Technical Report on Socioeconomic Impacts of the State Alternatives

A Component of the Yakima River Basin Storage Feasibility Study
Ecology Publication Number 07-11-044

December 2007
Washington State Department of Ecology

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December 2007

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PROJECT DESCRIPTION

This Technical Report addresses the socioeconomic impacts associated with the State Alternatives proposed for the Yakima River Basin Water Storage Feasibility Study. These alternatives include Enhanced Water Conservation, Market-Based Reallocation of Water Resources, and Groundwater Storage.

Some of the interactions between the three State Alternatives and the economy would be similar to those that would occur with the Joint Alternatives, but others would be different in kind, scope, or both. The State Alternatives would increase the supply of water available for some uses by inducing spatial, temporal, or usage shifts within the existing, overall supply of water, but they would not incur large costs to construct a dam and a reservoir, for example, involve on-going reservoir-related operation and maintenance costs, or generate economic benefits associated with reservoir recreational opportunities.

The three State Alternatives would, among themselves, also have different interactions with the economy. Each focuses on transferring water from a lower-valued use to a higher valued use, but they probably would have different temporal and spatial scales. The Groundwater Storage Alternative would shift the supply of water resources, removing water from lower-valued instream flows when water is abundant in winter months, storing it underground, and withdrawing it to increase the supply of water available for higher-valued uses when water is scarce in summer months. The Enhanced Water Conservation Alternative would lead to a smaller temporal shift in the supply of water, if any, by reducing the amount of water that otherwise would percolate into the ground and reemerge as surface water some days or weeks later. The Market-Based Reallocation of Water Resources Alternative would not temporally alter the overall supply of water during any period but, instead, it would affect where and how the existing supply would be used during a given period. The spatial shift under each alternative could be small or large, depending on the locations of where the water would be used with and without the alternative.

The three State Alternatives also differ in the temporal distribution of their costs and benefits. Both the Groundwater Storage Alternative and the Enhanced Water Conservation Alternative would involve initial investments plus on-going expenses that would affect water supplies and generate economic benefits during subsequent years. The Market-Based Reallocation of Water Resources Alternative would follow a similar pattern only insofar as it would involve initial lump-sum payments—through the purchase or long-term lease of a water right—that would affect the movement and use of water for subsequent years. With annual or split-season leases, however, the costs and benefits would occur at roughly the same time. Each of the alternatives would require operational expenditures.

The State Alternatives also differ among themselves in the distribution of their costs and benefits among different groups. With the Market-Based Reallocation of Water Resources Alternative, those who realize the direct benefits of a water transfer would incur most, perhaps all, of the costs; for a given transfer, the buyer would compensate the seller and, perhaps, also cover the procedural costs water-management institutions would incur to execute and formalize the transaction. Public entities might incur costs associated with these institutions and to purchase or lease water to accomplish public objectives, such as improving habitat for fish and other aquatic species. With the other two alternatives, the general public likely would bear some or all of the costs—to develop groundwater storage capability and increase water conservation—and realize some of the benefits, but some of the benefits also could accrue to private water-right holders who would enjoy a greater water supply.

AFFECTED ENVIRONMENT

The proposed State Alternatives might affect five distinct components of socioeconomic conditions in Washington:

- The value of water-related goods and services;
- The level and composition of jobs and incomes;
- The distribution among different groups of the costs and benefits resulting from management of water resources;
- The socioeconomic structure; and
- Economic uncertainty and risk.

