EXECUTIVE SUMMARY

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Introduction

The Yakima River Basin Water Storage Feasibility Study (Storage Study), as authorized by the Omnibus Appropriations Act of 2003 (Omnibus Act), Public Law 108-7, examines the feasibility and acceptability of storage augmentation for the benefit of fish, irrigation, and future municipal water supply for the Yakima River basin. The Bureau of Reclamation (Reclamation) and the State of Washington, represented by the Department of Ecology (Ecology), are the co-lead agencies of the Storage Study.

The purpose of the Storage Study is to evaluate plans that would create additional water storage for the Yakima River basin, and assess each plan's potential to supply the water needed for fish and the aquatic resources that support them, basinwide irrigation, and future municipal demands.

The need for the study is based on the existing finite water supply and limited storage capability of the Yakima River basin. This finite supply and limited storage capability does not meet the water supply demands in all years and results in significant adverse impacts to the Yakima River basin's economy, which is agriculture-based, and to the basin's aquatic resources—specifically those resources supporting anadromous fish.

Through a process of meeting with stakeholders, Tribal, Federal, State, and local agencies, and utilizing previous investigations, Reclamation developed the goals for the Storage Study. Storage Study goals include:

- Improve anadromous fish habitat by restoring the flow regimes of the Yakima and Naches Rivers to more closely resemble the natural (unregulated) hydrograph. Through a collaborative process with the Storage Study Technical Work Group (SSTWG),[1] Reclamation developed nonbinding flow objectives to assist in measuring goal achievement (table ES.1).

- Improve the water supply for proratable (junior) irrigation entities by providing a not less than 70-percent irrigation water supply for irrigation districts during dry years relying on diversions subject to proration. This 70-percent goal equates to 896,000 acre-feet of proratable entitlements.

- Meet future municipal water supply needs by maintaining a full municipal water supply for existing users and providing additional surface water supply of 82,000 acre-feet for population growth to the year 2050.

[1] A biologist work group formed to assist on technical matters related to the Yakima River basin aquatic habitat aspects.

Table ES.1 Monthly flow objectives (cubic feet per second [cfs]) for an average water year for the Easton, Cle Elum River, Ellensburg, Wapato, and lower Naches River reaches

Reach	Spring				Summer				Winter			
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Easton	722	1,166	1,400	787	450	375	375	375	425	450	450	450
Cle Elum River	511	954	1,500	1,301	589	400	400	400	425	425	425	425
Ellensburg	1,982	2,424	3,700	2,586	2,000	1,000	1,000	1,000	980	1,016	1,257	1,459
Wapato	3,109	2794	3,500	2655	1,300	1,300	1,300	1,300	1,758	1,854	2,163	2,460
Lower Naches River	1,265	1,802	2,297	2,291	988	550	550	550	500	576	691	720

This Draft Planning Report/Environmental Impact Statement (Draft PR/EIS) combines a planning report and an environmental impact statement into one document. Because Ecology is a co-lead of the Storage Study, the storage augmentation alternatives are referred to in this document as "Joint Alternatives." The following Joint Alternatives are considered:

- Black Rock Alternative
- Wymer Dam and Reservoir Alternative
- Wymer Dam Plus Yakima River Pump Exchange Alternative

In addition to Reclamation's authorization and focus on storage augmentation, Ecology, to meet the intent of the State Environmental Policy Act (SEPA), evaluated a broader range of potential actions—encompassing both structural and nonstructural options both within the Yakima River basin and elsewhere in the Columbia River Basin—that may improve water availability for fish, irrigation, and municipal demands. Consequently Ecology evaluated alternatives that were not limited to storage options or storage facilities located within the Yakima River basin. These alternatives are referred to as "State Alternatives."

- Enhanced Water Conservation Alternative
- Market-Based Reallocation of Water Resources Alternative
- Groundwater Storage Alternative

All alternatives have been compared to the No Action Alternative, and the results are presented in this Draft PR/EIS.

Background

The Yakima Project's surface water supply comes from the natural unregulated runoff of the Yakima River and its tributaries, irrigation return flows, and releases

of stored water from the five main reservoirs in the basin.[2] Only 30 percent of the average annual natural runoff can be stored in the storage system. The Yakima Project depends heavily on the timing of unregulated spring and summer runoff from snowmelt and rainfall. The spring and early summer natural runoff flows supply most river basin demands through June in an average year. The majority of spring and summer runoff is from snowmelt; as a result, the snowpack is often considered a "sixth reservoir." In most years, the five major reservoirs are operated to maximize storage in June, which typically coincides with the end of the major natural runoff. The reservoirs have a combined storage capacity of about 1.07 million acre-feet (maf).

Demand for water from the Yakima River cannot always be met in years with below-average runoff. Currently, Reclamation storage contracts total 1.74 maf, but the average yearly runoff passing through the storage reservoir system is only 1.71 maf. Though all of the entitlement holders do not call on their full entitlement volume every year, the existing surface water supply does not presently meet all water needs in dry years. A poor water year results in prorationing during the irrigation season. Prorationing refers to the process of equally reducing the amount of water delivered to junior, i.e., "proratable" water right holders in water-deficient years. In addition, reduced summer and early fall streamflows inhibit migrating, spawning, and rearing conditions for anadromous fish.

Currently, only the cities of Cle Elum and Yakima obtain their municipal and domestic water from the surface waters of the Yakima River basin. Groundwater supplies the remainder of the municipal and domestic needs (83 percent) and is the preferred source for meeting future needs.

Alternatives

Analytical Process

Operation studies were conducted and resource indicators were used to assess the effects of the No Action, Black Rock, Wymer Dam and Reservoir, Wymer Dam Plus Yakima River Pump Exchange, Groundwater Storage, and Enhanced Water Conservation Alternatives on water resources. Water resources include flows in the Yakima and Columbia Rivers, reservoir operations in the Yakima River basin, and water supply. The operation studies and resource indicators also were used to assess the environmental consequences of the alternatives on many of the Yakima River basin's aquatic and terrestrial resources.

The operation studies include the use of several analytical models including RiverWare, Sediment Impacts Analysis Methods (SIAM), Decision Support

[2] The five major reservoirs (and their acre-foot active capacities) are: Keechelus (157,800); Kachess (239,000); Cle Elum (436,900), Bumping (33,700), and Rimrock/Tieton Dam (198,000).

System (DSS), U.S. Geological Survey (USGS) temperature, and Ecosystem Diagnostic and Treatment (EDT) models. RiverWare is a river flow model used to estimate daily average streamflow at several locations throughout the Yakima River basin, plus estimate daily irrigation diversions and daily reservoir storage volume by reservoir for each alternative. The RiverWare model uses a 25-year hydrologic period of historical water years of 1981-2005 (November 1, 1981-October 31, 2005). The SIAM model estimates bedload movement and bed scour for key stream reaches. The DSS model for the Easton, Ellensburg, Union Gap, Wapato, and lower Naches River reaches was used to estimate the amount (acres) and difference in summer rearing habitat for the spring Chinook and steelhead fry and yearling life stages under each Joint Alternative compared to the No Action Alternative. The USGS temperature model focuses on the Parker-to-Prosser Diversion Dam reach, comparing the relative change in water temperature between alternatives. The EDT model estimates the difference in salmon and steelhead abundance based on habitat quantity and quality.

Seepage modeling for the Black Rock Alternative indicates that an increase in groundwater flow (estimated up to 30 cfs) into the Hanford Site would be expected. The seepage would change groundwater conditions on the Hanford Site so that flow direction, contaminant concentrations, and rate of contaminant movement toward the Columbia River could be affected. Mitigation measures are being considered to reduce the seepage into the Hanford Site.

Joint Alternatives

The Joint Alternatives addressed in this document were developed via processes that conform to the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies* (*P&Gs*). The alternatives are then compared using the four accounts—National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE)—to facilitate evaluation and to display effects of the alternatives.

Federal feasibility studies conducted by Reclamation, such as the Storage Study, are detailed investigations specifically authorized by Congress to determine the desirability of seeking congressional authorization for implementation of a preferred alternative, normally the NED Alternative, which reasonably maximizes net national economic development benefits. However, none of the alternatives developed in this feasibility study meet the requirements to be identified as the NED Alternative. The alternatives do, however, result in positive changes in regional income and regional employment, anadromous fish habitat improvements, and improved urban and community attributes as shown in the RED, EQ, and OSE accounts, respectively. Because of these positive changes, the alternatives are presented in this Draft PR/EIS, although no alternative has been identified as a

"preferred alternative." A preferred alternative may be identified in the Final PR/EIS based on factors other than the economic standard. The reason for the selection will be explained in the Final PR/EIS.

