CHAPTER 4.0 IMPACTS AND MITIGATION MEASURES FOR MANAGEMENT PROGRAM COMPONENTS

This chapter analyzes potential impacts that could be associated with implementation of the Columbia River Water Management Program (Management Program). Because this is a programmatic EIS, and at this time the details of projects that would be proposed under the Management Program are unknown, impacts are discussed in general terms. Specific projects proposed in the future under the Management Program may be required to undergo additional environmental review to identify specific impacts.

The nature and magnitude of impacts from implementation of the Management Program would vary depending on the specific project proposed. Water conservation measures such as the installation of on-farm conservation improvements would have limited impacts for short periods of time. Impacts would largely be confined to the property where the project is located. Large storage projects and regional conservation projects would generate more impacts over a larger area.

Section 4.1 presents the impacts associated with implementation of the Management Program. The potential impacts of storage projects are described in Section 4.1.1. Conservation program impacts are presented in Section 4.1.2, and the potential impacts of Voluntary Regional Agreements (VRAs) are described in Section 4.1.3. The impacts of not implementing the Management Program are described in Section 4.2, the No Action Alternative. Anticipated cumulative impacts of the Management Program components are described in Section 4.3.

The level of analysis of impacts varies by element of the environment. The most detailed analysis is presented for those issues that generated the most comments during the scoping period, and/or have the greatest potential for impact (see Section 1.5). Water quantity and quality issues, water rights, socioeconomics, and fish and wildlife impacts were the issues most frequently commented on during scoping and are the ones presented in the greatest detail in this programmatic EIS.

Implementation of the components of the Management Program will require additional studies. Some of those studies are currently being conducted by the Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Geological Survey, and Confederated Tribes of the Colville Reservation. Construction of storage and conservation projects will be coordinated with federal agencies that have a permitting and regulatory role. In addition, the program will be coordinated with those agencies and utilities already involved with storage and conservation projects such as the Bonneville Power Administration (BPA), Natural Resources Conservation Service (NRCS), and extension offices. Continuing coordination among the key stakeholders, including Reclamation, the Washington Department of Fish and Wildlife, the Department of Archaeology and Historic Preservation, federally recognized tribes in the project area, and other state and federal agencies, will be essential to implementation of the project.

4.1 Columbia River Water Management Program

4.1.1 Storage Component

This section describes the short-term and long-term impacts that could be associated with storage projects proposed under the Management Program. Potential mitigation measures for minimizing impacts are also described. This programmatic EIS does not evaluate the impacts of any specific storage project because none has currently been proposed under the Management Program. Instead, this EIS describes the range of impacts associated with the general types of storage projects likely to be proposed under the Management Program. The general types of projects considered are new large storage projects, new small storage projects, modification of existing storage facilities, aquifer storage and recharge (ASR), and pump exchanges. These types of storage projects are described in Section 2.1.2.1.

Many of the storage projects that could be proposed under the Management Program would require additional environmental review. Depending on the extent of federal funding or permitting required for the project, the environmental review could be under the National Environmental Policy Act (NEPA) as well as the State Environmental Policy Act (SEPA). Large-scale storage projects would undergo extensive studies to determine their technical and economic feasibility. This detailed level of analysis would occur when specific projects are proposed under the Management Program.

While construction of a single large facility would likely be very expensive, the costs and environmental impacts may be less than building several smaller facilities to achieve the same benefit. Pursuing several smaller sites would require that feasibility study, environmental review, design, permitting, land acquisition, and construction be conducted multiple times, rather than once for a single large facility. Construction of a single facility would limit environmental and cultural impacts to one geographic area, while the construction of several smaller sites would create such impacts in several geographic areas.

4.1.1.1 Earth

Short-term impacts

The most extensive short-term earth impacts of potential storage projects would be associated with construction. Construction may include land clearing, the development of new roads, excavation, and filling. These activities would disturb the ground and expose soils and could increase soil erosion by removing protective vegetation, disrupting soil profiles, and modifying slopes and drainage patterns. The magnitude of these potential impacts would depend on the type and scale of construction activities, the inherent erodibility of the local soils, the local climate, and the season during which the construction would occur (Ecology 2003b; Ecology 2005b).

Construction may require the import of large quantities of fill material and concrete for access roads, a dam, a dam spillway, or conveyance facilities. Imported fill materials would need to be from an approved source that would meet the requirements of the state Model Toxics Control Act (RCW 70.105D). In addition, design and construction would be subject to design plan reviews and construction inspections by the Dam Safety Office (Ecology 2003b; Ecology 2005b). Construction of (or modification to) storage facilities would involve the consumption of earth resources, such as gravel, sand, and concrete.

Short-term impacts associated with the construction of an underground storage reservoir for ASR could include ground disturbances from drilling recharge, recovery, and monitoring wells, and construction of conveyance facilities and well buildings.

Long-term impacts

New storage reservoirs, including both on-channel and off-channel reservoirs, may increase ground water levels (see Section 4.1.1.4). It is possible that changes in ground water levels and the hydrostatic force of the water in storage facilities could lead to geologic instabilities. These could include local subsidence, increased slope failures, and erosion due to development of new seeps and springs (Ecology 2003b). Changes to the capacity of existing impoundments may result in similar impacts.

Increases in ground water elevations in underground storage reservoirs could lead to deformation at the ground surface as a result of increased hydrostatic pressures in the storage aquifer. Seepage of recharge water from the storage aquifer could result in instability or slope failure. Specific potential impacts associated with proposed projects would be analyzed in detail during feasibility and design evaluations. These types of impacts would be described in subsequent site-specific investigations.

Mitigation

Requirements for erosion control would be defined for each project through review by state and local regulatory agencies (Ecology 2005b). Requirements could include construction best management practices (BMPs) such as the use of straw bales or silt fencing to trap sediments. Any proposed storage projects would undergo further design and geotechnical review, and additional project-level environmental review, prior to construction to assess the site's suitability (Ecology 2005b). Erosion control requirements would reduce sediment production and delivery from new roads. Roadways would have to be properly designed, and projects would have to comply with stream buffer requirements in applicable local critical areas ordinances and stormwater requirements. Mitigation measures to reduce erosion could also include watershed restoration activities such as planting vegetation on exposed stream banks and improving drainage culverts (Ecology 2005b).

Mitigating the risks associated with potential or actual geologic instabilities may require structural changes to the facility itself, and construction of control or mitigation structures both upstream and downstream of the facility. The risks associated with geological instability caused by increased ground water levels and weight of the impounded water may be reduced through geotechnical design and long-term monitoring of the facility (Ecology 2003b).

Mitigation measures to reduce the potential for ground deformation include performing a geotechnical evaluation of the materials overlying the storage aquifer prior to design, so that geotechnical considerations are adequately incorporated into project design, and managing hydrostatic pressures in the storage aquifer so that the lithostatic pressure of the materials surrounding the storage aquifer is not exceeded (including a factor of safety). Geotechnical evaluations of potential unstable slopes prior to design will minimize the potential for facilities to be located in unstable areas. Managing recharge volumes and pressures in the storage aquifer to limit seepage from the aquifer, inventorying slopes in the project area, and monitoring pressures in slope areas during recharge and storage are measures to minimize slope instability.

4.1.1.2 Air

Short-term impacts

Construction of new storage facilities would require the use of heavy equipment and vehicles for excavation, grading, filling, and material hauling activities. Excavation can result in temporary fugitive dust and equipment combustion emissions. However, Ecology regulations and/or those of the local governing air agency would minimize fugitive dust by requiring best available control technologies (BACT). In addition, most of the construction equipment emission sources would be mobile and intermittent in nature. Air quality impacts would not be expected to exceed any ambient air quality standard. Consequently, construction activities associated with municipal conservation programs could produce adverse, but likely insignificant, air quality impacts within a localized project region.

Currently, there are three non-attainment areas in eastern Washington: Spokane (carbon monoxide), Wallula (particulate matter), and Yakima (carbon monoxide) (EPA 2003). Construction projects in these areas, especially large projects, could exacerbate local air quality issues. However, because construction activities are temporary and intermittent in nature, and all projects would be required to comply with regional and local regulations regarding emissions, cumulative construction impacts on air quality would not be significant.

Long-term impacts

Some amount of fugitive dust and combustion emissions could be generated by vehicles during maintenance activities associated with storage projects. However, these emissions would be negligible and intermittent in nature. Fugitive dust could also be generated during periods of reservoir drawdown when lake beds are exposed.

Although new storage projects are not expected to directly affect climate in the region, climate change could affect the need for water in the region over the long term. If the warming trend continues to reduce glaciers and snowpack in the mountains that feed the Columbia and Snake Rivers, water supplies could be reduced. Increased demand for irrigation water could reduce hydropower production. To make up for reduced electric power production due to reduced water availability, power would be purchased from other generation facilities. These facilities are typically hydrocarbon-based (gas or coal) turbine generators that produce significant air emissions.

Mitigation

Air pollution control regulations implemented by Ecology and/or local air agencies would limit emissions of fugitive dust during construction and facility operations. Some of the control measures include:

- Use of wetting agents in active areas that generate visible dust;
- Use of covers, wetting agents, or sealed load containers to prevent materials from escaping out of truck loads while on public roads;
- Cleaning techniques to prevent vehicles from tracking soil/particulate matter onto public roads;
- Stabilization of storage piles;
- Use of water sprays during material handling and transfer operations, such as those performed by a loader;
- Surfacing dirt roads with gravel or pavement; and
- Dust management considerations in reservoir operations.

For construction activities occurring in or near carbon monoxide non-attainment or maintenance areas, consideration should be given to reducing construction emissions. The following equipment control measures could be implemented:

- Use of heavy-duty diesel-powered construction equipment manufactured after 1996 (with federally mandated “clean” diesel engines) whenever feasible;
- Use of construction equipment with the minimum practical engine size;
- Use of efficient management practices to minimize the construction equipment operating simultaneously; and
- Maintenance of construction equipment in tune per the manufacturer’s specifications.

4.1.1.3 Surface Water

Short-term impacts

Water Quantity. Temporary impacts may be associated with the construction of new storage facilities. For new on-channel facilities, impacts may occur primarily during the dam and overflow spillway construction phase. Interruption of flow may occur during this phase (Ecology 2003b). The construction phase of a large or small on-channel storage facility can also pose unique threats from dam breach during the short periods where structural elements and failsafe design features are incomplete or awaiting final inspection (Ecology 2003b).

Disturbance of contaminated sediment could release toxic contaminants into the water column and in aquatic species. The level of impact will vary depending on the level of contamination and disturbance. However, this could contribute to existing concentrations of contaminants, such as DDE, Aroclors, zinc, and aluminum, that have already bioaccumulated in fish tissue (EPA 2002a).

For new off-channel storage facilities, short-term impacts would be similar to those described for on-channel facilities. Facilities may require constructing a diversion structure or pump station on a stream and bypassing a short reach of the stream during construction. Construction of a dam and reservoir to store water would require filling, thereby reducing flows in the stream from which the water was diverted.

Short-term impacts for modifications to existing storage facilities may be similar to those described above if the resulting use of water from the existing storage facility requires construction of an additional diversion structure or pump station. Short-term impacts to surface water for development of an underground reservoir are limited to decreases in streamflow in the stream from which the water is diverted.

Water Quality. Construction of on-channel storage facilities requires substantial disturbance of earth as discussed in Section 4.1.1.1. There is a potential for post-construction sediment loading to the downstream channel from sloughing and superficial erosion of earthen berms until the berm surface reaches structural stability. Similarly, there could be increased sediment loading to the reservoir from bank sloughing until the banks reach structural equilibrium. The level of impact on the quality of surface water would vary, depending on the volume of earthwork, proximity to a water body, condition of surrounding vegetation, and mitigation measures implemented (Ecology 2005b). These sediment inputs to water bodies, even if short-term, may be significant. Inputs of sediment to any water body may increase turbidity until the site is revegetated. Inputs of fine sediment may also affect the substrate condition in streams. The level of impact will vary with the amount of sediment input into the water body. Additionally, the import of non-native soils may affect the chemistry of nearby surface waters.

For new off-channel storage facilities, short-term impacts would be similar to those described for on-channel facilities. The facilities may require construction of a diversion structure or pump station on a stream and construction of a dam and reservoir to store water.

Short-term impacts for modifications to existing storage facilities may be similar to those described above if the resulting use of water from the existing storage facility requires construction of an additional diversion structure or pump station. Other modifications to existing structures could have limited construction and limited short-term impacts. Short-term impacts to surface water for development of an underground reservoir are limited to temporary construction impacts for construction or modification of conveyance infrastructure.

Long-term impacts

Water Quantity. New on-channel storage facilities would change the stream reach from free flowing to a regulated river, thereby affecting the flow regime and stream morphology processes downstream. The storage structure would, by design, change the flow regime by storing more water during periods when the impacts to Columbia River fisheries are relatively low and releasing it to augment instream flows when it is critical to fisheries. One-third of the water yield of the reservoirs would be dedicated to this purpose. Creating an impoundment would also interrupt natural surface and subsurface flow routing. The flux of shallow ground water typically moving laterally toward the stream would be altered. Similarly, the surface water elevation of tributary streams in the inundation area would be altered as the water backs up behind the impoundment rather than flowing freely downstream. A new equilibrium between upland flow and the new surface water elevation of the reservoir would be established. In addition, evaporative losses would be expected from the surface of any reservoir (Ecology 2003b).

The ability to augment instream flows during low flow periods using water from new storage will result in an increased ability to meet minimum mainstem Columbia River flow targets established by NOAA Fisheries, and reserved tribal rights to water to hunt and fish in usual and accustomed places.

The specific nature and degree of the impacts to surface water quantity would depend on operation of the storage facility. Other long-term impacts may include:

- Long-term rapid fluctuations in reservoir and downstream channel water surface levels dependent on gate operation, which will have large impacts on near-bank and overbank biota.
- Potential for the dam to breach, resulting in catastrophic flooding downstream. Dam safety regulations require extensive studies such as a downstream hazard assessment and mapping of potentially inundated areas. In addition, an emergency action plan would be required to alert and evacuate downstream residents in the event of a dam breach.
- Evaporative losses would occur from any reservoir (Ecology 2003b).

Construction of new off-channel storage facilities could change the stream morphology and flow regime downstream of the intake. The hydrologic effects would be similar to on-channel storage projects. The specific nature of the impacts to surface water resources would depend on how the storage facility was operated. Secondary effects may include enhancement of recharge of the aquifer under the reservoir. Evaporative losses would also occur from off-channel reservoirs (Ecology 2003b).

With regard to dam safety issues, creating storage in off-channel impoundments could have the same long-term impacts as on-channel storage facilities (Ecology 2003b).

The long-term impacts of modifying the operations or raising existing on-channel storage facilities on surface water may range from negligible to significant depending on the type of project. Impacts may include those discussed above. Fluvial processes already disturbed from the initial construction of the facility may be slightly altered due to the expansion or change in flow regulation. Peak flows may be further reduced and low flows may be increased. For a project that increases the storage area, evaporative losses would be predicted to increase in proportion to the increase in surface area. In cases where large existing facilities are raised by a small percentage, the effects may be small. In cases where small facilities are increased significantly in size, the effects may be pronounced (Ecology 2003b).

Modifications to existing dam structures must be authorized by the Dam Safety Office and must conform to the provisions of the guidelines for structural modification outlined in WAC 173-175. As the elevation of an existing structure is raised, the volume stored behind the reservoir will increase exponentially. The increased volume of water increases the risks of dam failure (Ecology 2003b).

The addition of beneficial uses of water from a reservoir or other storage facility may reduce return flows if new consumptive uses are allowed from a facility that was previously allocated for recreation, power, instream flow, or other non-consumptive uses. This impact may be significant. Also, unanticipated dam safety issues may arise. Evaluation on a case-by-case basis would be required (Ecology 2003b).

Development of underground storage could result in increased ground water discharge to seeps, springs, wetlands, and surface water if recharge water discharges from the storage aquifer as a result of increased ground water elevations or pressures. This would increase baseflows in surface water bodies where discharge occurs. Streamflow impacts from development of underground storage are similar to those for above-ground reservoirs. Streamflows used for underground storage are generally diverted during periods of high streamflows, such as during snowmelt. Thus, impacts on stream temperatures and low flows are minimized (Ecology 2003b).

Water Quality. The extent of the impacts of on-channel storage facilities on water quality will be dependent on the size and location of the facility. Small impoundments (for example, impoundments the size of stock ponds or run-of-river diversions) may not have substantial effects on water quality. Large dams may have very significant effects. The local nutrient loading and the mitigation measures incorporated into the project will also influence the changes in water quality associated with on-channel facilities.

The specific nature and degree of the impacts to surface water quality would depend on operation of the storage facility. Long-term impacts may include:

- Seasonal increases in downstream sediment loading and gas entrainment resulting from rapid drawdown in anticipation of flood events. Rapid drawdown may entrain and discharge sediment. It may also result in spillway flow that entrains dissolved gas.
- Blockage of natural debris carried downstream by the stream, reducing the organic loads in the stream below the dam.
- Potential changes in downstream overbank soil characteristics and riparian zone vegetation due to flood control measures that change the flood inundation profile.
- Eventual silting of the reservoir that will require dredging or reduce storage capacity with associated environmental impacts.
- Decreased turbidity and bedload sediment downstream of the impoundment.
- Increased stream temperature downstream of the impoundment.
- Decreased dissolved oxygen downstream of the impoundment.
- Increased stream temperature within the impoundment.
- Potential for eutrophication of water where nutrient levels are high.
- Potential for the accumulation of pollutants in the sediments at the headwaters of the impoundment.
- Decreased organic loads in stream below the reservoir due to blockage of natural debris behind the dam (Ecology 2003b).