VALUE OF GOODS AND SERVICES

Water and related resources are economically important when, as part of an ecosystem, they produce *goods and services*, such as those illustrated in Table 1, that benefit people, impose costs on them, or both (National Research Council, 2005). The value of a good or service generally is measured in terms of the amount of money people are willing to pay to acquire it, or the amount they require as compensation to relinquish it. Some goods and services have value when people use the Yakima River basin's water and related resources, as when irrigators remove water from the river to irrigate crops, anglers fish in the basin's streams, or developers build homes overlooking a pleasant view of the river and surrounding lands. Some goods and services have value even though people are not aware that they are using the basin's resources, as when riparian wetlands remove undesirable substances from the runoff from irrigated fields. Sometimes people place a value on a good or service even though they do not use the resources or intend to use them. These so-called nonuse values materialize, for example, when people want to maintain for future generations the existence of species threatened with extinction, or to maintain a particular characteristic of a resource that they believe has cultural or ecological significance.

Table 1. Functions, Goods, and Services of Water-Related Ecosystems

Functions	Examples of Goods and Services Produced
Production and regulation of water	Natural and human-built features capture precipitation; filter, retain, and store water; regulate levels and timing of runoff.
Formation & retention of soil	Wetlands and biota accumulate organic matter, and prevent erosion to help maintain productivity of soils.
Regulation of atmosphere & climate	Biota produce oxygen, and help maintain good air quality and a favorable climate.
Regulation of disturbances	Wetlands and reservoirs reduce flood damage by storing flood waters, and reducing and slowing flooding.
Regulation of nutrients and pollution	Wetlands improve water quality by trapping pollutants before they reach streams and aquifers.
Provision of habitat	Streams and reservoirs provide habitat for fish and wildlife.
Food production	Biota convert solar energy into edible plants and animals edible.
Production of raw materials	Streams possess energy convertible to electricity.
Pollination	Insects facilitate pollination of wild plants and agricultural crops.
Biological control	Birds, bats, and microorganisms control pests and diseases.
Production of genetic & medicinal resources	Genetic material in wild plants and animals provide potential basis for drugs and pharmaceuticals.
Production of ornamental resources	Products from plants and animals provide materials for handicraft, jewelry, worship, decoration, and souvenirs
Production of aesthetic resources	Wetlands, riparian vegetation, streams, and reservoirs provide basis for enjoyment of scenery.
Production of recreational resources	Streams, reservoirs, riparian vegetation, fish, and wildlife provide basis for outdoor sports, eco-tourism, etc.
Production of spiritual, historic, and cultural resources	Wetlands, riparian vegetation, streams, and reservoirs serve as basis for spiritual renewal, folklore, group identity, etc.
Production of scientific and educational resources	Wetlands, riparian vegetation, streams, and reservoirs provide inputs for research and focus for on-site education.

The State Alternatives would affect socioeconomic conditions in the basin insofar as they would alter the supply and, therefore, the value of individual goods and services derived from the basin's water resources. They also would affect the basin's economy insofar as they would alter the amount of money spent in the basin: an increase would be a benefit for the basin's economy, a decrease would be a cost. A broader state or national perspective, however, is likely to yield a different accounting of benefits and costs, insofar as benefits (costs) within the basin might be offset by costs (benefits) elsewhere in the state or in other states. An increase in the income from irrigated crops produced in the Yakima basin, for example, might induce offsetting reductions in the income from irrigated crops produced in other areas within Washington or in other states.

Water and related resources in the Yakima River basin produce many goods and services, but there exists no accounting of their overall value. Economists have, however, estimated for the larger Columbia River Basin the overall value of water used for irrigation and the value of marginal (incremental) changes in the supply of water to produce irrigated crops and a few other goods and services. Table 2 shows, by major irrigated crop, farmers' average gross and net (revenues minus production costs) economic returns early this decade (Huppert et al., 2004). Net economic return per acre ranged from negative $25 for hay to positive $464 for potatoes, and net economic return per acre-foot of water diverted for irrigation ranged from negative $91 to positive $147 per acre-foot, depending on crop. For hay, wheat, and "other crops," the production cost exceeded the gross value of the crop and the net return was negative. Farmers continued to grow these crops, however, because from a cash-accounting basis, they were able to overlook some costs, such as the costs of using equipment and property that had already been paid for (Huppert et al., 2004). Analysis of agricultural conditions in the Yakima River basin also has found there is a wide disparity in the productivity of water used to irrigate different crops (Willey and Diamant, 1994). This example illustrates the scope of the disparity: the gross value of water used by tenant farmers during the late 1980s and early 1990s to irrigate hay was about $30 per care-foot, while water used by landowners to irrigate spearmint had a gross value of about $325 per acre-foot (Willey and Diamant, 1994).

