 jobs in year 2025. The job increases would be due to an increase in gross farm income and an increase of Odessa potatoes supplied to the local processors in 2025, associated with implementation of a partial-replacement alternative.

Table 5- 21. Partial Replacement Alternatives—Regional impacts stemming from changes in gross farm income and associated potato processing

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
2025 - No Action	449	0.50%	$7	0.22%	$54	0.42%
2025 - Partial	819	0.92%	$20	0.59%	$121	0.64%
Net Change	370	0.42%	$13	0.37%	$67	0.22%

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

Labor income in 2025 for a partial-replacement alternative would equal $20 million (0.59 percent of total labor income in the four-county area) in 2025. Labor income as a result of implementation of a partial-replacement alternative would increase by $13 million compared to year 2025 of the No Action Alternative.

Output in 2025 for a partial-replacement alternative would equal $121 million (0.64 percent of total output in the four-county area). Implementation of a partial replacement alternative would create $67 million more in output compared to year 2025 of the No Action Alternative.

5.2.5 Alternative 2B: Partial—Banks + FDR

The regional impacts would be the same as those presented for Alternative 2A: Partial—Banks.

5.2.6 Alternative 2C: Partial—Banks + Rocky

5.2.6.1. Construction

Alternative 2C: Partial—Banks + Rocky adds Rocky Coulee Dam and Reservoir, which were not included in Alternatives 2A: Partial—Banks and 2B: Partial—

Banks + FDR; therefore, construction impacts would be slightly higher with this alternative. Like Alternatives 2A: Partial—Banks and 2B: Partial—Banks + FDR, construction expenditures spent within the analysis area would positively affect employment, labor income, and regional sales, as shown in Table 5- 22. These short-term impacts would occur during the construction phases proportional to the expenditure levels during each year of construction. Because construction phases overlap, regional impacts associated with each phase cannot be summed into a total construction impact for this alternative to avoid double counting. The TEROs of the Colville, Spokane, and Yakama Tribes may apply to construction of this alternative.

Table 5- 22. Total regional economic impacts stemming from Alternative 2C: Partial—Banks + Rocky related to construction expenditures by phases

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area	Total ($ millions)	Percent of the 4-county area
Four-County Analysis Area	89,255		$3,385		$12,862	
Phase 1	735	0.82%	$38.1	1.13%	$107.5	0.84%
Phase 2	870	0.98%	$45.1	1.33%	$127.0	0.99%
Phase 3	307	0.34%	$15.9	0.47%	$44.9	0.35%
Phase 4	284	0.32%	$14.7	0.43%	$41.5	0.32%
Rocky Coulee	1,117	1.25%	$54.4	1.61%	$132.32	1.03%

a Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.6.2. O&M

Annual O&M expenditures would result in positive economic long-term impacts greater than the No Action Alternative. Table 5- 23 summarizes regional impacts stemming from annual O&M expenditures after construction.

5.2.6.3. Agriculture

The regional impacts related to agriculture would be the same as Alternative 2A: Partial—Banks.

Table 5- 23. Total regional economic impacts stemming from Alternative 2C: Partial—Banks + Rocky annual O&M expenditures

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-county area	Total ($ millions)	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
Annual O&M Impacts	35	Less than 1%	$2.2	Less than 1%	$4.3	Less than 1%

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.7 Alternative 2D: Partial—Combined

5.2.7.1. Construction and O&M

Construction and long-term O&M impacts would be the same as Alternative 2C: Partial—Banks + Rocky.

5.2.7.2. Agriculture

Regional economic impacts associated with agriculture would be the same as Alternative 2A: Partial—Banks.

5.2.8 Alternative 3A: Full—Banks

5.2.8.1. Construction

Construction expenditures within the analysis area would positively impact employment, labor income, and regional sales, as shown in Table 5- 24. These short-term impacts would occur during construction phases proportional to expenditure levels during each year of construction. In the analysis when construction phases overlapped, construction costs were combined to measure regional economic impacts. Because not all construction phases would be concurrent, the economic impacts cannot be summed into a total construction-related regional economic impact for this alternative to avoid double counting. The TEROs of the Colville, Spokane, and Yakama Tribes may apply to construction of this alternative.

Table 5- 24. Total regional economic impacts stemming from Alternative 3A: Full—Banks related to construction expenditures by phases

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
Phase 1	735	0.82%	$38.1	1.13%	$107.5	0.84%
Phase 5	3,382	3.79%	$175.5	5.19%	$494.3	3.85%
Phase 2&8	1,713	1.92%	$89	2.63%	$250.7	1.95%
Phase 3 &6	1,356	1.52%	$70.3	2.08%	$198	1.54%
Phase 4, 7, & 9	1,385	1.55%	$71.8	2.12%	$202.3	1.53%

a Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.8.2. O&M

Annual O&M expenditures required for this alternative would result in positive economic long-term impacts, which would be greater than the No Action alternative. Table 5- 25 summarizes the regional impacts stemming from annual O&M expenditures after all the construction phases have been implemented.

Table 5- 25. Total regional economic impacts stemming from Alternative 3A Full—Banks annual O&M expenditures

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
Annual O&M Impacts	62	Less than 1%	$3.86	Less than 1%	$7.65	Less than 1%

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.8.3. Agriculture

The gross farm incomes as a result of implementing Alternative 3A: Full—Banks were evaluated using the spreadsheet model discussed in the NED agricultural section and are shown in Table 5- 26. These numbers were run through IMPLAN to estimate the regional economic impacts associated with the alternative.

