RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

ODESSA SUBAREA SPECIAL STUDY
Columbia Basin Project

STUDY UPDATE
October 2007

STUDY BACKGROUND

The Odessa Subarea Special Study involves investigation of continued phased development of the Columbia Basin Project (Project) for the purpose of replacing groundwater currently used for irrigation in the Odessa Ground Water Management Subarea with Project surface water. The aquifer is declining to such an extent that the ability of farmers to irrigate their crops is at risk and domestic, commercial, municipal, and industrial uses and water quality are also affected. In response to the public's concern about the declining aquifer and associated economic and other effects, Congress has provided funding to Reclamation to investigate the problem. The State of Washington has partnered with Reclamation, providing funding and collaborating on various technical studies.

In 2006, Reclamation completed a Potential Alternatives Solutions Study (PASS) that recommended several preliminary alternatives and options for appraisal-level investigation. The PASS is documented in a report entitled *Initial Alternative Development and Evaluation, Odessa Subarea Special Study*, available on Reclamation's website: http:/www.usbr.gov/pn/. Reclamation has spent the past year conducting an appraisal investigation of the report's recommendations.

SCOPE OF APPRAISAL INVESTIGATION

The purpose of the appraisal investigation was to screen the PASS recommendations and identify viable alternatives that merit more comprehensive analysis in the next Study phase. The appraisal investigation predominately relied on existing data and included engineering, geologic, hydrologic, and hydrogeologic analyses to assess the technical feasibility of recommendations and to develop preliminary cost estimates. Potential environmental, social, and cultural resource effects were also identified. The information and assumptions developed in the PASS were reviewed and verified, or revised, as appropriate. Refinements included 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. This information is presented later.

Reclamation can only deliver water to lands authorized to receive Project water. Previous estimates determined that of the 170,000 groundwater irrigated acres located in the Odessa Subarea, approximately 121,000 acres were eligible to receive Project surface water within the Study area. A Reclamation and Washington Department of Ecology review of water rights and other information resulted in revising the total eligible groundwater acreage. The appraisal investigation assumed that up to 140,000 groundwater irrigated acres occur in the Study area and are eligible to receive surface water from the Project.

ALTERNATIVES AND OPTIONS EXAMINED

Reclamation's appraisal investigation studied water delivery alternatives and water supply options recommended by the PASS.

Water Delivery Alternatives

Four water delivery alternatives were examined, proposing possible infrastructure (canals, pumping plants and laterals) and configurations to deliver replacement surface water by the Project to groundwater irrigated lands in the Study area.

Alternative A **-** Construct a new East High Canal system sized to 30 percent capacity of the original feasibility plan; siphons and tunnels sized to 100 percent capacity (Figure 1).

Alternative B – Construct the northern portion of a new East High Canal system sized to 15 percent capacity of the original feasibility plan; siphons and tunnels sized to 100 percent capacity. Enlarge existing East Low Canal sections south of Weber Siphon (near Interstate 90) and construct a 2.3 mile extension east towards Connell, WA (Figure 2).

Alternative C – Enlarge existing East Low Canal sections south of Weber Siphon (near Interstate 90) (Figure 3).

Alternative D – Use existing East Low Canal configuration; the canal capacity only allows serving lands north of Interstate 90 (Figure 4).

Figures 1 through 4 provide a visual configuration of the four alternatives and identify the groundwater irrigated acres that would receive the replacement surface water supply for each. Table 1 summarizes the number of acres served and the volume of additional Columbia River diversion required to provide a replacement water supply.

Table 1. Water Delivery Alternatives - Groundwater Acres Served and Water Supply Needed.

Water Delivery Alternative	Groundwater Acres Served		Additional Columbia River Diversion[1]
	acres	*percent*	*(acre-feet)*
Alternative A – Construct East High Canal	140,000	100	515,300
Alternative B – Construct north portion of East High Canal / Enlarge and extend East Low Canal	127,300	91	453,200
Alternative C – Enlarge East Low Canal	70,100	50	216,800
Alternative D – Use existing East Low Canal	40,700	29	125,900

[1] Does not account for changes to current diversions if return flow changes are caused by the alternatives. This will be addressed in future studies.

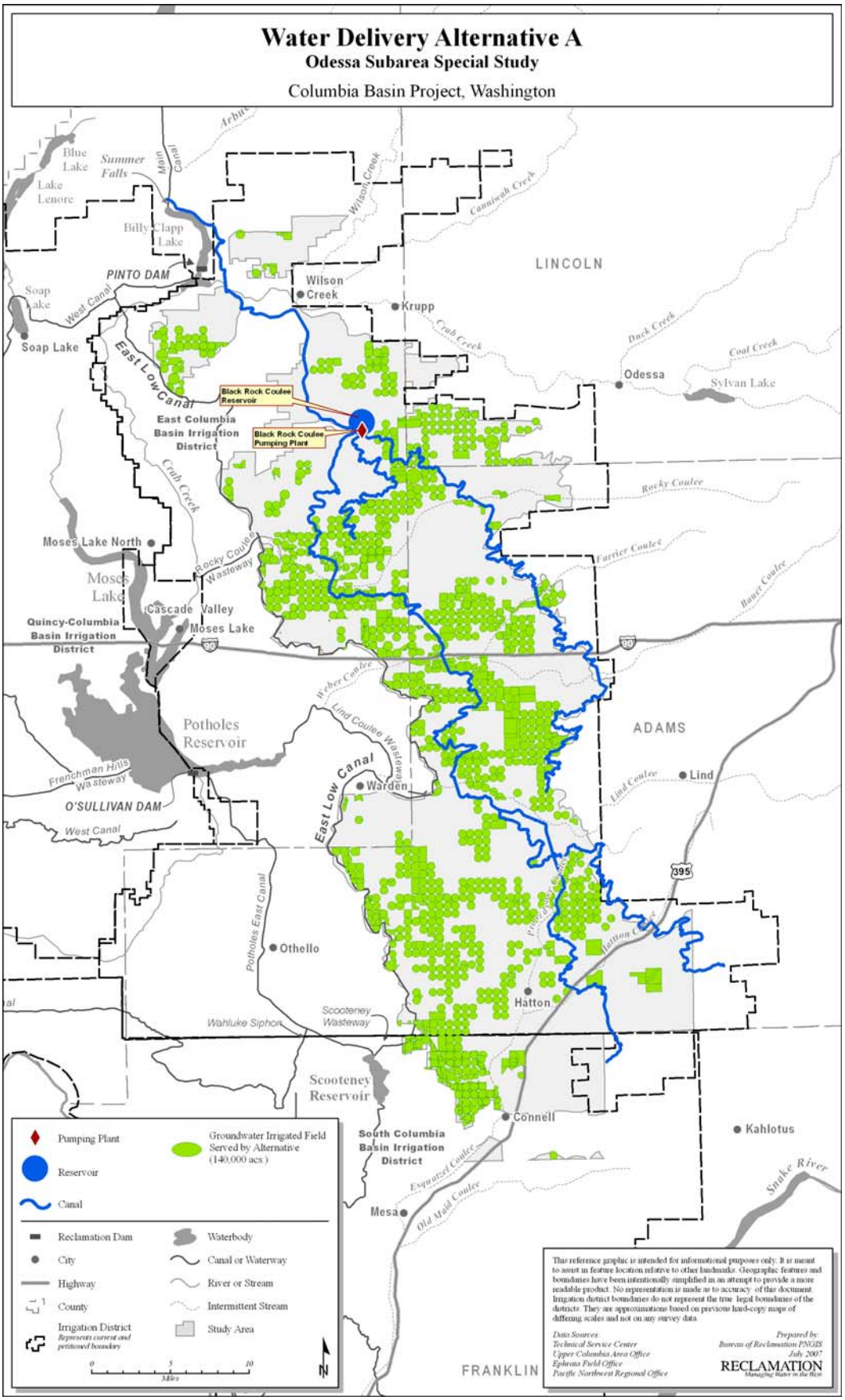

Figure 1. Water Delivery Alternative A.