No Action Alternative

The No Action Alternative is intended to represent the most likely future expected in the absence of constructing additional storage, against which all action alternatives are measured. The No Action Alternative includes future implementation of water conservation measures and water acquisitions as proposed under Title XII of the Act of October 31, 1994, which established the Yakima River Basin Water Enhancement Program. The water conservation measures included in the No Action Alternative are those plans submitted by irrigation entities under the Basin Conservation Program that are currently being constructed or considered for future implementation with funding from the Basin Conservation Program or from other sources.

The No Action Alternative will include construction of new facilities such as reregulation reservoirs, pumping plants, pipelines, etc., along the alignment of the existing facilities. The costs of the No Action Alternative would be the same under all alternatives; therefore, the costs of implementing the No Action Alternative do not impact the economic analysis.

Accomplishments

Instream Flows Provided.—Instream flow objectives were established by the SSTWG for wet, average, and dry water years. For the sake of simplicity, the monthly flow objectives were grouped by season—spring (March-June); summer (July-October); and winter (November-February)—and were expressed in terms of total acre-feet of water required to meet the combined monthly flow objective for each season. The seasons are based on the general life history pattern of steelhead and salmon in the Yakima River basin. These seasonal flow volume objectives (acre-feet) for the Ellensburg reach (Umtanum gage) and Wapato reach (Parker gage) are shown in table ES.2 for an average water year. The Ellensburg and Wapato reaches represent the general flow conditions in the upper and middle-to-lower Yakima River, which are the reach areas most influenced by the Storage Study alternatives.

In addition, a natural (unregulated) flow regime for the Yakima, Naches, Cle Elum, Bumping, and Tieton Rivers was developed by modeling the 25-year period of record (1981-2005) for the river system without the existing Yakima Project storage reservoirs and diversions and associated return flows. This flow regime was also used in developing instream flow water supply goals.

Table ES.2 Seasonal flow objectives and model results for the Umtanum and Parker gages for an average water year (acre-feet)

Flows	Umtanum gage			Parker gage		
	Spring	Summer	Winter	Spring	Summer	Winter
Flow objective	741,915	304,920	380,010	780,410	316,602	898,766
No Action Alternative	685,946	614,456	380,010	725,734	190,155	698,766
Black Rock Alternative	751,152	476,734	434,527	1,007,651	313,234	758,113
Wymer Dam and Reservoir Alternative	701,927	550,763	418,356	700,894	187,865	689,855
Wymer Dam Plus Yakima River Pump Exchange Alternative	702,532	549,792	418,433	863,031	375,893	690,108
Enhanced water conservation	695,326	604,366	379,163	765,463	194,416	694,414

Dry Year Proratable Irrigation Supply Provided.—Under the current operation, there are 6 years in the 25-year period of record (1981-2005) when the proration level is less than 70 percent. In 5 of these years, the proration level is better under the No Action Alternative than under the current operation; however, in the third year (1994) of the 3-year dry cycle of 1992-94, it is not. Table ES.3 presents the proration level for the 6 dry years for the No Action Alternative as compared to the current operation.

Table ES.3 Irrigation proration level for the No Action Alternative compared to the current operation for the 25-year period of record (1981-2005)[1]

Water year	Proration level (percent)		
	Current operation	No Action Alternative	Difference under No Action Alternative
1987	64	69	+5
1992	68	70	+2
1993	56	57	+1
1994	28	27	-1
2001	40	44	+4
2005	38	45	+7

[1]The irrigation water supply benefits of the conservation actions are realized in 1992 and 1993, as shown by the improved irrigation proration levels of the No Action Alternative. By 1994, the third year of the dry cycle, the difference in the proration level of the No Action Alternative and the current operation is negligible and is due to rounding of the Yak-RW model results.

Municipal Supply Provided.—The municipal water supply need would be satisfied by the communities' acquiring water rights from existing water right holders.

Black Rock Alternative

The Black Rock Alternative involves a diversion and partial exchange of Columbia River water for Yakima Project water currently diverted by Roza and Sunnyside Divisions for irrigation. Roza and Sunnyside have been identified as potential willing water exchange participants. Both Sunnyside and Tieton Divisions' management have indicated they do not desire an additional dry year proratable supply; however, Sunnyside is willing to participate in an exchange.

Water from the Columbia River would be pumped from the Priest Rapids Lake any time Columbia River water is available in excess of current instream target flows and storage space is available in a Black Rock reservoir, with the exception of July and August, when no Columbia River withdrawals would occur. In addition, the State of Washington, as a part of its Columbia River Basin Water Management Program, has indicated that withdrawal of water from the Columbia River for out-of-stream uses in July and August is prohibited (unless appropriately mitigated). The operation objective is to maintain Black Rock reservoir at full capacity to assure the water exchange can be affected. Stored water would be conveyed to the lower Yakima Valley and delivered to Roza and Sunnyside's existing canals. Yakima Project water currently diverted from the Yakima River by these two water exchange participants would not be diverted, and the freed-up water would instead be used to meet the Storage Study goals.

Reclamation has concluded that the Black Rock Alternative is technically viable, including the ability to withstand expected seismic activity. The dam design has been selected to absorb any anticipated ground shaking and maintain the ability to contain the reservoir behind it. Reclamation has also determined that the water exchange would meet the goals of the Storage Study. Reclamation has made estimates of the total seepage from the Black Rock reservoir and the seepage that travels toward the Hanford Site to the east. The impacts of that seepage will be identified through an analysis being conducted by the U.S. Department of Energy. That analysis will be concluded in 2008 and will be included in the Final PR/EIS. Reclamation is preparing an analysis of reducing that seepage flowing toward the Hanford Site that will also be included in the final PR/EIS.

The total project cost for the Black Rock Alternative was estimated at $4.5 billion (April 2007 prices). The total project cost is the estimate to construct the features of the Black Rock Alternative. The annual operation, maintenance, replacement and energy costs are estimated at $60.2 million, including energy, or pumping, costs of $50 million.

Accomplishments

Instream Flows Provided.—Table ES.2 presents instream flows provided under the Black Rock Alternative.

Dry Year Proratable Irrigation Water Provided.—Table ES.4 presents the irrigation proration level for the 6 dry years for the 25-year period of record (1981-2005). The Black Rock Alternative meets the irrigation water supply goal in all years, including the third year (1994) of the 3-year dry cycle.

Table ES.4 Irrigation proration level for the Black Rock Alternative compared to the No Action Alternative for the 25-year period of record (1981-2005)

Water year	Irrigation proration level (percent)		
	No Action Alternative	Black Rock Alternative	Difference under Black Rock Alternative
1987	69	82	+13
1992	70	80	+10
1993	57	73	+16
1994	27	70	+43
2001	44	70	+26
2005	45	70	+25

Municipal Supply Provided.—The average annual municipal water supply provided under the Black Rock Alternative for the 25-year period of record (1981-2005) is 81,100 acre-feet. The municipal water supply available for Black Rock in 1994, the third year of a 3-year drought cycle, is 79,000 acre-feet.

Wymer Dam and Reservoir Alternative

The Wymer Dam and Reservoir Alternative involves construction of an off-channel storage facility on Lmuma Creek, approximately 8 miles upstream of Roza Diversion Dam. Wymer reservoir would have an 162,500-acre-foot active capacity filled by pumping water from the Yakima River and would release water back to the Yakima River by gravity. For operational purposes, Wymer reservoir storage space is divided into two components:

(1) 82,500 acre-feet to be used annually to provide portions of the stored water for downstream irrigation demands and for instream flows each year during July and August (withdrawn from the Yakima River from October 1–May 31 from Cle Elum Lake releases) and

(2) 80,000 acre-feet to improve the proratable irrigation water supply in dry-years when the proration level is determined to be less than 70 percent (withdrawn during January 1–March 31), when Yakima River flows at the pumping plant are in excess of 1,475 cfs.

The irrigation, instream flow, and municipal water supply goals are the same as for the Black Rock Alternative description.

Total project cost for the Wymer Dam and Reservoir Alternative was estimated at $1.1 billion (April 2007 prices). The total project cost is the estimate to construct the features of the Wymer Dam Alternative. The annual operation, maintenance, replacement and energy costs are estimated at $3.0 million, including energy or pumping, costs of $1.9 million.

Accomplishments

Instream Flows Provided.—Table ES.2 presents instream flows provided under the Wymer Dam and Reservoir Alternative.

Dry Year Proratable Irrigation Supply Provided.—Table ES.5 presents the proration level for the 6 years for the 25-year period of record (1981-2005). The Wymer Dam and Reservoir Alternative proration level is better than under the No Action Alternative in all years, including the third year (1994) of the 3-year dry cycle. The primary reasons for this are that, while moving 185-200 cfs from Cle Elum Lake during October 1-May 31 (for aquatic habitat improvements) to Wymer reservoir is primarily a shift in reservoir contents, it does (1) provide the opportunity for subsequent refill of some of the vacated Cle Elum Lake storage space and (2) create specific carryover storage in Wymer reservoir to improve the proratable water supply in dry years.