Table 5- 26. Comparison Of 2010 And 2025 Gross Farm Incomes For The No Action Alternative And Alternative 3A: Full—Banks

Gross Farm Income by Crop	Year 2010	Year 2025
No Action Alternative Gross Farm Income		
Potato	$59,020,857	$11,592,038
Wheat	$19,901,973	$18,195,488
Mixed Crops	$27,503,791	$12,951,198
Total	$106,426,621	$42,738,724
Alternative 3A: Full—Banks Gross Farm Income		
Potato	$59,020,857	$59,020,857
Wheat	$19,901,973	$21,416,085
Mixed Crops	$27,503,791	$23,124,445
Total	$106,426,621	$108,467,377
Difference in Income		
Potato	$0	+$47,428,819
Wheat	$0	+$4,928,957
Mixed Crops	$0	+$13,370,877
Total	$0	+$65,728,652

Implementing a full-replacement alternative would result in 1,115 jobs (1.25 percent of total employment in the four-county area), as shown in Table 5-27. Implementation of a full-replacement alternative would cause a net change of 666 jobs, compared to the No Action Alternative in year 2025. The job increases would be due to an increase in gross farm income and an increase of Odessa potatoes supplied to the local processors in 2025.

Table 5- 27. Full Replacement Alternatives: Regional impacts stemming from changes in gross farm income and associated potato processing

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
2025 - No Action	449	0.50%	$7	0.22%	$54	0.42%
2025 - Full	1,115	1.25%	$30	0.88%	$174	1.35%
Net Change	666	0.75%	$23	0.66%	$120	0.93%

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

Labor income in 2025 for a full-replacement alternative would equal $30 million (0.88 percent of total labor income in the four-county area) in 2025. Labor income would increase by $23 million, as compared the No Action Alternative, as a result of constructing a full-replacement alternative.

Full-replacement alternatives output would equal $174 million (1.35 percent of total output in the four-county area). Implementing a full-replacement alternative would result in a net change of $120 of output compared to the No Action Alternative.

5.2.9 Alternative 3B: Full—Banks + FDR

The regional economic impacts from construction, O&M, and agriculture would be the same as Alternative 3A: Full—Banks.

5.2.10 Alternative 3C: Full—Banks + Rocky

5.2.10.1. Construction

Alternative 3C: Full—Banks + Rocky adds Rocky Coulee Dam and Reservoir, which were not included in Alternatives 3A: Full—Banks and 3B: Full—Banks + FDR; therefore, construction impacts would be slightly higher with this alternative. Like Alternatives 3A: Full—Banks and 3B: Full—Banks + FDR, construction expenditures spent within the analysis area would have a positive impact on employment, labor income, and regional sales, as shown in Table 5- 28. These are short-term impacts that would occur during the construction phases and are proportional to the expenditure levels during each year of construction. During analysis when the phases were concurrent, constructions costs were combined to measure regional economic impacts. Additionally, because not all construction phases would be at the same time, economic impacts for each of the construction phases were not summed into a total construction-related regional economic impact for this alternative to avoid double counting. The TEROs of the Colville, Spokane, and Yakama Tribes may apply to construction of this alternative.

Table 5- 28. Total Regional Economic Impacts Stemming From Alternative 3C: Full—Banks + Rocky Related To Construction Expenditures By Phases

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
Phase 1	735	0.82%	$38.1	1.13%	$107.5	0.84%
Phase 5	3,382	3.79%	$175.5	5.19%	$494.3	3.85%
Phase 2&8	1,713	1.92%	$89	2.63%	$250.7	1.95%
Phase 3 &6	1,356	1.52%	$70.3	2.08%	$198	1.54%
Phase 4, 7, & 9	1,385	1.55%	$71.8	2.12%	$202.3	1.53%
Rocky Coulee	1,117	1.25%	$54.4	1.61%	$132.32	1.03%

a Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.10.2. O&M

Annual O&M expenditures required for this alternative would have a positive economic long-term impact greater than the No Action Alternative. Table 5- 29 summarizes regional impacts stemming from annual O&M expenditures after all the construction phases have been implemented.

Table 5- 29. Total Regional Economic Impacts Stemming From Alternative 3C: Full—Banks + Rocky Annual O&M Expenditures

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area	Total ($ millions)	Percent of the 4-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
4Annual O&M Impacts	74	Less than 1%	$3.98	Less than 1%	$7.9	Less than 1%

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.10.3. Agriculture

Regional economic impacts to agriculture would be the same as Alternative 3A: Full—Banks.

5.2.11 Alternative 3D: Full—Combined

The regional economic impacts from construction, O&M, and agriculture, would be the same as Alternative 3C: Full—Banks + Rocky.

5.2.12 RED Results

Table 5- 34 presents a summary of the results of the regional economic impact analyses for the alternatives under consideration.