These potential impacts would be considered in the project-level review of the proposed storage facilities.

Construction of off-channel storage facilities may also have significant effects on streamflow. Reductions in flows may result in long-term increases in water temperature if the reduction in flow is substantial. In addition, water quality could be affected if the off-channel facility were built on a location where local soils and/or geology contained contaminants. The magnitude of the effect would depend on local conditions. There are potential impacts of increased baseflows and, therefore, surface flows on water quality. If the quality of the recharge water is lower than the quality of local ground water, degradation of water quality may occur. Secondarily, degradation of surface water quality could occur under these circumstances; however, surface water quality degradation would likely be less than that of ground water due to the effect of dilution by surface flow (Ecology 2003b).

The long-term impacts of modifying the operations or raising existing on-channel storage facilities on water quality may include those discussed above. Long-term effects on surface water quality from allocating water from existing storage facilities to additional beneficial uses could be variable and depend on the current allowable uses and the newly added beneficial uses.

The addition of recreational use or stock watering adjacent to a reservoir currently permitted only for drinking water may decrease water quality. The degree of effect would depend on the type of use allowed and the extent of use. Protecting water quality would be more challenging in reservoirs that are popular recreational areas. If new recreational uses include the use of motorboats, oil and gas may pollute the water body (Ecology 2003b).

Residential development, grazing, and other land uses can also affect water quality. Residential development may introduce chemicals from lawns and potentially some septic leakage. Grazing can increase nutrient loads. The extent of potential impact to water quality would be directly related to the extent and type of use (Ecology 2003b).

The preceding paragraphs focus on the addition of beneficial uses to systems used for drinking water. Other situations have a lower potential for affecting water quality. For instance, adding stock watering as a beneficial use for a facility currently permitted for irrigation is unlikely to have a significant effect on water quality. Likewise, the addition of a hydropower facility to an impoundment that provides water for irrigation is unlikely to have significant effects on water quality. In situations where drinking water is added as a beneficial use, improvements in water quality may be achieved through the introduction of source protection measures. Therefore, water quality may be either improved or degraded depending on the change that is implemented. The significance of changes in permitted beneficial uses would depend on the quantity of pollutants that are introduced to or removed from a water body as a result of the change in beneficial use (Ecology 2003b). Site-specific investigations for future projects will identify potentially adverse or beneficial impacts to water quality and will identify specific mitigation measures as needed.

Mitigation

Water Quantity. Short-term impacts on water quantity can be mitigated by minimizing the area and time of disturbance or flow interruption. To minimize the possibility of inadvertent dam failure during construction, the construction plans should be evaluated to identify vulnerabilities in dam safety, and best construction management practices should be implemented.

Long-term impacts may be mitigated by:

- Developing an augmentation plan to reduce the impacts on other water right holders;
- Developing operating rule curves to compensate for flow alterations;
- Scheduling high flow releases to mimic natural event magnitudes;
- Releasing sediment from facilities along with flushing flows to maintain natural scour patterns; and
- Performing extensive studies as required by dam safety regulations, such as a downstream hazard assessment and mapping of potentially inundated areas. In addition, an emergency action plan would be required to alert and evacuate downstream residents in the highly unlikely event of a dam breach.

Water Quality. Short-term impacts of construction on water quality can be mitigated to some extent by implementing soil erosion BMPs, constructing the facility "in-the-dry," and revegetating disturbed areas quickly. Impacts to water quality would be reduced by a site selection process that includes an analysis for those geologic characteristics that will minimize ongoing turbidity and control erosion in the surrounding areas. However, some sediment input to streams is unavoidable. The effects of local soils and geology on water quality can be minimized through careful review of site conditions during project planning and the avoidance of sites containing potential pollutants (Ecology 2003b).

Long-term effects of on-channel facilities on water quality can be substantial. Mitigation of some of these effects may include:

- Controlling the depth of the intake to minimize downstream effects on temperature and dissolved oxygen;
- Reducing elevated temperatures in water discharged from the reservoir by infiltrating the water to allow cooling before recharging surface waters;
- Providing sediment bypass facilities (only effective on small impoundments); and
- Implementing measures to control nutrient inputs.

The appropriate mitigation measures for surface water quality effects of adding beneficial uses to an existing storage facility will depend on the change in use. Proposed changes in use should be reviewed and any potential effects on water quality identified during site-specific investigations. Effects may be mitigated by limiting use (for example, limiting or excluding motorized recreation on lakes), implementing source control measures to protect municipal supplies, and/or by controlling methods of use (for example, requiring off-site watering of animals). Appropriate mitigation would be identified on a project-specific basis (Ecology 2003b).

Implementation of water quality plans may protect, restore, or enhance water quality. The rate and magnitude of improvement will depend on the requirements of individual plans (Ecology 2003b).

Monitoring of water quality may influence the effectiveness of water quality management programs. This can have a net effect of reducing the impacts of land management practices on water quality (Ecology 2003b).

Numerous other mitigation measures may also be appropriate and will tend to be project-specific. Proposed on-channel facilities would be subject to extensive review to ensure that the potential effects are well understood and that appropriate mitigation measures are applied.

4.1.1.4 Ground Water

Short-term impacts

Water Quantity. Short-term impacts to ground water resources could involve changes in ground water levels and gradients during construction. If construction includes substantial ground water control activities, required construction dewatering could temporarily reduce ground water levels and availability in the alluvial aquifer and/or sedimentary aquifer system (Ecology 2003b; Ecology 2005b).

Short-term impacts to ground water from development of underground storage include changes in ground water levels and gradients during pilot testing of recharge, storage, and recovery. There may be short-term increases in ground water elevations or pressures during recharge and storage, and short-term decreases in ground water elevations or pressures during recovery pumping.

Water Quality. Potential water quality impacts from construction include contamination from surface water sources if soil removal has created a means for contaminants to reach the ground water system. Pilot testing of recharge and storage to develop ASR will result in the mixing of recharge water and native ground water. Depending on the quality of each water source, there may be physio-chemical reactions between the recharge water, the native ground water, and the aquifer matrix that could adversely affect ground water quality.

Long-term impacts

Water Quantity. Operating an on-channel storage facility or raising the level of an existing on-channel or off-channel storage facility could permanently increase ground water recharge rates and ground water levels near the storage facility. The magnitude of these potential impacts would depend on the size and depth of the storage facility, the hydraulic head created by the storage impoundment, and local hydrogeologic characteristics (the properties of the underlying aquifers and water table elevation) (Ecology 2003b; Ecology 2005b).

Reducing or eliminating stream diversions within the reservoir service area would potentially raise alluvial aquifer ground water levels along reaches downstream of diversions. The additional water flowing in the streams would either recharge ground water along these reaches, or reduce the amount of ground water discharging to these reaches. Decreased ground water irrigation demands due to readily available or supplemental surface water may also lead to increased ground water levels (Ecology 2005b).

Long-term impacts to ground water could occur with the development of underground storage. The quantity of water injected for ASR and the properties of the aquifer(s) used for ASR would affect the magnitude of the impact on ground water levels or pressures, changes in vertical and horizontal ground water flow directions, and ground water flow velocities during ASR operations.

Ground water levels or pressures could increase significantly with the recharge of an underground reservoir. The magnitude of the increase depends on several characteristics of the storage aquifer: the size, transmissivity (the rate at which ground water can be transmitted horizontally in an aquifer), and storativity (the volume of water that an aquifer releases from storage with a decline in hydraulic head).

The rise in ground water pressures could occur over a large area in a transmissive, confined aquifer with low storativity. If ground water pressures rise above ground surface in a confined aquifer, flowing artesian conditions could develop at existing wells, resulting in loss of stored water, and possibly damage to the well and surrounding area and localized flooding and erosion. Increased ground water elevations or pressures could also result in increased discharge to surface water, seeps, springs, and wetlands, and could cause slope instability or ground deformation.

During ASR recharge, ground water will flow radially away from the recharge well(s). When recharge stops, ground water elevations in the vicinity of the well will decrease as water levels equilibrate. The horizontal hydraulic gradient in the aquifer could increase near the well, resulting in increased ground water flow velocities.

Where primary aquifers overlie the storage aquifer, increased ground water elevations in the underlying storage aquifer near the area of the recharge well can result in a change in hydraulic gradient, and a subsequent reversal in vertical flow direction between the storage aquifer and overlying aquifer(s) (i.e., the flow direction between two aquifers changes from downward to upward). Seepage of stored water to overlying aquifers may result in a ground water level rise in these aquifers and possibly an increase in ground water discharge to seeps, springs, and surface water.

Water Quality. Ground water quality could be affected if the reservoir is built at a location where local soils and/or geology contain contaminants that could leach to ground water. Contaminants from past land use practices (e.g., agricultural chemical applications or septic tanks) may include natural or elevated concentrations of salts, agricultural chemicals (pesticides, lime, fertilizers, petroleum products), and domestic or agricultural wastes (onsite sewage systems, disposal pits, manure). The ground water impact would depend on the contaminant concentration, the ability of underlying soil and aquifer materials to absorb contaminants, and the hydraulic connection with underlying aquifers. Changes in ground water quality could potentially impact domestic water use near the reservoir or facility and surface water quality at the point of ground water discharge to streams (Ecology 2005b).

Ground water quality could change as a result of recharge and aquifer storage of water. If the quality of the recharge water and native ground water are significantly different, physio-chemical reactions could occur that could result in precipitation of minerals, along with taste and odor problems with the recovered water (if used for drinking water supply). Similarly, the recharge water could react with the aquifer matrix, resulting in dissolution of the aquifer matrix, increasing the dissolved solids content of the ground water. Precipitation of other minerals could occur, which could clog aquifer pore space or recharge well screens.

The recharge water may also contain other chemical constituents that are not present in native ground water including pesticides, herbicides, endocrine disruptors, or other chemicals. Water intended as a future drinking water supply may need to be disinfected or treated before it is injected. Treated and disinfected water contains chemicals such as chlorine and byproducts (trihalomethanes and haloacetic acids) that are not present in the native ground water.

Site-specific investigation would be conducted for each proposed storage project to characterize the full extent of potential impacts, avoid them where possible, and if impacts cannot be avoided, develop appropriate mitigation.

Mitigation

Water Quantity. For all storage projects, impacts to ground water could be avoided and/or mitigated by conducting appropriate hydrogeological studies prior to design and construction or implementation and during operation. The degree of study required would depend on the type and magnitude of the storage project. If any adverse ground water effects were predicted as a result of the studies, then design or construction would be adjusted to reduce the effects (Ecology 2005b). Hydrogeologic studies could include seasonal monitoring of current ground water levels near current and anticipated points of water diversion and use. The monitoring results would be used to estimate the impacts of changes in use or diversion on ground water levels. For areas where ground water levels would be reduced, the timing or magnitude of the changes in water use could be avoided, or other measures, such as artificial recharge or withdrawal, could be considered (Ecology 2005b).

In compliance with dam safety regulations, an inspection program would be required to monitor for potential seepage in the immediate vicinity of the dam, near the toe of the dam, and at its abutments. This monitoring program, which would occur over the life of the structure, would involve the installation and maintenance of permanent and temporary piezometers, observation wells, seepage galleries, geotechnical soil and rock borings, and excavated test pits. The dam operator may also need to monitor ground water levels and flow near the impoundment. This may require the installation, maintenance, and abandonment of piezometers, test wells, and observation wells (Ecology 2003b).

Site-specific hydrogeologic studies for underground storage would include evaluations of the physical ground water system, including hydrostratigraphic units, aquifer hydraulic properties, aquifer boundaries, ground water recharge, discharge, and ground water flow, recharge water and ground water quality and compatibility, along with evaluation of other ground water users, water rights, and natural and environmental hazards. The assessment of hydrogeologic conditions can then be used as a foundation for the development of a project pilot testing and operation strategy and a monitoring plan for ground water levels, recharge and recovery volumes, recharge and recovered water quality, and natural and environmental hazards.

Water Quality. Potential impacts to ground water quality beneath a reservoir, caused by leaching and migration of natural or artificial contaminants, could be reduced by assessing and removing manmade sources of contamination (if present) before filling the reservoir. Assessing the chemistry of reservoir site soils (and determining the likely ground water flow from the reservoir) would indicate the potential for contamination sources. Natural mixing and dilution of ground water may sufficiently mitigate changes to ground water quality. Potential impacts to ground water quality from the introduction of contaminated water could be reduced through sampling of source water and engineered system design so that water from a potentially contaminated source is not used to recharge ground water (Ecology 2003b; Ecology 2005b).

Periodic monitoring of source water and ground water quality would help ensure that contaminated water is not being introduced to ground water. Long-term cumulative implementation of water quality plans may result in improved ground water quality. Implementation of water quality monitoring plans may improve the effectiveness of ground water quality management programs and efforts by providing data with which to make management decisions. This could lead to an improvement in ground water quality by reducing contaminant levels in recharge (Ecology 2003b).

Water quality plans and public education could also help to restore, protect, or enhance ground water quality by reducing contamination of ground water, soil, and/or surface water bodies that recharge ground water. The effect on ground water quality would depend on the current ground water quality, the degree to which existing water quality plans are implemented, and the effectiveness of water quality plans to reduce contamination in the water source (Ecology 2003b).

4.1.1.5 Water Rights

New storage, whether it is a new reservoir, increased storage capacity in an existing reservoir, or storage in an underground aquifer, would require a water right permit from Ecology. Ecology makes decisions for reservoir permits under the same standards as for any other water right as provided in RCW 90.03.250 through RCW 90.03.320. Ecology may not issue a water right permit, including a reservoir permit, if there would be any adverse impact to existing water rights. State law allows Ecology to consider mitigation proposed by a water right applicant to offset any potential adverse effects of their proposed water use (Ecology 2003). Mitigation "strategies are as varied as the conditions they are designed to protect and improve" (Ecology 2003).

Short-term impacts

Potential impacts to water rights from storage projects are primarily long-term operational impacts. However, water rights, including instream flows, could be affected during the filling of a reservoir.

Long-term impacts

Operation of a storage project has the potential to reduce availability of water to existing water users. These considerations would be included in Ecology's analysis in deciding whether to issue a storage permit. Long-term beneficial impacts would include increased availability of water for instream and out-of-stream uses during low flow periods.

Mitigation

Potential impacts on other water rights during reservoir filling for off-channel storage could be mitigated through management of the rate and timing of pumping from the stream to the reservoir. Mitigation measures for any long-term impacts would be determined on a project-specific basis.

4.1.1.6 Fish, Wildlife, and Plants

Short-term impacts

Fish. Discussions of fish in the text below are intended to be broad, including anadromous fish species (salmonids, lamprey, sturgeon, among others), resident fish species (salmonids, coldwater and warmwater game fish and non-game fish species) as well as native freshwater shellfish species (mussels, clams, snails, limpets, etc.) as described in Section 3.7.1. Two basic storage project designs are proposed – in-channel storage and off-channel storage. Some aspects of both types of project have similar impacts to aquatic resources, while many of the project features are vastly different with respect to aquatic impacts.

In-channel projects that impound water in the existing channel can influence fish by:

- Restricting or adversely influencing upstream and downstream passage;
- Entraining or impinging juvenile species at points of diversion and gated orifices;
- Inundating channel habitat features important for spawning or rearing habitat;
- Altering the quantity (streamflow levels), flow rate, and quality (temperature; dissolved oxygen, nutrients, pesticides, herbicides, suspended and bedload sediment levels) of water in the channel downstream of the reservoir that could have an influence on modifying trophic relationships, shellfish beds, behavioral cues, and migratory timing of fish; and
- Partitioning habitats on a longitudinal basis, thereby influencing habitat connectivity.

Off-channel storage reservoirs can influence the quantity of water downstream of the point of water intake and the quality of water downstream of the return point. They also have the potential to adversely influence channel habitat features if the site includes an existing drainage used by aquatic species. Surface water sources for off-channel facilities either occur through gravity feed or via pump-storage options. In either process, supplying water to the storage facilities can create instream flow issues downstream of the point of diversion.

Construction-related impacts for any type of storage project are primarily a function of soil disturbances and short-term increases in suspended sediment (turbidity) and bedload sediment in local water bodies. Compliance with Washington Department of Fish and Wildlife Hydraulic Project Approval (HPA) provisions for in-channel work within the Ordinary High Water Mark (OHWM) and use of WDFW mitigation policy[1] should minimize construction-related effects.

---

[1] The stated goal of the mitigation policy is to achieve no loss of habitat function and value. The hierarchy or continuum of preferred actions is (1) avoiding damage, (2) minimizing damage, (3) repairing damage, (4) reducing damage through long-term maintenance, (5) compensating damage by replacing resources and (6) taking corrective measures over the long-term. It lists the guiding principles for making decisions on appropriate mitigation activities, required elements of mitigation plans and appropriate legal documentation. A complete copy of the policy is in Appendix J.

One natural response of reservoir fill is a short-term increase in nutrient levels with the decomposition of the vegetative matter under the reservoir. An early spike in reservoir productivity for aquatic species is typical. Although beneficial, this effect is short-lived within the first few years following reservoir creation. Reservoir productivity typically declines thereafter, depending on operational characteristics.