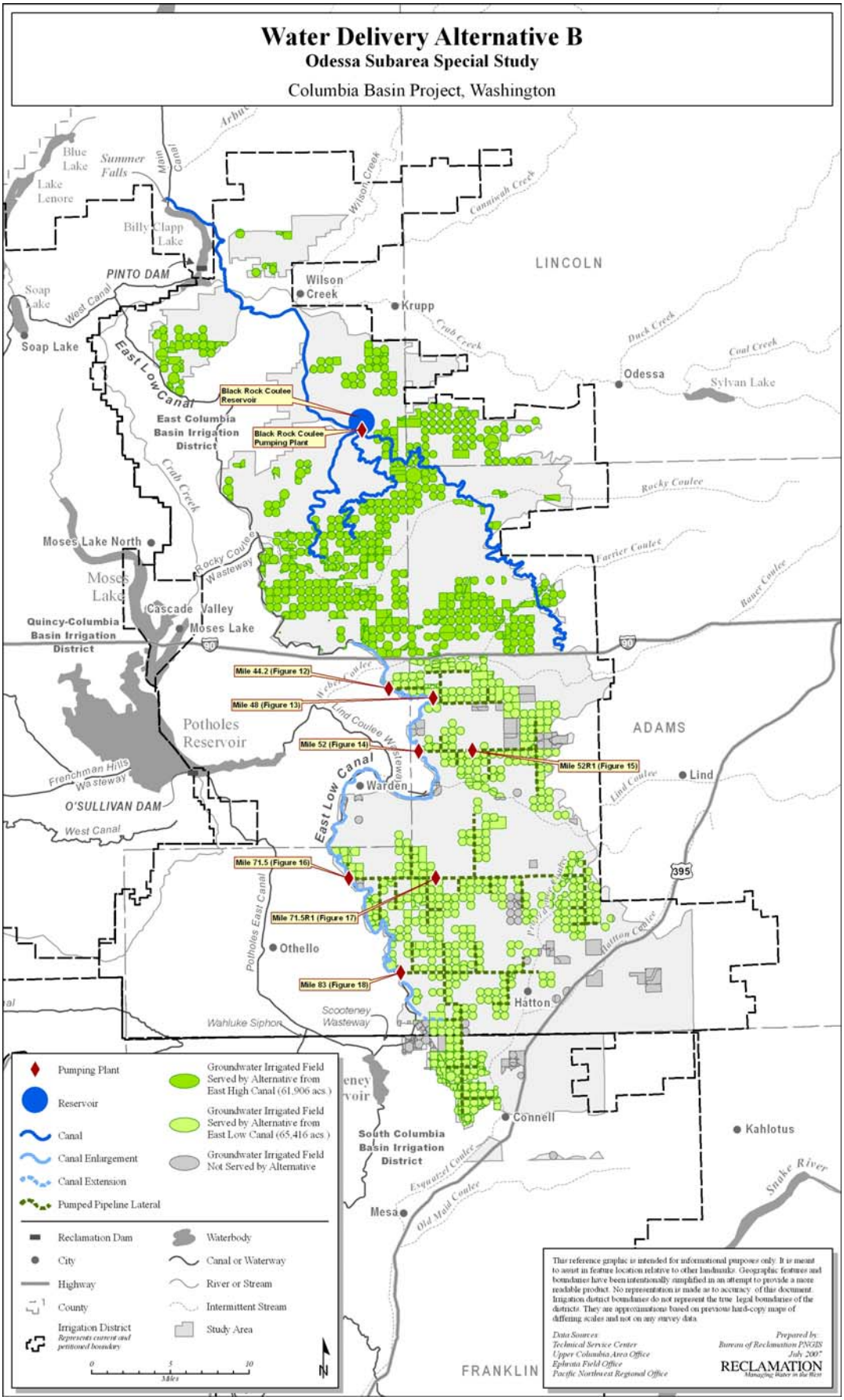

Figure 2. Water Delivery Alternative B.

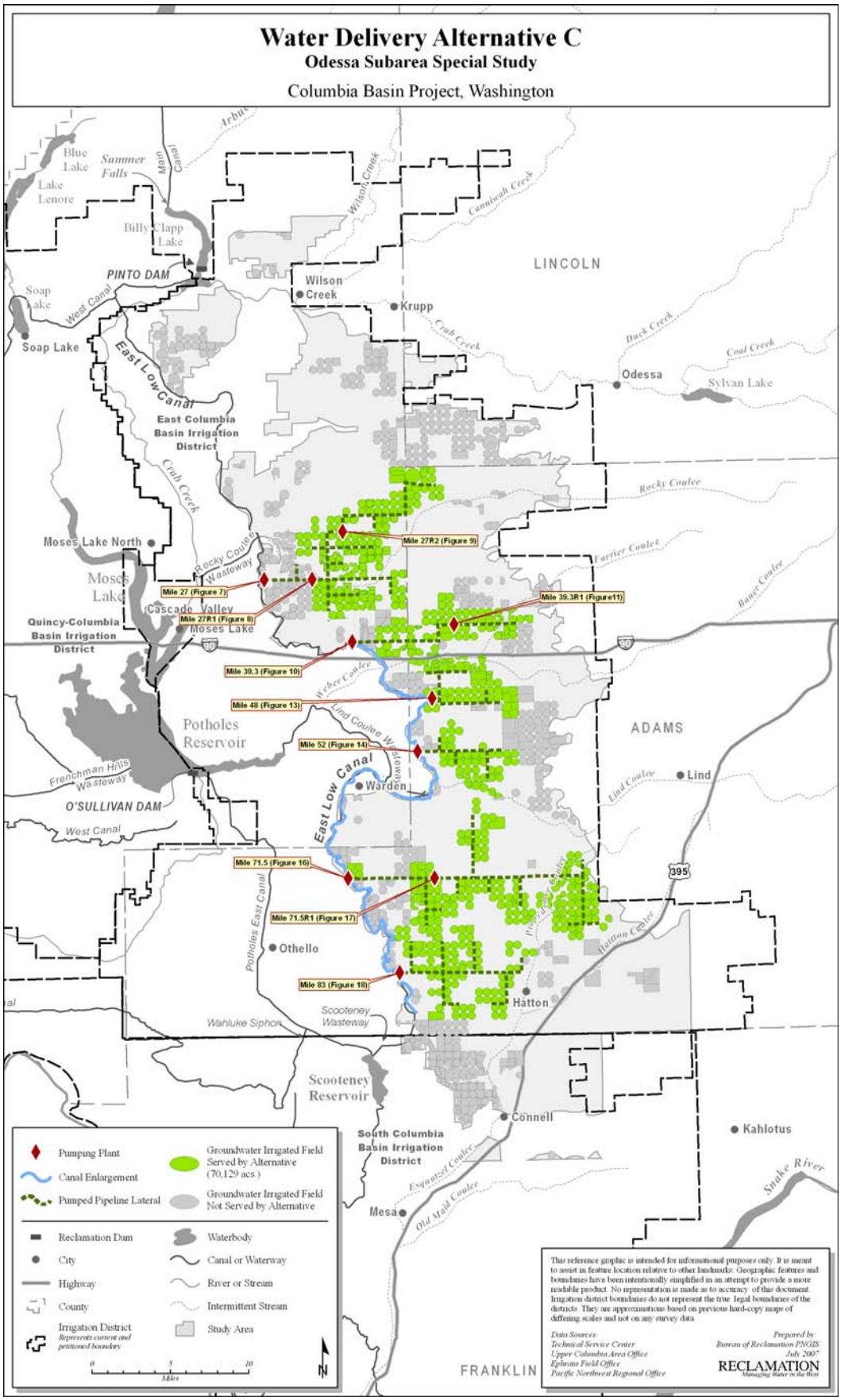

Figure 3. Water Delivery Alternative C.