5.3. Environmental Quality Analysis

The Environmental Quality (EQ) account measures the degree to which the project benefits or adversely affects the quality of the natural and cultural resources and ecosystems of the area. These natural and cultural resources sustain and enrich human life in one of three ways:

- **Ecological:** Components of the environment and the interactions among all its living (including people) and nonliving components that directly or indirectly sustain dynamic, diverse, viable ecosystems. Surface water

quantity, groundwater resources, surface water quality, geology, soils, vegetation and wetlands, wildlife and wildlife habitat, fisheries, and threatened and endangered species were analyzed.

- **Cultural:** Evidence of past and present habitation that can be used to reconstruct or preserve human lifeways. Cultural and historic resources were analyzed.

- **Aesthetic:** Perceptual stimuli that provide diverse and pleasant surroundings for human appreciation. Air quality, noise, and visual resources were analyzed.

The EQ analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa DEIS and summarized in Section 4.8, "Summary of Impacts," of this Special Study Report. The EQ resources considered are:

- Groundwater
- Water quality
- Vegetation and wetlands
- Wildlife and wildlife habitat
- Fisheries and aquatic resources
- Cultural resources
- Visual resources)

5.3.1 EQ Methodology

Impacts were compared using indicators, a characteristic of an EQ resource that serves as a direct or indirect means of measuring or otherwise describing changes in the quantity and/or quality of an EQ resource. Scores within each impact indicator were assigned on a simple scale of 0 (No Impact) through +4 (most beneficial) or -4 (most adverse).

For this impact comparison, no judgment was made regarding relative importance of one indicator compared with others. Thus, a +4 or -4 score in one indicator should not be considered equal in importance compared with the same scores in other indicators when making decisions.

Only resources and indicators under which significant adverse impacts and/or important beneficial effects would occur are included in the analysis.

Total scores for each EQ resource were derived by adding the scores of all impact indicators for a resource and dividing by the number of indicators for that resource.

EQ scores were derived by adding the total scores for each EQ resource.

5.3.2 EQ Results

Table 5- 30 shows the EQ total score for each alternative, listed from best to worst.

Table 5- 30. EQ rankings for alternatives

Alternative	Total EQ Score
No Action	-2.0
2C: Partial—Banks + Rocky	-2.8
2A: Partial—Banks	-2.9
2B: Partial—Banks + FDR	-2.9
2D: Partial—Combined	-5.1
3B: Full—Banks + FDR	-10.9
3D: Full—Combined	-12.2
3C: Full—Banks + Rocky	-16.3
3A: Full—Banks	-16.9

Table 5- 31 presents a summary of results for the EQ resources for each alternative, including the total EQ score.

Table 5- 31. Impact comparison for EQ resources

	Indicator	No Action		2A: Partial—Banks		2B: Partial—Banks + FDR		2C: Partial—Banks + Rocky		2D: Partial—Combined		3A: Full—Banks		3B: Full—Banks + FDR		3C: Full—Banks + Rocky		3D: Full—Combined	
		Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Groundwater Resources			**0.0**		**3.0**		**3.0**		**3.0**		**3.0**		**4.0**		**4.0**		**4.0**		**4.0**
Groundwater	Groundwater acres to be replaced by surface water acres	0	0	58,000	3	58,000	3	58,000	3	58,000	3	102,614	4	102,614	4	102,614	4	102,614	4
Surface Water Quality			**0**		**-2**		**-2**		**0**		**-2**		**-4**		**-2**		**-4**		**-2**
Temperature (Banks)	Professional judgment and exceedance of standard	No/minimal impact	0	Significant impact	-2	Significant impact	-2	No/minimal impact	0	Significant impact	-2	Significant impact; greater than Alternative Alternative 2A	-4	Same as Alternative 2A	-2	Same as Alternative 3A	-4	Same as Alternative 2A	-2
Dissolved oxygen (Banks)	Professional judgment and exceedance of standard	No/minimal impact	0	Significant impact	-2	Significant impact	-2	No/minimal impact	0	Significant impact	-2	Significant impact; greater than Alternative 2A	-4	Same as Alternative 2A	-2	Same as Alternative 3A	-4	Same as Alternative 2A	-2
Vegetation and Wetlands			**-0.2**		**-0.4**		**-0.4**		**-0.8**		**-0.8**		**-3.6**		**-3.6**		**-3.6**		**-3.6**
Impacts on native plant communities	Impacted area	Potential significant impacts from weeds	-1	Potential significant impacts from weeds north of I-90. Significant impacts on native plant communities.	-2	Same as Alternative 2A	-2	Same as Alternative 2A but greater impacts on native plant communities due to Rocky Coulee Reservoir	-2	Same as Alternative 2C	-2	Significant impacts over a large area of native communities, including Black Rock Coulee Reregulating Reservoir	-4	Same as Alternative 3A	-4	Significant impacts over a large area of native communities, including Black Rock Coulee Reregulating Reservoir and Rocky Coulee Reservoir	-4	Same as Alternative 3C	-4
Fragmentation of native plant communities	Professional judgment	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impacts due to construction of new canals	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4
Impacts on special status plants	Species presence within areas that would be impacted	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impacts on rare plants	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4
Habitat restoration	Area that would need to be restored	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant requirement for restoration of disturbed habitat over large areas	-2	Same as Alternative 2C	-2	Significant requirement for restoration of disturbed habitat over large areas	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4
Long-term loss of wetland area	Impacted area	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impacts at Banks Lake and Black Rock Coulee	-2	Same as Alternative 3A	-2	Same as Alternative 3A	-2	Same as Alternative 3A	-2
Wildlife and Wildlife Habitat			**-0.5**		**-0.5**		**-0.5**		**-1.0**		**-1.0**		**-4.0**		**-4.0**		**-4.0**		**-4.0**
Impacts on intact shrub-steppe habitat	Impacted area	Potential significant impacts from weeds	-2	Significant impacts	-1	Same as Alternative 2A	-1	Same as Alternative 2A	-2	Same as Alternative 2A	-2	Significant impacts over substantially larger area than Alternatives 2A-2D	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4
Barriers to unrestricted movement by wildlife	Professional judgment	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impacts due to canal construction	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4