Table ES.5 Irrigation proration level for the Wymer Dam and Reservoir Alternative compared to the No Action Alternative for the 25-year period of record (1981-2005)

Water year	Proration level (percent)		
	No Action Alternative	Wymer Dam and Reservoir Alternative	Difference under Wymer Dam and Reservoir Alternative
1987	69	73	+4
1992	70	76	+6
1993	57	68	+11
1994	27	29	+2
2001	44	59	+15
2005	45	49	+4

Municipal Supply Provided.—The average annual municipal water supply provided under the Wymer Dam and Reservoir Alternative over the 25-year period of record (1981-2005) is 79,800 acre-feet. The municipal water supply available for the Wymer Dam and Reservoir Alternative in 1994, the third year of a 3-year drought cycle, is 68,000 acre-feet.

Wymer Dam Plus Yakima River Pump Exchange Alternative

The Wymer Dam Plus Yakima River Pump Exchange Alternative couples the Wymer Dam and Reservoir with a pump exchange component. The pump exchange aspect of this alternative involves a "bucket-for-bucket" exchange of up to 1,050 cfs that would not be diverted by the Roza and Sunnyside Divisions of the Yakima Project, but would remain in the river to enhance instream flows. In return, water would be pumped from the mouth of the Yakima River upstream for delivery to these two divisions, beginning in mid-to-late March and continuing through the irrigation season of April through October. The water supply for the Wymer dam component of this alternative would be obtained from the Yakima River in the same manner and quantities described for the Wymer Dam and Reservoir Alternative.

Total project cost for the pump exchange was estimated at $4 billion (April 2007 prices). The total project cost is the estimate to construct the features of the Wymer Dam Plus Yakima Pump Exchange Alternative. The annual operation, maintenance, replacement and energy costs are estimated at $38.0 million, including energy, or pumping, costs of $20 million.

Accomplishments

Instream Flows Provided.—Table ES.2 presents instream flows provided under the Wymer Dam Plus Yakima River Pump Exchange Alternative.

Dry Year Proratable Irrigation Supply Provided.—Same as for Wymer Dam and Reservoir Alternative.

Municipal Supply Provided.—Same as for Wymer Dam and Reservoir Alternative.

State Alternatives

Ecology evaluated the impacts of the State Alternatives according to SEPA requirements. SEPA is intended to ensure that environmental values are considered during decisionmaking by State and local governments. Although not required to do so under SEPA, Ecology included costs information on the State Alternatives in Chapter 5, "Affected Environment and Environmental Consequences: State Alternatives." In addition, Ecology used Reclamation's study goals described above as one benchmark for evaluating the effectiveness of the State Alternatives.

Enhanced Water Conservation Alternative

The Enhanced Water Conservation Alternative represents a more aggressive program of conservation than is currently being implemented in the Yakima River basin. The Enhanced Water Conservation Alternative

would change the allocation of conserved water and the funding for conservation programs to provide more incentives to implement agricultural conservation measures identified in existing Conservation Plans. It would also include conservation programs for onfarm, municipal, commercial, and industrial water. Implementation of the alternative would require construction, including canal lining or piping, reregulation reservoirs, installing pump-back stations, constructing onfarm irrigation improvements, and improvements to municipal water supply infrastructure. Table ES.2 presents instream flow objectives.

Market-Based Reallocation of Water Resources Alternative

The Market-Based Reallocation of Water Resources Alternative would utilize market incentives to reallocate water. The proposal includes options for water marketing and water banking. Three options are proposed for each. One option would work within existing water laws, while a second option would require legislative changes to implement marketing and banking. A third option would establish water marketing and banking within and between irrigation districts. For all alternatives, it is assumed that water would be reallocated from low-value uses to higher value uses. This alternative is primarily a change in the administration of water rights and would not require any construction. The exception would be new irrigation infrastructure required if water rights are permanently transferred to irrigate different areas.

Groundwater Storage Alternative

The Groundwater Storage Alternative would use surface water to recharge aquifers for later recovery and use to enhance streamflows, meet out-of-stream needs, and replenish aquifers. Aquifers could be recharged through direct injection by wells or through surface infiltration. Direct injection would utilize wells to pump water into the aquifer and would require treatment facilities. Surface infiltration would require a series of large infiltration basins. Water could be recovered from aquifers either actively by pumping or passively by allowing the groundwater to flow to surface discharge points. This alternative would require the construction of facilities to recharge and recover water, including injection wells, treatment facilities, infiltration basins, pump stations and conveyance lines.

Resource Analysis

Following is a narrative summary of the effects of the Joint and State Alternatives on key resources that would likely be affected by the alternatives. Tables ES.6 and ES.7 at the end of the Executive Summary present summaries of impacts on all resources evaluated in the Draft PR/EIS.

Water Resources

No Action Alternative

Under the No Action Alternative, the hydrograph is little changed from the existing condition. Winter and spring flows throughout the systems are essentially unchanged as a result of water conservation. Summer flows increase slightly, in some reaches, mostly downstream from the Parker gage, as water that currently is released from storage and diverted downstream for irrigation remains instream to meet the higher flow targets.

Because the conservation is achieved by improving efficiency which reduces return flow, the effects are limited to the reaches where conservation occurs. Downstream of those reaches, there is no effect.

Black Rock Alternative

Modeling results show an improvement in the Yakima Project water supply over the 25-year period of record (1981-2005) under the Black Rock Alternative when compared to the No Action Alternative and meets the dry-year proratable irrigation water supply goal of 70 percent in all years. In general, the Black Rock Alternative also provides the greatest increase in spring flows at the Parker gage and the greatest reduction in summer flows in the upper Yakima River compared to the two Wymer alternatives. Winter flows are generally higher for the Black Rock Alternative than for all the other alternatives.

Wymer Dam and Reservoir Alternative

The addition of the Wymer Dam and Reservoir Alternative would increase the Yakima Project total active storage capacity from 1,070,700 acre-feet to 1,233,200 acre-feet. In general, the Wymer Dam and Reservoir Alternative provides spring flows at Parker gage similar to the No Action Alternative, while summer flows there are somewhat higher than under the No Action Alternative. Summer flows in the upper Yakima River (Umtanum gage) are similar between the two Wymer Alternatives, with a reduction in summer flows that falls between the Black Rock and No Action Alternatives. Modeling results show an improvement in the Yakima Project water supply over the 25-year period of record (1981-2005) when compared to the No Action Alternative and meets the dry-year proratable irrigation and municipal water supply goals of 70 percent in 2 of the 6 years.

Wymer Dam Plus Yakima River Pump Exchange Alternative

This operation would improve the aquatic habitat of the Yakima River by leaving some of the water in the river that otherwise would have been diverted by Roza and Sunnyside. There would be an improvement in the Yakima Project water supply over the 25-year period of record (1981-2005) under this alternative. In general, the Wymer Dam Plus Yakima River Pump Exchange Alternative

provides higher spring flows than No Action at the Parker gage, but with the same stream runoff pattern as the No Action Alternative and the highest summer flows of all the alternatives. Summer flows in the upper Yakima River (Umtanum gage) are identical to those under the Wymer Dam and Reservoir Alternative, with a flow reduction that falls between that of the Black Rock and No Action Alternatives. Modeling results show an improvement in the Yakima Project water supply over the 25-year period of record (1981-2005) when compared to the No Action Alternative and meets the dry-year proratable irrigation and municipal water supply goals of 70 percent in 2 of the 6 years.

Enhanced Water Conservation Alternative

Under the Enhanced Water Conservation Alternative, the hydrograph is little changed from the existing condition and the No Action Alternative. Winter and spring flows throughout the systems are changed slightly as a result of an intensive program of water conservation. Summer flows increase downstream from the Parker gage because this alternative includes the conservation measures included in the No Action Alternative, along with increased flow targets set by Title XII. Total water supply available for irrigation and instream flows is up to 63,000 acre-feet greater during drought years compared to the No Action Alternative, except in the last year of a series of drought years such as that occurred from 1992 to 1994. The predicted increase in 1994 conditions is 12,000 acre-feet. The increase improves irrigation reliability over the No Action Alternative.

Market-Based Reallocation of Water Resources Alternative

This alternative would facilitate the transfer of existing water rights to help alleviate shortfalls in water supply for irrigation and municipal uses. Water supply conditions would improve for individual farmers, irrigation districts, or municipal users, but this alternative would not result in increases in the overall water supply for the Yakima River basin.

Groundwater Storage Alternative

One of the purposes of the Groundwater Storage Alternative is to increase streamflows in the Yakima River and its tributaries. Streamflows would be increased through return flow to a stream from surface infiltration and direct injection with passive recovery. Initial analysis of potential return flows to the Yakima River indicates that the Groundwater Storage Alternative could increase streamflows by an average of 22,800 to 25,800 acre-feet during the April to September period and 14,900 to 15,900 acre-feet during the July to September period. This represents an increase in the average daily discharge from the current 470 cfs to approximately 533 to 541 cfs. Because it is assumed that no water would be available to recharge aquifers during drought years, the Groundwater Storage Alternative would not affect irrigation deliveries or

proration levels. Streamflows at the Parker gage could be approximately 60 to 70 cfs greater, but during drought years, streamflows would only be approximately 4 cfs greater.