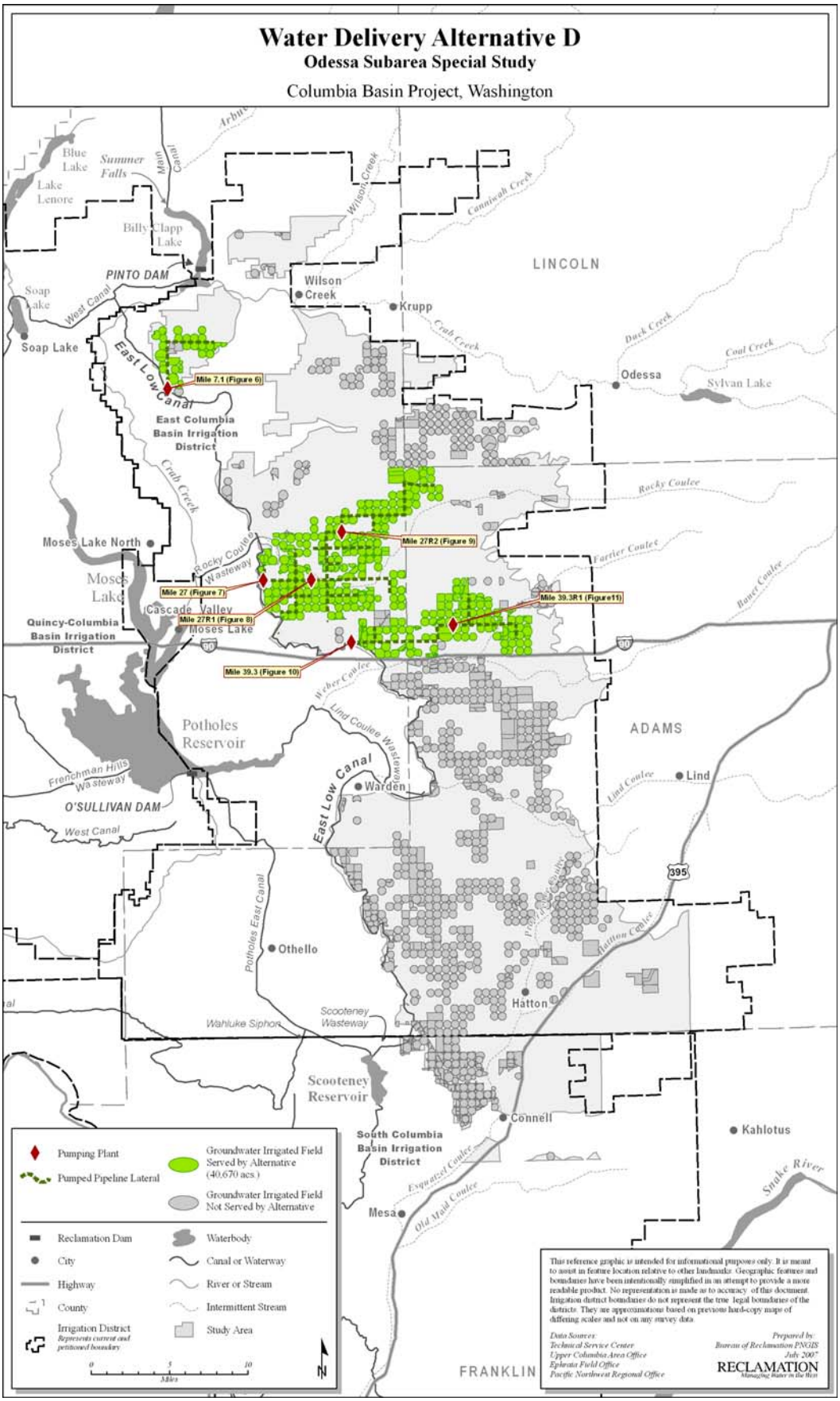

Figure 4. Water Delivery Alternative D.

Water Supply Options

Reclamation will need to divert additional water from the Columbia River greater than current Project diversions in order to provide a replacement water supply. Reclamation conducted a hydrologic modeled analysis to determine when water could be diverted from the Columbia River and not impact flow objectives identified by the National Marine Fisheries Service (NMFS) for anadromous fish listed under the Endangered Species Act (ESA). The analysis concluded no water is available for diversion during the months of April through August in drier years (see Figure 5). However, there is significant water available for diversion when the canals are still operational in September and October, even in the drier years. Water supply options examined included using existing Project storage reservoirs or building new storage reservoirs.

Use Existing Project Storage

Using existing Project storage facilities would require operational modifications as described here.

Banks Lake Drawdown – Drawdown Banks Lake to elevations lower than current operations. Alternative A would require an additional 16 feet of drawdown below current (baseline) operation (see Figure 6). Alternative D would require about 4 feet of additional drawdown.

Banks Lake Operational Raise - Raise the operational water surface of the reservoir by 2 feet. This would require modifications to the two dam embankments forming Banks Lake and to the Grand Coulee Feeder Canal.