Table 2. Farmers' Average Economic Returns for Irrigated Crops in the Columbia River Basin, by Crop

	Hay	Orchards	Vegetables	Other	Potatoes	Wheat
Per acre						
Gross economic return	$877	$5,485	$1,408	$961	$3,122	$344
Net economic return	-$25	$312	$276	-$271	$464	-$99
Per acre-foot of water						
Net economic return	-$5	$82	$89	-$91	$147	-$34

Source: Huppert et al. 2004.

One recent analysis estimated what effect water transfers would have on farmers' net earnings during a drought year in which the supply of water to irrigators with proratable water rights would be 50 percent of their entitlement (Scott et al., 2004). The analysis found that, under market conditions typical of the middle 1990s, if a proratable irrigator growing corn or alfalfa were to fallow the land, the loss would be $250 and $37 per acre-foot of water, respectively. If the water released from this land were used, instead, to irrigate cabernet grapes grown by a proratable irrigator, the increase in output would be worth $403 per acre-foot. Similarly, if a senior irrigator growing corn or alfalfa were to fallow the land and transfer the released water to a proratable irrigator growing cabernet grapes, the losses would be $131 and $26 per acre-foot, respectively, and the gain would be $403 per acre-foot.

These results indicate that shifting water from irrigating lower-valued crops to irrigating higher-valued crops might, under conditions that existed in the mid 1990s, increase the gross value of irrigated crops produced in the Yakima River basin by $150 – $350 per acre-foot of water. Fallowing a field capable of growing a low-value crop, such as hay, and reallocating the water to grow a high-value crop might have increased the total, gross value of irrigated crops by more than $400 per acre. Similar opportunities to increase crop values by shifting water from lower-valued crops to higher-valued crops should persist in the future. The existence of such opportunities will provide a basis for voluntary, mutually beneficial trades that can increase the overall value of the agricultural products derived from the basin's water resources.

Table 3 shows there probably are opportunities to increase the value of water-related goods and services other than crops. The data in the table report recent estimates of the marginal value of several water-related goods and services in the Columbia River Basin. The top portion focuses on irrigation and assumes marginal, or incremental, changes would have the same characteristics as current averages. From a farmer's perspective the value of a marginal change in the supply of irrigation water, which equals the net return on irrigated crops, ranges from negative $91 to positive $147 per acre-foot (Huppert et al., 2004). From a statewide perspective, however, the marginal value of water used for irrigation in the Columbia River Basin is far different; it ranges from negative $60 to negative $70 per acre-foot (Williams and Capps, Jr., 2005). The value is negative because, as individual farmers increased their production, they would drive down the prices and, therefore, earnings for all farmers.

Table 3. Estimates of Marginal Value of Selected Water-Related Variables

Variable	Marginal Value	Source
Water for irrigation, local perspective	($91) – $147/ac-ft	Huppert et al., 2004
Water for irrigation, state perspective	($60) – ($70)/ac-ft	Williams and Capps, Jr., 2005
Water for municipal or industrial use	$65 – $452/ac-ft	Zhang, 2004
Water for hydropower (McNary Dam downstream)	$7.46/ac-ft	Huppert et al., 2004
Water for navigation	$5.60/ac-ft	NRC, 2004)
Water for general recreation	$7.70 – $130/ac-ft	NRC, 2004
Water for waste assimilation	$0.20–$0.28/ac-ft	NRC, 2004
Water for ecosystem functions	$21/ac-ft	Brown, 2004