Table 5- 31. Impact comparison for EQ resources

	Indicator	No Action		2A: Partial—Banks		2B: Partial—Banks + FDR		2C: Partial—Banks + Rocky		2D: Partial—Combined		3A: Full—Banks		3B: Full—Banks + FDR		3C: Full—Banks + Rocky		3D: Full—Combined	
		Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Impacts on special status species, including migratory birds	Area (which affects number of species impacted)	No/minimal impact	0	Significant impacts on multiple species	-1	Same as Alternative 2A	-1	Same as Alternative 2A, with increased area of effect due to Rocky Coulee Reservoir	-2	Same as Alternative 2C	-2	Significant impacts on multiple species, over substantially larger area and a larger number of species than Alternatives 2A-2D	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4
Habitat fragmentation and population viability	Professional judgment	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impacts due to canal construction	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4	Same as Alternative 3A	-4
Fisheries and Aquatic Resources			**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**-4.0**		**-2.0**		**-3.0**		**-2.0**
Banks Lake: Overall condition of the fishery	Professional judgment	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impact likely in all water year conditions	-4	Significant impact in drought years. Minimal impact in wet, average or dry years.	-2	Significant impact likely in all water year conditions, but less severe than Alternative 3A	-3	Significant impact in drought years. Minimal impact in wet, average or dry years.	-2
Cultural Resources			**0.0**		**-2.0**		**-2.0**		**-2.7**		**-3.0**		**-3.0**		**-2.3**		**-3.7**		**-3.3**
High potential for impact to significant resources	Miles of linear facilities	No impact	0	172	-3	172	-3	172	-3	172	-3	248	-4	248	-4	248	-4	248	-4
	Acres of site facilities	No impact	0	90	-1	90	-1	6170	-4	6170	-4	128	-1	128	-1	6208	-4	6208	-4
	Acres exposed at Banks due to additional drawdown	No impact	0	780	-2	690	-2	30	-1	500	-2	2310	-4	690	-2	1170	-3	690	-2
Visual Resources			**-1.3**		**-1.0**		**-1.0**		**-1.3**		**-1.3**		**-2.3**		**-1.0**		**-2.0**		**-1.3**
Landscape-level change	Conversion from irrigated agriculture to dryland or fallow (acres)	102614	-4	48416	-2	48416	-2	48416	-2	48416	-2	0	0	0	0	0	0	0	0
Introduction of new developed facilities	Professional judgment: Distinction among alternatives is south of I-90 only or both north and south of I-90	No impact	0	Delivery & distribution system south of I-90 only	-1	Delivery & distribution system south of I-90 only	-1	Delivery & distribution system south of I-90 and Rocky Coulee Reservoir north of I-90	-2	Delivery & distribution system south of I-90 and Rocky Coulee Reservoir north of I-90	-2	Delivery & distribution system north & south of I-90	-3	Delivery & distribution system north & south of I-90	-3	Delivery & distribution system north & south of I-90 plus Rocky Coulee Reservoir	-4	Delivery & distribution system north & south of I-90 plus Rocky Coulee Reservoir	-4
Changes in reservoir drawdown patterns at Banks Lake and Lake Roosevelt	Professional judgment	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impact at Banks Lake in Aug/Sep of average years	-4	No/minimal impact	0	Significant impact at Banks Lake in Aug/Set of dry & drought years	-2	No/minimal impact	0
Total EQ Score		**-2.0**		**-2.9**		**-2.9**		**-2.8**		**-5.1**		**-16.9**		**-10.9**		**-16.3**		**-12.2**	

5.4. Other Social Effects Analysis

The OSE account displays information on effects from perspectives that are not reflected in the NED, RED, or EQ accounts. The OSE analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa DEIS and summarized in Section 4.8, "Summary of Impacts," of this Special Study Report. The OSE resources considered are:

- Land Use and Shoreline Resources
- Recreation Resources
- Transportation

5.4.1 OSE Methodology

Impacts were compared using the same analyses techniques described for the EQ Account. See Section 5.3.1, "EQ Methodology."

5.4.2 OSE Results

Table 5- 32 shows the OSE total score for each alternative, listed from best to worst.

Table 5- 32. OSE rankings for alternatives

Alternative	Total OSE Score
No Action	0
2A: Partial—Banks	-1.3
2B: Partial—Banks + FDR	-1.3
3B: Full—Banks + FDR	-2.5
3A: Full—Banks	-4.7
2C: Partial—Banks + Rocky	-5.4
2D: Partial—Combined	-6.2
3D: Full—Combined	-7.3
3C: Full—Banks + Rocky	-8.1

Table 5- 33 presents a summary of results for the OSE resources for each alternative, including the OSE scores.