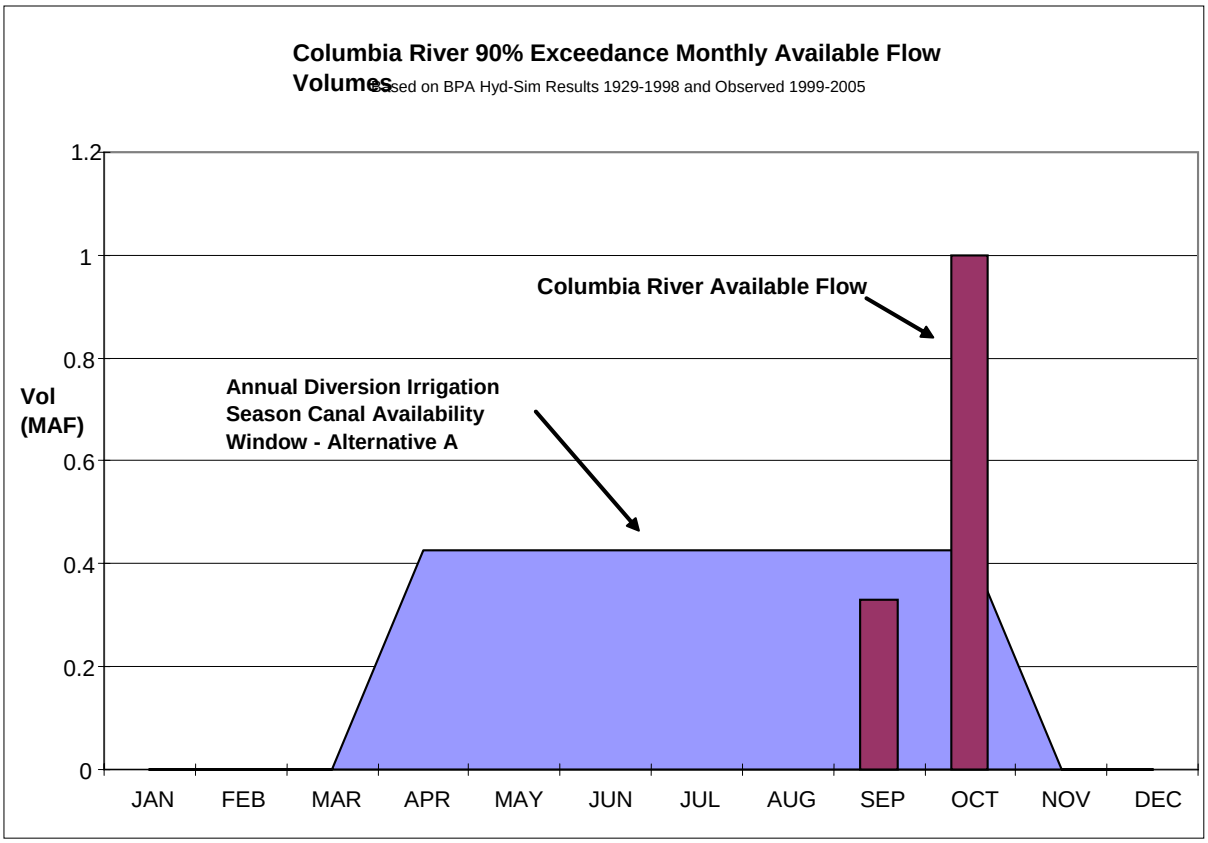

Figure 5. Columbia River Monthly Available Flow Volume for 90 Percent Exceedance (in Million Acre-Feet – MAF).

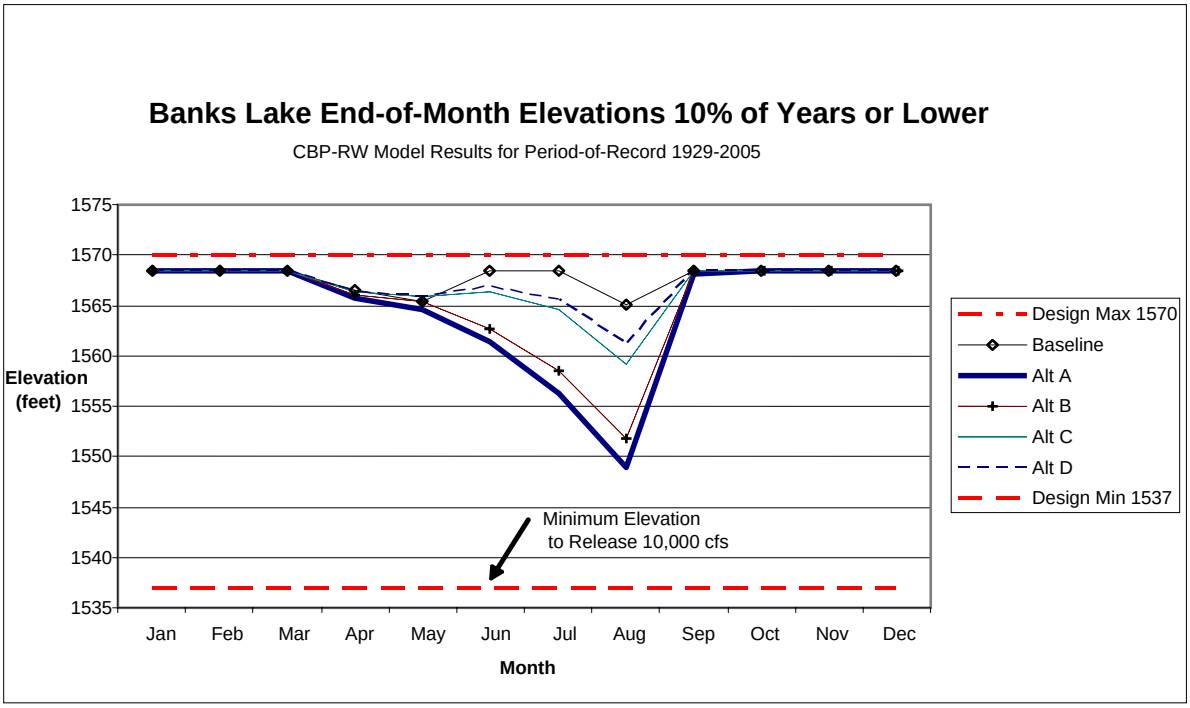

Figure 6. Banks Lake End-of-Month Elevations – 10 Percent of Years or Lower for 1929-2005 Period.

Potholes Reservoir Reoperation – Modify current operation by adjusting the timing of water storage in the reservoir. This would require structural modifications to O'Sullivan Dam and acquisition of downstream right-of-way along Lower Crab Creek to provide for changes to downstream flood passage.

Construct New Storage

New storage facilities would be filled in the months of September and October for use in April through August when water is not available for diversion from the Columbia River. The appraisal investigation examined three sites.

Dry Coulee Reservoir - Construct a new reservoir in Dry Coulee with an active storage capacity of 481,000 acre-feet. The reservoir would be fed via a new inlet canal from the existing Main Canal at a location upstream of Summer Falls. The reservoir would have two outlets. The upper outlet would feed to the West Canal immediately upstream of the existing West Canal Siphon. The lower outlet would discharge into Crab Creek for reservoir evacuation.

Rocky Coulee Reservoir and Pumping Plant - Construct a new reservoir in Rocky Coulee with an active storage capacity of 126,000 acre-feet and a pumping plant. The reservoir would be fed via a new inlet canal from the existing East Low Canal immediately upstream of the siphon crossing Rocky Coulee. A proposed Rocky Coulee Pumping Plant will convey water back to the East Low Canal via the proposed reservoir inlet canal to meet irrigation demands.

Lower Crab Creek Reservoir – Construct a new reservoir in Lower Crab Creek. Two reservoir sizes were examined, one with active storage capacity of 200,000 acre-feet and another with 472,000 acre-feet activity capacity. The reservoir would be fed from Potholes Reservoir via Lower Crab Creek. This option requires the construction of an outlet structure within the Potholes East Canal immediately downstream of O'Sullivan Dam and acquisition of right-of-way along Lower Crab Creek to provide for increased flows downstream. Water would be released from the proposed reservoir to the Columbia River to offset upstream irrigation diversions at Grand Coulee Dam.

Figure 7 identifies the locations of the water supply options. Table 2 summarizes the active storage and groundwater irrigated acres provided a replacement water supply for each option.

COST ESTIMATES

Appraisal-level cost estimates are used to determine whether more detailed feasibility-level investigations of alternatives are warranted. The cost estimates developed during the appraisal investigation were based on preliminary engineering designs and analysis, using limited available data and information. The designs are based on design data developed in previous Reclamation studies (completed between the 1960s and 1980s) supplemented with limited additional data. The design data collected for future studies may change future cost estimates significantly from that presented here. For these reasons, the cost estimates presented should be considered preliminary and are not suitable for determining actual construction costs, or requesting construction fund appropriations from the Congress. However, they are acceptable for making relative comparisons between the proposed water delivery alternatives and water supply options examined.

Figure 8 provides the estimated range of construction costs for each water delivery alternative. These cost estimates reflect field and non-contract costs. Field costs include the direct contract cost of materials and services for construction of facilities. Non-contract costs include investigations, designs and specifications, and construction engineering and supervision. Figure 8 cost estimates do not reflect the cost associated with obtaining a new replacement water supply. The range of cost estimates for individual water supply options are depicted in Figure 9.

Table 2. Water Supply Options – Active Storage and Groundwater Irrigated Acres Served.