The middle rows of Table 3 show the estimated, marginal value per acre-foot of water for municipal use, hydropower, navigation, general recreation, waste assimilation, and ecosystem functions. The estimate for municipal use exceeds the others, indicating that, as municipal demand grows, the overall value of water–related goods and services could be increased by shifting water from any other use to this one. The hydropower values represent all the electricity that would be generated from McNary Dam downstream. The estimates for navigation, recreation, and waste assimilation are typical for the region and are not site-specific. The estimate for ecosystem functions represents the marginal value of water protected or acquired for environmental purposes.

The marginal value of water that produces other goods and services could be substantial, but reliable estimates are not available. If an increase in instream flow would increase the population of salmon or steelhead, for example, the benefit has been estimated to be $715 per fish (Huppert et al., 2004) but further research is needed to determine the specific increase in population that would result from increasing the instream flow at a specific place by a specific amount. Similarly, additional research is needed to determine the marginal value of water used for other purposes.

The estimates in Table 3 do not reflect the spillover effects, or environmental externalities, associated with each use. The full value of a use would reflect not just the value of water to the user but also the value of the impacts on others. The full value of agricultural, municipal, and industrial uses, for example, would account for the harm imposed on others from any pollutants these uses introduce to streams, and the full value of hydropower generation would account for the harm imposed on salmon populations.

Spillover effects notwithstanding, the data in Table 3 indicate that there probably are numerous opportunities in the Yakima River basin to increase the overall value of water-related goods and services by shifting water from lower-valued uses, such as irrigation, waste assimilation, and hydropower, to higher-valued uses, such as some recreation, ecosystem functions, and municipal uses. Additional research is needed to flesh out specific opportunities to transfer water from a given lower-value use to a higher-value use.

With some exceptions, the demand for all the water-related goods and services illustrated in Table 1 likely will increase in the future as the population grows and becomes wealthier, and as the economy expands. Some demands are likely to grow faster than others. Demand for urban water services and for water-related amenities, such as water-related recreational opportunities and healthy fish populations, are likely to grow faster, for example, than demand for low-value irrigated crops. The demand for water to irrigate some crops might even diminish, if competing growers elsewhere expand their production enough to reduce crop prices. The likely rate and pattern of change in the different demands for water-related goods and services has yet to be estimated. To some extent the factors that will affect future demands are too complex or too poorly understood to allow reliable estimation.

JOBS AND INCOMES

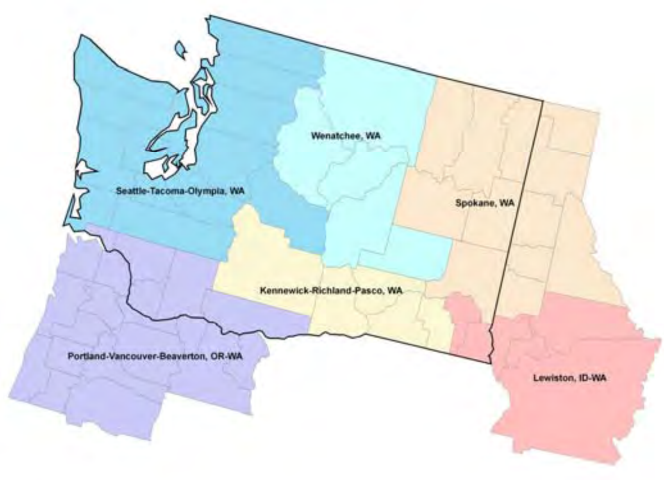
Water and related resources influence jobs and incomes through three mechanisms:

- providing goods and services that are inputs to commercial activities;
- producing goods and services that create a quality of life that influences the location decisions of households and businesses; and
- providing other valuable ecosystem goods and services.