Table 5- 33. Impact comparison for OSE resources

Resources and Impact Indicators	Indicator	No Action		Partial Groundwater Irrigation Replacement Alternatives								Full Groundwater Irrigation Replacement Alternatives							
				2A: Partial—Banks		2B: Partial—Banks + FDR		2C: Partial—Banks + Rocky		2D: Partial—Combined		3A: Full—Banks		3B: Full—Banks + FDR		3C: Full—Banks + Rocky		3D: Full—Combined	
		Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Land Use and Shoreline Resources			**0.0**		**0.2**		**0.2**		**-0.7**		**-0.7**		**-0.7**		**-0.7**		**-1.3**		**-1.3**
Changes in land ownership and land status	Total land acquisition requirement (acres)	0	0	4,905	-1	4,905	-1	13,843	-2	13,843	-2	19,766	-3	19,766	-3	28,705	-4	28,705	-4
Changes in land or shoreline uses	Protection of irrigated agriculture (acres)	0	0	58,000	3	58,000	3	58,000	3	58,000	3	102,614	4	102,614	4	102,614	4	102,614	4
	Occupied structures impacted (#)	0	0	6	-1	6	-1	21	-3	21	-3	16	-3	16	-3	31	-4	31	-4
	Center pivots impacted (#)	0	0	9	-1	9	-1	45	-2	45	-2	72	-3	72	-3	108	-4	108	-4
	Irrigated agriculture impacted (acres)	0	0	2,209	-2	2,209	-2	6,036	-3	6,036	-3	4,384	-3	4,384	-3	8,211	-4	8,211	-4
Consistency with relevant plans, policies and programs	Consistent with County Plans (acres)	0	0	58,000	3	58,000	3	58,000	3	58,000	3	102,614	4	102,614	4	102,614	4	102,614	4
Recreation Resources			**0.0**		**-1.5**		**-1.5**		**-0.7**		**-1.5**		**-4.0**		**-1.8**		**-2.8**		**-2.0**
Banks: Loss of boating capacity	Main ramps (ramp-weeks beyond No action in avg. year)	0	0	6	-1	5	-1	1	-1	6	-1	29	-4	5	-1	13	-2	7	-1
Banks: Exposure of boating hazards	Drawdown beyond no action in avg. year (feet)	0	0	3.4	-2	3	-2	0.1	-1	3	-2	8.5	-4	3	-2	5	-3	3	-2
Banks: Loss of fishing opportunities from impact on fishery (impact on fishing access reflected in boating capacity indicator)	Professional judgment	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impact likely in all water year conditions	-4	Significant impact in drought years. Minimal impact in wet, average or dry years.	-2	Significant impact likely in all water year conditions, but less severe than Alternative 3A	-3	Same as Alternative 3B	-2
Banks: Loss of usability at developed swimming areas	Swimming sites (site-weeks beyond No Action in avg. year)	0	0	12	-2	12	-2	0	0	15	-2	30	-4	12	-2	21	-3	21	-3
Banks: Decrease in usability or aesthetic quality at developed camping or day use facilities	Drawdown beyond no action in avg. year (feet)	0	0	3.4	-2	3	-2	0.1	-1	3	-2	8.5	-4	3	-2	5	-3	3	-2
Banks:	Drawdown	0	0	3.4	-2	3	-2	0.1	-1	3	-2	8.5	-4	3	-2	5	-3	3	-2

Table 5- 33. Impact comparison for OSE resources

Resources and Impact Indicators	Indicator	No Action		Partial Groundwater Irrigation Replacement Alternatives								Full Groundwater Irrigation Replacement Alternatives							
				2A: Partial—Banks		2B: Partial—Banks + FDR		2C: Partial—Banks + Rocky		2D: Partial—Combined		3A: Full—Banks		3B: Full—Banks + FDR		3C: Full—Banks + Rocky		3D: Full—Combined	
		Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Dispersed recreation	beyond no action in avg. year (feet)																		
Transportation			**0.0**		**0.0**		**0.0**		**-4.0**		**-4.0**		**0.0**		**0.0**		**-4.0**		**-4.0**
Existing roads and railroads: crossings by new surface facilities or inundation by new reservoirs	Professional judgment	No/minimal impact	0	No/minimal impact	0	No/minimal impact	0	Significant impact on local circulation due to road closures necessary for Rocky Coulee reservoir.	-4	Same as Alternative 2C	-4	No/minimal impact	0	No/minimal impact	0	Same as Alternative 2C	-4	Same as Alternative 2C	-4
Total OSE Score		**0**		**-1.3**		**-1.3**		**-5.4**		**-6.2**		**-4.7**		**-2.5**		**-8.1**		**-7.3**	