Wildlife and Plants. Short-term impacts to wildlife and plants would result from the disturbance and removal of vegetation during construction of new storage facilities. The magnitude of the impact will range from significant to less significant depending on the several variables, including:

- The quality of existing habitat in the proposed facility area;
- The size of the proposed facility and amount of habitat that will be disturbed and/or lost;
- The level of use by wildlife, particularly listed and priority species;
- The location of nearby similar and suitable wildlife habitats; and
- The timing of construction activities (i.e., during critical periods for wildlife).

If conveyance lines are needed for a new storage project, vegetation along the conveyance corridor would be removed. If those plant communities provide habitat for wildlife, that habitat will be lost. Similarly, wildlife in those habitats, such as birds, small mammals, amphibians or reptiles, including priority wildlife species, could be lost or displaced by construction activities. Wildlife in the vicinity of the new storage area would also be displaced by noise and construction activities.

Impacts would be greater if they occurred in riparian areas, intact shrub-steppe habitats, and those habitats suitable for listed wildlife species such as pygmy rabbit, Washington ground squirrel, sage grouse, or spotted frog. Impacts to disturbed habitats such as active agricultural lands would be less significant. As previously mentioned, construction impacts would be minimized through compliance with wetland regulations set by the U.S. Army Corps of Engineers and Ecology, and the use of the WDFW mitigation policy.

Long-term impacts

Fish. The long-term and operational impacts of storage facilities on aquatic species include:

- Modification of existing habitat under the reservoir;
- Altered hydrological and thermal regimes downstream;
- Fish passage hindrances;
- Shifts in species composition; and
- Interruption of downstream gravel recruitment.

The region has made a substantial commitment to artificial production facilities to support and supplement fish populations and fisheries in the Columbia River Basin. Storage projects under the Management Program could potentially influence hatchery operations by modifying the quality or quantity of source water, influencing habitat conditions or species compositions near the traditional hatchery release points, or by influencing stock assessments or harvest management considerations by means of altered species compositions. Site-specific environmental review conducted when storage projects are identified will assess potential effects on hatchery programs.

Operational factors of the storage facility that could affect fish include fill timing and rate; reservoir turnover rate (length of storage); reservoir elevation fluctuations; access to tributary habitats; and downstream flow regimes including up-ramping and/or down-ramping rates. A shift in aquatic species compositions with a change from lotic (free-flowing) to lentic (ponded) hydrological systems is typical of reservoir creation. In the Columbia River Basin, warmwater species would likely dominate the reservoirs. An increase in non-native species and species that might prey on salmonid fishes is also likely with reservoir creation.

Wildlife and Plants. Long-term impacts to wildlife and plants associated with operation of new storage facilities include loss of habitat, permanent displacement of wildlife, and change in vegetation communities.

The permanent loss of plant communities would result due to inundation by the new facility. To comply with dam safety regulations, all large and deep-rooted plants would be permanently prohibited on the face of earthen impoundment structures, and grasses or other shallow-rooted plants would be maintained to allow inspection of the impoundment surface. If new facilities are proposed in or near native grasslands, shrub-steppe communities, and Garry oak communities, those habitats would be permanently removed from future regeneration. New storage projects may also result in the permanent loss of microbiotic crust if it is present in the area of new facilities.

The addition of water to arid areas may increase plant species diversity through alteration of vegetation communities. However, vegetation typically associated with reservoirs and altered hydrology is composed of primarily non-native or invasive species, such as Eurasian watermilfoil (*Myriophyllum spicatum*), saltcedar (*Tamarix ramosissima*), purple loosestrife (*Lythrum salicaria*), Russian olive (*Elaeagnus angustifolia*), common reed (*Phragmites australis*), and reed canarygrass (*Phalaris arundinacea*). Invasive species and non-native plants can spread rapidly and outcompete native species, forming single-species stands that reduce habitat for native fish, waterfowl, and other aquatic wildlife. An increase in non-native species is likely with reservoir creation.

Increasing the storage of existing facilities may result in changes in vegetation communities and fluctuating water levels that expose variable amounts of rock, vegetation, mudflat, etc. depending on the amount of water released. Long-term rapid fluctuations in water surface levels at facilities and downstream channels could have impacts on near-bank and overbank plants and wildlife during all times of the year. Impacts could include loss of vegetation or the nests of waterfowl and shorebird species. The changing levels of inundation could alter the suitability for wildlife that use these habitats for wintering, breeding, or during migration.

New storage facilities would permanently displace wildlife in and around the facility through inundation of their habitat. The level of effect will be dependent on the quality of current habitat and the species assemblages using that habitat as well as the size of the facility. Additional open water or mudflat areas may create new habitat for waterfowl species, especially during spring and fall migration. However; insects including mosquitoes could breed in the additional mudflat areas and wetlands. The increase in mosquitoes may require an increase in the insecticides used for mosquito control, which would have an impact on fish and wildlife using these areas. In addition, mosquitoes could carry diseases, including the West Nile virus. During summer drawdowns, exposed mudflats could be colonized by a mix of native and non-native plant species, including smartweed (*Polygonum*) and cocklebur (*Xanthuim*).

New storage facilities may also result in new water supply to areas where it was previously unavailable. New water supply could increase demand for agricultural land use and increase the pressure to convert native habitats, such as intact shrub-steppe, to agricultural uses. This would result in an increased habitat loss for species dependent on shrub-steppe habitats or other native habitats and may further decrease populations of those species. Listed plant species in these habitats may include Spalding's catchfly, northern wormwood, and whitebluffs bladderpod. Wildlife may include listed species such as pygmy rabbit, Washington ground squirrel, and sage grouse. As required by federal and state regulations, a site-specific evaluation of threatened and endangered species in the proposed project area would be conducted for each storage project, and would include an analysis of the associated increase in agriculture.

Mitigation

Fish. Mitigation measures associated with storage projects will be discussed on a site-specific basis with the project proponent, Reclamation, Ecology, and WDFW. The federal Services, including NOAA Fisheries and USFWS, would also be consulted if federal funding or permitting is involved. The following items are generally considered ways to minimize the influence of dams and reservoirs on local aquatic environments:

- Seasonal restrictions on surface water withdrawals from supply reservoirs to the period with the least influence on key species;
- Adult and juvenile fish passage provisions at all in-channel storage sites;
- Reservoirs designed with low width/depth ratios to minimize thermal heating;
- Reservoirs designed with bottom withdrawals for downstream water temperature control, where appropriate;
- Construction techniques that minimize work activity and the seasonal timing within the OHWM and in compliance with HPA provisions;
- Intake screens and seasonal restrictions on surface water withdrawals to supply the storage reservoir for off-channel projects;
- Diversion screens for reservoir withdrawal;
- Fish barriers in discharge canals;
- Ramping rates for diversions and for initiating or terminating downstream releases to minimize water level fluctuations and adverse effects on aquatic species; and
- Monitoring, periodic review, and adaptive management.

In addition, coordination between Ecology, Reclamation, WDFW, tribes, the federal Services, and various hatchery operators will be important to minimize impacts to artificial production (hatchery) programs.

Wildlife and Plants. Site-specific feasibility investigations would include an evaluation of the presence of threatened, endangered, or sensitive plant or wildlife species. If these species are found, the area should be avoided. If the project cannot be relocated to a less sensitive area, mitigation measures for the specific project will need to be developed to reduce or prevent adverse impacts to the affected plants, wildlife, and wildlife habitat. Mitigation measures and BMPs may include:

- Minimize the area of disturbance;
- Revegetate and restore disturbed areas around the reservoir with native plant species to provide improved habitat for wildlife species and encourage recolonization by native plants;
- Monitor and maintain replanted areas until species are well-established;
- Implement a noxious weed control program to control invasive species that may establish in the new storage area;
- Coordinate with NRCS to minimize impacts to areas set aside in federal Farm Bill programs such as the Conservation Reserve Program;
- Acquire habitat or other unmanaged land near new storage site for restoration and maintenance as mitigation for lost habitat;
- Select construction windows to minimize disturbance to sensitive or listed wildlife species during critical periods such as breeding or raising young; and
- Set reservoir operation schedules to minimize the impact of rapid fluctuations in facility and downstream channel water surface levels on near-bank and overbank plants and wildlife.

4.1.1.7 Socioeconomics

Short-term impacts

The design and scope of individual storage projects would determine the levels of costs and benefits, impacts on jobs and income, distribution of costs and benefits, interactions with the socioeconomic structure, and levels of risk and uncertainty. Construction activities would likely generate job opportunities and income in the local area. These opportunities would accrue to local residents unless workers come from outside the area. If the local economy is functioning at full employment, the construction projects would engage local workers by inducing them to leave jobs elsewhere, increasing labor costs for local businesses in other sectors, and tightening the local labor market. If workers come from outside, they would tighten local markets for housing, public services, and consumer products.

The level and distribution of costs among Washingtonians would be influenced by the amount of funding available from outside sources. Federal guidelines restrict funding for projects that generate local benefits, such as increased farm earnings, at the expense of competitors in other regions (U.S. Water Resources Council 1983). To the extent a construction project attracts funding that otherwise would be invested elsewhere in the state, then its economic consequences would be offset by the forgone consequences of the displaced investment in other projects and programs. Momentum generated by the Management Program may lower the costs of making decisions about, and accelerate the implementation of, structural projects that would happen anyway.

Long-term impacts

Predicting the long-term economic impacts of the proposed Management Program with precision is difficult because the Management Program would interact with many factors, such as shifting markets for water-related goods and services, overlapping trends in the overall economy, individual industries, community economies, and society's preferences regarding water and related resources. By increasing the supply of resources for some while decreasing the supply for others, the Management Program would have both positive and negative impacts on the relationship among competing demands for scarce resources. Both types of impacts would materialize, for example, as the program alters competitive markets by enabling some producers of irrigated crops to increase their output, and by altering the demand for the products produced by others.

Recent studies of water-related economic issues in the Columbia River Basin have reached different conclusions, reflecting different assumptions about how households, farms, communities, businesses, and the state as a whole would respond to a change in the management of the area's water supplies. The following discussion reflects, rather than resolves, these differences in assumptions and conclusions, and outlines the factors that will affect those impacts while providing a framework for considering the potential outcomes.

The design and scope of individual storage projects would determine the levels of costs and benefits, impacts on jobs and income, distribution of costs and benefits, interactions with the socioeconomic structure, and levels of risk and uncertainty. An increased supply of water during periods when water would normally be more scarce would have value, as it reduces shortage-related risk and uncertainty for water users. Table 4-1 shows the distribution, by crop, of new water for irrigation if it were used in the same manner as existing irrigation in the project area. About one-half would irrigate field crops (hay and wheat), 17 percent orchards, 20 percent row crops, and 13 percent other crops. If new water for irrigation were as productive as existing irrigation, it would yield the direct, net economic returns (value of the crop minus the cost of producing it) to the local economy shown in Table 4-1. These range from negative $91 to positive $147 per acre-foot of irrigation water for the project area as a whole, and from negative $82 to positive $129 per acre-foot in the Columbia Basin Project (Huppert et al. 2004). Irrigation of potatoes, vegetables, and orchards would yield positive net economic returns. For hay, wheat, and other crops, the costs of production would exceed the crop value, although individual farmers, by not fully accounting for some costs, might see positive cash-flow. According to Huppert et al. (2004), if new water for irrigation were used in the same manner as existing irrigation, the net economic return per acre-foot of the new irrigation water would be about $22.

Table 4-1. Use of New Irrigation Water and Net Economic Return, by Crop, if New Irrigation Resembles Existing Irrigation (Huppert et al. 2004)

	Hay	Orchards	Vegetables	Other	Potatoes	Wheat
Percent of new water that would be used for each crop	34%	17%	9%	13%	11%	15%
Local, Direct Net Economic Return per Acre-Foot Diverted						
Project area average	-$5	$82	$89	-$91	$147	-$34
Columbia Basin Project	-$5	$67	$96	-$82	$129	-$29

Source: Huppert et al. 2004

Huppert et al. (2004) recognized that the figures in Table 4-1 give an incomplete representation of the statewide economic consequences of new supplies of water for irrigation in the project area, because farmers are unlikely to use new water in exactly the same way as they use existing water, or to earn the same net returns. Moreover, if farmers using the new water significantly expand the supply of irrigated crops produced in the state, they would likely depress the market prices all farmers receive for the crops, diminishing the net economic returns of existing farmers.

Two studies took these factors into account and extended the analysis of Huppert et al. (2004). They concluded that increasing irrigation in the project area by 1 million acre-feet would reduce the overall value of the state's agricultural output, and the statewide net economic return of increasing irrigation in the project area would be between negative $60 and negative $70 per acre-foot (Griffin 2005; Williams and Capps, Jr. 2005). Federal guidelines (U.S. Water Resources Council 1983) indicate that these findings, along with the likelihood that increased production from new irrigation in the project area would lower the earnings of farmers producing the same crops in other states, diminish the likelihood that new storage projects in the project area would qualify for federal funding. Olsen (2006), however, challenged the notion that increases in the production of irrigated specialty crops, such as orchard, vegetables, potatoes, and other high-value crops, would depress prices, especially in the long run. He also identified "problems/issues" with the findings of Williams and Capps Jr. (2005), but did not provide theoretical or empirical substantiation for these concerns or offer a substitute analysis.

Expansion of irrigated agriculture in the project area would likely generate some new jobs and income. Huppert et al. (2004) estimated that increasing irrigation by 1,000 acre-feet would generate about 20 new jobs in agriculture and directly related industries, assuming new irrigation were similar to existing irrigation in terms of crop mix and productivity. They also predicted that the increased spending by farms, workers, and others would generate additional jobs and income elsewhere in the economy through the so-called multiplier effect. Using a common economic model, Huppert et al. predicted that for each new job directly related to new irrigation, the multiplier effect would generate an additional 1.4 jobs. Olsen (2006) also predicted that new irrigation would have a multiplier effect on jobs and income.

Other economists, however, have determined that the multiplier effect from new irrigation is likely to be much smaller than this model predicts, and may be zero. They reach this conclusion in part because the negative effect on crop prices, described above, would diminish earnings of other farmers. In addition, the expansion of irrigation would draw labor, capital, and other resources from other uses so that the generation of irrigation-related jobs would be accompanied by the loss of jobs elsewhere. Agricultural economists at Washington State University and the University of Idaho (Hamilton et al. 1991) summarized the literature on this point 15 years ago. Zhang (Ecology 2004a) found the current literature indicates that new irrigation in the project area would have no secondary effects, and Griffin (2005) endorsed this view. Bhattacharjee and Holland (2005) took an intermediate view and recognized that, if declining water supplies in the Odessa Subarea cause farmers there to stop growing potatoes, a range of outcomes is possible, from a collapse of potato-related sectors of the economy to a transfer of production from the Odessa Subarea to nearby areas so that the overall economy experiences little change.

The proposed Management Program's impacts on the value of irrigation-related goods and services constitute only part of the overall impact. The Independent Economic Analysis Board of the Northwest Power Planning Council (1999) has concluded that the non-market values of resources affected by water-management decisions "can rival in magnitude" the values of the market-oriented goods and services, such as those associated with irrigated agriculture and hydropower. The impacts on these and other values will be addressed in the future examination of specific projects, if any, implemented under the program.

Increases in the supply of water for producing goods and services, such as municipal-industrial uses, recreation, waste assimilation, and fish conservation, probably would have positive economic value. Direct increases in jobs and income probably would accompany resulting increases in industrial uses of water, water conservation, recreation, and other commercial activities.

Improvements in streamflow and riparian habitat may increase the supply of amenities, such as scenic vistas and opportunities for fishing, viewing wildlife, and other recreational activities. These improvements probably would have direct economic value and they may directly generate jobs and incomes in tourism, recreation, and related sectors of the economy. Impacts on the supply and location of water-related amenities also may affect household location decisions and, therefore, derivative jobs and income. For example, a water storage project that increases downstream streamflows during critical periods, boosts salmon populations, and creates fishing opportunities closer to urban centers than those that currently exist, might attract households to the area. The increased population would then generate jobs and income in industries with no direct connection to the water-storage project. Such changes in the supply of resource-related amenities would reinforce efforts—such as the Othello Sandhill Crane Festival, Coulee City Bald Eagle Festival, and Audubon birding loop—to improve access to resource amenities and develop the resource-related tourism sector.

To the extent that new storage increases streamflow at critical periods and boosts fish populations, it would generate economic benefits currently estimated at $715 per salmon or steelhead (Huppert et al. 2004). These benefits would be distributed among tribal members, commercial fishers, anglers, and others who place a value on conserving these species. It is reasonable to assume that benefits to tribal members would be greater than $715 per fish, as salmon and steelhead have cultural and spiritual values not represented in the research underlying this estimate. Increased fish populations could generate increases in jobs and income in commercial fisheries (tribal and non-tribal, both in-river and ocean) and recreational fisheries.

Such increases may provide additional benefits to tribal members and others, for whom fishing is an integral part of maintaining a traditional lifestyle.