Water Quality

No Action Alternative

Water quality in Yakima River reaches under the No Action Alternative would be the same as under the current condition.

Black Rock Alternative

Analysis shows no effect, either adverse or beneficial, on water quality in the Columbia River resulting from the withdrawal of water for pumping.

Seepage from Black Rock reservoir has the potential to raise the water table level beneath the Hanford Site. Raising the water table would have the potential to mobilize contaminants currently in the soil as well as shorten the travel time.

In the Yakima River, higher flows in the lower river during the summer should provide improved water quality conditions relative to nutrients, dissolved oxygen, and DDT.

Wymer Dam and Reservoir Alternative

In the Yakima River in wet and average years, there is likely beneficial cooling downstream from the Wymer reservoir discharge point during summer and autumn. In dry years, there may be some slight warming of Yakima River temperatures during August. Mitigation measures are proposed to monitor water quality parameters to prevent releases of warm or otherwise low-quality water into the Yakima River from the Wymer reservoir.

Wymer Dam Plus Yakima River Pump Exchange Alternative

Effects on water quality under the Wymer Dam Plus Yakima River Pump Exchange Alternative would be the same as under the Wymer Dam and Reservoir Alternative. In the mid- to lower Yakima River, higher summer flows at the Parker gage would provide water quality improvements as a result of dilution.

Enhanced Water Conservation Alternative

The greater flow in the Yakima River would provide some water quality benefit as a result of dilution, but no substantial benefit to temperature would result. Sediment could wash into water bodies during construction, causing short-term impacts to water quality. Long-term impacts may include increased dissolved oxygen, reduced stream temperatures, and increased pollutant concentrations in

runoff. Onfarm conservation measures may reduce surface water and groundwater pollutant loadings because of improved irrigation practices.

Market-Based Reallocation of Water Resources Alternative

Transfers may improve or degrade water quality, including water temperature, depending on volume and location of water transferred. However, the volume of water that would likely be transferred is not likely to result in substantial changes in temperature. Changes in use may also improve or degrade water quality depending on the change of use.

Groundwater Storage Alternative

The Groundwater Storage Alternative could alter surface and groundwater quality. Water infiltrated or injected to aquifers could change water quality, including temperature within aquifers, depending on the water quality of the surface water used for the recharge. Water used for direct injection would be treated prior to recharge. The recharged water that discharges to streams may create areas of cooler water within the streams.

Vegetation and Wildlife

No Action Alternative

The No Action Alternative would have no effect on shrub-steppe habitat, movement corridors, and black cottonwoods when compared to the current condition.

Black Rock Alternative

The Black Rock Alternative would impact, both directly and indirectly, approximately 3,850 acres of shrub-steppe habitat, which would impact the sage-grouse population by reducing available shrub-steppe habitat, and would disturb more than one-third of animal movement corridors. This alternative would increase black cottonwood regeneration.

Wymer Dam and Reservoir Alternative

The Wymer Dam and Reservoir Alternative would generally have a negligible or slight effect on shrub-steppe habitat, movement corridors, and black cottonwoods when compared to the No Action Alternative.

Wymer Dam Plus Yakima River Pump Exchange Alternative

Effects on vegetation and wildlife under the Wymer Dam Plus Yakima River Pump Exchange Alternative would be the same as under the Wymer Dam and Reservoir Alternative.

Enhanced Conservation Alternative

The Enhanced Conservation Alternative would not have substantial impacts on vegetation or wildlife. Some vegetation along canals may be removed to improve canal efficiency. No impacts to shrub-steppe habitat or movement corridors are anticipated since conservation projects would be located on land already in agricultural use. The alternative may benefit black cottonwood regeneration if higher streamflows result from conservation measures.

Market-Based Reallocation of Water Resources Alternative

This alternative is not expected to affect vegetation or wildlife. Water transfers may allow the expansion of irrigated agriculture, but this is expected to occur in areas already used for agriculture. No impacts to shrub-steppe habitat or movement corridors are anticipated. Water transferred to instream flows may benefit black cottonwood regeneration.

Groundwater Storage Alternative

The Groundwater Storage Alternative is not expected to have major impacts to vegetation or wildlife. The alternative may result in increased flows in the Yakima River and its tributaries which could benefit fish, depending on the timing and location of the increased flows. Construction of the facilities for groundwater storage would require the permanent removal of vegetation, but this is not expected to affect shrub-steppe habitat or movement corridors because the facilities would be located in previously disturbed areas. Because the infiltration basins would be approximately 20 acres in size, substantial amounts of vegetated area would be replaced by ponds. Because the basins would be located in disturbed areas, they are not expected to decrease habitat.

Anadromous Fish

No Action Alternative

For the No Action Alternative, the average rate of change in daily flow and the summer rearing habitat in the upper Yakima River basin are essentially unchanged from the current condition. Therefore, no effect is expected in the biological consequence to anadromous salmonids under the No Action Alternative compared to the current condition. However, the greater spring flows downstream from the Parker gage are considered beneficial to improve anadromous salmon smolt outmigration survival through the middle and lower Yakima River. The greater channel velocity during summer in the lower Yakima River would result in habitat losses in the main channel.

Black Rock Alternative

Differences in flow in the Yakima River under the Black Rock Alternative (compared to the No Action Alternative) are the greatest of any action

alternative. Spring flows are greater throughout the system, while summer flows in the mid- and lower Yakima River are substantially greater as a result of being able to meet higher target flows at the Parker gage because of a greater available water supply for instream flow augmentation. These differences would generally benefit anadromous fish.

Of the Joint Alternatives, the Black Rock Alternative would provide the greatest increase in steelhead and spring Chinook summer rearing habitat in the Easton reach that would potentially equate to an increase in juvenile survival and the ability to accommodate more summer rearing fish. For similar reasons, the Black Rock Alternative appears most beneficial to steelhead yearlings in the Ellensburg reach of the Joint Alternatives.

For the lower Yakima River, the stream runoff pattern is better than under the No Action Alternative, as the high flows continue into April, May, and June when most smolt migration is occurring. These greater flows should increase overall smolt outmigration survival. However, the summer flows downstream from the Parker gage would not result in a significant change in the amount of coho summer yearling habitat compared to the No Action Alternative.

The fishery models estimated approximate increases of 20 to 60 percent in anadromous fish populations for the Black Rock Alternative compared to the No Action Alternative, which, of all the Joint Alternatives, afforded the greatest modification of the current flow regime in the Yakima River basin. These population increases do not approach the numbers of fish that are estimated to have historically inhabited the basin. Possible reasons for this are as follows:

- The Joint Alternatives do not improve the habitat itself; they only change the amount of access to it;
- The Joint Alternatives only affect the stream reaches downstream from the five major storage reservoirs, not habitat conditions in the tributaries;
- Fisheries habitat conditions have significantly changed through decades of development, both within the Yakima River basin and downstream; and
- Changes in habitat conditions (e.g., hydropower development and loss of estuary habitat) along the mainstem Columbia River have reduced smolt and adult migration survival.

Wymer Dam and Reservoir Alternative

Winter flows from Cle Elum Lake to the Wymer site are greater under this alternative, resulting in more than doubling of flows in the Cle Elum River. During the summer months, flows in the upper Yakima River are lower, as some of the irrigation needs in the middle basin are met by releases from Wymer reservoir. Because the percent change in habitat values are all less than

10 percent compared to the No Action Alternative, no effect on the biological response of steelhead or spring Chinook upper Yakima River population is expected, compared to the No Action Alternative.

Also, there is virtually no difference, in the flow volumes or in the spring runoff pattern, and no significant change in summer habitat downstream from the Parker gage. Therefore, no effect in the survival or rearing capacity for anadromous fish in the Wapato reach is expected compared to the No Action Alternative.

Wymer Dam Plus Yakima River Pump Exchange Alternative

There are no significant differences (i.e., greater than 10 percent) between this alternative and No Action Alternative for either of the species and life stages for the Easton or Ellensburg reaches. As under the Wymer Dam and Reservoir Alternative, habitat would generally be better for steelhead and spring Chinook in the Easton reach, while results are mixed in the Ellensburg reach.

Spring flows downstream from the Parker gage are substantially greater (79 percent) than under the No Action Alternative, which should increase overall smolt outmigration survival. In addition, a small potential exists to improve the survival or rearing capacity for anadromous fish in the Wapato reach compared to the No Action Alternative.