Table 5- 34. RED summary table

	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Construction									
Phase 1									
Employment (Jobs)	No Impact	785	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A
Labor Income ($ million)		38.1							
Regional Sales ($ million)		107.5							
Phase 2									
Employment (Jobs)	No Impact	870	Same as 2A	Same as 2A	Same as 2A	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Labor Income ($ million)		45.1							
Regional Sales ($ million)		127.0							
Phase 3									
Employment (Jobs)	No Impact	307	Same as 2A	Same as 2A	Same as 2A	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Labor Income ($ million)		15.9							
Regional Sales ($ million)		44.9							
Phase 4									
Employment (Jobs)	No Impact	284	Same as 2A	Same as 2A	Same as 2A	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Labor Income ($ million)		14.7							
Regional Sales ($ million)		41.5							
Phase 5									
Employment (Jobs)	No Impact	Not Applicable	Not Applicable	Not Applicable	Not Applicable	3,382	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						175.5			
Regional Sales ($ million)						494.3			
Rocky Coulee									
Employment (Jobs)	No Impact	Not Applicable	Not Applicable	1,117	Same as 2C	Not Applicable	Not Applicable	Same as 2C	Same as 2C
Labor Income ($ million)				54.4					

Table 5- 34. RED summary table

	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Regional Sales ($ million)				132.32					
Phase 2 & 8									
Employment (Jobs)	No Impact	Not Applicable	Not Applicable	Not Applicable	Not Applicable	1,713	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						89.0			
Regional Sales ($ million)						250.7			
Phase 3 & 6									
Employment (Jobs)	No Impact	Not Applicable	Not Applicable	Not Applicable	Not Applicable	1,356	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						70.3			
Regional Sales ($ million)						198.0			
Phase 4, 7, & 9									
Employment (Jobs)	No Impact	Not Applicable	Not Applicable	Not Applicable	Not Applicable	1,385	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						71.8			
Regional Sales ($ million)						202.3			
OM&R									
Employment (Jobs)	No Impact	33	Same as 2A	35	Same as 2C	62	Same as 3A	74	Same as 3C
Labor Income ($ million)		2.06		2.2		3.86		3.98	
Regional Sales ($ million)		4.09		4.3		7.65		7.9	
Agriculture									
		Net Change from No Action				Net Change from No Action			
Employment (Jobs)	-658	370.0	Same as 2A	Same as 2A	Same as 2A	666	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)	-9.0	13.0				23.0			
Regional Sales ($ million)	-45.0	67.0				120.0			

Table 5- 35. Summary of Four-Account Analyses

	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
National Economic Development Account (Results of NED BCA Based on current planning rate: 4.375%)									
1) Total NED Benefits:	N/A	1,170.2	1,170.2	1,170.2	1,170.2	1,820.5	1,820.5	1,820.5	1,820.5
a) Agriculture Benefits:	N/A	1,153.3	1,153.3	1,153.3	1,153.3	1,800.7	1,800.7	1,800.7	1,800.7
b) Other Direct Benefits – Municipal:	N/A	5.1	5.1	5.1	5.1	8.1	8.1	8.1	8.1
c) Other Direct Benefits – Industrial:	N/A	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
2) Total NED Costs (including Lost Benefits):	N/A	1,276.7	1,276.7	1,726.1	1,726.1	4,148.6	4,148.6	4,597.9	4,597.9
a) Canal & Reservoir Construction & IDC Costs:	N/A	908.0	908.0	1,326.0	1,326.0	3,255.7	3,255.7	3,673.7	3,673.7
b) Canal & Reservoir OMR&P Costs:	N/A	180.7	180.7	212.1	212.1	401.5	401.5	432.8	432.8

Table 5- 35. Summary of Four-Account Analyses

	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
c) Drainage System Construction & IDC Costs:	N/A	28.5	28.5	28.5	28.5	83.5	83.5	83.5	83.5
d) Drainage System OMR&P Costs:	N/A	3.1	3.1	3.1	3.1	10.4	10.4	10.4	10.4
e) Lost Hydropower Benefits:	N/A	156.4	156.4	156.4	156.4	397.6	397.6	397.6	397.6
3) Net Benefits (row 1 minus row 2):	N/A	-106.5	-106.5	-555.9	-555.9	-2,328.1	-2,328.1	-2,777.4	-2,777.4
4) Benefit-Cost Ratio (row 1 divided by row 2)	N/A	.917	.917	.678	.678	.439	.439	.396	.396
Regional Economic Development Account									
Construction									
Phase 1									
Employment (jobs)	No Impact	785	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A
Labor Income ($ million)		38.1							
Regional Sales ($ million)		107.5							
Phase 2									
Employment (jobs)	No Impact	870	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A
Labor Income ($ million)		45.1							
Regional Sales ($ million)		127.0							
Phase 3									
Employment (jobs)	No Impact	307	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A
Labor Income ($ million)		15.9							
Regional Sales ($ million)		44.9							
Phase 4									
Employment (jobs)	No Impact	284	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A
Labor Income ($ million)		14.7							
Regional Sales ($ million)		41.5							
Phase 5									
Employment (jobs)	No Impact	N/A	N/A	N/A	N/A	3,382	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						175.5			
Regional Sales ($ million)						494.3			
Rocky Coulee									
Employment (jobs)	No Impact	N/A	N/A	1,117.0	Same as 2C	N/A	N/A	Same as 2C	Same as 2C
Labor Income ($ million)				54.4					
Regional Sales ($ million)				132.3					