	Active Storage *(acre-feet)*	**Groundwater Acres Served**		**Comments**
		acres	*percent*	
1) Banks Lake Drawdown	50,000 for every 2' drop	Up to 140,000	100	No engineering costs, but depending on extent of drawdown, environmental, cultural, and social costs. Drawdown up to 16 feet from baseline required for full replacement supply (see Figure 6).
2) Banks Lake Raise	50,000	16,700	12	Modification to embankments of both dams and to Grand Coulee Feeder Canal.
3) Potholes Reservoir Reoperation	50,000	16,700	12	Structural modifications to O'Sullivan Dam. Entails changing timing of storage.
4) Dry Coulee Reservoir	481,000	140,000	100	Two rockfill embankment dams proposed.
5) Rocky Coulee Reservoir	126,000	46,900	34	Earthfill embankment dam proposed.
6) Lower Crab Creek Reservoir	200,000	60,000	43	Rockfill embankment dam proposed. Filled from releases from Potholes Reservoir via Lower Crab Creek.
	472,000	140,000	100	

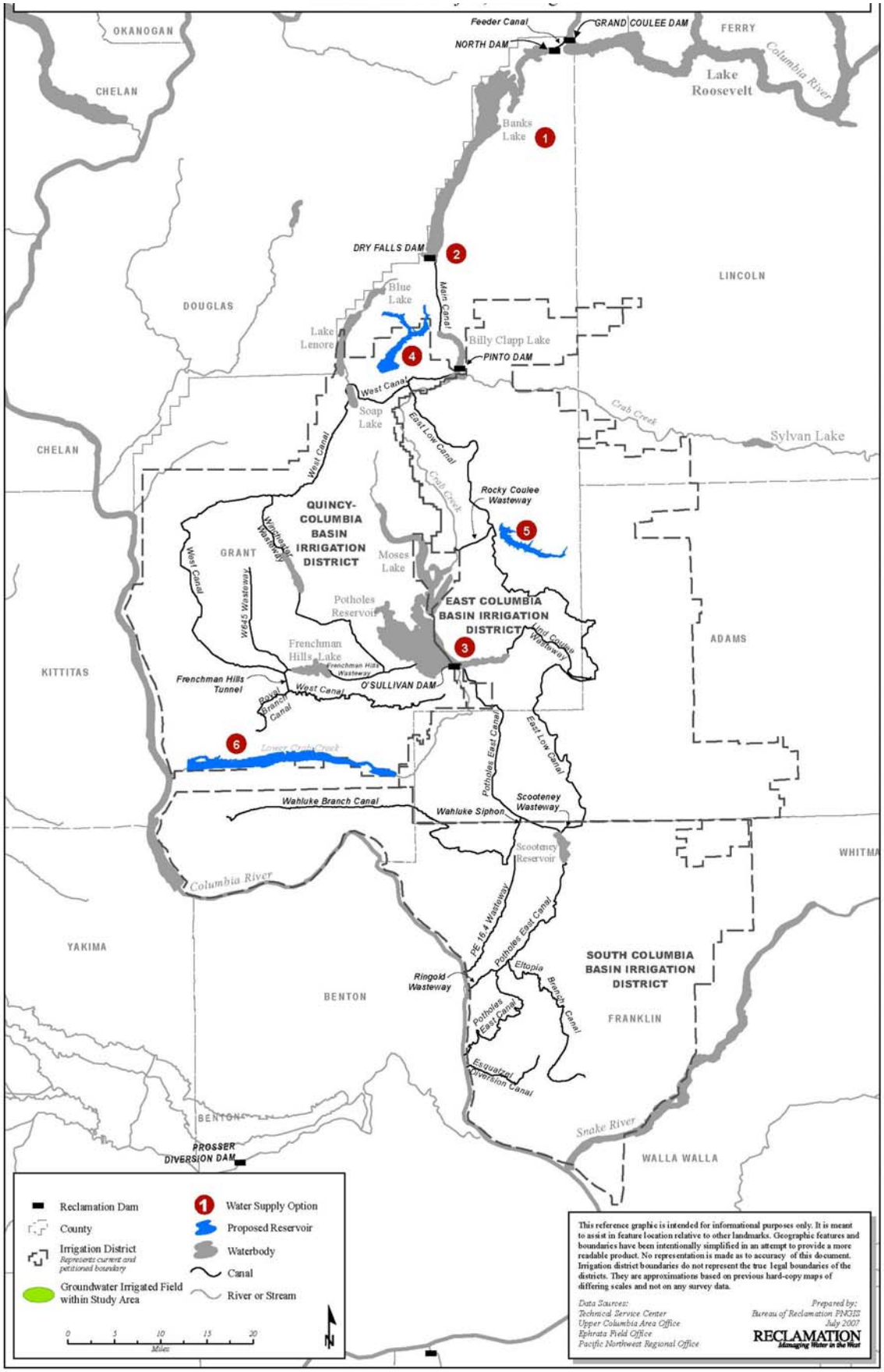

Figure 7. Water Supply Options *(Numbers on map are referenced in Table 2.).*

The total combined cost for providing a replacement water supply to groundwater irrigated lands in the Study area is dependent on the water supply option(s) selected for a water delivery alternative. Several water supply options may be needed to provide the replacement water supply required; numerous combinations are possible. Figure 10 illustrates the cost estimate range by water delivery alternative when combined with possible water supply option(s). Figure 11 provides the estimated cost per acre by water delivery alternative.

COMPARISON OF ALTERNATIVES AND OPTIONS

Reclamation has conducted a preliminary comparison of the water delivery alternatives and water supply options using the Study objectives developed during the PASS by stakeholders in the Study area. Seven study objectives (see box) were developed and were used to evaluate and rank concepts during the pre-appraisal PASS analysis. These objectives, as well as other criteria, will assist in evaluating and ranking the water delivery alternatives and water supply options for the purpose of identifying alternative(s) to investigate in the next Study phase.

Attachments 1 and 2 compare the water delivery alternatives and water supply options, respectively, using these Study objectives and also identify some potential environmental, social, and cultural effects and issues associated with each.

STUDY OBJECTIVES DEVELOPED DURING PASS

"How do the alternatives differ in the ability to…?"

- Replace all or a portion of current groundwater withdrawals within the Project area of the Odessa Subarea with Project water.
- Maximize use of existing Project infrastructure.
- Retain the possibility of full Project development in the future.
- Address ESA issues, including the National Marine Fisheries Service's Columbia River seasonal flow objectives for salmon and steelhead, and potential impacts to shrub-steppe habitat.
- Provide environmental and recreational enhancements.
- Minimize potential delay in the Study schedule.
- Be developed in phases based on funding expectations, physical and operational constraints, and rate of groundwater decline.

NEXT STUDY PHASE

Reclamation will review the information developed during the appraisal investigation, as well as the feedback we receive, to evaluate and compare the water delivery alternatives and water supply options. One or more alternatives and options could be selected for future study, taking into account all of this information. A report documenting the appraisal investigation and recommendations will be issued early in 2008.

Selection of alternatives and options will initiate the next Study phase – feasibility investigation. Up to this point the Study has relied predominately on readily available information to develop conceptual engineering designs and preliminary cost estimates, and identify potential environmental and social issues. The feasibility investigation will study alternatives at a level of detail sufficient to allow a comprehensive analysis and comparison so that Reclamation managers have full understanding of the benefits and tradeoffs, allowing an informed selection of a preferred alternative. The feasibility investigation provides the supporting information for any requests to Congress for construction funding.