Expansion of agricultural, municipal, and industrial use of water in the project area would likely increase the economic costs associated with emissions of pollutants to streams and aquifers, and with other spillover effects (negative externalities). Potential emissions include heat energy, sediment, nutrients, pesticides, and pharmaceuticals (NRC 2005 and Ribaudo and Johansson 2006). Diverting water from the Columbia River for storage and use elsewhere might reduce the amount of water available to generate hydropower and support navigation activities (Huppert et al. 2004). Any potential impacts to hydropower or navigation would be closely reviewed with the potentially affected utilities and coordinated under the Federal Columbia River Power System. Diverting water from one location to another may reduce the number or quality of recreational opportunities and the water's waste assimilation capacity at the point of diversion, but may increase them as the water passes through other waterways or is stored elsewhere.

Changes in water available for release and water surface elevations in the reservoirs behind Grand Coulee Dam and downstream dams, including Chief Joseph, McNary, John Day, The Dalles and Bonneville, among others, can impact hydropower production available for marketing and revenues received by the Bonneville Power Administration. The Confederated Tribes of the Colville Reservation have an agreement with BPA that provides an annual payment to the Confederated Tribes for lands needed by the United States for Grand Coulee Dam and Lake Roosevelt and taken from the Colville Reservation. The annual payment to the Confederated Tribes would be affected by changes in power production at Grand Coulee Dam and the downstream dams, as well as revenues received by BPA throughout the hydropower system in the state of Washington and upstream states. Studies by the Confederated Tribes demonstrate that the annual payment can be favorably increased or adversely decreased by as much as $500,000 annually depending upon marginal changes in future diversion and use of water and the magnitude and timing of consequent changes to release patterns at relevant dams (Watson, personal communication, 2007).

Mitigation

The design and scope of individual storage projects would determine the nature, location, and timing of long-term adverse impacts, their distribution among different groups, and the nature of opportunities for mitigating them. Reductions in recreational opportunities resulting from the diversion of water at one point, for example, might be mitigated by creating compensatory recreational opportunities nearby. Coordination with tribal and non-tribal resource managers, and consultation with communities of interest, would promote the identification and balancing of their respective economic concerns. Evaluations of specific storage projects would consider economic impacts, both direct and indirect. Projects involving the expenditure of federal funds would be subject to evaluation under federal evaluative principles and guidelines (U.S. Water Resources Council 1983).

4.1.1.8 Land and Shoreline Use

Short-term impacts

Short-term impacts to land and shoreline use from the construction of new storage facilities could include relocation of some uses in areas to be inundated, and temporary disruption of access to businesses or recreational uses during construction. In addition, right-of-way may be required for conveyance lines. The scale of these impacts is dependent on the characteristics and size of the new or modified facility and its proximity to other land uses. Siting and feasibility studies for each facility will identify and evaluate potentially sensitive land uses within the proposed area of inundation, and will attempt to avoid impacts to existing beneficial land uses as much as possible.

Long-term impacts

Development of new storage facilities may result in significant long-term impacts to land use, based on the amount of land and type of land use affected. Constructing a new storage facility or raising the level of an existing storage facility would inundate additional shoreline areas and could eliminate or curtail current land uses. At the same time, it could encourage some new uses, such as recreation, that may not have been present before. Extensive property acquisition may be required in order to construct a new storage facility. Property acquisition can be highly controversial in some areas, and will be an important consideration in site-specific evaluations. Land use considerations, including the amount and type of land uses to be inundated, will be incorporated into site-specific feasibility evaluations. Impacts to land use associated with development of storage facilities are linked to water availability and the economic impacts that can result from changes to current water management practices. Refer to Section 4.1.1.7 for a more detailed discussion of this linkage. Following is a discussion of general land use impacts that can result from changes in water availability and distribution.

Potential beneficial long-term impacts of new storage facilities include additional, reliable water resources for out-of-stream uses, such as irrigated agriculture and urban development. New storage facilities would result in additional water for irrigation. The increased reliability could result in several possible effects on agricultural land use, including:

- Conversion of low value crops, such as hay, to high value crops such as orchards, vineyards, and potatoes;
- Shift to smaller farm units with conversions to orchard and vineyards;
- Expansion of the non-farm uses associated with the wine tourist industry;
- Shift to larger scale agriculture;
- Conversion of non-irrigated lands to agriculture; and
- Reduced pressure to convert agricultural land near urban areas to residential uses.

Changes in types of agriculture are not generally regulated by local zoning or comprehensive plans and would not be considered adverse impacts on land use. The changes in types of agriculture could cause several minor changes in land use patterns, which could conflict with existing land use policies. These changes in land use could result in a trend toward reduction of existing wildlife habitats, as discussed in Section 4.1.1.6.

Because orchard and vineyard production could take place on a smaller scale than some irrigated annual crops, changes of these types could result in smaller farms with more workers, and thus higher density of residences. However, the increase in density would be developed in compliance with local zoning regulations and would continue to support the goals of preserving and enhancing the productivity of agricultural lands. Therefore this would not be an adverse impact on land use.

The vineyard industry has produced a related tourist industry that requires non-agricultural development such as lodging, eating, and drinking establishments. These types of commercial uses may or may not be consistent with local comprehensive plans or zoning regulations. Increased vineyard production could contribute to the success of wine tourism and create pressure to convert more agricultural land to these types of non-farm uses.

Crops such as potatoes also produce high yields if sufficient water is available. More water being available could result in more land being converted to large-scale potato production, which could occur with little increase in population density.

New irrigation and crop conversions could take place on lands that are zoned for agriculture; these conversions would be expected to be in accordance with adopted land use plans. Expansion of an individual crop such as potatoes could have adverse effects on existing farms due to impacts on market conditions, which in turn can affect uses that are dependent on potato production such as processors and equipment producers. Refer to Section 4.1.1.7 for a discussion of potential economic impacts associated with increased water availability.

The improved reliability of irrigation could be expected to reduce pressures to convert agricultural land to residential land in some areas, because of the potential for improved economic viability of the agricultural use. This would be consistent with comprehensive plan goals and policies that emphasize the importance of maintaining and enhancing agricultural lands.

Mitigation

Specific projects proposed under the Management Program will be required to comply with applicable shoreline master programs, zoning codes, local comprehensive plans, and critical area ordinances. All storage projects will undergo an extensive site-specific evaluation, which will include an analysis of consistency with adopted land use plans and policies, as well as an extensive public outreach program. Local permits may not be required for smaller facilities such as on-farm storage facilities or ASR projects.

Any proposed development that receives the benefits of new water storage facilities may also be subject to project-level review and approval by a local permitting agency before the project could be constructed. This would provide an opportunity to determine whether the proposed development is consistent with local policies and regulations.

Any property acquisition would be done on a case-by-case basis and in accordance with applicable state and/or federal requirements. Property owners would be compensated at fair market value for any property that would need to be acquired for construction of the storage facilities.

4.1.1.9 Cultural Resources

Short-term impacts

Construction of a storage facility could adversely impact cultural resources in the short term. Any ground disturbing activity, including removal of vegetation prior to inundation, earthmoving, and use of heavy equipment, could adversely affect cultural resources in the area of the construction activity as well as in staging areas. Other impacts could include removal of historic structures prior to inundation.

Long-term impacts

Construction of a storage facility could adversely impact cultural resources over the long term. The impacts to cultural resources within reservoirs could include destruction or damage of archaeological sites, historic structures, or Traditional Cultural Properties (TCPs). There are generally three zones of impact to cultural resources in storage reservoir settings: the inundation zone, the direct impact (fluctuation) zone, and the indirect impact (backshore) zone.

Archaeological sites can be damaged or destroyed through erosion, inundation, chemical weathering, vandalism/artifact collecting, and land development. These impacts often occur in combination. Of these, erosion by wind and water is the most predominant impact (Lenihan et al. 1981). Erosion impacts vary based on the site type, land form, severity of wind and water action, soil structure, and type of cultural resource. Depending on the fluctuation zone of the reservoir (the area between normal high and low water levels) and the angle of the landform slope, sites can slump, be washed out, or suffer bank calving. Inundation impacts sites by making them inaccessible for research. The sites may become covered with sediment, although there is some speculation that the sedimentation provides protection to the site. Artifacts and features may be damaged by long-term inundation due to changes in the chemical composition of the surrounding geologic matrix. No detailed studies have been conducted to evaluate the impacts of sedimentation on fragile archaeological deposits.

Chemical weathering impacts to archaeological sites could include damage to organic remains through repeated wetting and drying of archaeological deposits, leading to a loss of scientific potential of sites along reservoir boundaries. This impact is often linked to irrigation-related reservoirs (Galm and Masten 1988).

Vandalism and artifact collecting could be expected, especially if a new reservoir provides recreational areas. Vandalism includes a range of activities from intentional looting of sites, to off-road vehicle use in culturally sensitive areas, to extended recreational use, which destabilizes soils. With increased boat use, more sites could be accessible and become vulnerable to vandalism. Increased boat use is also likely to increase erosion due to wake action. Rock art is often the target of graffiti. Site erosion often makes sites more susceptible to vandalism by increasing site exposure.

Land development in the areas surrounding a reservoir can include construction of roads and recreational facilities, grazing, agricultural or orchard uses, and increased residential, commercial, or industrial use. Grazing cattle can adversely affect cultural deposits up to a meter below ground surface as cattle come to water's edge to drink and wallow. The impacts to trampled sites are compounded by fluctuations in the shoreline and changes to soil chemistry related to manure incorporation.

Historic structures in the inundation and fluctuation zones will likely be removed prior to inundation. Historic structures in the backshore zone could have increased access, which often leads to increased vandalism. The increased proximity of water may adversely impact the significance of the historic structure by altering the integrity of its setting.

Traditional Cultural Properties (TCPs) in the inundation zone would become permanently inaccessible. TCPs in the fluctuation zone would likely be so altered that even when exposed, they would lose their characteristics (such as isolation or resource availability), which provide their integrity of setting, feeling, or association. TCPs in the backshore zone may suffer adverse effects due to alteration of the integrity of setting, feeling, or association as well.

Mitigation

The construction of storage facilities would require additional environmental review, after which the exact mitigation measures would be developed in coordination with the Department of Archaeology and Historic Preservation (DAHP), the affected tribes, and other interested parties. Ecology will develop a Cultural Resources Management Plan (CRMP) in consultation with interested parties. The CRMP will support the goals of the Management Program while ensuring appropriate cultural resources management. The CRMP will outline efforts to identify cultural resources in the project area, develop a review process for planned actions, outline potential mitigation measures, and include processes to identify and resolve conflicts.

Because of the anticipated multi-agency and multi-government involvement with projects proposed as part of the Management Program, it may be appropriate to develop a Programmatic Agreement. Federal involvement is likely at the project level which will require compliance with Section 106 of the National Historic Preservation Act. A Programmatic Agreement outlines an alternative to meeting the requirements of Section 106 in cases where the project is complex and the full range of impacts is not well-defined. The CRMP can provide the basis for the Programmatic Agreement. Signatories to the Programmatic Agreement would likely include Ecology, Reclamation, and the appropriate historic preservation officer. Invited signatories could also include the affected tribes, including Tribal Historic Preservation Officers, and the Advisory Council on Historic Preservation. The Programmatic Agreement should be negotiated to clearly outline the responsibilities of each party and the approach to identifying cultural resources and mitigating impacts to them.

Mitigation measures would differ by impact zone (inundation, fluctuation, or backshore). Mitigation measures could include archaeological remote sensing during reservoir planning to allow avoidance; excavation of archaeological sites that would be adversely affected by the reservoir; documentation of historic structures; site protection/stabilization, including site burial, use of filter fabrics, revegetation, site armoring, creation of no-wake zones, and other measures;

efforts to reduce vandalism through public education, fencing, or site surveillance; and archaeological monitoring during construction and for the length of the project (Draper 1992; Lenihan et al. 1981). Construction contracts would require that if any archaeological material is encountered during construction, construction activities in the immediate vicinity would halt, and DAHP, a professional archaeologist, and, if appropriate, tribal cultural resources staff would be contacted for further assessment prior to resuming construction activity in that area.

Mitigation measures for TCPs would need to be determined in consultation with the appropriate cultural group. Mitigation measures might incorporate the purchase and protection of properties to mitigate indirect effects, encompass mitigation of ongoing effects of the project, and provide for off-site mitigation as appropriate. Because TCPs contribute to the maintenance of a culture, mitigation efforts also might include documentation of the significance of the place through oral histories or recording traditional storytellers. It is important to note that it is not always possible to mitigate adverse effects to TCPs.

Existing reservoirs within the region have ongoing programs for the life of the project to assure that operational changes, continuing erosion, and new project elements address cultural resources issues.

4.1.1.10 Transportation

Short-term impacts

Construction activities would result in additional traffic on roads near the construction areas, including trucks, heavy equipment, and worker vehicles. Numerous truck trips would be necessary to haul materials to the site or to dispose of waste materials. The number of construction-related trips as well as the frequency and duration of impacts is dependent on the location, nature, and scale of the project.

If construction takes place adjacent to roads, disruption of traffic on these roads would likely occur. Delays or detours may be necessary, depending on the nature and location of the project, and may involve construction of temporary access roads. The degree of impact depends, in part, on the current level of service on potentially affected roads. Roads at or above capacity would be more heavily affected than roads that are substantially below capacity.

In-water construction activities could have a minor impact on barge transportation routes, for example if an existing on-line storage facility on the Snake River were modified.

Long-term impacts

Depending on a project's location, new storage facilities could require relocation of roads, highways, or railroads in the project area. This would potentially result in minor to moderate impacts on transportation systems, depending on the number of people affected by the relocation, the number of road/highway/railroad miles that are relocated, and the distances involved. Increased municipal development could require additional roads.

If a storage project were constructed on the Columbia River below the Tri-Cities or on the Snake River, navigation by barges could be affected. Construction of a project that could adversely affect barge navigation would require coordination with the Corps of Engineers and other federal agencies to minimize navigational impacts.

Mitigation

Potentially relevant mitigation measures include:

- Preparing a construction traffic management plan that includes signage, detour routes, pedestrian safety measures, limited access, designated parking and staging areas, hours of construction, and public information measures; and
- If a roadway needs to be relocated for a new storage facility, the relocated roadway could be constructed to ensure equal or better access and circulation to that which existed prior to construction. Replacement roads or road segments could be constructed prior to the completion of the new storage facility.

4.1.1.11 Recreation and Scenic Resources and Aesthetics

Short-term impacts

Recreation use and access may be temporarily disrupted during construction of new storage facilities. If a recreation area is near a new storage site, access to part or all of the recreation area may be limited during construction. Construction activities may also introduce noise and dust that would degrade the recreational experience at the site. Construction in or near existing water bodies may temporarily increase water turbidity. In a water-oriented recreational area, turbidity may make the area less attractive for swimming, fishing, or passive enjoyment. Once the project is completed, however, recreation use would generally continue as before.

Because storage facility construction would affect the visual quality of the surrounding area, recreational opportunities could be reduced or changed. This would be of greatest potential impact in areas where the scenic resources play a significant role in the recreational use. For example, impacts could result from loss of vegetation, inundation of areas previously available for hiking, fishing, or other activities, and/or the introduction of construction equipment. The magnitude of the impact will vary depending on the character of the area, the level of existing use, and the scope of the proposed project, but some level of impact is unavoidable. Site-specific investigations would be conducted for any potential storage project to characterize existing recreational usage and to assess specific recreational impacts.

New storage projects would similarly affect local scenic and aesthetic resources during construction, through the alteration of the landscape, introduction of construction equipment, and short-term generation of dust. The potential duration and magnitude of the impact will depend on the nature of the existing scenic resources and the extent of potential modification, but in some cases, the existing visual environment would be significantly altered.

Long-term impacts

Construction of a storage facility could impact recreation resources over the long term. Construction of new on-channel storage facilities would change the stream reach from free flowing to a river with regulated flow, affecting the water flows downstream. The flow regime would be altered by the storage facilities, which would store water during high flow periods and release it during lower flow periods to augment instream flows and other beneficial uses. This could alter recreational opportunities downstream, reducing or eliminating the potential for canoeing, rafting, or other boating opportunities in some areas. However, the increase of flow during the dry season may provide improved recreational opportunities for some aspects of water-related recreation. Changes in riparian vegetation may change hunting opportunities. Hunting areas for upland species would be reduced where a reservoir inundates dry land. Changes in streamflow may affect recreational fishing opportunities.

Constructing storage facilities will permanently alter the visual character of the surrounding area. The magnitude of the impact will depend on the proposed location of the facility, the existing character of the surrounding landscape, and the anticipated scale of the specific project. Areas inundated will be permanently removed from the visual landscape; downstream reaches of receiving waters would be altered where the flow regime is altered. Project-level evaluations will incorporate visual and scenic resource considerations to avoid impacting significant, unique scenic resources. It will not be possible to avoid visual impacts associated with storage facilities, and some individuals will likely consider these impacts significant.

In some cases, new storage facilities could create recreational opportunities associated with the creation of a large body of water, including fishing, boating, or swimming. To the extent that storage projects increase instream flows, downstream fish populations may benefit, which in turn could benefit recreational fishing.

Mitigation

Project-specific environmental analysis will assess current recreational and scenic resources within potentially affected areas. Specific measures to offset or minimize affected recreational resources will be developed for specific projects. Some potential measures include:

- Restore vegetation in disturbed areas after construction to diminish the impact to recreation, scenic resources, and aesthetics;
- Incorporate recreational usage into discharge flow regimes from the facility; and
- Employ construction best management practices to minimize potential for construction-related turbidity in downstream water bodies.