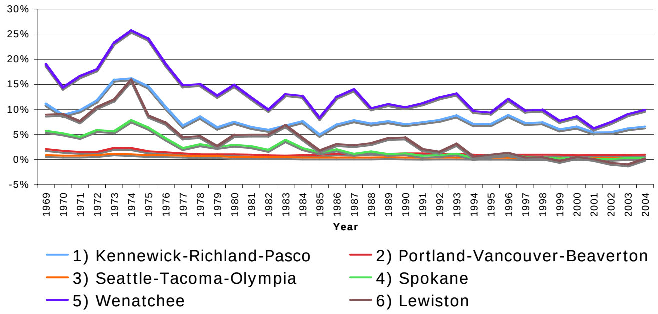
Impacts on jobs and incomes from the State Alternatives would materialize largely in the context of the two, distinct regional markets for labor and local commerce, shown in Figure 1A, which split the Yakima River basin. Impacts in Kittitas County would occur against a background in which the county's workers and consumers in Kittitas County connect more closely to the Seattle-Tacoma-Olympia region than to other parts of the state. Impacts in Yakima and Benton Counties would connect more closely to the Kennewick-Richland-Pasco region. Although municipal, industrial and commercial uses of water are important, agriculture is the largest commercial user of water in the Yakima River basin, but Figures 1B and 1C show that agriculture's share of jobs and personal income has been declining for several decades, especially in the Seattle-Tacoma-Olympia regional labor market, but less so in the Kennewick-Richland-Pasco regional market. Quality-of-life impacts materialize when amenities, such as water-related recreational opportunities, induce households to live nearby, and businesses expand to take advantage of the resulting increases in labor supply and consumer buying. Quality-of-life impacts have become more important in recent decades and now account for about one-half the interstate variation in job growth (Partridge and Rickman, 2003). Some water-related goods and services can influence jobs and incomes even though not direct inputs for commerce or amenities for households. Wetlands and floodplains, for example, can influence the risk of flood damage and, therefore, the cost of living and doing business in downstream communities (Daily, 1997).

Figure 1. Agriculture's Role in Washington's Regional Economies

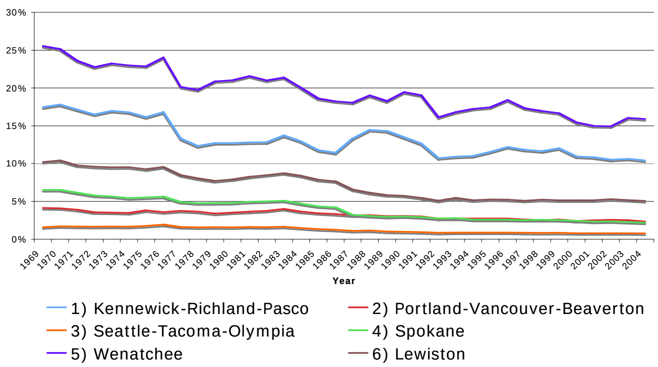
A. Washington's Economic Regions



B. Farm Income as Percent of Total



C. Farm Employment as Percent of Total



Source: Johnson and Kort, 2004; U.S. Department of Commerce, 2006

A recent estimate of the agricultural employment in the Columbia River Basin provides a context for anticipating the potential impacts of changes in water use in the Yakima River basin, indicating that permanently shifting 1,000 acre-feet of water into (or out of) irrigation would increase (or decrease) employment directly linked to the agricultural industry by about 18 jobs, and related, statewide employment by about 45 jobs (Huppert et al., 2004). These estimates tell only part of the story, however. Any increases or decreases in employment that occur if water for irrigation were increased or decreased probably would be accompanied by tradeoffs in jobs associated with the alternative uses of water that would be affected. Transferring water from irrigation to municipal-industrial use, for example, would see a decrease in irrigation-related jobs, but an increase in municipal-industrial jobs. Transferring water from irrigation to instream flow would have similar tradeoffs, insofar as any improvement in the basin's water-related amenities would attract households to the basin, create new recreational opportunities, and, therefore, stimulate economic activity. Similar offsetting impacts could occur if a transfer of water were to enhance the ability of the basin's water-related ecosystem to provide services, such as absorbing and removing impurities from water and mitigating flooding, that would affect the cost of living and working in the basin and, therefore, the level of economic activity. Additional research is needed to determine the full impacts on jobs and incomes associated with changes in water use in the Yakima River basin.