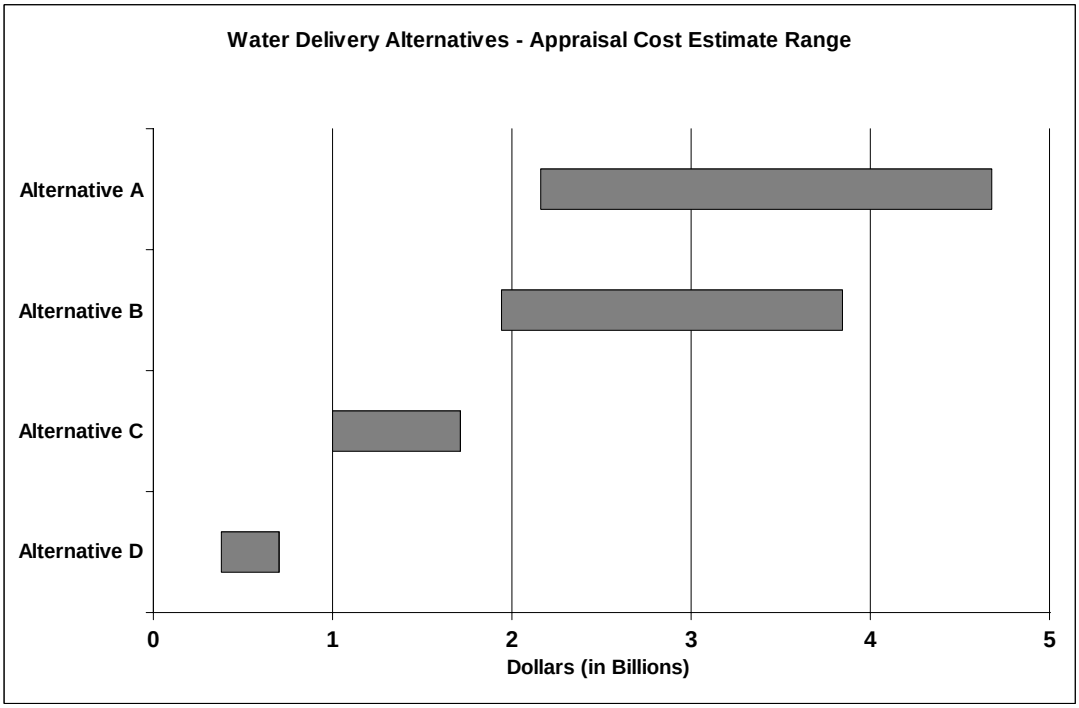

Figure 8. Appraisal Cost Estimate Range by Water Delivery Alternative (in Billions).

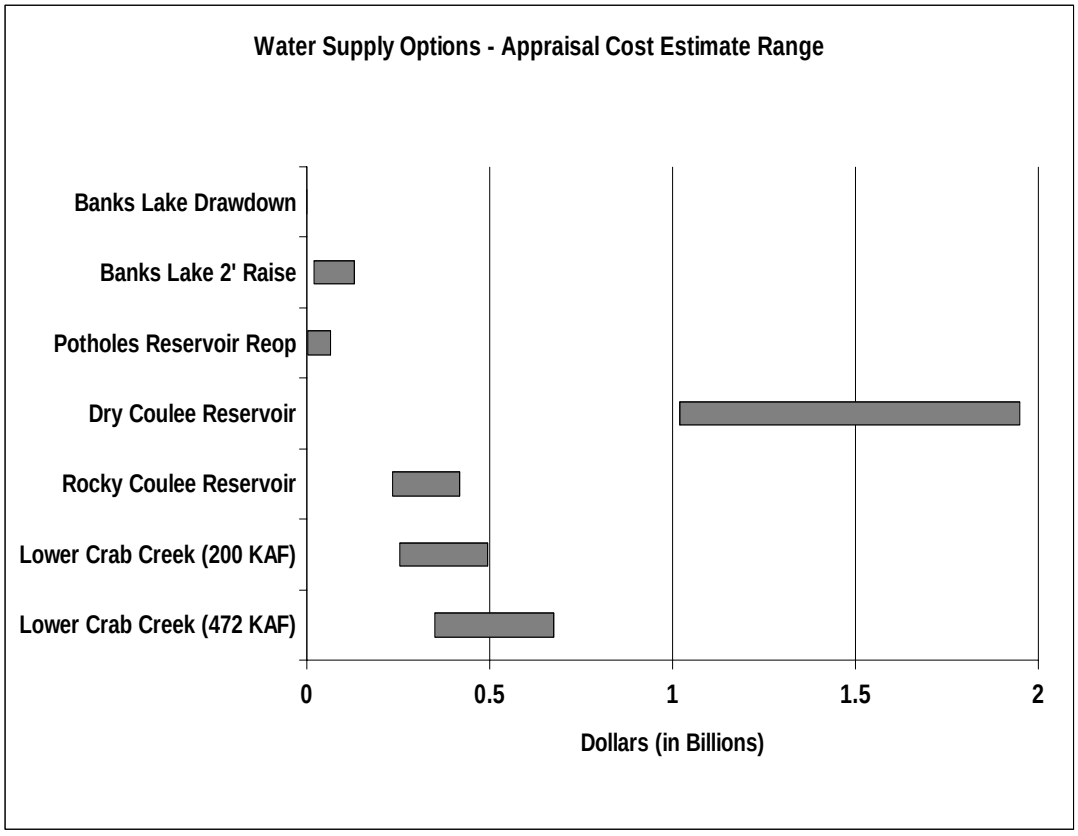

Figure 9. Appraisal Cost Estimate Range for Each Water Supply Option (in Billions).

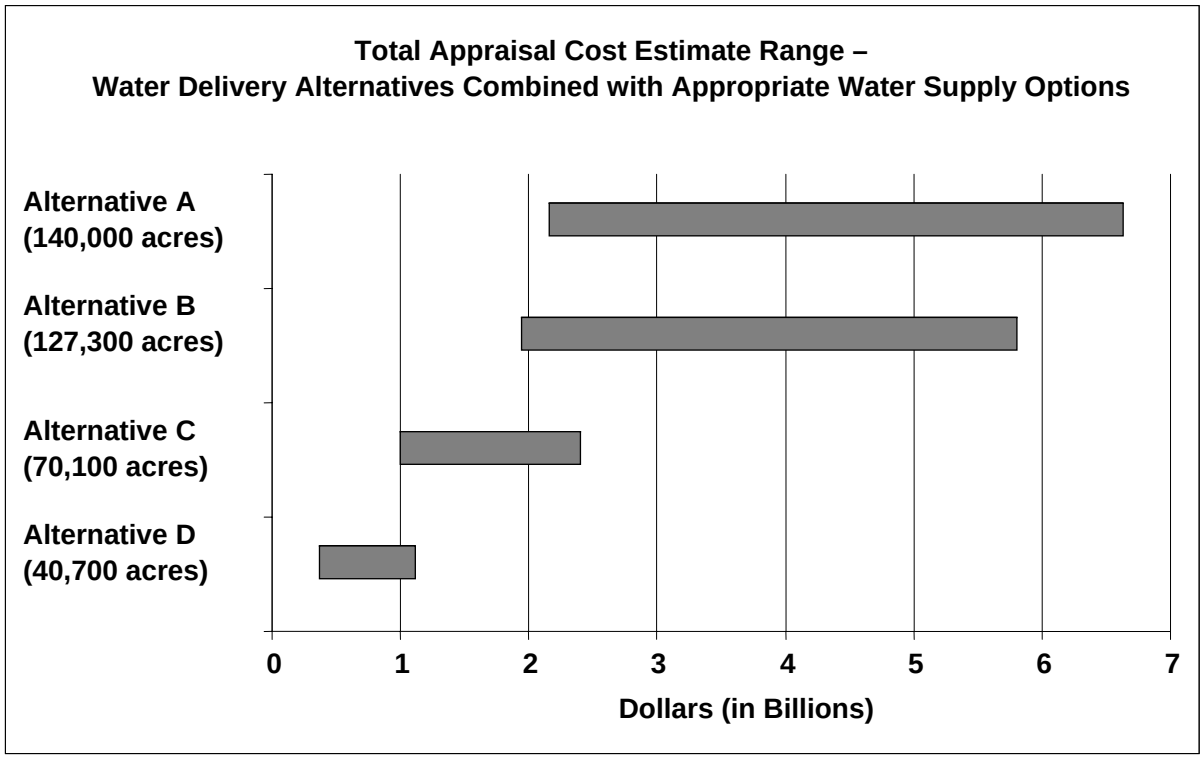

Figure 10. Total Appraisal Cost Estimate Range by Water Delivery Alternative Combined with Appropriate Water Supply Options(s) (in Billions).