Enhanced Conservation Alternative

For the Enhanced Conservation Alternative, the average rate of change in daily flow and the summer rearing habitat in the upper Yakima River basin is essentially unchanged from the current condition and the No Action Alternative. Therefore, no effect is expected in the biological consequence to anadromous salmonids under this alternative compared to the current condition. However, the increased spring flow downstream from the Parker gage is considered beneficial to improve anadromous salmon smolt outmigration survival through the middle and lower Yakima River. The channel velocity increases during summer in the Wapato Reach of the lower Yakima River result in a reduction of habitat in the main channel, primarily because of lack of access to side channels at mid-range flows between 300 cfs and approximately 1,000 cfs.

Market-Based Reallocation of Water Resources Alternative

The impacts of this alternative would likely be similar to the No Action Alternative. Transfers to instream flows may benefit anadromous fish, especially in tributaries. No other impacts to anadromous fish are anticipated from this alternative.

Groundwater Storage Alternative

Groundwater storage may benefit anadromous fish by increasing the recharge of cold water to streams. Groundwater storage may also supplement streamflows and potentially benefit anadromous fish, depending on the timing and location of returned flows.

Land and Shoreline Use

No Action Alternative

The No Action alternative includes conservation-oriented system improvements, including pump stations and pipelines, at various locations in the Yakima Valley region. These improvements are associated with existing approved programs and orient predominantly to existing facilities; none are being or will be constructed under the auspices of the Storage Study. To the extent that NEPA or SEPA analysis is required for these actions, appropriate documentation of the directly affected land/shoreline use environment would be prepared separately, apart from the Storage Study process.

Black Rock Alternative

Land acquisition requirements and associated land use impacts associated with Black Rock dam and reservoir would be long-term and unavoidable. Mitigation would focus exclusively on (1) compensating impacted landowners at fair market value according to established Federal regulations, guidelines, and procedures, and (2) relocating/rerouting existing utility and transportation infrastructure. In the latter regard, State Route 24 is proposed to be rerouted along the south side of the reservoir. The impacted transmission lines and fiber optic cable would be relocated/reconstructed along the new State Route 24 alignment.

Wymer Dam and Reservoir Alternative

Land use impacts associated with Wymer dam and reservoir would be long-term and unavoidable. Mitigation would focus exclusively on compensating impacted landowners at fair market value according to established Federal regulations, standards, and procedures.

Wymer Dam Plus Yakima River Pump Exchange Alternative

Land and easement/right-of-way acquisition and associated short- and long-term land use impacts from pipeline, pumping plant and transmission line facilities of the Yakima River Pump Exchange Alternative would be largely unavoidable. However, more detailed studies of pipeline and transmission line routing options should explore opportunities for avoiding direct, dislocation impacts on existing residences and business to the maximum extent feasible. For example, in the rural/agricultural lands of Benton and Yakima Counties, routing of the pipeline on/near property lines or on quarter- or half-section lines (rather than immediately

along roads) in some areas may offer the opportunity to avoid dislocation impacts to residences and minimize construction-phase access disruptions. Such detailed routing studies should also seek opportunities to minimize long-term impacts on existing developed uses in the urban environments of Richland, Kennewick, and West Richland.

Beyond such site/alignment adjustments during detailed planning, mitigation would focus primarily on compensating impacted landowners at fair market value according to established Federal guidelines, standards, and procedures.

Enhanced Conservation Alternative

Agricultural conservation would be confined to lands already designated for agriculture and is not expected to affect land use. Conservation measures may improve the viability of existing agricultural operations and reduce the potential conversion from agriculture to other uses. Some new facilities or construction activities may take place in shoreline areas, but are not expected to affect shoreline use.

Market-Based Reallocation of Resources Water Alternative

Water rights transfers may affect land uses in both the area of origin and the recipient area. Transfers from agricultural lands may increase fallow lands that would otherwise be used for agriculture. On the other hand, transfers to agricultural lands may improve the reliability of the water supply and keep some properties in agricultural use. Transferred water rights may be used to irrigate different lands. This is expected to occur in areas already designated for agriculture. Water rights could be transferred from agricultural uses to municipal uses, allowing the expansion of municipal or residential areas. This expansion is also expected to occur in areas already designated for these uses. Transfers from out-of-stream uses to instream uses may reduce the water available for future agricultural or municipal development.

Groundwater Storage Alternative

Groundwater storage projects would require land for the facilities. The land would be purchased from willing sellers or would be obtained through acquisition following applicable State and Federal regulations. The infiltration basins would require the purchase or acquisition of substantial areas of land. Siting of the facilities would comply with local comprehensive plans and zoning designations where possible, but may require changes in zoning in some cases. Some groundwater storage facilities may be located in shoreline areas, but impacts to those areas are not expected to be substantial.

National Economic Development (NED)

The NED benefit-cost analysis compares the present value of a proposed project's benefits to the present value of its costs. If benefits exceed costs, the project is considered economically justified. Since both benefits and costs can occur at various points throughout the study period, it is important to convert them to a common point in time. For this analysis, the costs and benefits were measured as of the start of the benefits period (which is equivalent to the end of the construction period). The study period or period of analysis for the benefits period was assumed to be 100 years, as suggested by the P&Gs for this type of dam construction project. The interest rate used to convert costs and benefits to a common year was Reclamation's fiscal year 2007 planning rate of 4.875 percent. See table ES.8 at the end of this Executive Summary for results of the NED analysis.

Regional Economic Development (RED)

The RED analysis focuses on economic impacts to the local region, whereas the NED analysis focuses on economic benefits to the entire Nation. Economic impacts measure total economic activity within a given region using such indicators as output (sales or gross receipts), income, and employment. Economic impacts stem from changes in expenditures within the region. 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. In addition to the geographic differences between the 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. See table ES.8 at the end of this Executive Summary for results of the RED analysis.

Consultation and Coordination

Concurrent with preparation of this document, agency coordination and consultation have been conducted in accordance with the Fish and Wildlife Coordination Act, Endangered Species Act of 1973, as amended, and National Historic Preservation Act of 1966. Additionally, consultation with the Yakama Nation has occurred.

Summary of Impacts

Tables ES.6 presents a summary of the impacts of the Joint Alternatives on resources. Table ES.7 presents a summary of the impacts of the State Alternatives. Table ES.8 presents the results of the NED and RED analyses.

Table ES.6 Comparative analysis of Joint Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS

Resource indicator measurement	Alternative			
	No Action	Black Rock	Wymer Dam and Reservoir	Wymer Dam Plus Yakima River Pump Exchange
WATER RESOURCES				
Average for water years 1981-2005 million acre-feet Actual difference from No Action Alternative Percentage difference from No Action Alternative				
Water supply				
April 1 TWSA	2.84	2.90 0.06 2%	2.94 0.10 4%	2.94 0.10 4%
Water distribution				
April-September Parker flow volume	0.62	0.98 0.36 58%	0.59 -0.03 -5%	0.90 0.36 58%
April-September diversion	1.91	1.47 -0.44 -23%	1.95 0.04 2%	1.64 -0.27 -14%
September 30 reservoir contents	0.30	0.43 0.13 45%	0.40 0.10 33%	0.40 0.10 33%
April-September flow volume at mouth of Yakima River	0.86	1.22 0.36 42%	0.83 -0.03 -4%	0.83 -0.03 -3%
Irrigation delivery volume shortage	-0.05	0.02 -0.03 -60%	0.05 0.00 0%	0.05 0.0 0%
1994 dry year million acre-feet Actual difference from No Action Alternative Percentage difference from No Action Alternative				
Water supply				
April 1 TWSA	1.75	1.94 0.19 11%	1.76 0.01 1%	1.77 0.02 1%
Water distribution				
April-September Parker flow volume	0.25	.58 0.33 132%	0.25 0.00 0%	0.57 0.32 128%
April-September diversion	1.42	1.32 -0.10 -7%	1.44 0.02 1%	1.13 -0.29 -20%

Table ES.6 Comparative analysis of Joint Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Resource indicator measurement	Alternative			
	No Action	Black Rock	Wymer Dam and Reservoir	Wymer Dam Plus Yakima River Pump Exchange
WATER RESOURCES (continued)				
1994 dry year million acre-feet Actual difference from No Action Alternative Percentage difference from No Action Alternative (continued)				
Sept 30 reservoir contents	0.07	0.04 -0.03 -43%	0.06 -0.01 -14%	0.06 -0.01 -14%
April-September flow volume at mouth of Yakima River	0.31	0.65 0.34 110%	0.31 0.00 0%	0.31 0.00 0%
Irrigation delivery volume shortage	0.38	0.12 -0.26 -68%	0.38 0.00 0%	0.38 0.00 0%
Irrigation proration level	27%	70% 43%	29% 2%	29% 2%
NON-FEDERAL AND FEDERAL COLUMBIA RIVER HYDROPOWER				
Generation loss (average annual MW)	None	- 9.2 MW	Not applicable	Not applicable
Value of generation loss (average annual $ millions)		- $4 million		
Additional generation capacity (average annual MW)	None	52.5 MW	Not applicable	Not applicable
Pumping power requirement (average annual MW)	None	132 MW	4.8 MW	61.7 MW
Cost of pumping (average annual $ millions)	None	$50 million	$1.9 million	$19.8 million
GROUNDWATER				
Volume and direction of seepage, continuous annual flow (cfs)	No change	57 cfs – toward Columbia River	Unknown – toward Yakima River	Unknown – toward Yakima River
SEDIMENT				
Sand transport	No change	Increased	No change	Increased
Bed scour	No change	No change	No change	No change
WATER QUALITY				
Temperature	No change	No change	No change	No change
Nutrients	No change	Decreased concentrations	No change	Decreased concentrations
Pollutants – Yakima River	No change	Decreased concentrations	No change	Decreased concentrations
Pollutants – Hanford reach	No change	Potential increase	No change	No change