DISTRIBUTION OF COSTS AND BENEFITS

The costs and benefits of water-management decisions are sometimes not distributed equally among different groups. Decisions affecting salmon and steelhead, for example, can have important distributional effects governed by treaties, laws, and regulations (Independent Economic Analysis Board, 2005). Also important is the unequal distribution resulting whenever those who enjoy the benefits of a good or service do not bear the full costs of its production. This outcome can arise from the fixed allocation of water to water-right holders without regard for the impacts on others, subsidies, the emission of pollutants, and other factors. It also encourages the beneficiaries to consume the goods and services beyond economically optimal levels (U.S. Army Corps of Engineers, 1991).

There are pervasive opportunities for one individual, business, or group to enjoy economic benefits derived from the basin's water and related resources with some or all of the costs falling on others. These opportunities arise, in large part, because these resources produce multiple goods and services desired by different groups, but the groups are not able to compete for the water resources through markets or market-like mechanisms (NRC, 2004; Houston et al., 2002). Therefore, recreationists, irrigators, commercial fishers, households, municipalities, electric utilities, barge owners, and industries can use water without having to pay the equivalent of a market price for what they use, or to provide compensation when these activities deprive others from using the water to provide other goods and services. Activities that produce agricultural, hydropower, or other benefits but degrade habitat for salmon and habitat can impose costs on anglers and commercial fishers, in the basin and throughout the region that extends into and borders on the northeastern Pacific Ocean. They also can negatively affect the economic well-being of individuals, living locally or far away, who place a nonuse value on the species (Fluharty, 2000; NRC, 2004). Conversely, persons successful in constraining activities harmful to fish can enjoy the benefits of their success without compensating those whose activities are constrained.

SOCIOECONOMIC STRUCTURE

Many aspects of economic activity and social organization in the basin have long been tied directly to water. Harvest of salmon and steelhead has provided a cultural focus and the basis for much economic activity for the members of tribal groups, commercial fisheries, and recreational fisheries (Fluharty 2000). Irrigation has enabled the expansion of agriculture and hydropower has flowed to homes and business throughout the western states. Water for municipal and industrial uses supports urban development. The federal government plays a dominant role in managing the river, the state oversees management of water rights, and local utilities and irrigation districts manage water within their control.

An important element of the socioeconomic structure is the state's water right system, which gives priority on a first-come basis. For further explanation of this system, see section 5.2.5 of the Yakima River Basin Water Storage Feasibility Study Draft EIS.

Irrigators can incur losses when the amount of water delivered to them falls short of the full amount to which they are entitled under their water rights. Irrigation districts also can incur additional costs to maintain and operate their systems when water supplies are low. Both irrigators and irrigation districts have indicated, however, that their losses and additional costs would be acceptable as long as they receive at least 70 percent of water to which they are entitled (Montgomery Water Group, Inc. 2002).

Federal laws and regulations play a major role in the management of the basin's water. Much of the water management system was developed with federal funding and is operated by Reclamation. Federal guidelines generally limit use of federal funds for water resource projects that would benefit one region at the expense of another, with no net gain in the national economy (U.S. Water Resources Council, 1983). Particularly important, the guidelines indicate there would be no net economic benefit from expenditures that would increase the supply of crops in the Yakima River basin if the increase would induce a decrease in production elsewhere by farmers who operate with similar levels of economic efficiency. This guideline generally applies to all crops other than those such as rice, cotton, corn, soybeans, wheat, milo, barley, oats, hay, and pasture that are grown in large quantities throughout the nation.