4.1.1.12 Public Services and Utilities

Short-term impacts

Providing additional water for some utilities or irrigation districts may reduce supplies for others. All potential modifications to water supply utilities would be evaluated as part of site-specific investigations, and would be coordinated closely with potentially affected utilities.

Construction of new storage facilities could cause temporary disruption or relocation of existing utilities. Any potential disruption would be evaluated and coordinated with the affected utility prior to construction. Construction of new water storage facilities would likely require significant financial resources for project design and construction. Large-scale projects may not be feasible without Congressional and/or state legislative appropriations. To offset part or all of project costs, increases in existing water rates (irrigation, municipal, etc.) may be necessary.

Substantial federal, state, and local agency involvement in permitting, including environmental review under SEPA and/or NEPA, would likely be necessary for any new storage facility. This could require additional agency staff resources.

Long-term impacts

The operating entity for new water storage facilities, such as an irrigation district or Reclamation, may require significant resources for operation and maintenance. There may also be significant opportunity costs associated with public funding of storage facilities, particularly larger and more costly facilities. That is, public funds spent on construction of a storage facility would not be available for other public purposes.

Water stored and used for out-of-stream consumptive uses could reduce potential power generation at downstream hydroelectric facilities, depending on when and where it is diverted. The reduction in power generation potential would affect the Federal Columbia River Power System. Potential impacts to hydropower generation would depend on the specifics of any proposed project. For any project that could reduce power generation potential, Ecology would work in conjunction with Reclamation to coordinate and negotiate with the Bonneville Power Administration, Columbia River PUDs, and the Corps of Engineers to determine potential impacts and appropriate mitigation.

Mitigation

Analyses of funding needs conducted by proponents for storage projects should consider all short-term and long-term public services costs and impacts, including resources required for permitting and public processes. Compensation could be provided for agency costs incurred in permitting and conducting public processes where appropriate.

Storage facilities could be operated to minimize any reduction in water availability for electrical generation. If the river or stream gradient is sufficient, it may be feasible to construct hydropower facilities at new storage projects or on conveyance systems to partially offset the power generating potential lost at downstream mainstem dams.

4.1.1.13 Comparison of Impacts for General Types of Storage Projects

Table 4-2 presents a comparison of the impacts that would be associated with the general types of storage projects that are likely to be proposed under the Management Program. This comparison is not exhaustive, but instead highlights the major differences in impacts of the types of projects.

Table 4-2. Comparison of Impacts for Types of Storage Projects

Element of the Environment	New Large Storage (> 1 Million AF)	New Small Storage (< 1 Million AF)	Modifications to Existing Storage	Aquifer Storage and Recharge
Earth *Short-Term* *Long Term* *Mitigation*	Primary impacts include erosion, sedimentation, non-native fills and the general consumption of earth materials. Soil saturation may decrease slope and soil stability. Mitigation measures to minimize impacts would include construction BMPs and appropriate hydrogeological studies.	Construction impacts will be of lesser magnitude than large storage projects, but of similar nature.	Construction impacts will be of lesser magnitude than large storage projects, but of similar nature.	Construction impacts will be of lesser magnitude than large surface storage projects, but of similar nature. There is an increased potential for ground deformation or slope instability during recharge and storage because of elevated ground water pressures. Mitigation measures may include geotechnical evaluations and management of ground water pressures during recharge and storage.
Air *Short-Term* *Long Term* *Mitigation*	Large storage facilities would require the most construction and therefore would have the greatest potential for air impacts. Mitigation includes compliance with Ecology and local air quality regulations	Small storage facilities would have comparatively less construction and therefore less potential impacts.	Modifications to existing storage facilities could involve less construction than new large facilities and thus would have less potential for air quality impacts.	ASR projects would have less construction associated with them; therefore, construction impacts would be less than for other storage projects.
Surface Water *Short-Term* *Long Term* *Mitigation*	Water quantity impacts may include interruption of flow, change in streamflow regime, rapid changes in reservoir and downstream channel levels and increases in evaporative losses. Water quality impacts may include sedimentation, increased temperature, seasonal increases in sediment loading and dissolved gas, eutrophication, accumulation of pollutants in the headwaters of the impoundment and decreased organic loads in streams. Mitigation may include scheduling flow releases to mimic natural event magnitudes, releasing sediment along with flushing flows and developing operating rule curves to compensate for flow alterations.	Construction and/or operational surface water impacts will be of lesser magnitude than large storage projects, but of similar nature. Mitigation will be similar but to a lesser extent.	Construction and/or operational surface water impacts will be of lesser magnitude than large storage projects, but of similar nature. Mitigation will be similar but to a lesser extent.	Temporary construction impacts would occur for construction or modification of diversion and conveyance infrastructure. Changes in flow and temperature would occur when flow is diverted for recharge. Increased discharge to seeps, springs, and surface water would occur.
Ground Water *Short-Term* *Long Term* *Mitigation*	Ground water impacts may include changes in ground water levels, gradients, and introduction of contaminants. Mitigation includes extensive hydrogeological investigations during feasibility to avoid high risk areas, conducting design and construction in accordance with dam safety requirements, and developing a comprehensive monitoring program	Construction and/or operational ground water impacts will be of lesser magnitude than large storage projects, but of similar nature.	Operational ground water impacts will be of lesser magnitude than large storage projects, but of similar nature.	Changes in ground water elevations, ground water flow directions, and water quality during pilot testing could occur. Changes in ground water elevations, ground water flow directions, and vertical hydraulic gradients could occur during recharge and storage. Changes in ground water quality could result from mixing and reactions between recharge water and native ground water and aquifer matrix. Precipitation of secondary minerals may also occur. Evaluation of hydrogeologic system and development of monitoring and mitigation plans would help to mitigate impacts, along with long term monitoring of ground water levels and water quality.

Element of the Environment	New Large Storage (> 1 Million AF)	New Small Storage (< 1 Million AF)	Modifications to Existing Storage	Aquifer Storage and Recharge
Water Rights *Short-Term* *Long-Term* *Mitigation*	Subject to review and mitigation under Chapter 90.030 RCW.	Subject to review and mitigation under Chapter 90.030 RCW.	Same water right review under RCW 90.03.290 for additional stored water as for new storage. Modifications to add or change purposes of use of stored water subject to review under RCW 90.30.380.	Project must meet standards for review and mitigation regarding specific issues listed in RCW 90.03.370(2)(a) and defined further in Chapter 173-157 WAC**.**
Fish *Short-Term* *Long Term* *Mitigation*	Large storage project reservoirs have the potential to stratify the water column. Warm surface water layers can adversely influence downstream water temperatures and aquatic species dependent upon cool water. Deep water withdrawals would be beneficial.	Small storage project reservoirs may heat the entire water column, with little potential for cool water withdrawals. Reservoir designs with small width to depth ratios would be beneficial with respect to thermal warming.	The effects of modifications to existing facilities might include either increasing storage capacity or operating in a different mode. Impacts of either type of change would be a small adjustment to the current level of ongoing effects.	Surface water diversion to supply ASR projects can influence seasonal instream flow levels for fish and aquatic oriented species. Restricting withdrawals to seasonal periods where abundant water is available will be important to support instream uses.
Wildlife and Plants *Short-Term* *Long Term* *Mitigation*	Construction-related impacts would be greatest of all options considered; potential for localized disruption of wildlife could be significant during construction. Operation of large storage facilities has greatest potential to affect plants and wildlife and alter vegetation communities associated with extensive inundation area and potential for alterations of downstream flow regimes. This option has the greatest potential to convert native habitats to agricultural uses. Mitigation for large storage projects includes 1) Minimization; 2) Revegetate disturbed areas; 3) Implementation of noxious weed control program; 4) Acquisition of disturbed habitats or other unmanaged land to be restored and maintained as mitigation area; 5) Implementation of timing windows.	Construction and operation impacts would be of lesser magnitude than large storage projects, but of similar nature. Mitigation measures for small sites would be the same.	Plants and wildlife using the edge of existing reservoirs could be impacted by the change in flood control and water levels at all times of the year. Impacts could occur to wintering wildlife (primarily waterfowl), breeding individuals, or species using habitats during migration. Reservoir operation schedules could be set to minimize this impact during critical periods.	ASR would raise ground water levels, which may affect vegetation communities and wildlife habitat over the long-term in some areas. This could be positive or negative for plants and animals, depending on the areas that are inundated. ASR is not likely to otherwise adversely affect wildlife and plants during construction or operation.
Land and Shoreline Use *Short-Term* *Long Term* *Mitigation*	Large storage facilities may spur the development of new recreational and residential uses utilizing the reservoir as an amenity, which may or may not be consistent with local planning goals. Large storage facilities would require the acquisition of more property. Availability of a more reliable source of water would allow continuation of agricultural land use practices in some areas. Mitigation includes compliance with adopted land use plans and policies.	Similar impacts to large storage, but smaller magnitude.	Existing storage facilities may have residential or recreational development adjacent to them that could be affected or displaced by raising the inundation level.	ASR projects would not likely result in changes in land use patterns. Acquisition and/or special management of lands in the vicinity of the aquifer recharge area may be required, similar to wellhead protection areas (Economic and Engineering Services, Inc. 2001).
Socioeconomics *Short-Term* *Long Term* *Mitigation*	Construction costs and forgone goods and services from inundated areas would be greatest of all options considered. Costs may be offset by federal contributions if a project satisfies economic guidelines. Of all	Potential costs, benefits, impacts on jobs and income, distribution of costs and benefits, interactions with the socioeconomic structure, and levels of risk and uncertainty probably would be similar	Location and design of modifications would determine levels of costs and benefits, impacts on jobs and income, distribution of costs and benefits, interactions with the socioeconomic structure, and levels of risk	If ASR affected vegetation and inundation in some areas, it would alter the production of goods and services by wetlands, floodplains, riparian vegetation, etc. Higher water levels in aquifers would reduce costs

Element of the Environment	New Large Storage (> 1 Million AF)	New Small Storage (< 1 Million AF)	Modifications to Existing Storage	Aquifer Storage and Recharge
	options considered, this has the greatest potential benefits for local irrigators and impacts on jobs and income associated with increased irrigation, but the greatest negative effects on crop prices and earnings associated with other irrigation, and the greatest negative potential for negative externalities, such as irrigation-related emissions of pollutants to streams and aquifers. Coordination with key stakeholders would ensure that economic considerations are incorporated into facility siting and design.	in nature but smaller than those of large storage projects.	and uncertainty.	irrigators, municipalities, Ecology, and others incur to pump water.
Cultural Resources *Short-Term* *Long Term* *Mitigation*	Construction-related impacts will be greatest of all options considered; potential for disturbing cultural resources during any ground disturbing activities, with heavy equipment, during site preparation, and in staging areas. Operational impacts include erosion, inundation, chemical weathering, vandalism, and land development. Mitigation measures should be outlined in a Cultural Resources Management Plan and possibly a Programmatic Agreement developed in consultation with Ecology, DAHP, Tribes, ACHP, federal agencies, and other stakeholders.	Construction impacts will be of lesser magnitude than large storage projects, but of similar nature. Site avoidance may be more feasible for smaller storage projects. Operational impacts will be of a similar nature to large storage projects.	Cultural resources could be adversely affected by changing water levels at existing reservoirs. Impacts would be similar to operational impacts.	ASR would raise ground water levels, which may affect the preservation of buried organic materials or the soil chemistry of buried cultural resources. ASR is not likely to otherwise adversely affect cultural resources during construction or operation.
Transportation *Short-Term* *Long Term* *Mitigation*	Large storage projects have the greatest potential for affecting transportation due to the volume of materials, and the likelihood of disrupting roads. Coordination with regional transportation managers will help to avoid and/or minimize impacts.	Impacts similar to large storage projects, but of lesser potential magnitude.	Modifications to existing storage are not likely to disrupt transportation.	ASR projects would have substantially less impact on transportation during construction due to the smaller amount of construction needed. Operation of ASR projects would not likely affect land-based transportation, except for occasional maintenance vehicles.
Recreation and Scenic Resources & Aesthetics *Short-Term* *Long Term* *Mitigation*	Construction-related impacts will be greatest of all options considered; potential for localized disruption of recreation could be extensive during construction. Operation of large storage facilities has the greatest potential to affect recreation associated with extensive inundation area and potential for alterations of downstream flow regimes. This option has the greatest potential for impacts to scenic/visual resources.	Construction impacts will be of lesser magnitude than large storage projects, but of a similar nature.	Recreational facilities such as docks and swimming facilities might have to be adapted to higher or lower water levels at existing reservoirs.	ASR would raise ground water levels, which may affect vegetation and inundation in some recreational areas. This could be positive or negative for recreation and scenic resources, depending on the areas that are inundated. ASR is not likely to otherwise adversely affect recreation or scenic resources during construction or operation.

Element of the Environment	New Large Storage (> 1 Million AF)	New Small Storage (< 1 Million AF)	Modifications to Existing Storage	Aquifer Storage and Recharge
Public Services & Utilities *Short-Term* *Long Term* *Mitigation*	Large storage facilities generally have the greatest costs, including agency costs, associated with them. Large facilities also have the greatest potential to affect existing utilities and hydropower production, but also may have more potential to generate electricity.	Smaller storage facilities would have similar impacts to large facilities but on a smaller scale.	Modifications may require only limited agency resources for permitting and environmental review, depending on the nature of the modification. Modifications to existing storage facilities could include the addition of hydroelectric plants, or improvements to existing hydropower facilities to increase the capacity for electrical generation. Mitigation would be similar to that required for new storage facilities.	ASR would have limited impacts on public services. Additional power may be required for pumping.

4.1.2 Conservation Component

This section describes the potential impacts that would occur from the range of conservation projects that could be proposed under the Management Program. No specific conservation project is analyzed because none has been proposed under the Management Program. The general types of conservation projects considered are municipal, regional agricultural efficiency improvements, on-farm, and industrial. These types of conservation projects are described in Chapter 2. Table 4-3 at the end of this section presents a comparison of the impacts that could occur from the different types of projects.

Some of the conservation projects that could be proposed under the Management Program, including regional agricultural efficiency improvements, would be likely to require additional environmental review. Smaller projects such as on-farm conservation would not likely require additional review.

4.1.2.1 Earth

Short-term impacts

Implementation of conservation projects may require canal installation, new roads to access canals for lining or piping, construction of water reclamation or reuse plants and new conveyance or distribution systems, installation of closed piping upgrades, pond construction, leak repair, and distribution system upgrades. These activities have the potential to disturb the ground and expose soils, resulting in the potential for erosion and delivery of sediments to nearby surface waters. Earth impacts from construction-related activities would be similar to those described in Section 4.1.1.1.

Long-term impacts

Long-term impacts to earth resources could involve the permanent removal of earth, the use of resources such as sand and gravel for construction fill or grading, and soil erosion from land clearing, excavation, and filling activities (Ecology 2003b).

Mitigation

Mitigation measures to minimize construction-related impacts would be similar to those discussed in Section 4.1.1.1. For any site in which reclaimed water is used to recharge ground water, thorough hydrogeologic studies should be conducted to properly select the injection or recharge site and prevent problems such as slumping or bank instability.

4.1.2.2 Air

Short-term impacts

Short-term impacts would be the same as described for construction activities in Section 4.1.1.2, except that conservation projects generally would require less construction.

Long-term impacts

Long-term impacts would be the same as for storage projects described in Section 4.1.1.2.

Mitigation

Mitigation for impacts to air would the same as described under Section 4.1.1.2.

4.1.2.3 Surface Water

Short-term impacts

Water Quantity. Short-term impacts to water quantity as a result of implementing the conservation component are expected to be the same as long-term impacts.

Water Quality. Construction associated with conservation projects may result in temporary impacts to surface water quality. The replacement of leaky irrigation ditches with pipelines, and municipal conservation activities such as leak detection and replacement programs, may have short-term construction impacts. Construction projects involving lining or modifying canals have the potential to directly transport sediment that has accumulated in the canal during construction to streams. The potential will be a function of the proximity of the project to a water body, the volume of sediment generated, the condition of vegetative buffers between the site and the water body, and the best management practices (BMPs) applied to control erosion. Inputs of sediment to any water body may increase turbidity until the site is revegetated. Inputs of fine sediment may also affect the substrate condition in streams. The level of impact will vary with the amount of sediment input into the water body. Construction-related surface water quality impacts would be similar to those discussed in Section 4.1.1.3.

Other conservation efforts, such as increasing incentives to install low volume showerheads and toilets, will have no short-term impacts to surface water.

Long-term impacts

Water Quantity. For cases in which both the point of diversion and place of water use occur in the same basin, saved water from conservation measures would reduce demand from streams and rivers and provide more water for instream flows in the reach immediately downstream from the diversion. If conservation projects result in a reduction in consumptive use, then the water budget for the entire river basin would benefit from an increase in water supply. Reduced demand resulting from conservation projects could result in an increased ability to meet minimum mainstem Columbia River flow targets established by NOAA Fisheries, and reserved tribal rights to water to hunt and fish in usual and accustomed places.

If water savings are implemented in a system that conveys water from one basin to another, the source stream or aquifer would benefit from the reduction in demand, and the basin where water is used would realize a decline in water supply due a reduction in return flows, leaks, or other losses.

In most cases, water conservation and irrigation efficiency efforts will increase surface water and ground water in the immediate area of the diversion or withdrawal by reducing demand on that source. Consumptive use reduction (i.e., reduction in evaporation or evapotranspiration) would benefit water supplies in the basin generally, not just downstream of the point of diversion from a stream or in the immediate area surrounding a well. Conservation efforts may make more water available for instream flow and other beneficial uses.