Table 5- 35. Summary of Four-Account Analyses

	No Action	Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives			
		2A: Partial—Banks	2B: Partial—Banks + FDR	2C: Partial—Banks + Rocky	2D: Partial—Combined	3A: Full—Banks	3B: Full—Banks + FDR	3C: Full—Banks + Rocky	3D: Full—Combined
Phase 2 & 8									
Employment (jobs)	No Impact	N/A	N/A	N/A	N/A	1,713	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						89.0			
Regional Sales ($ million)						250.7			
Phase 3 & 6									
Employment (jobs)	No Impact	N/A	N/A	N/A	N/A	1,356	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						70.3			
Regional Sales ($ million)						198.0			
Phase 4, 7, & 9									
Employment (jobs)	No Impact	N/A	N/A	N/A	N/A	1,385	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)						71.8			
Regional Sales ($ million)						202.3			
Operation and Maintenance									
Employment (jobs)	No Impact	33	Same as 2A	35	Same as 2C	62	Same as 3A	74	Same as 3C
Labor Income ($ million)		2.06		2.2		3.86		3.98	
Regional Sales ($ million)		4.09		4.3		7.65		7.9	
Agriculture									
		Net Change from No Action				Net Change from No Action			
Employment (jobs)	-658	370	Same as 2A	Same as 2A	Same as 2A	666	Same as 3A	Same as 3A	Same as 3A
Labor Income ($ million)	-9.0	13.0				23.0			
Regional Sales ($ million)	-45.0	67.0				120.0			
Environmental Quality Account									
	-2.0	-2.9	-2.9	-2.8	-5.1	-16.9	-10.9	-16.3	-12.2
Other Social Effects Account									
	0	-1.3	-1.3	-5.4	-6.2	-4.7	-2.5	-8.1	-7.3

Chapter 6: Findings and Conclusions

This chapter explains the findings of the analysis that Reclamation and Ecology have performed on the alternatives.

6.1. Findings

6.1.1 Technical Viability

Based on feasibility-level engineering and design, all of the eight action alternatives are technically viable.

6.1.2 Purpose and Need

The purpose of the Odessa Special Study is to assess the effects of potential replacement of groundwater currently used for irrigation in the Odessa Subarea Special Study Area (Study Area) with CBP surface water.

- This CBP surface water would be provided as part of the continued phased development of the CBP, and would come from existing surface water rights in the Columbia River system.
- Reclamation can deliver water to up to approximately 102,600 acres authorized to receive CBP water in the Study Area.

The Study responds to four specific needs in the study area:

- Address declining groundwater supply for agriculture and other uses in the Study Area,
- Avoid significant economic loss to the region's agricultural sector because of decline of groundwater,
- Address environmental concerns and interests, and
- Fulfill commitments by Reclamation, the State, and CBP irrigation districts to conduct the Study.

6.1.2.1. Water Supply

The Full-Replacement Alternatives supply approximately 102,600 acres with surface water supply. The Partial-Replacement Alternatives supply surface water to about 57,000 of the approximate 102,600 eligible acres.

Groundwater wells are also used to support municipal, industrial, and domestic uses in the Study Area. More than 80 percent of the public and domestic drinking water in the mid-Columbia Basin comes from groundwater. Similar to irrigation wells, the wells for municipal, industrial, and domestic uses also are at risk from

dropping aquifer levels. Converting from 57,000 to 102,600 plus irrigated acres from groundwater to surface water within the study area could alleviate groundwater level declines thereby aiding municipal, industrial, and domestic uses.

The Full-Replacement Alternatives supply approximately 102,600 acres with surface water supply.

6.1.2.2. Agricultural Production

As discussed in the Odessa DEIS, Gross Farm Income was calculated by multiplying the number of acres of representative crops by yield per acre and the price received for each unit of yield. This amount was then used as an input for the RED analysis presented in this Special Study Report. Following are the findings from this analysis:

- Gross Farm Income, as calculated by multiplying the number of acres of representative crops by yield per acre and the price received for each unit of yield, was used as an input for the RED analysis presented in this Special Study Report.
- Under current 2010 conditions, the average annual gross farm income for the Study Area is $110.9 million. The average annual gross farm income for the surrounding four-county region is $1.6 billion. Thus, the Study Area's gross farm income accounts for 6.9 percent of the gross farm income generated in the four-county region.
- Under the No Action Alternative, about 50,000 acres of the currently irrigated acres in the Study Area would revert to dryland by 2025 (as irrigation wells continue to decline in usability). Annual gross farm income for the Study Area would decline from the current level of $110.9 million to $42.7 million by 2025, a 60-percent decrease. The gross farm income for the Study Area of $42.7 million would be less than 3 percent of the $1.6 billion gross farm income for the surrounding four-county region in 2025.
- Under any of the four partial-replacement alternatives, about 50 percent fewer acres would revert to dryland by 2025 (at the end of all construction phases) compared to the No Action Alternative. By 2025, partial-replacement alternatives would provide $36.5 million more in gross farm income than the No Action Alternative. The change in gross farm income of $36.5 million would be less than 3 percent of the gross farm income for the surrounding four-county region in 2025.
- Under any of the four full-replacement alternatives, no currently irrigated acres in the Study Area would revert to dryland after the completion of the construction phases in 2025. The full-replacement alternatives each provided an increase of $65.7 million in gross farm income compared to the

No Action Alternative. The change in gross farm income of $65.7 million would be less than 5 percent of the gross farm income ($1.6 billion) for the surrounding four-county region in 2025.