Reclamation operates the Yakima Project so that instream flows in various river reaches do not fall below minimum-flow targets. The Instream Flow Technical Advisory Group, however, has recommended that flows be higher than the minimum levels. To meet these recommended levels would require an additional 110,000 acre-feet of water during a severe drought year, such as 1994, 48,000 acre-feet of water during an average year, such as 1998, and 1,200 acre-feet of water during a wet year, such as 1997 (Montgomery Water Group, Inc. 2002).

There is a long history of efforts in the Yakima River basin to develop mechanisms to enable and facilitate the voluntary transfer of water—through donation, conservation, lease, or purchase—from the terms of use allowed under a water right to another place, type, and time of use. Such transfers have been seen as necessary to achieve objectives associated with reducing the economic damage from drought, offsetting the adverse environmental and economic impacts of changes in streamflows, increasing the economic benefits and jobs derived from the basin's water resources, and providing water for new demands.

Many transfers have occurred within the basin's irrigation districts. Each non-federal district may approve temporary or permanent transfers within its boundaries that alter the place of use. A non-federal district may, itself, own or lease water rights, with the water to be used within its boundaries, and each district has authority to sell or lease water rights to municipal and quasi-municipal entities, to the state of Washington and state entities, and to agencies, public and private corporations and individuals located within and outside the district's boundaries.

Water users in the basin perceive that Reclamation has, in essence, operated a water bank in the basin since 1905, in conjunction with its ownership and operation of the majority of the infrastructure for collecting, storing, moving, and accounting for water in the basin (Roundtable Associates, 2003.). If space is available in its reservoirs and other requirements satisfied, Reclamation may allow someone with a contractual right to obtain federal water at a specific time to leave the water in the reservoirs and forgo delivery until a later date, through a process known as "bucketing." In 2001, for example, Reclamation agreed to a request from Roza Irrigation District to defer the release of water because the district had leased water from water right holders on tributaries between the reservoirs and the district. The agreement allowed the district to use the leased water first and then the "bucketed" water from the reservoirs.

Reclamation also has limited authority to support the efforts of others to initiate and expand market-related transactions that would increase water conservation, increase instream flows beneficial to salmon and other species, and augment the supply of water for out-of-stream uses. In doing so, however, it defers to existing water uses and requires that its activities must not impair federal contracts, the United State's treaty trust obligation to the Yakama Nation, or the operation of the Yakima Project itself.

Transactions can have diverse characteristics. In 1971, for example, Reclamation made water available to facilitate the exchange of water rights between the Kittitas Reclamation District and the City of Ellensburg. In 2001, Trendwest and Pat and Mary Burke transferred water rights to the state's Trust Water Program so that the City of Roslyn could use water above the limits of its water rights during drought conditions. In 2002, Trendwest completed the purchase of water rights on tributaries and transferred them to the water trust program to offset the effects of increased consumption of water associated with the MountainStar Resort and related development. In 2005, during drought conditions, Ecology leased water rights covering the diversion of 4,764.6 acre-feet of water and 1,626.2 acre-feet of consumptive use (Ecology, 2006).

It also is possible for a private or public entity to purchase land to gain control over the appurtenant water right, and then redirect the water to another type of use. Much of this activity in the basin over the past decade has occurred under Title XII of Public Law 103-434, enacted October 31, 1994, which authorizes Reclamation to lease or purchase land, water, or water rights to secure water to be used for instream flows for the benefit of anadromous fish. Under this authority, Reclamation has acted on its own and in cooperation with Ecology, the Washington Department of Fish and Wildlife (WDFW), Washington Water Trust, and Steve Johnson, to purchase land and water rights for habitat and instream flows. Combined, these entities since 1999 have spent almost $20 million to purchase 2,215.54 acres and 267,180.8 acre-feet of water rights (Isley, 2007). Since 2003, Washington Water Trust has leased or received donation of water rights for instream flows in some of the basin's tributaries, and it subsequently developed additional leases and purchases in the basin. In 2005, it completed short-term leases (less than 10 years) that totaled less than 0.5 cubic feet per second (cfs), and long-term leases (10 years or longer) that totaled 30 cfs (Washington Water Trust, no date).