Secondary effects may include evaporative losses and ground water recharge associated with new or resized reservoirs used for regulating irrigation canal flow, changes in the timing and location of ground water recharge through irrigation district expansion, and the potential for reduced recharge along any discontinued, lined, or piped irrigation facilities.

Changes in return flow patterns may have an adverse impact on the availability of water for down-gradient water users who are relying on the return flows as a source of supply. Implementation of regional agricultural efficiency improvements could decrease artificial recharge to ground water, which could have the effect of locally lowering water tables or decreasing ground water discharge to down-gradient streams. The existence and magnitude of these impacts would depend on many factors, including the number and size of irrigation canals and ditches, the degree to which these structures are currently leaking, the amount and efficiency of new lining that may be installed, the depth to the water table, the underlying soil permeability, the amount of recharge from other sources, and the rates of ground water withdrawal (Ecology 2003).

For municipal conservation, demand management strategies such as increasing rate structures and public education should promote conservation and therefore require less water to be diverted from the source. Replacing leaky pipelines and retrofitting plumbing fixtures will also save on the amount of water required to serve customers. Secondary effects include locally reduced recharge from these previously leaking conveyance facilities, potentially altering the timing of baseflows.

Water Quality. Increases in flow may subsequently reduce stream temperature and increase dissolved oxygen, particularly in situations where summer water depths are currently low and flows are substantially increased. Increased flows may also result in reductions in the concentrations (not total load) of other pollutants. Additionally, reductions in return flow may reduce the inputs of sediment, pesticides, and fertilizers associated with agricultural practices.

In situations where water is diverted and transported to a different subbasin, reductions in return flow could reduce streamflow in the subbasin where the water is used. Reductions in streamflow have the potential to increase stream temperature. This potential may be significant in situations where a substantial portion of the flow is reduced.

Reductions in streamflow also have the potential to increase the concentration of other pollutants in a stream. This effect would tend to be offset by the reduction of inputs of non-point source pollutants unless other pollutants of another source and type are present. The latter situation is likely rare but may occur in some locations. In this situation, reductions in flow would tend to increase the concentration, but not the load, of the pollutants input through other sources. The magnitude of effect would depend on the current pollutant load, the expected post-project pollutant load, and the amount of reduction in streamflow caused by the reduction in return flow.

Mitigation

Water Quantity. In order to maximize the benefits from conservation measures, detailed, coordinated conservation planning should be conducted to address the continued problem of surface water supply shortages during periods of low streamflow. Conservation planning should lead to a coordinated approach to maintaining instream flows to ensure that some of the water savings resulting from conservation efforts is retained to enhance instream flows (Ecology 2005b).

Situations where projects would effectively reduce flow in a stream by reducing return flow should be carefully reviewed prior to implementation to ensure that the net effect of the project will be beneficial and meets the objectives of the implementing or funding agency. The geographic extent of changes in place of diversion and use should also be minimized.

Water Quality. Direct inputs of sediment from construction in canals can be minimized by completing work "in the dry," attempting to clear canals of sediment prior to releasing water into them, and/or providing for sediment filtration of the initial water release. Other BMPs may also help reduce sediment inputs.

4.1.2.4 Ground Water

Short-term impacts

Water Quantity. Construction involved with implementing conservation projects may include installation or upgrades of canals, on-farm ponds, and reclamation or reuse facilities. These activities could result in changes in ground water levels and gradients during construction. Should construction include substantial ground water control activities, construction dewatering may temporarily reduce ground water levels and water availability in the alluvial aquifer and/or sedimentary aquifer system (Ecology 2003b; Ecology 2005b).

Water Quality. Potential water quality impacts from construction include contamination from surface water sources if soil removal has created an easy route for contaminants to reach the ground water system.

Long-term impacts

Water Quantity. The magnitude of potential ground water impacts from conservation projects would depend on the project. Municipal and industrial conservation programs that include demand management and operational efficiency measures could reduce withdrawals of ground water and increase water table elevations in the vicinity where ground water is withdrawn. Lining or piping of conveyance systems and more efficient on-farm irrigation systems would reduce the loss of surface water to seepage, decreasing recharge to ground water. The loss of recharge to ground water could change local ground water recharge patterns and would lower ground water levels, resulting in both positive and negative impacts (Ecology 2003b; Ecology 2005b).

Implementation of water reclamation and reuse could result in additional ground water resources being available for withdrawal should the project involve artificially recharging ground water with reclaimed, reused, or graywater. The artificial recharge of ground water may support stream baseflows in areas where the receiving aquifer is in hydraulic continuity with surface waters.

Single on-farm conservation measures may cause long-term impacts to surface water quantity associated with new or resized storage ponds, changes in the timing and location of ground water recharge locally through implementation of a more efficient irrigation method, and the potential for reduced recharge along any discontinued or lined irrigation facilities (Ecology 2003b).

Implementation of conservation projects could change the quantity and distribution of ground water recharge and withdrawals within and between basins (should interties involve more than one basin). For example, recharge could be reduced if water use changes from irrigation to municipal uses. The nature and magnitude of these potential impacts would depend on a number of factors, including the nature and location of the changes in water uses and the volume of water subject to the change (Ecology 2003b).

Water Quality. Artificially recharging ground water with reclaimed, reused, or graywater, available through conservation, could potentially introduce contaminants into the ground water. The magnitude of these impacts would depend on factors such as the volume and quality of water reintroduced to the ground water, natural recharge, and ground water withdrawal patterns. Reductions in deep percolation from less efficient irrigation systems may reduce the inputs of pesticides and fertilizers associated with agricultural practices. Changes in water quality could potentially impact domestic water use near the project and surface water quality at the point of ground water discharge to streams (Ecology 2003b; Ecology 2005b).

Mitigation

For all conservation projects, impacts to ground water could be mitigated by conducting appropriate hydrogeological studies prior to project implementation. The degree of study required would depend on the type of project being undertaken. If adverse ground water effects were predicted as a result of the studies, then construction, design, or operation of the project could be adjusted to reduce the effects (Ecology 2005b).

Water Quantity. Conservation projects such as canal lining would require study to determine the effects on ground water recharge. Available water level data are not sufficiently detailed and precise to assess the current amount of leakage from irrigation canals and ditches, the artificially elevated ground water levels due to leakage, and the artificially elevated ground water discharge to streams resulting from increased alluvial aquifer storage. These studies would include measuring surface water and ground water levels in and next to the open irrigation structures before lining to determine the current leakage rate, then estimating the potential change in ground water level decline with the loss of leakage (Ecology 2005b).

Increased water efficiency would locally reduce ground water recharge to the alluvial aquifer, reduce ground water levels, and reduce stream baseflow downstream of leaky irrigation canals or inefficiently irrigated areas. For areas where declining ground water levels would reduce baseflow or impair habitat (wetlands), the timing or magnitude of the decrease in ground water levels could be avoided, lining activities could be avoided or limited, or other measures such as artificial recharge could be considered (Ecology 2003b; Ecology 2005b).

Water Quality. Proper design and operation of a reuse or reclamation facility would ensure adequate treatment that prevents contaminants from being introduced into the ground water, and ensure compliance with Department of Health and Ecology standards. Compliance with standards would require regular monitoring of reclaimed water and ground water quality to ensure that contaminated water is not being introduced to ground water (Ecology 2003b) and that beneficial uses are being preserved.

4.1.2.5 Water Rights

Short-term impacts

Any potential impacts of conservation and efficiency efforts on water rights would be long-term impacts.

Long-term impacts

An analysis of the potential impact to existing water rights may arise in two instances. Ecology will investigate potential impairment to existing water rights when a request is made to change the place or purpose of use, or the point of diversion of water saved through a conservation project. Additionally, water right holders may bring private actions in court claiming impairment of their rights due to reduced availability of water. Water saved through irrigation conservation projects is primarily water that previously became return flow under less efficient systems. Water users may use return flow that is available and "may obtain a right to return flow provided that flow naturally originated from and returned to a water course within the same watershed. Such rights are …subject to the availability of the water based on the first appropriator's right to make further uses of the water on the lands to which the right is appurtenant" (*Ecology v. Aquavella,* Memorandum Opinion Re: Subbasin Exceptions 1995).

A reduction in return flow is not, however, an impairment of downstream water rights because the water user is not obligated to provide return flow to downstream users (*Burke v. Department of Ecology,* PCHB No. 03-155, July 24, 2004)[2]. As a result, although changes in return flow patterns may have an adverse impact on the physical availability of water, they would not have an adverse impact on the legal availability of water, i.e., existing water rights.

Impacts from municipal and industrial conservation projects would be expected to be neutral or positive to the extent the projects reduce the demand for water. Negative impacts could arise from changing the place or purpose of use, or the point of diversion, of the saved water and would be addressed through Ecology's review of a water right change application for impairment.

[2] This Board's decision was upheld on appeal by the *Acquavella* court. The court's decision was appealed to Division 3 of the Court of Appeals.

Implementation of regional agricultural efficiency improvements could decrease artificial recharge to ground water. Artificial ground water recharge caused by leakage from unlined irrigation canals or ditches may be reduced or eliminated should conservation projects include lining of these structures. As noted above, this could have the effect of locally lowering water tables. The existence and magnitude of these impacts would depend on many factors, including the number and size of irrigation canals and ditches, the degree to which these structures are currently leaking, the amount and efficiency of new lining that may be installed, the depth to the water table, the underlying soil permeability, the amount of recharge from other sources, and the rates of ground water withdrawal (Ecology 2003).

Impacts from municipal and industrial conservation projects would be expected to be positive to the extent the projects free up more water for instream and/or out-of-stream uses. Any negative impacts could arise from changing the place or purpose of use, or the point of diversion, of the saved water and would be addressed through Ecology's analysis of the change application.

Mitigation

As explained above, although changes in return flow patterns may have an adverse impact on the physical availability of water, they would not have an adverse impact on the legal availability of water (i.e., existing water rights) and no mitigation would be required.

4.1.2.6 Fish, Wildlife, and Plants

Short-term impacts

Fish. Conservation projects are not expected to result in short-term impacts to fish, native freshwater shellfish, or aquatic resources if water savings result in withdrawals that are less than the existing full water right.

Wildlife and Plants. Short-term impacts to plants and wildlife associated with conservation projects would primarily occur during construction of improvements by irrigation districts. Impacts would be similar to those described for storage projects in Section 4.1.1.6. Some conservation projects would have no impacts. Lining canals to prevent water loss or complete replacement of canals or ditches with piped systems would result in construction activities that may displace wildlife. Installation of pump-back stations and re-regulating reservoirs will also result in noise and construction impacts to wildlife that may extend through critical periods (e.g., breeding) for some listed species. Soil disturbance from dozing and excavation may alter conditions for plant re-growth or remove areas of microbiotic crust.

Those projects implemented by individual landowners would likely have a reduced impact on wildlife due to the smaller scale of the project. Impacts would occur in localized areas and would be the same as those discussed in Section 4.1.1.6 but on a smaller scale. Projects such as replacement of canals with piped systems would disturb small amounts of localized habitat for birds and small mammals, such as Washington ground squirrel.

Long-term impacts

Fish. Conservation projects are expected to result in a net benefit to fish and shellfish species by reducing existing water withdrawals and future water right needs. For aquatic benefits to be gained, conservation projects must achieve water savings that result in less withdrawal than the full allocation of existing water rights.

Wildlife and Plants. Long-term impacts to wildlife associated with conservation and irrigation efficiency projects include both positive and negative impacts. Operation of conservation projects may locally remove wildlife habitat or modify conditions that alter species composition and wildlife use at or near the site. Certain projects will result in additional water delivery to areas that are currently dry, and others will reduce water in areas that are currently wet. For example, on-farm ponds for tail water reuse could provide additional wintering habitat for waterfowl, or habitat that waterfowl could use during spring and fall migration. On a larger scale, many conservation and irrigation efficiency projects are meant to free up water. In some cases this water is used to fill junior downstream rights and/or to increase the number of irrigated acres, which may result in habitat loss. In such cases, no major change in streamflow would be expected. In other cases; however, water conservation and irrigation efficiency projects would result in increased instream flow. Increases in streamflow would have the positive effects on fish habitat and fish production described in Section 4.1.1.6. In areas where streams are currently dry or nearly dry, increases in flow would also provide additional water for terrestrial organisms and convert arid habitats into wetter areas. However, those species currently associated with arid areas such as grassland or shrub-steppe area could be negatively impacted.

Alternatively, if implementation of agriculture conservation measures results in controlling leakage of irrigation systems, some existing wetlands that may have formed along the irrigation canals and ditches could experience reduced flows or may become dry. Similarly, riparian or other vegetation associated with leaky canals or ditches can also be dewatered by implementation of this alternative, resulting in reduction or loss of this plant life. Such changes may result in a shift in species composition toward non-wetland or more arid plant community types.

Mitigation

Fish. Since conservation efforts are assumed to result in a net benefit to aquatic species production, no mitigation action is recommended. The following administrative recommendations should be considered to assure the conservation measures provide a benefit:

- Codify conservation gains with water right transfers, trust agreements, or conservation agreements to benefit instream water uses.
- Provide incentives to the agricultural community to implement conservation measures.

Wildlife and Plants. Where construction is involved, the mitigation measures described in Section 4.1.1.6 should be implemented to minimize adverse impacts to fish, plant communities, and wildlife.

Another possible means to mitigate for potential impacts to plants and wildlife could come from incentive-based programs for conservation projects that create additional terrestrial or aquatic habitat. Landowners could be rewarded for implementing projects that create new habitat or improve existing habitats. For example, rather than line an open ditch or canal with an impermeable surface, the ditch could be enclosed or buried in a pipe and the land reclaimed where the ditch previously existed. Piping the ditch may also result in improvements to migration or movement of terrestrial species where a ditch previously acted as a barrier.

4.1.2.7 Socioeconomics

Short-term impacts

Implementation of conservation programs may entail limited construction activity, such as eliminating leakage from canals or levelling fields; adoption of conservation technologies, such as drip irrigation; and/or changes in behaviour, such as relying on scientific measurements of soil moisture before irrigating a field. Construction-related effects probably would be less intensive than those associated with construction of storage facilities described in Section 4.1.1.7.

In order to implement substantial conservation activity, irrigators would have to overcome hesitancy that has impeded the adoption of conservation measures in the past. Conservation efforts may reduce uncertainty and risk regarding the impact of conservation on water right holders and/or alter the structure of the socioeconomic relationship between water and local communities. Conservation that reduces or eliminates farmers' use of a particular type of farming technology, for example, may reduce sales of that technology.

Long-term impacts

Long-term costs, benefits, impacts on jobs and income, distributional effects, interactions with socioeconomic structure, and effects on risk and uncertainty would be determined by the scope and design of individual conservation projects and programs. Conservation programs could reduce economic value, jobs, and income associated with water uses and practices, but could increase value, jobs, and income associated with conservation activities and with the goods and services produced by the conserved water. The direct benefits, costs, and impacts on jobs and income associated with the use of conserved water would likely be similar, on a per unit basis, to those associated with the use of water from storage projects. The distribution of costs and benefits would depend on the details of individual conservation programs and projects. The availability of state and federal funding, for example, may reduce costs to individual farmers, irrigation districts, municipalities, and industries that undertake conservation.

The overall scope of conservation opportunities remains unknown. Schaible (2000) found there are opportunities for irrigators in the Pacific Northwest (Idaho, Washington, and Oregon) to implement conservation technologies and practices that would reduce water diversions by 1.7 million acre-feet per year and realize substantial net economic benefits or minimal net costs. In-depth research (Gleick et al. 2003) that was acknowledged by the National Research Council (2004) indicates that municipal-industrial conservation can satisfy all of California's foreseeable urban demands for water. Similar efforts may yield similar results in the project area. The Management Program may accelerate the lowering of barriers that otherwise would slow the pace of conservation. It may reduce uncertainty by clarifying what would happen with conserved water, and how conservation would affect all parties with an interest in the conserved water. It may also reduce financial risk to water right holders by increasing the funding available for conservation efforts on individual farms and across larger landscapes (National Research Council 2004; Schaible 2000).

Mitigation

Mitigation for impacts from construction and operation of conservation projects would be similar to those described for construction of storage facilities in Section 4.1.1.7. The design and scope of individual conservation projects and programs would determine the nature, location, and timing of long-term adverse impacts, their distribution among different groups, and the nature of opportunities for mitigating them. Coordination with tribal and non-tribal resource managers, and consultation with communities of interest, would promote the identification and balancing of their respective economic concerns. Evaluations of proposed conservation projects and programs would consider project- or program-specific economic impacts.

4.1.2.8 Land and Shoreline Use

Short-term impacts

Conservation projects would generally not affect land use in the short term because the projects would likely involve changes to existing regional and on-farm irrigation infrastructure that would not require much, if any, additional land area. One exception would be the siting of reclamation plants and associated facilities, which could result in short-term land use impacts due to displacements. However, siting of these facilities, as well as any conservation project, would be required to be consistent with applicable local comprehensive plans, zoning codes, shoreline master programs, and critical area ordinances.