Table ES.6 Comparative analysis of Joint Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Resource indicator measurement	Alternative			
	No Action	Black Rock	Wymer Dam and Reservoir	Wymer Dam Plus Yakima River Pump Exchange
VEGETATION AND WILDLIFE				
Shrub-steppe				
Disturbance number of acres	None	3,850	1,055	1,055
Movement corridors				
Disturbance number of places animal corridors are disturbed	None	Impedes passage over 1/3 of corridor	Negligible	Negligible
Black cottonwood				
Regeneration	None	Increase	No change	Slight increase
Wetland abundance and distribution				
Number of acres disturbed	None	9	83	83
ANADROMOUS FISH				
High summer flows in the upper Yakima and Cle Elum Rivers (acres of available habitat)				
Easton reach				
Steelhead fry habitat	4.1	4.4 7.3%	4.4 7.3%	4.3 5.5%
Steelhead yearling habitat	57.9	63.9 10.4%	58.6 1.7%	58.7 1.3%
Spring Chinook fry habitat	2.5	2.4 -4.0%	2.5 0.0%	2.5 0.0%
Spring Chinook yearling habitat	47.9	52.6 9.8%	49.3 2.9%	49.0 2.3%
Ellensburg reach				
Steelhead fry habitat	2.2	2.1 -4.5%	2.1 -4.5%	2.1 -4.5%
Steelhead yearling habitat	20.2	26.1 29.2%	20.5 1.5	20.6 2.3%
Spring Chinook fry habitat	1.7	1.8 5.9%	1.8 5.9%	1.8 4.5%
Spring Chinook yearling habitat	14.9	14.6 -2.0%	13.8 -7.4%	14.5 -2.4%
Rate of change flip-flop (average cfs per day August 15 to September 14)				
Easton reach	-8 cfs	-4 cfs	-7 cfs	-6 cfs
Ellensburg reach	-78 cfs	-51 cfs	-58 cfs	-57 cfs
Lower Naches River reach	34 cfs	20 cfs	37 cfs	36 cfs

Table ES.6 Comparative analysis of Joint Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Resource indicator measurement	Alternative			
	No Action	Black Rock	Wymer Dam and Reservoir	Wymer Dam Plus Yakima River Pump Exchange
ANADROMOUS FISH (continued)				
Reduced spring freshets downstream from the Parker gage (percentage difference in spring season flow between the alternative and flow objective; if >=0 then target flow reached)				
Stream runoff timing	-7% Not applicable	29% Improved	-10% No change	-11% No change
Summer flows downstream from the Parker gage (acres of available habitat)				
Coho yearling habitat				
Total	63.7	64.7 1.5%	63.7 -0.1%	66.4 4.1%
Mainstem	56.7	44.2 -22.0%	56.7 -0.2%	41.8 -26.2%
Side channel	7.0	19.8 184.9%	7.0 0.6%	23.6 239.7%
Average annual fish escapement (includes harvest) numbers (natural + hatchery)				
Spring Chinook	7,189	9,066	7,294	8,428
Fall Chinook	6,893	11,128	7,112	9,321
Coho	8,475	10,242	8,591	9,392
Steelhead	2,700	4,067	2,724	3,338
RESIDENT FISH				
Summer flows in the upper Yakima and lower Naches Rivers (acres of available habitat and difference from No Action Alternative)				
Easton reach				
Rainbow trout fry habitat	5.2	5.5 5.8%	5.4 3.8%	5.5 5.8%
Rainbow trout yearling habitat	57.2	63.2 10.5%	57.9 -3.8%	54.6 -4.5%
Bull trout yearling habitat	61.9	66.1 6.8%	62.9 1.6%	62.8 1.5%
Ellensburg reach				
Rainbow trout fry habitat	2.5	2.4 -4.0%	2.4 -4.0%	2.4 -4.0%
Rainbow trout yearling habitat	19.9	25.7 28.9%	20.3 -20.1%	17.0 -9.5%
Bull trout yearling habitat	20.5	20.3 -1.0%	20.3 -1.0%	2.3 -1.0%
Lower Naches River reach				
Rainbow trout fry habitat	4.3	4.2 -0.8%	4.3 0.0%	4.3 0.0%
Rainbow trout yearling habitat	45.9	47.2 2.9%	48.1 0.2%	46.0 0.1%
Bull trout yearling habitat	64.8	65.0 0.3%	64.8 0.0%	64.6 -0.3%

Table ES.6 Comparative analysis of Joint Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Resource indicator measurement	Alternative			
	No Action	Black Rock	Wymer Dam and Reservoir	Wymer Dam Plus Yakima River Pump Exchange
RESIDENT FISH (continued)				
Bull trout spawner upmigration at reservoirs (inseason days impeded)				
Kachess Lake	18	15 -16.7%	18 0.0%	17 -5.5%
Keechelus Lake	37	38 2.7%	37 0.0%	37 2.7%
Rimrock Lake	3	3 0.0%	1 -66.6%	1 -66.6%
Average minimum and maximum reservoir elevation during bull trout spawning migration: July 15 – September 15 (feet)				
Kachess Lake	2,248.4 2,202.4 - 2,262.0	2,253.1 2,206.0 - 2,262.0	2,249.3 2,201.0 - 2,262.0	2,249.7 2,202.4 - 2,262.0
Keechelus Lake	2,467.3 2,427.5 - 2,513.3	2,466.6 2,427.6 - 2,514.4	2,467.6 2,427.5 - 2,514.9	2,468.0 2,427.5 - 2,514.9
Rimrock Lake	2,909.9 2,869.8 - 2,927.8	2,906.2 2,839.8 - 2,927.7	2,912.3 2,872.4 - 2,927.8	2,911.7 2,868.0 - 2,927.8
AQUATIC INVERTEBRATES				
Community changes	No change	Positive	No change	Slight benefit
THREATENED AND ENDANGERED SPECIES				
Middle Columbia River steelhead – false attraction	No effect	No effect	No effect	No effect
Bull trout – false attraction	No effect	No effect	No effect	No effect
Bald eagle	No effect	No effect	No effect	No effect
Greater sage-grouse	No effect	Moderate adverse effect	Moderate adverse effect	Moderate adverse effect
Ferruginous hawk	No effect	Low effect	No effect	No effect
Ute Ladies'-tresses	No effect	Low to moderate beneficial effects	No effect	No effect
Umtanum wild buckwheat	No effect	Low effect	No effect	No effect
RECREATIONAL RESOURCES				
Annual visitation for new facilities	No effect	400,000 - 700,000	70,000 - 200,000	70,000 - 200,000
Additional annual visitation at existing facilities (average year)	No effect	14,745	3,631	3,631
LAND USE AND SHORELINE RESOURCES				
Acquisition of private land (approximate acres)	Not applicable	13,000	4,000	110
Acquisition of public lands (approximate acres)	Not applicable	0	0	0
Easement/right-of-way acquisition across private land (approximate miles)	Not applicable	18	6	61

Table ES.6 Comparative analysis of Joint Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Resource indicator measurement	Alternative			
	No Action	Black Rock	Wymer Dam and Reservoir	Wymer Dam Plus Yakima River Pump Exchange
LAND USE AND SHORELINE RESOURCES (continued)				
Compatibility with existing uses	Not applicable	Local incompatibilities	Local incompatibilities	Local incompatibilities
Consistency with relevant county land use plans and policies	Not applicable	Reservoir: consistency uncertain. Other facilities: likely consistent as conditional use	Reservoir: consistency uncertain. Other facilities: likely consistent as conditional use	Reservoir: consistency uncertain. Pump exchange: locally significant inconsistencies
REGIONAL ECONOMY. See Regional Economic Development (RED) section of table ES.8				
PUBLIC SERVICE AND UTILITIES				
Exceedance of service or utility capacity (long-term impact)	Not applicable	None	None	None
Disruption of services or utilities for existing residents and landowners (short-term, construction-phase impacts)	Not applicable	High potential but mitigable	Minor potential; mitigable	Highest potential but mitigable
TRANSPORTATION				
Long term: Road/highway relocations (miles)	Not applicable	15	0	0
Short term: Road/ highway crossings (instances)	Not applicable	1	1	9
AIR QUALITY				
Emissions during construction	Not applicable	Slight, short-term effect	Slight, short-term effect	Slight, short-term effect
Emissions during operation	Not applicable	No effect	No effect	No effect
NOISE QUALITY				
Noise levels during construction	Not applicable	Slight, short-term effect	Slight, short-term effect	Slight, short-term effect
Noise levels during operation	Not applicable	No effect	No effect	No effect
VISUAL RESOURCES				
Large-scale changes in visual setting	Not applicable	Visible to the public (significant)	Visible to the public (significant)	Visible to the public (significant)
Local-scale changes in visual setting	Not applicable	Yes – significant	Yes – significant	Yes – significant
HISTORIC PROPERTIES				
Number of affected properties	Not applicable	Unknown	Unknown	Unknown
INDIAN SACRED SITES				
Number of affected sites	Not applicable	Unknown	Unknown	Unknown
INDIAN TRUST ASSETS				
No./type affected	None	None	None	None