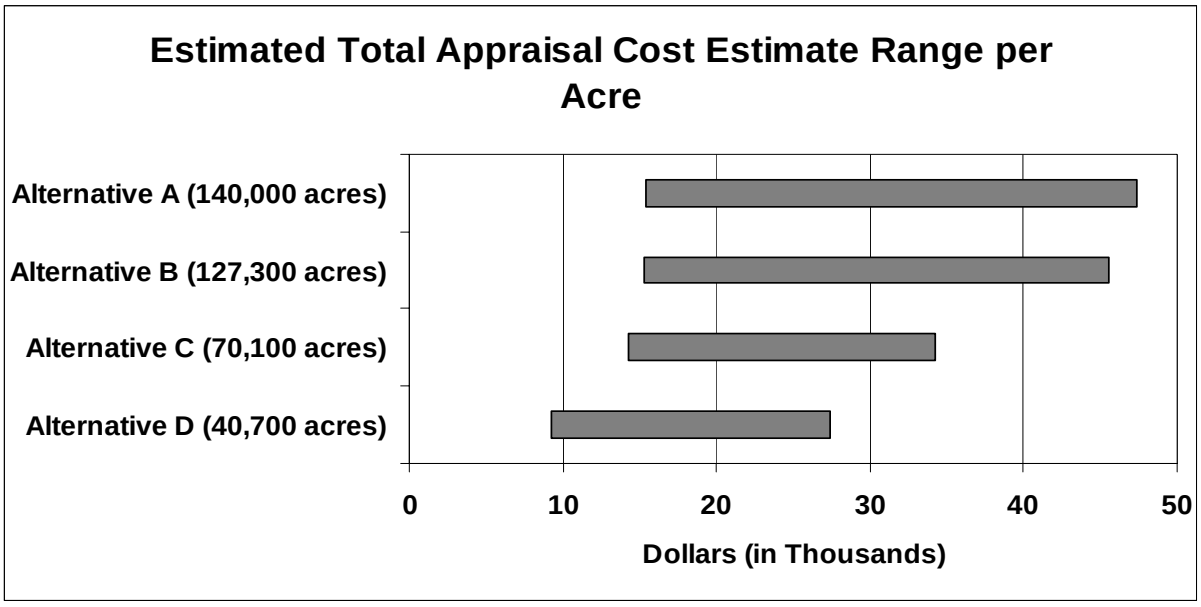

Figure 11. Total Appraisal Cost Estimate Range per Groundwater Acre Served (in Thousands).

The feasibility investigation will entail extensive data collection and analysis and development of detailed engineering drawings and cost estimates. The economic and financial feasibility of alternatives will be calculated. Various data collection efforts will begin, including surveys for fish, wildlife, plant, and cultural resources, as well as additional geologic and hydrologic investigations, and continued aquifer monitoring activities.

Environmental compliance activities will begin sometime in 2008, shortly after the feasibility investigation begins, and will include activities to meet National Environmental Policy Act (NEPA) and ESA requirements. The feasibility investigation and environmental analyses will be integrated in a combined planning report and appropriate NEPA document (entailing either an Environmental Impact Statement or Environmental Assessment). The feasibility and environmental studies are anticipated to take three years.

WE WANT TO HEAR FROM YOU

During the next few months, Reclamation will use the appraisal investigation results and the feedback received to compare and evaluate the water delivery alternatives and water supply options. We will use this information to select those that will be studied during the feasibility investigation. We welcome your thoughts on the criteria we should use or issues that should be considered during this process. Please provide your comments to Ellen Berggren, Study Manager, by **November 30, 2007** (see contact information in the box below).

FOR MORE INFORMATION

We will continue to provide you updates about Study progress and the availability of reports and other Study documents. If you have any comments or questions, please contact

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Or visit our website at: www.usbr.gov/pn/.

ATTACHMENT 1 – Comparison of Water Delivery Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D	Comments
STUDY OBJECTIVES					
Replace all or portion of current GW within Project area of Odessa Subarea with Project water. (GW acres replaced)	140,000 ac. 100%	127,300 ac. 91%	70,100 ac. 50%	40,700 ac. 29%	
Maximize use of existing infrastructure (no/minimal impact to existing users).	Significant new infrastructure construction, including EHC system and Black Rock Re-regulating Reservoir	Significant new infrastructure construction, including EHC system and Black Rock Re-regulating Reservoir . Expands and extends existing ELC	Expands capacity of and extends existing ELC	Uses existing ELC and adjustments in operations	All alternatives require new pipelines, laterals and pumping plants to convey water to irrigated lands. Alternative with ELC component will need to coordinate construction to not interfere with current irrigation delivery. Additional Columbia River diversion will affect power generation. However, this may be offset to some extent by reduced pumping of ground water.
Retain the possibility of full Project development in the future.	Yes	Yes	Yes	Yes	
Address ESA issues (NMFS Columbia River flow objectives, shrub-steppe habitat impacts)	Shrub-steppe habitat impacted with new infrastructure construction	Shrub-steppe habitat impacted with new infrastructure construction	No significant ESA issues anticipated	No significant ESA issues anticipated	Effects to NMFS Columbia River ESA flow objectives are dependent on water supply option selected. Effects to other ESA species based on extent of new construction crossing shrub-steppe habitat.
Provide environmental and recreational enhancements.	Possible secondary benefits from conveyance facilities seepage that will result in wetlands and wildlife habitat.	Possible secondary benefits from conveyance facilities seepage that will result in wetlands and wildlife habitat.	Possible secondary benefits from conveyance facilities seepage that will result in wetlands and wildlife habitat.	Possible secondary benefits from conveyance facilities seepage that will result in wetlands and wildlife habitat.	Modeling studies assumed that greatest seepage occurred for Alternatives A and B.
Minimize study schedule delays (NEPA/ Feasibility completed in 2011).	New construction entails greater study effort and time. Could not be completed by 2011.	New construction entails greater study effort and time. Could not be completed by 2011.	Will require more time to study than Alt. D, but not as much as Alternatives A and B.	Least amount of study time required	East High Canal system and associated components would entail significant study effort and could not be completed by 2011.

	Alternative A	Alternative B	Alternative C	Alternative D	Comments
Developed in phases based on funding, physical /operational constraints, and rate of groundwater decline.	Would likely require a phased approach to obtain sufficient funding to study and implement.	Would likely require a phased approach to obtain sufficient funding to study and implement.			
POTENTIAL EFFECTS AND ISSUES [1]					
Habitat and Species	Upper end crosses significant areas of shrub-steppe habitat	Upper end crosses significant areas of shrub-steppe habitat	Laterals may affect some shrub-steppe habitat	Predominately cropland	Shrub-steppe habitat associated with Federal and State species of concern, including Columbia Basin pygmy rabbit, WA ground squirrel, greater sage grouse, sharp-tail grouse, sagebrush lizard, sage sparrow, brewer's sparrow, grasshopper sparrow, and sage thrasher.
Land Use	Potential for effects to wildlife related recreation	Potential for effects to wildlife related recreation	Potential for effects to wildlife related recreation	Potential for effects to wildlife related recreation	Detailed inventories of land use along proposed water delivery infrastructure have not yet been conducted.
Cultural and Historic Resources	May cross areas with prehistoric sites	May cross areas with prehistoric sites ELC eligible for National Federal Register	Lesser probability of prehistoric sites ELC eligible for National Federal Register	Lesser probability of prehistoric sites ELC eligible for National Federal Register No significant cultural resource issues anticipated	Alternatives A and B entail construction of new infrastructure through some undisturbed areas. Alternatives C and D less likely to encounter cultural resources as it entails expansion of existing facility which already has disturbance in vicinity. ELC recommended eligible for listing on National Register of Historic Places

1) Potential effects are based on preliminary review of Geographic Information System (GIS) datasets and communications with the Washington Department of Fish and Wildlife and U.S. Fish and Wildlife Service. It is not intended to be a comprehensive assessment of effects. Data was not available for all sites during appraisal investigation. More detailed studies and surveys of potential land areas are required to more accurately assess the presence of cultural and historic resources, species, habitat, and possible effects. This will occur for those water delivery alternatives that are selected for feasibility investigation.