Long-term impacts

Land use impacts associated with conservation projects are similar to those described for storage projects in that they relate to changes in water availability and management practices. To the extent that these changes would be more subtle following conservation projects than with storage projects, impacts would be expected to be less significant. Demand management programs may involve modification of water rate structures to encourage conservation. This could impose a proportionately larger burden on large, low-income families or small businesses with high water needs.

The Management Program could assist with the development of water reclamation and reuse facilities to conserve municipal water. Operation of these facilities is required by state health regulations to be consistent with the long-term land and water use planning objectives of the community. In counties fully planning under the Growth Management Act, comprehensive plans must address the need for and the means to accommodate public utilities. Thus any facility developed would likely be sited to minimize land use conflicts.

When conserved water is made available for uses such as recreation, instream flow, agriculture, municipal water supplies, or other beneficial uses, it could result in indirect impacts associated with new development, conversion of cropland to higher value crops, conversion of non-irrigated farmland to irrigated farmland, and reduced pressure to convert agricultural uses to residential development, similar to those described for new storage facilities. If development proceeds according to locally adopted plans, land use impacts would not be expected to be significant. Potential beneficial impacts include a potential increase in reliable municipal water supply or wastewater treatment capacity that would support planned community growth.

Mitigation

In addition to the mitigation measures discussed under Section 4.1.1.8, the Management Program could include efforts to inform farmers of available federal cost-sharing programs administered through the state and local conservation districts.

4.1.2.9 Cultural Resources

Short-term impacts

Impacts would be similar to but likely less than the short-term impacts associated with construction of storage facilities described in Section 4.1.1.9. Generally, conservation projects would not require construction over areas as large as would be expected for storage facilities. As such, it may be feasible to locate a project to avoid adversely affecting cultural resources.

Long-term impacts

In most cases where modifications are made to existing systems, such as lining irrigation canals, the operation of conservation projects is not expected to have significant long-term impacts on cultural resources. Existing systems may include historic properties and the effects to them would need to be mitigated. Long-term and operational impacts related to reservoirs or ponds would be similar but of lower magnitude than those associated with construction of storage facilities described in Section 4.1.1.9. Conservation projects may be able to be located to avoid impacts to cultural resources.

Mitigation

Mitigation for impacts from construction and operation of conservation projects would be similar to those described for construction of storage facilities in Section 4.1.1.9.

4.1.2.10 Transportation

Short-term impacts

Short-term impacts from conservation projects would be similar to those described for storage projects in Section 4.1.1.10, except that the scale of construction would generally be smaller and impacts would be proportionately less. Conservation projects are less likely to disrupt roads during construction, unless conservation projects are immediately adjacent to roadways.

Long-term impacts

Operation of conservation projects would entail only infrequent trips by maintenance vehicles and would have minor impacts on transportation systems.

Mitigation

Although implementation of conservation projects would likely require less construction than new storage facilities, mitigation measures similar to those listed in Section 4.1.1.10 could be required for construction of conservation projects. No mitigation is necessary for operation of conservation projects.

4.1.2.11 Recreation and Scenic Resources and Aesthetics

Short-term impacts

Impacts would be similar to but likely less than short-term impacts associated with construction of storage facilities described in Section 4.1.1.11. Generally, conservation projects would not require construction over areas as large as would be expected for storage facilities.

Long-term impacts

The operation of conservation projects is not expected to have significant long-term impacts on recreation. Availability of additional irrigation water may be beneficial for uses that depend on irrigation such as golf courses and active sports fields; however, this effect is not expected to be significant.

Mitigation

Mitigation for impacts from construction and operation of conservation projects would be similar to those described for construction of storage facilities in Section 4.1.1.11.

4.1.2.12 Public Services and Utilities

Short-term impacts

Conservation projects could temporarily disrupt utilities during construction, including both those that would benefit from the project and those adjacent to the construction site, such as power lines or pipelines. Coordination with affected utilities would occur for each specific project.

Conservation and efficiency measures, such as lining irrigation ditches, could result in cost impacts to irrigation districts and irrigators. Over the short-term, these costs will need to be absorbed by the irrigation districts unless funded by grants or through the sale or lease of conserved water. For municipal and industrial conservation measures, similar impacts could occur.

If industrial water use efficiency activities involve water reclamation and reuse, a sewer utility or municipality would need to commit significant resources to design and construct reclamation and reuse facilities.

Long-term impacts

Conservation measures could reduce energy consumption over time by reducing the volume of water that needs to be pumped to irrigate a given area. Changes in irrigation practices such as from rill to center pivot irrigation may increase electricity demand.

Implementation of this alternative could involve substantial commitments of financial resources by irrigation districts and irrigators unless funding is provided by federal, state, and tribal resource agencies and entities. Some conservation program elements for municipal water systems could require long-term commitments of financial resources by public water systems. These commitments would need to be factored into utility rate systems.

Water reclamation plants may be more expensive to operate than more conventional forms of wastewater treatment and could potentially require increased utility rates. However, reclaimed water can be used to offset potable water consumption, which would help to reduce costs and hold rates down in the long term.

Mitigation

Costs to irrigation districts, irrigators, municipalities, or sewer districts associated with implementation of this alternative could be offset to some degree by the availability of saved water to be put to another beneficial use, or to be used to meet planned future growth.

4.1.2.13 Comparison of Impacts for General Types of Conservation Projects

Table 4-3 compares the potential impacts that could occur for each general type of conservation project. The table highlights the differences between the types of projects and does not present every potential impact.

Table 4-3. Comparison of Impacts for Types of Conservation Projects

Element of the Environment	Municipal	Regional Agricultural Efficiency Improvements	On-Farm Conservation	Industrial
Earth *Short-Term* *Long Term* *Mitigation*	Municipal conservation projects involving construction may have similar earth impacts and mitigation as discussed for Earth in Table 4-2.	Construction of pipelines, canal lines, new canals or wasteways will impact earth resources. Impacts and mitigation measures are discussed in Section 4.1.1.1.	Increased soil erosion due to construction activities, including the construction of storage ponds.	Industrial conservation projects involving construction may have similar impacts as discussed for Earth in Table 4-1.
Air *Short-Term* *Long Term* *Mitigation*	Water reclamation facilities may, at times, produce odors that would be a nuisance to persons living or working in the vicinity. The most effective mitigation strategy for preventing odor impacts would be to properly design and operate the facility to minimize odor emissions and to provide a sufficient distance between a proposed reclamation facility and potential human receptors.	No impacts to air quality or climate are expected.	No impacts to air quality or climate are expected.	Impacts associated with industrial water reclamation could produce odors similar to those described for municipal projects. Proper design and operation will minimize the potential for odor generation.
Surface Water *Short-Term* *Long Term* *Mitigation*	Impacts and mitigation would be similar to Regional Agricultural Improvement projects, but of a lesser magnitude.	Short-term construction impacts could occur from sediment washed into water bodies. Long-term impacts may include an increase in streamflow in the stream being diverted from along with a reduction in stream temperature, increase in dissolved oxygen and a reduction in return flow from reduced seepage in other streams, possibly causing an increase in pollutant concentrations. Mitigation of short-term impacts can be achieved through construction related BMPs. Long-term impacts can be mitigated by ensuring the net effect of the project is beneficial.	Impacts and mitigation would be similar to Regional Agricultural Improvement projects, but of a lesser magnitude.	Although surface water quality impacts from industrial conservation projects are likely to be similar to those of the municipal projects, industrial sources of reclaimed or conserved water may be more likely to introduce contaminants into the surface water. Mitigation of industrial impacts could include storm water controls and appropriate discharge permits.
Ground Water *Short-Term* *Long Term* *Mitigation*	Construction-related ground water impacts will be similar to those discussed in Section 4.1.1.1. Ground water impacts may include changes in level, gradient, recharge and discharge rates and contaminant introduction. Impacts may be mitigated by conducting appropriate hydrogeological studies prior to project implementation.	Regional agricultural efficiencies may decrease artificial recharge of ground water.	Increased irrigation efficiencies may decrease artificial recharge of ground water.	Ground water impacts from industrial conservation projects are likely to be similar to those of municipal conservation projects.
Water Rights *Short-Term* *Long-Term* *Mitigation*	Municipal conservation projects are not expected to adversely affect water rights.	Potential impacts on physical availability of water are of wider geographic scope than with single farm projects.	Potential for local reductions in ground water recharge from more efficient irrigation methods.	Industrial conservation projects are not expected to adversely affect water rights.

Element of the Environment	Municipal	Regional Agricultural Efficiency Improvements	On-Farm Conservation	Industrial
Fish *Short-Term* *Long Term* *Mitigation*	Municipal conservation that results in a water saving and a reduction of instream withdrawals, would have an immediate benefit on fish populations, influencing habitat capacity and abundance compared to existing conditions. Efficiency improvements that result in water quality enhancements would have an immediate benefit on fish productivity metrics. Benefits would accrue over the long-term should conservation measures remain in place.	Water quantity savings and quality improvements through agricultural improvements and conservation measures will directly benefit fish species. Natural resource benefits compared to the other types of conservation measures will vary directly with the relative level of water savings and improvements.	Water quantity savings and quality improvements through on-farm conservation measures will directly benefit fish species. Natural resource benefits compared to the other types of conservation measures will vary directly with the relative level of water savings and improvements.	Water quantity savings and quality improvements through industrial conservation measures will directly benefit fish species. Natural resource benefits compared to the other types of conservation measures will vary directly with the relative level of savings and improvements.
Wildlife and Plants *Short-Term* *Long Term* *Mitigation*	Construction and operation of municipal projects would have less impact than regional agricultural projects and some municipal projects would have no impacts.	Construction of regional agriculture efficiency projects would have similar noise and disturbance impacts to large storage projects. Operation could benefit plant and wildlife species diversity by providing additional water to dry habitats. Increases in streamflow could provide additional water and convert arid habitats into wetter areas. Conversely, controlling leaky systems may locally dewater wetlands and riparian areas.	On-farm conservation projects would have similar construction and operation impacts to municipal projects, but on a smaller scale. Some on-farm projects would have no impacts.	Industrial conservation projects would have similar impacts to municipal projects.
Land and Shoreline Use *Short-Term* *Long Term* *Mitigation*	Municipal conservation facilities could include water reclamation and reuse facilities that must be designed and sited carefully to minimize odor and noise impacts on neighboring properties.	Regional agricultural conservation efforts are not expected to have a significant impact on land use.	On-farm conservation efforts are not expected to significantly affect land use.	Development and implementation of industrial conservation measures, such as in-process efficiency measures, may result in cost impacts to individual industries. Land use impacts are not expected to occur.
Socioeconomics *Short-Term* *Long Term* *Mitigation*	The scope and design of demand-management programs and investments in infrastructure would determine their costs, benefits, impacts on jobs and income, distribution of costs and benefits, interaction with the socioeconomic structure, and levels of risk and uncertainty. Mitigation, if any, probably would entail spreading the costs so they are not concentrated within a particular group.	The nature and location of conservation projects and programs would be different than those for municipalities. The scope and design of demand-management programs and investments in infrastructure would determine their costs, benefits, impacts on jobs and income, distribution of costs and benefits, interaction with the socioeconomic structure, and levels of risk and uncertainty. Mitigation, if any, probably would entail spreading the costs so they are not concentrated within a particular group.	The economic effects, positive and negative, of on-farm conservation probably would be smaller than those for regional projects and programs. Mitigation, if any, probably would entail spreading the costs so they do not fall heavily on individual farmers.	Impacts and mitigation opportunities probably would resemble those for municipal conservation.

Element of the Environment	Municipal	Regional Agricultural Efficiency Improvements	On-Farm Conservation	Industrial
Cultural Resources *Short-Term* *Long Term* *Mitigation*	Municipal conservation projects are not anticipated to impact cultural resources unless there are modifications to the historic infrastructure.	Regional agriculture efficiency improvements which involve ground disturbing activities or modifying historic structures have potential to impact cultural resources. Operational impacts may occur related to pump-back stations or re-regulation reservoirs. Avoidance of cultural resources may be feasible. Mitigation measures should include development of a Cultural Resources Management Plan and possibly a Programmatic Agreement.	On-farm conservation projects which involve ground disturbing activities or modifying historic structures have the potential to impact cultural resources. Operational impacts may occur related to on-farm ponds.	Industrial conservation projects are not anticipated to impact cultural resources unless there are modifications to the historic infrastructure.
Transportation *Short-Term* *Long Term* *Mitigation*	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.
Recreation and Scenic Resources & Aesthetics *Short-Term* *Long Term* *Mitigation*	Conservation projects could benefit municipal recreation facilities, for example, by providing additional water for irrigating playfields.	Regional agriculture efficiency projects are not expected to affect recreation or scenic resources.	On-farm conservation is not likely to affect recreational resources because construction would not occur on public recreational lands.	Industrial conservation programs are not expected to affect recreation or scenic resources.
Public Services & Utilities *Short-Term* *Long Term* *Mitigation*	Conservation programs including the development of reclamation and reuse facilities could require additional investments by local utilities and require increased rates in the short term. However, over the long-term, conservation programs could reduce costs of providing municipal water as the cost of new water supplies increases.	Conservation and efficiency measures, such as lining irrigation ditches, will result in cost impacts to irrigation districts and conservation districts. Over the short-term, these costs will need to be absorbed by the irrigation districts.	On-farm conservation measures would have minimal impacts on public services and utilities. Conservation measures, such as more efficient irrigation application rates that result in less return flow, could reduce water reaching lakes and rivers as return flow, which could affect other irrigation districts' ability to provide adequate water.	If industrial water use efficiency activities involve water reclamation and reuse, the Departments of Health and Ecology would need to issue permits for that portion of the activities.

4.1.3 Voluntary Regional Agreement Component

The Voluntary Regional Agreement (VRA) component of the Columbia River Water Management Act is described in Chapter 2. The primary impacts that would be associated with VRAs would be to water rights and to streamflows outside of mandated no-net-loss months. The VRAs will likely include specific projects such as storage or conservation. The impacts of those specific projects would be similar to those described in Sections 4.1.1 and 4.1.2 and may require future environmental review. The following is a discussion of water rights related impacts associated with VRAs. In addition, the policy discussion in Chapter 6 includes water rights implications of different alternatives for implementing and processing VRAs. Potential impacts to fish and wildlife are also discussed in this section.

RCW 90.90.030 authorizes Ecology to enter into voluntary regional agreements for three purposes: (1) to provide new water for out-of-stream purposes; (2) to streamline the application process; and (3) to protect instream flow. Instream flows on the mainstem of the Columbia and lower Snake Rivers are to be protected from negative impact in July and August and from April through August, respectively. "Mainstem" is defined for purposes of VRAs as follows:

> (a) "Columbia river mainstem" means all water in the Columbia River within the ordinary high water mark of the main channel of the Columbia River between the border of the United States and Canada and the Bonneville dam, and all ground water within one mile of the high water mark.
>
> (b) "Lower Snake river mainstem" means all water in the lower Snake River within the ordinary high water mark of the main channel of the lower Snake River from the head of Ice Harbor pool to the confluence of the Snake and Columbia Rivers, and all ground water within one mile of the high water mark (RCW 90.90.030(12)).

The alternatives for defining "ordinary high water mark" (OHWM) and the alternatives for defining "no negative impact" are discussed in Sections 6.1.9 and 6.1.10.

The term "instream flow" is used to identify a specific streamflow (typically measured in cubic feet per second, or cfs) at a specific location for a defined time, and typically following seasonal variations. Instream flows are usually defined as the streamflows needed to protect and preserve instream resources and values, such as fish, wildlife, and recreation. Instream flows are most often described and established in a formal legal document, typically an adopted state rule.

The Columbia River Water Management Act is unclear in its references to "instream flows." It is unclear whether the Act refers to those flows adopted in state rule that represent the minimum streamflow necessary for preservation of fisheries, or merely the flow present in the river. It is unclear whether the Legislature was referring to the adopted regulatory structure on the Columbia and the Snake Rivers, or whether it was effectively identifying a "no-net-loss" standard for referenced summer months.

WAC 173-163 defines adopted instream flows for the Columbia River. There are currently no instream flows set for the lower Snake River. The unappropriated waters of the mainstem Snake River were withdrawn from appropriation by WAC 173-564-040, but it expired on July 1, 1999, and no instream flows have subsequently been set under the instream resources protection program in accordance with Chapter 173-500 WAC. The lack of adopted instream flows for the Snake River would suggest that the Legislature was not referring to regulatory flows when specifying the standard of no impact in RCW 90.90.030(2)(b): "[f]or water rights issued from the lower Snake River mainstem, there is no negative impact on Snake River mainstem instream flows from April through August as a result of new appropriations under the agreement." Rather, the implication is that the Legislature was referring to streamflows.

The National Research Council study was an important technical foundation for discussion of the Columbia River Partnership process and subsequent negotiation of the 2006 legislation. The standard for protection chosen by the Legislature is one of no net loss of streamflow during the referenced summer months, and that standard comes from the National Research Council study. The study stated that new appropriations during those months were not advised. The alternatives in Chapter 6 regarding acceptable mitigation incorporate the interpretation that the Legislature meant the flow of the river when it said "instream flows".

RCW 90.90.030 proposes to streamline the application process. Two streamlining features are apparent in the law. First, protection of instream flows in the mainstem Columbia and lower Snake Rivers during the designated months is deemed "adequate for purposes of mitigating instream flow impacts resulting from" new water rights issued under a VRA. Second, the law reduces and restructures the consultation requirements in Chapter 173-563 WAC (RCW 90.90.030(3)) if an applicant is part of a VRA. Applicants not participating in a VRA are still subject to the consultation requirements identified in the 1998 rule amendments.