Table ES.6 Comparative analysis of Joint Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Resource indicator (measurement)	Alternative			
	No Action	Black Rock	Wymer Dam and Reservoir	Wymer Dam Plus Yakima River Pump Exchange
PUBLIC HEALTH				
Hazardous and toxic materials	No change	No change	No change	No change
Mosquitoes	No change	No change	No change	No change
ENVIRONMENTAL JUSTICE				
Impact to minority and low-income populations	None	Negligible	None	Unknown

Table ES.7 Comparative analysis of State Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS

Element of the environment	Enhanced Conservation	Market-Based Reallocation of Water Resources	Groundwater Storage
Surface water *Construction* *Long-term* *Mitigation*	There is potential to increase sediment loading to surface water bodies during construction. Long-term impacts may include an increase in streamflow in the stream being diverted from along with a reduction in return flow from reduced seepage in other streams. The reduction in return flow may reduce base flows in streams. Reservoir levels may change from existing if conservation allows water to be stored in the reservoir for a longer period of time before being released. Mitigation of construction impacts can be achieved through construction related BMPs. Long-term impacts can be mitigated by ensuring the net effect of the project is beneficial.	Construction and long-term impacts and mitigation measures would be similar to that of Enhanced Conservation, but of a lesser magnitude.	Construction impacts would be similar to those described under Enhanced Conservation. Changes in flow and temperature would occur when flow is diverted for recharge. Flows will decrease when water is diverted and increase when the stored water reaches the river. Increased discharge to seeps, springs, and surface water would occur. Construction and long-term mitigation measures would be similar to those described for Enhanced Conservation.
Water rights *Construction* *Long-term* *Mitigation*	No construction impacts to water rights would occur. In the long term, conservation may free up water under existing water rights for potential transfer and reallocation. Additional water may be available, which may reduce curtailment of junior water rights during water-short years.	By law, all existing water rights, senior and junior, are protected from impairment by any proposed transfer. One of the impediments to an active market is the administrative approval of the transfer. Some of the water marketing and water banking alternatives propose changes to the review of transfers. To the	Proposed projects must meet the same standards as described for the Enhanced Conservation Alternative. Construction and long-term impacts and mitigation measures would be similar to those described under Enhanced Conservation.

Table ES.7 Comparative analysis of State Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Element of the environment	Enhanced Conservation	Market-Based Reallocation of Water Resources	Groundwater Storage
Water rights (continued)	Proposed projects must meet State standards for review and mitigation regarding specific issues listed in RCW 90.03.370 (2)(a) and defined further in Chapter 173-157 WAC.	extent the law is changed to facilitate transfers through markets, there may be additional impacts to water rights. Proposed projects must meet the same standards as described for the Enhanced Conservation Alternative.	
Groundwater *Construction* *Long-term* *Mitigation*	Construction impacts are not anticipated. Long-term impacts may include changes in the level, gradient, recharge and discharge rates, and contaminant introduction. Impacts may be mitigated by conducting appropriate hydrogeological studies prior to project implementation.	Construction impacts are not anticipated. Long-term impacts and mitigation measures would be similar to those described under Enhanced Conservation. Mitigation measures would be similar to those described under Enhanced Conservation.	Limited construction impacts would be associated with the development of groundwater storage facilities including infiltration basins and treatment facilities; however construction is not expected to extend to the groundwater table and dewatering is not anticipated. Long-term impacts and mitigation measures would be similar, but possibly greater than, those described under Enhanced Conservation.
Hydropower *Construction* *Long-term* *Mitigation*	Construction impacts are not anticipated, because construction activities will not impact streamflows. Conservation may result in reduced power generation at the BIA plants during most years, but may be improved during drought years.	Similar to the Enhanced Conservation Alternative, no construction impacts are anticipated. Long-term impacts would depend on the location of the transfers. If water is transferred to the WIP, some increase in hydropower may occur. No mitigation would be required.	No construction impacts are anticipated. There would be no long-term impacts to hydropower generation. No mitigation would be required.
Sediment *Construction* *Long-term* *Mitigation*	Construction could temporarily increase rates of sediment erosion. There would be no long-term impacts to channel morphology. Mitigation measures would include the implementation of BMPs including the timing of construction, and measures that limit erosion and stabilize degraded conditions.	Impacts and mitigation would be similar to those described under the Enhanced Water Conservation Alternative. In the long-term, changed land uses could cause increased or decreased erosion depending on the new land use. No mitigation would be required.	Impacts and mitigation would be similar to those described under Enhanced Conservation.

Table ES.7 Comparative analysis of State Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Element of the environment	Enhanced Conservation	Market-Based Reallocation of Water Resources	Groundwater Storage
Water quality *Construction* *Long-term* *Mitigation*	There is potential to increase sediment loading to surface water bodies during construction. Long-term impacts may include increased dissolved oxygen, reduced stream temperatures and increased pollutant concentrations in runoff. Mitigation for construction impacts would be similar to the preventive measures described under Sediment.	Construction impacts would be similar to those described under the Enhanced Water Conservation Alternative, but to a lesser degree. Long-term impacts from water transfers are not known. Water quality parameters (including temperature) may improve or degrade depending on the type of land use the water is transferred to, and the volume and location of water transferred. Mitigation for construction impacts would be similar to the preventive measures described under Sediment.	Construction impacts would be similar to those described under Enhanced Conservation. Changes in groundwater quality could occur, but these changes are not expected to be significant. Mitigation for construction impacts would be similar to the preventive measures described under Sediment.
Vegetation and wildlife *Construction* *Long-term* *Mitigation*	Construction impacts from irrigation improvements may alter existing vegetation structure and the distribution of habitat potentially disrupting wildlife. Construction impacts would also include noise and activities that would temporarily displace wildlife. Over the long term, reduced seepage and water rights transfers may alter the distribution of vegetation and wildlife. Mitigation measures for construction impacts would be alleviated by siting and designing facilities to minimize the need for vegetation removal. These measures would also include the application of construc-tion BMPs, and the restora-tion of disturbed areas.	Construction impacts and mitigation measures would be similar to those described under Enhanced Conservation, except to a lesser degree. In the long-term, water rights transfers may impact land use ultimately altering vegetation structure and wildlife habitat distribution in some areas. Mitigation measures for construction impacts would be similar to those described under Enhanced Conservation.	Construction impacts would be similar to those described under Enhanced Conservation. Over the long-term, groundwater levels would rise, which may affect vegetation communities and wildlife habitat in some areas. This could have both positive and negative impacts. Mitigation measures for construction impacts would be similar to those described under Enhanced Conservation.
Anadromous fish *Construction* *Long-term* *Mitigation*	There is potential to increase sediment loading to surface water bodies during construction. Long-term impacts associated with the potential increase in streamflow would be considered beneficial. Mitigation for construction impacts would be similar to the measures described for Sediment.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative, except to a lesser degree.	Construction impacts and mitigation measures would be similar to those described under Enhanced Conservation. In the long-term, groundwater storage is expected to benefit anadromous fish and other aquatic organisms by potentially improving base flows and providing influxes of cold water.