Ac. = acres
GW = groundwater
EHC = East High Canal
ELC = East Low Canal

ATTACHMENT 2- Comparison of Water Supply Options

	Banks Lake Drawdown	Banks Lake 2' Raise	Potholes Reop	Dry Coulee	Rocky Coulee	Lower Crab Creek (200 KAF)	Lower Crab Creek (472 KAF)	Comments
STUDY OBJECTIVES								
Replace all or portion of current GW within Project area of Odessa Subarea with Project water. (GW acres replaced)	Up to 140,000 ac. 100%	Up to 16,700 ac. 12% (50 KAF)	Up to 16,700 ac. 12% (50 KAF)	Up to 140,000 ac. 100% (481 KAF)	Up to 46,900 ac. 34% (126 KAF)	60,000 ac. 43% (200 KAF)	Up to 140,000 ac. 100% (472 KAF)	
Maximize use of existing Infrastructure (no/minimal impact to existing users).	Yes; new impacts to users of recreation and other resources from further drawdown	Requires modifications to dams	Requires modifications at dam; flood evacuation route downstream	New construction	New construction	New construction	New construction	
Retain possibility of future full Project development.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Address ESA issues (NMFS Columbia River flow objectives, shrub-steppe habitat impacts)	No significant ESA issues anticipated.	No significant ESA issues anticipated.	Potential downstream issues to Lower Crab Creek; ESA listed steelhead	Site predominately shrub-steppe	Site predominately under agricultural production	Shrub-steppe, wetlands, ESA-listed Upper Columbia River steelhead critical habitat	Shrub-steppe, wetlands, ESA-listed Upper Columbia River steelhead critical habitat	All water supply options were developed with the goal of minimizing effects on Columbia River ESA flow objectives; potential effects to other aspects of ESA species focused on possible effects to shrub-steppe habitat.
Provide environmental and recreational enhancements.	Drawdowns below current baseline of 1565' will likely result affect recreation access & experience	Possible impacts to recreational facilities; short term, may extend seasonal access in long-term	Higher winter elevation may impact recreation facilities short term, enhance in long term	May provide new recreational and wildlife habitat opportunities*	May provide new recreational and wildlife habitat opportunities*	May provide new recreational and wildlife habitat opportunities*	May provide new recreational and wildlife habitat opportunities*	* New reservoirs may provide additional opportunities, but timing of refill (Sept. - Oct.) and drawdown (April-August) may preclude quality experience; more analysis would be required.
Minimize study schedule delays (NEPA/ Feasibility completed in 2011).	Least amount of study time required	Requires study of possible modifications to dams	Requires study of possible modifications to dam	New construction entails greater effort and time	New construction entails greater effort and time	New construction entails greater effort and time	New construction entails greater effort and time	New water storage would entail significant study effort and may not be completed by 2011.

	Banks Lake Drawdown	Banks Lake 2' Raise	Potholes Reop	Dry Coulee	Rocky Coulee	Lower Crab Creek (200 KAF)	Lower Crab Creek (472 KAF)	Comments
Developed in phases based on funding, physical /operational constraints, and rate of groundwater decline.	Quickest and cheapest to implement			See comment	See comment	See comment	See comment	Construction of new storage reservoirs will require more extensive study before construction. Dry Coulee and Lower Crab Creek have the most complex issues to address.
POTENTIAL EFFECTS AND ISSUES [1]								
Habitat and Species	Reservoir fisheries and other aquatic species Aquatic, emergent and shoreline vegetation	Inundation of existing shoreline vegetation	Aquatic and wildlife resources associated with Lower Crab Creek and Columbia National Wildlife Refuge from increased stream flows	4442 ac. shrub-steppe High value raptor, bat, snake, and lizard habitat Loggerhead shrike White-tailed jackrabbit Leopard frog Potentially supports 10 WA State Species of Concern	392 ac. shrub-steppe Potentially supports 5 WA State Species of Concern	3874 ac. shrub-steppe 1,603 ac. wetland High value raptor, bat, snake, and lizard habitat Sandhill crane Striped whipsnakes Loggerhead shrike Leopard frog Waterfowl Potentially supports 11 WA State Species of Concern Potential occurrence of State endangered or threatened plant species	4,461 ac. shrub-steppe 1,868 ac. wetlands High value raptor, bat, snake, and lizard habitat Sandhill crane Striped whipsnakes Loggerhead shrike Leopard frog Waterfowl Potentially supports 10 WA State Species of Concern Potential occurrence of State endangered or threatened plant species	Shrub-steppe habitat associated with Federal and State species of concern, including Columbia Basin pygmy rabbit (proposed ESA), WA ground squirrel, greater sage grouse, sharp-tail grouse, sagebrush lizard, sage sparrow, brewer's sparrow, grasshopper sparrow, and sage thrasher.

	Banks Lake Drawdown	Banks Lake 2' Raise	Potholes Reop	Dry Coulee	Rocky Coulee	Lower Crab Creek (200 KAF)	Lower Crab Creek (472 KAF)	Comments
Land Use	Effects to reservoir access and quality of recreation May affect State Highway 155 road stability, adjacent to reservoir	May affect recreation access and land use surrounding reservoir from increase in elevation	Roads, bridges, utilities, recreation facilities, other structures, and cropland associated with the Columbia National Wildlife Refuge and private entities may be affected with increased flows in Lower Crab Creek	1342 ac. public 3766 ac. private 6 residences 10 miles road 258 ac. cropland Moderate wildlife related recreation value	79 ac. public 2941ac. private 6 residences 5 miles road 1925 ac. cropland Low wildlife related recreation value	5411 ac. public 3558 ac. private 20 residences 21 miles road 0.8 miles railroad 2291 ac. cropland High wildlife related recreation value See comment*	7876 ac. public 4806 ac. private 20 residences 27 miles road 1.3 miles railroad 2933 ac. cropland High wildlife related recreation value See comment*	*The proposed Lower Crab Creek Reservoir would inundate portions of the Columbia National Wildlife Refuge, affecting roads, bridges, utilities, recreation facilities, and other structures. Private land would also be affected and include roads, structures and cropland.
Cultural and Historic Resources	Increased exposure of sites	Could result in new exposure of cultural resources	Unknown	Possibility of prehistoric sites	Possibility of prehistoric sites	Possibility of prehistoric and historic sites	Possibility of prehistoric and historic sites	.

1) Potential effects are based on preliminary review of Geographic Information System (GIS) datasets and communications with the Washington Department of Fish and Wildlife and U.S. Fish and Wildlife Service. It is not intended to be a comprehensive assessment of effects. Data was not available for all sites during appraisal investigation. More detailed studies and surveys of potential land areas are required to more accurately assess the presence of cultural and historic resources, species, habitat, and possible effects. This will occur for those water supply options that are selected for feasibility investigation.

Ac. = acres
GW = groundwater
WA = Washington