The administrative rule for the Columbia River establishes instream flows for all months of the year, not just July and August. By providing that if a new water right does not have a negative impact on the Columbia River flows during the months of July and August, impacts to instream flows have been mitigated, the Legislature decided that water is available during the other 10 months of the year. Further, by directing Ecology to only consider impairment of instream flows during the referenced summer months, the Legislature has effectively made an overriding consideration of the public interest determination that the adopted instream flows outside of July and August will not be protected.

This appears to be inconsistent with RCW 90.90.030(8), which prohibits any interpretation or administration of the section regarding VRAs "that impairs or diminishes a valid water right or a habitat conservation plan for purposes of compliance with the federal endangered species act."

The instream flows for January through June in the Columbia River are valid water rights. This conflict could be resolved if Ecology amended WAC 173-563 to reflect the legislative intent and the different standards that apply to applications processed under VRAs and all other applications. Ecology's administrative rule for the Columbia River requires that a decision whether a water right is subject to instream flow protection or mitigation conditions is to be determined case-by-case (WAC 173-563-020). The mitigation provision in RCW 90.90.030 would streamline the application process at the expense of more focused case-by-case analysis.[3]

[3] RCW 90.90.03092)(b) also requires that VRAs ensure that "[f]or water rights issued from the lower Snake River mainstem, there is no negative impact on Snake River mainstem instream flows from April through August as a result of new appropriations under the agreement[.]"

RCW 90.90.030(3) also overrides consultation requirements in Chapter 173-563 WAC. As discussed above, the Columbia River rule provides that any water right application must be "evaluated for possible impacts on fish and existing water rights" in consultation with appropriate local, state, and federal agencies and Indian tribes (WAC 173-563-020(4)). RCW 90.90.030(4)(a) requires that before Ecology executes a VRA Ecology shall:

> Provide a sixty-day comment period for consultation with county legislative authorities and watershed planning groups with jurisdiction over the area where the water rights included in the agreement are located, the department of fish and wildlife, and affected tribal governments, and federal agencies (RCW 90.90.030(4)(a)).

The Washington Department of Fish and Wildlife is required to make written comments. Consultation on a VRA substitutes for consultation on water right applications submitted pursuant to a VRA.

> The consultation process for voluntary regional agreements developed under the provisions of this section is deemed adequate for the issuance of new water rights provided for in this section and satisfies all consultation requirements under state law related to the issuance of new water rights (RCW 90.90.030(4)(a)).

The Columbia River Water Management Act thus creates two consultation pathways: a streamlined consultation for VRAs, and the case-by-case consultation required by WAC 173-563-020(4) for applications not covered by a VRA. Historically, consultation with local, state, and federal agencies and Indian tribes under WAC 173-563 has taken much longer than the 60 days provided for in the VRAs. Again, this has the potential to streamline the application process; however, it may reduce the effectiveness of the consultation process with governmental entities under a VRA. Following consultation under a VRA, opportunities for coordination among governmental entities still exist for specific project applications under a VRA. These include public notice for the water right applications, environmental reviews (e.g., SEPA) for the projects, and stakeholder outreach groups formed by Ecology to provide input into the process (e.g., the Policy Advisory Group and the Technical Advisory Group).

4.1.3.1 Fish, Wildlife, and Plants

Short-term impacts

Short-term impacts are expected to be similar to long-term impacts.

Careful consideration of benefits to fish species attributed to VRAs will be needed since it is likely VRAs will increase overall consumptive use of water in the Columbia River Basin. Depending on the timing of withdrawal and the life history characteristics of the species, a reduction in water volumes could adversely affect fish habitat, fish migration, and fish populations both locally and regionally as discussed by the National Research Council (2004). Endangered Species Act (ESA) target instream flows along the mainstem Columbia River are frequently not met (Fish Passage Center 2006) depending upon the water year. According to NOAA Fisheries, Columbia River flows are critical in every month and any project that increases the risk to complying with the Biological Opinion flow targets is a potential concern

(Columbia River Policy Advisory Group meeting minutes October 11, 2006; http://www.ecy.wa.gov/programs/wr/cwp/images/pdf/ meeting_notes_10112006.pdf). Specific influences will be addressed in environmental documentation associated with each VRA as they are identified.

Long-term impacts

Water transfers contemplated under VRAs are an exchange of water between two or more entities in a manner that would benefit the production of fish species in a local area. The exchanges may either be in the form of water right transfers or new permits mitigated by the acquisition of an existing water right and retirement or placement into the Trust Water Right Program.

Negative impacts to fisheries may occur if acquired water rights are transferred upstream, or if mitigation credit from a downstream water right is applied to an upstream diversion. The flow of a stream or river would be reduced between the new upstream point of diversion and the old downstream point of diversion. Chapter 6 describes four policy choices that would identify the stream reach to which a mitigation credit could be applied. Limiting transfers or the use of mitigation credits to within a single pool as opposed to within one of four major stream reaches would reduce the distance that a mitigation credit could be assigned to a new permit to divert water upstream of the site of the mitigation credit. As a result, there would be fewer miles of river with the potential for reduced streamflow and that, consequently, might negatively impact fisheries or other elements of the built or natural environment. The significance of the impact to fisheries by any particular upstream transfer or mitigation credit assigned from a downstream water right would depend on the location of and distance between the two points, the time that water would be used, and the habitat available for fish within the affected reach.

A VRA may also contemplate a physical exchange of water between two sources that would benefit fisheries. Inter-basin transfer of waters might influence the homing instincts of returning adult anadromous fishes to various locations within the watershed. Water from one basin discharged into another has been shown to alter the olfactory response that could confuse, delay, or preclude successful migration to the spawning grounds.

If the inter-basin transfer is permanent and continuous, outmigrating juvenile fishes originating in the receiving basin will imprint upon the mixed-water source and return appropriately to their spawning areas in subsequent years. However, if the inter-basin water transfers are discontinuous or seasonal, or if the transfer discharge point is near the confluence of both basins, long-term impacts related to straying adults from one basin to the other can ensue.

Mitigation

Mitigation measures associated with VRAs will be discussed on a site-specific basis with the project proponent, Ecology, and WDFW. The federal Services including NOAA Fisheries and USFWS would also be consulted if federal funding or permitting is required. The following measures are generally considered beneficial ways to either avoid or minimize the influence of inter-basin transfer of water:

- Preclude not only WRIA but inter-basin transfer of water under local VRAs where distinct spawning populations occur;
- Locate the point of discharge in the receiving water a sufficient distance upstream of the confluence of both basins to facilitate mixing of the two water sources. An un-mixed water mass attached to nearshore region in the receiving basin can attract returning adult fish destined for the source basin; and
- Ensure the transfer is permanent and continuous so that the discharge of source water in the receiving basin does not fluctuate beyond natural levels.

4.2 No Action Alternative

Under the No Action Alternative, the Management Program would not be implemented. Water management in the Columbia River Basin would continue under existing regulations and policies. Ecology would not aggressively pursue new water in the area, and no state funding would be provided for storage or conservation projects. Ecology would not enter into VRAs. Storage and conservation projects could be developed independent of the Management Program, but the number and scale of programs would likely be smaller and further in the future due to staffing and funding limitations. In some cases, these projects may not be implemented.

If the Management Program is not implemented, the opportunity to improve the reliability of interruptible water rights and increase instream flow in the Columbia River may not occur. Because there would be no comprehensive management program, mitigation efforts would occur individually and may be less effective than under a coordinated basin-wide program.

For most elements of the environment, the impacts of implementing storage and conservation projects independent of the Management Program would be similar to the impacts described in Sections 4.1.1 and 4.1.2. Socioeconomic and land use impacts of not implementing the Management Program are discussed below.

4.2.1.1 Socioeconomics

Short-term impacts

Without the Management Program, construction of new water storage projects and implementation of conservation measures could materialize under existing programs and policies, but implementation probably would move slower because the funding would be smaller and interested parties would lack the Management Program's coordinated efforts to overcome obstacles. The distribution of costs and benefits could be different, because state funds available under the Management Program might not otherwise be available. Without the Management Program's stimulus for investigations into the feasibility of projects and programs, the risks and uncertainties might remain at current levels. These risks and uncertainties could impede farmers and others from initiating storage and water conservation initiatives (National Research Council 2004; Schaible 2000), and progress in these areas would be slower than with the Management Program.

Long-term impacts

The probability of incurring the costs and realizing the benefits of storage projects and conservation programs would be lower without the Management Program because the investigation and implementation of such projects and programs would not be accelerated.

Water users probably could continue to take actions to reduce or compensate for risk of water shortage. Irrigators, for example, probably would continue to apply more water than crops require in order to reduce the risk that crops would become stressed before the next irrigation.

The adverse socioeconomic impacts of past reductions in fish populations would continue absent action to improve instream flow and other aspects of fish habitat. These impacts include losses of value, jobs, and income associated with commercial and recreational fishing, as well as losses of cultural, spiritual, and other non-use values to tribal members and others.

Private parties, communities, and state agencies would likely respond to future drought as they have responded in the past, with the accompanying impacts. The 2005 drought, for example, induced farmers to transfer water from low-value to high-value crops, and from areas with more water to areas with less. Some farmers drilled emergency wells to supplement supplies. Federal, tribal, state, and local entities coordinated their activities to facilitate ensuring that water was available for the most critical demands (Ecology 2006). Markets would respond, where they could, to short-run drought in the future as they have in the past. During the 2001 drought, for example, price increases enabled the total value of the state's potato and apple production to rise 24 percent and 20 percent, respectively, even though the number of acres in production was cut back 8.6 percent and 5.9 percent, respectively (Washington Office of Community, Trade and Economic Development et al. 2005).

Impacts of long-run declines in water supply, stemming from long-run drought or the declining availability of ground water in the Odessa Subarea for example, could be similar in nature, but more extreme. The reduced supply of water, or the increased cost of securing water, might induce some irrigators and businesses to close and some households to leave the area. Bhattacharjee and Holland (2005) have estimated that, if declining ground water in the Odessa Subarea were to cause the cessation of all potato production and all related economic activity in the Subarea, with no off-setting economic adjustments, the total impact in the surrounding counties would be a loss of $630 million in sales, $211 million in income, and 3,650 jobs. As irrigation, business activity, and population decline in one area, however, they would increase in areas elsewhere in the state, if these areas have sufficient water to accommodate growth. Bhattarchajee and Holland (2005) found that if declining ground water in the Odessa Subarea were to cause current producers in the Subarea to cease potato production, but potato processors elsewhere in the Columbia Basin Project were to increase their production to offset the loss, most of the negative regional impacts foreseen in the more extreme scenario would fail to materialize.

Mitigation

Mitigation of negative economic effects under the No Action Alternative would have to be designed to offset the negative effects of individual projects or programs, and implemented subject to appropriate funding. Mitigation of short-run droughts probably would entail actions similar to those that have addressed recent droughts, described above. Mitigation of risks to species and habitats will also resemble recent actions, and entail both voluntary efforts, such as attempts to improve riparian vegetation, as well as regulatory efforts, such as litigation over the enforcement of environmental legislation. Mitigation of long-run droughts or declines in ground water might include emergency assistance, such as subsidized loans to promote the adoption of water-conserving technology by irrigators and municipal-industrial users. Long-run mitigation also might include increased efforts to expand the economic opportunities for residents and businesses in water-short areas. Such efforts might include, for example, improvements in transportation infrastructure to increase the access of businesses and workers in water-short areas to new economic opportunities in nearby areas.

4.2.1.2 Land and Shoreline Use

Short-term impacts

If the Management Program were not implemented, short-term impacts similar to those described in Section 4.1.1.8 would occur, except that the rate of development of projects would be slower.

Long-term impacts

If the Management Program were not implemented, long-term impacts similar to those described in Section 4.1.1.8 would occur, except that the rate of development of both storage and conservation projects would be slower. Municipal water suppliers would continue to experience difficulty obtaining new water rights; therefore, growth and development in some areas could become constrained by available water supplies in the future.

If reliable irrigation water is not made available, pressure may increase to convert some land holdings in agricultural use to residential use. This may result in a low-density development pattern that may not include commercial agriculture. This low-density pattern of development may be allowed under zoning regulations, but still may be inconsistent with goals for containing most new development within urban service areas, and maintaining and enhancing productivity of agricultural lands. This type of development pressure is already occurring in the project area, especially near urban areas, and could be expected to continue if the lack of reliable water makes commercial agriculture too risky.

Mitigation

Mitigation for individual projects would be developed on a project-by-project basis and could be similar to that described earlier for projects under the Management Program.

4.3 Cumulative Impacts

Many of the cumulative impacts of the Management Program components are included in the discussions in previous sections. This section highlights the major cumulative impacts that could occur from implementation of the Management Program.

A major cumulative impact of the Management Program could be the addition of storage projects to a river basin that has already been extensively dammed. Additional storage facilities could exacerbate the impacts of existing facilities. For example, on-channel storage could add additional impediments to fish passage and further increase migration times; new dams could add to existing total dissolved gas (TDG) problems in the Columbia River; water quality could be further degraded by releases from reservoirs. These cumulative impacts could cause species already in decline to experience more severe impacts than if a single project were constructed in a less disturbed environment. Any proposed storage facility will undergo additional environmental analysis under SEPA and/or NEPA. The analysis of impacts would consider the impacts a project would add to existing conditions and would be evaluated against established water quality and stream flow standards, such as the Total Maximum Daily Load (TMDL) and final Biological Opinion flows.

Fish species, including listed threatened and endangered species, could also be affected by decreases in streamflows from additional withdrawals from the rivers and tributaries. The additional diversions could further impair water quality and increase migration times. Any new water rights will undergo review by Ecology and must not impair existing water rights or instream flows. Several components of the Management Program are intended to improve streamflows and Ecology is developing a strategy for streamflow augmentation; however, despite these measures, some negative impacts could occur.

The combined impacts of the projects proposed under Voluntary Regional Agreements (VRAs) have the potential to affect fish and other natural resources in the Columbia River Basin. VRAs will undergo several levels of environmental review. This Programmatic EIS has evaluated the impacts of how Ecology will implement the VRA program. As a result of the EIS analysis, Ecology has decided to develop Implementation Plans that will detail the actions that will be undertaken for each proposed VRA. The Implementation Plans will be subject to SEPA review. The Implementation Plans will be supplemented by Ecology as new information becomes available or as conditions change. The supplemented Implementation Plans will also be subject to SEPA review. Some of the specific projects proposed as part of a VRA will also be subject to SEPA and/or NEPA review. This phased environmental review process is intended to provide Ecology and the public with opportunities to evaluate the cumulative impacts of VRAs.

The Management Program could further impact shrub-steppe habitat and the wildlife associated with it. Shrub-steppe habitat in the Columbia River Basin has declined by over 50 percent from historic levels through agricultural and other development. Increased water supply from storage or conservation projects could encourage farmers to shift to more permanent crops or expand irrigation in areas not currently cultivated. This expansion could occur in shrub-steppe areas causing further decline of the habitat. An increased loss of shrub-steppe habitat could further impact plant and animal species already in decline. In addition, the changed hydrology associated with conservation projects and lining of irrigation canals could reduce habitat or harm wildlife species.

If the Management Program were implemented, several social opportunity costs would accrue to the state, region, and nation. (These impacts are described in Section 4.1.1.7, 4.1.2.7, and 5.1.1.7). Funding spent in the project area would not be invested elsewhere in the state, which could similarly contribute to a trend toward budget shortfalls. If projects receive federal funds, the federal funds would not be available for uses in other parts of the region or nation.

Another regional impact of the project is the potential that benefits downstream would be at the cost of upstream users, thus continuing or exacerbating current impacts related to water scarcity or lack of availability. As discussed in Section 4.1.1.6, increased lake fluctuations to provide streamflows downstream of storage reservoirs may impact resident fish, adding to existing stresses on those populations. Benefits to upstream users could negatively affect downstream users as well. Benefits that accrue to the project area may have negative impacts in other areas. If the new water availability significantly expands the supply of irrigated crops, market prices for all farmers could be reduced. The distribution of costs and benefits of the Management Program are described in Section 4.1.1.7.

As noted in Sections 4.1.1.3 and 4.1.1.4, large storage projects could impact the local surface and ground water hydrology. Large-scale conservation can decrease recharge of ground water. These hydrology impacts can in turn affect water supply and fish and wildlife habitat. Modifications to existing flow regimes could negatively affect long-term fisheries habitat, if flows to already stressed systems are further reduced. These potential impacts will require careful evaluation on a project-specific basis.

Water that is diverted from the Columbia River will reduce the potential hydropower generation at dams downstream of Grand Coulee, which could cause the regional power system to rely on other forms of power. Those other forms of power could produce more air pollutants. Because power production in the Columbia River Basin is highly regulated, any potential impacts to hydropower production will need to be coordinated with the federal agencies and Public Utility Districts charged with producing and distributing the power.

This Programmatic EIS is the first step in a phased review of the Columbia River Water Management Program. Potential impacts of projects that could be developed have been identified. As stated throughout the EIS, additional project level review will be required for many project components. Project-level review will be used to identify specific projects impacts and ways to avoid or mitigate those impacts. To avoid the potential cumulative impacts of the Management Program, Ecology will continue to coordinate with the local, state, and federal agencies and tribes that manage resources in the area.