Table ES.7 Comparative analysis of State Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Element of the environment	Enhanced Conservation	Market-Based Reallocation of Water Resources	Groundwater Storage
Resident fish *Construction* *Long-term* *Mitigation*	Construction and long-term impacts are similar to those described for anadromous fish.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative, except to a lesser degree.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.
Aquatic invertebrates *Construction* *Long-term* *Mitigation*	Construction impacts are anticipated to be minor and isolated to areas adjacent to instream disturbances. Long-term impacts may include changes to the community composition of aquatic invertebrates due to potential increases in streamflows, and site specific alterations created during the enhancement irrigation infrastructure. Project-specific studies would be required to determine potential impacts to aquatic invertebrates.	Construction and long-term impacts and mitigation would be similar to those described under Enhanced Water Conservation.	Construction and long-term impacts and mitigation would be similar to those described under Enhanced Water Conservation.
Threatened and endangered species *Construction* *Long-term* *Mitigation*	Construction and long-term impacts would be similar to those described for Anadromous Fish and Vegetation and Wildlife. Mitigation measures would be similar to those described for Anadromous Fish and Vegetation and Wildlife.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative, except to a lesser degree.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.
Recreation *Construction* *Long-term* *Mitigation*	Impacts to recreation from construction are not expected. Conservation may increase streamflows in some reaches, but not to the extent that recreation would be impacted. No mitigation would be required.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative, except to a lesser degree.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.
Land use and shorelines *Construction* *Long-term* *Mitigation*	Impacts to land use from construction are not expected. Improvements to irrigation efficiency could reduce the potential conversion of agricultural lands to other uses. No mitigation would be required.	Construction impacts would be similar to those described under the Enhanced Water Conservation Alternative, except to a lesser degree. Transfers of water rights may result in changes in land use intensity. Whether development intensity increases or decreases is dependent on currently unspecified transfers.	Construction impacts would be similar to those described under the Enhanced Water Conservation Alternative. Acquisition and/or special management of lands in the vicinity of the infiltration or injection areas may be required. Property would be purchased from willing sellers or acquired

Table ES.7 Comparative analysis of State Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Element of the environment	Enhanced Conservation	Market-Based Reallocation of Water Resources	Groundwater Storage
Land use and shorelines (continued)		Impacts to land use would be mitigated by compliance with existing land use and zoning regulations.	according to applicable State and Federal regulations.
Socioeconomics *Construction* *Long-term* *Mitigation*	The scope and design of specific projects would determine their short-term costs and benefits on socioeconomic factors. In the long term, this alternative is intended to yield net economic gains sooner rather than later, by lowering legal, financial, and/or institutional barriers that otherwise would impede the extent and speed of conservation efforts in the basin. Mitigation, if any, would be determined by future socioeconomic conditions. Measures may include, but would not be limited to compensation and /or replacement of lost goods and services.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. In the long-term, transfers of water would likely increase the economic well-being of those who participate in them because a transaction would occur only if both the buyer and the seller expected it to be beneficial.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. In the long-term, increases in groundwater levels could alter the production of goods and services near wetland, floodplain, and riparian areas.
Public services and utilities *Construction* *Long-term* *Mitigation*	Construction along roadways could cause temporary disruption of utilities and increased response time for police and fire emergencies. Over the long-term, conservation programs would reduce overall expenditures on public services and utilities.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. In the long-term, this alternative would incur costs for implementation and administration; however, water rights transfers have potential to improve the reliability of irrigation supplies.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. In the long-term, groundwater storage would require additional costs for treatment and operation.
Transportation *Construction* *Long-term* *Mitigation*	Construction impacts could include temporary disruption of traffic depending on project site locations. No long-term impacts are anticipated. Mitigation would include maintaining access to properties, installing signage, and providing information to the public.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative, except to a lesser degree.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.
Air quality *Construction* *Long-term* *Mitigation*	Construction impacts would include increases in fugitive dust from disturbed soils and increased emissions.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.

Table ES.7 Comparative analysis of State Alternatives by indicator: Yakima River Basin Water Storage Study Draft PR/EIS (continued)

Element of the environment	Enhanced Conservation	Market-Based Reallocation of Water Resources	Groundwater Storage
Air quality (continued)	No long-term impacts are anticipated.	Long-term impacts would not affect air quality unless water transfers create fallow field conditions increasing the potential for fugitive dust.	Long-term impacts would not affect air quality unless infiltration basins go dry, increasing the potential for fugitive dust.
Noise *Construction* *Long-term* *Mitigation*	Noise sources would temporarily increase during construction activities. No long-term impacts are anticipated. No mitigation measures are required.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. Pumps used at storage facilities would generate noise during operations, but the noise would be minimal and likely undetectable offsite.
Visual *Construction* *Long-term* *Mitigation*	Construction equipment and activities would temporarily alter, but not obstruct, views. Conservation projects would alter to the long-term views of the landscape, but impacts are anticipated to be limited. No mitigation measures are required.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. Long-term impacts to visual resources from land type conversion would depend on the type and amount converted land.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. Long-term impacts to visual resources from the development of infiltration and well facilities would depend on location and size of the facilities.
Cultural *Construction* *Long-term* *Mitigation*	Any construction that involves ground disturbing activities has the potential to impact cultural resources. In the long-term, human activity patterns may be altered by conservation projects resulting in relic collecting and site disturbance. Ecology would initiate additional cultural resource surveys when specific projects are identified.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.	Construction impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative. Increasing groundwater levels may affect the preservation of buried organic materials or the soil chemistry of buried cultural resources. Groundwater storage is not likely to otherwise adversely affect cultural resources during construction or over the long-term.
Public health and safety *Construction* *Long-term* *Mitigation*	Construction activities are not anticipated to significantly impact public health and safety. No significant long-term impacts are anticipated.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.	Construction and long-term impacts and mitigation measures would be similar to those described under the Enhanced Water Conservation Alternative.

Table ES.8 Comparative display of the NED and RED accounts for the Draft PR/EIS

	No Action Alternative[1]	Black Rock Alternative	Wymer Dam and Reservoir Alternative	Wymer Dam Plus Yakima River Pump Exchange Alternative
NED account				
Beneficial effects – Present value of 100-year annual benefit stream in excess of No Action Alternative ($ million)				
Agriculture	Not applicable	84.6	26.5	26.5
Municipal and industrial	Not applicable	286.8	285.2	286.1
Hydropower	Not applicable	62.5	0	0
Recreation	Not applicable	602.4	102.7	111.1
Fisheries	Not applicable	8.7	0.5	5.1
Total benefits	Not applicable	1,045.1	414.8	428.7
Adverse effects – OM&R and power costs reflect present value of 100-year annual cost stream ($ million)				
Construction costs	Not applicable	4,419.9	1,053.0	4,023.0
Interest during construction	Not applicable	1,095.9	304.1	1,130.6
OM&R costs (present value)	Not applicable	206.8	22.0	370.1
Power costs (present value)	Not applicable	1,016.9	38.6	403.1
Total costs	Not applicable	6,739.5	1,417.7	5,926.8
Net benefits (total benefits – total costs)	Not applicable	(5,694.4)	(1,002.9)	(5,498.1)
Benefit-cost ratio (total benefits ÷ total costs)	Not applicable	0.16	0.29	0.07
RED account				
Construction period impacts				
Construction: Estimates reflect impacts summed over the entire 10-year construction period.				
Output/sales ($ million)	Not applicable	$2,100	$613	$1,732
Income ($ million)	Not applicable	$710	$216	$589
Employment (jobs)	Not applicable	18,667	5,677	15,539
Annual benefit period impacts				
Irrigated agriculture: Agricultural impacts only occur in years when the proration percentage falls below 70%. As a result, impacts occur periodically and not every year. Agricultural impacts occurred in 5 of the 25 years of the hydrologic record (i.e., 1987, 1993, 1994, 2001, and 2005).				
Output/sales ($ million)				
1987	Not applicable	$53.9	$16.8	$3.4
1993	Not applicable	$66.4	$45.7	$38.0
1994	Not applicable	$234.1	$14.5	$12.1
2001	Not applicable	$126.9	$81.3	$70.8
2005	Not applicable	$121.2	$22.8	$19.9
Labor income ($ million)				
1987	Not applicable	$18.4	$5.7	$1.2
1993	Not applicable	$22.7	$15.6	$13.2
1994	Not applicable	$82.6	$5.3	$4.4
2001	Not applicable	$44.2	$28.6	$25.3
2005	Not applicable	$42.2	$8.0	$7.2

Table ES.8 Comparative display of the NED and RED accounts for the Draft PR/EIS (continued)

	No Action Alternative[1]	Black Rock Alternative	Wymer Dam and Reservoir Alternative	Wymer Dam Plus Yakima River Pump Exchange Alternative
Employment				
1987	Not applicable	580	179	37
1993	Not applicable	716	493	407
1994	Not applicable	2,608	169	140
2001	Not applicable	1,394	902	786
2005	Not applicable	1,330	254	222
Recreation (Recreation effects were converted to an average annual basis)				
Existing sites				
Output/sales ($ millions)	Not applicable	$ 0.14	$ 0.05	$ 0.09
Labor income ($ million)	Not applicable	$ 0.07	$ 0.02	$ 0.04
Employment	Not applicable	2	1	1
Black Rock reservoir				
Output/sales ($ million)	Not applicable	$ 23.6	Not applicable[2]	Not applicable[2]
Labor income ($ million)	Not applicable	$ 9.2	Not applicable	Not applicable
Employment	Not applicable	360	Not applicable	Not applicable

[1] All the economic effects were measured as a change from the No Action Alternative; as a result, No Action Alternative effects were not analyzed.

[2] Recreators at Wymer reservoir are assumed to be from the local area; therefore, no regional impacts were generated.