6.1.2.3. Environmental Considerations—Columbia River Flow Targets

None of the Study's eight action alternatives would result in a significant change in Columbia River flows. Current instream flow requirements intended to protect resource values would continue to be met as a first priority in all hydrologic conditions. Water management programs and requirements are in place that establish minimum flows and levels for the Columbia River to protect the resource values associated with the mainstem of the Columbia River, including ESA-listed fish species in the river.

Instead, providing CBP surface water to lands in the Study Area would require changing reservoir operations during and immediately after the irrigation season at Banks Lake for all action alternatives and at Lake Roosevelt for Alternatives 2B, 2D, 3B, and 3D. At both reservoirs, these changes would mean increased drawdowns—and therefore lower pool levels—when compared with the No Action Alternative. In all cases, the increased drawdowns would reach their minimum elevations at the end of August. The Rocky Coulee Reservoir proposed in Alternatives 2C, 2D, 3C, and 3D would be a working reservoir, filled and emptied each year exclusively to provide irrigation water supply.

6.1.3 Four-Account Analysis

6.1.3.1. National Economic Development (NED) Account

Benefit-cost comparisons of alternatives were made by dividing total project benefits by total project costs—resulting in the benefit-cost ratio (BCR). For benefits to exceed costs, a BCR greater than one is required. Before comparison, all benefits and costs were converted to a common point in time across all alternatives – that is, the year 2025, which is assumed as the end of the construction period for any of the action alternatives.

- The highest BCR of 0.917 was calculated for two of the partial-replacement alternatives—Alternatives 2A and 2B. These two alternatives would utilize existing facilities for water supply (that is, Banks Lake for Alternative 2A, and Banks Lake and Lake Roosevelt for Alternative 2B), and are therefore less costly (for the same level of benefits) then Alternatives 2C and 2D, which would both include a new water supply (Rocky Coulee Reservoir). A BCR of 0.678 was calculated for each of Alternatives 2C and 2D.
- Lower BCRs were calculated for full-replacement alternatives compared to the partial-replacement alternatives. A BCR of 0.439 was calculated for Alternatives 3A and 3B, and a BCR of 0.396 was calculated for

Alternatives 3C and 3D. Although the full-replacement alternatives would provide about $650 million more in benefits than the partial-replacement alternatives, the full-replacement alternatives would cost at least $2.4 billion more for construction and operation of delivery and storage facilities, including a new 80-mile East High Canal.

6.1.3.2. Regional Economic Development (RED) Account

This account evaluates the beneficial and adverse impacts of each alternative on the economy of the affected region, with particular emphasis on income and employment measures. The affected region reflects the geographic area where significant impacts are expected to occur. Impacts can be measured in both monetary and nonmonetary terms.

The RED analysis includes not only the initial or direct impact on the primary affected industries, but also the secondary impacts resulting from those industries providing inputs to the directly affected industries as well. This analysis also includes the changes in economic activity stemming from household spending of income earned by those employed in the sectors of the economy impacted either directly or indirectly. These secondary impacts are often referred to as "multiplier effects." The common measures of regional economic impacts include employment (jobs), income, and regional output (sales).

The No Action Alternative would have minimal adverse impacts from a regional perspective. The four-county analysis area would see a small (less than 1 percent) net decrease in jobs, labor income, and sales. The partial-replacement alternatives would have minimal beneficial effects. There would be a less than 2-percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative. The full-replacement alternatives would have minimal beneficial effects. There would be a less than 6 percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative.

6.1.3.3. Environmental Quality (EQ) Account

This account displays the effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources which cannot be adequately measured in monetary terms within the NED and RED accounts. The EQ analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa DEIS and summarized in Section 4.8, "Summary of Impacts," of this Special Study Report. The EQ resources considered are groundwater, water quality, vegetation and wetlands, wildlife and wildlife habitat, fisheries and aquatic resources, cultural resources, and visual resources.

Impacts were compared using indicators, a characteristic of an EQ resource that serves as a direct or indirect means of measuring or otherwise describing changes

in the quantity and/or quality of an EQ resource. Scores within each impact indicator were assigned on a simple scale of 0 (No Impact) through +4 (most beneficial) or -4 (most adverse). The EQ score for No Action was -2.0. EQ scores for the partial replacement alternatives ranged from -2.8 to -5.1 whiles scores for the full replacement alternatives ranged from -10.9 to -16.9.

6.1.3.4. Other Social Effects (OSE) Account

This account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. Like the EQ account, the OSE analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa DEIS and summarized in Section 4.8, "Summary of Impacts" of this Special Study Report. The OSE resources considered are land use and shoreline resources, recreation resources, and transportation.

Impacts were compared using the same analyses techniques described for the EQ Account. The OSE score for No Action was 0. The OSE scores for the partial replacement alternatives ranged from -1.3 to -4.7, while scores for the full replacement alternatives ranged from -5.4 to -8.1.

6.2. Conclusions

Reclamation and Ecology will carefully consider all comments received on the Odessa DEIS during the public comment period. Substantive comments will be addressed in the final EIS by modifying alternatives, supplementing the analyses, or making factual corrections as appropriate. Based on feedback from the public on the DEIS and in consultation with study partners, Reclamation and Ecology will choose a preferred alternative for inclusion in the final EIS and Special Study Report.

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