Much of the interest in water transfers has occurred during drought years, when the water supply is insufficient to cover all the pro-ratable water rights. At the beginning of a year, when irrigators see that water supplies are likely to fall short, there are several options for transferring water from low-value to high-value crops. Farmers that would use water to irrigate annual crops, such as corn or hay, for example, can leave their lands fallow and transfer the water to irrigate perennial crops, such as apples or grapes. With such transfers, farmers who fallow fields lose one year's yield of the annual crops, but those who receive additional water reduce the risk that drought will kill trees or vines and cause them to lose multiple years' yield.

Barriers to Water Transfers

Several factors constitute barriers to growth in number and extent of water transfers in the basin. Transfers have not occurred in enough volume or for a long enough time for there to be widespread awareness, among both potential sellers and potential buyers, of the mechanics and economic opportunities associated with transfers. This lack of awareness is made more acute because no permanent set of institutions exists to facilitate transfers and, thereby, build familiarity and trust. Instead, ad hoc efforts to promote transfers have had intermittent and limited success. For example, in 2005, a drought year, Ecology implemented a market-like mechanism, inviting water-right holders to indicate their willingness to accept payment to lease their water right to Ecology. The agency received and completed transactions on 27 offers, totaling 4,764.6 acre-feet (1,626 acre-feet of consumptive water rights) (Ecology, 2006). A similar invitation in 2007 elicited no valid responses, and a preliminary, follow-up investigation found water-right holders cited these reasons for not responding:

- They have little trust in Ecology,
- They were not expecting and/or did not understand the 2007 invitation,
- They did not see an imperative to consider transfers in a nondrought year,
- They disagree with Ecology's efforts to increase instream flows, or
- The value they place on continuing to exercise their water rights to irrigate their lands exceeds the amount they perceived they would have received from leasing them to Ecology.

Additional barriers stem from the nature of water rights, which requires each water-right holder not to diminish the rights of others. As a consequence, a proposal to lease, purchase, or donate a water right triggers a complicated process that allows all interested parties to review the proposal, gives anyone that feels it would cause harm to present evidence, and calls for a court to review all evidence before making a ruling. To reduce the time required to complete this process, Ecology, Reclamation, and the Yakima River Basin Water Enhancement Project Conservation Advisory Group created the Yakima River Basin Water Transfer Program to respond to the 2001 drought. The program lead Ecology, Reclamation, the Yakama Nation, WDFW, U.S. Fish and Wildlife Service, and NOAA Fisheries to establish the Water Transfer Working Group (WTWG), which facilitates voluntary, expedited review of proposed transfers by these agencies, irrigation districts, and others. This group facilitated the temporary transfer of more than 60,000 acre-feet of water during the drought of 2001 and, almost 50,000 acre-feet of water during the drought of 2005. It also has assisted proposals for temporary and permanent transfer of water in non-drought years. The group can recommend court approval of proposals that satisfy six criteria:

- The proposed transfer would have a neutral effect on the total water supply available in the basin;
- The proposed transfer would not increase consumptive use;
- The water would have been used, but for the transfer;
- The transfer would incorporate a specific delivery schedule;
- The transfer would not adversely affect instream flow; and

- The transfer would satisfy operational considerations for the Yakima Project.

Neither the WTWG nor any other entity has undertaken the task of expediting future transfers even further, which might occur by reviewing potential transfers in advance of specific proposals. Such an effort would evaluate an entire class of potential transfers from one specific area to another and from one specific use to another, for example.

The physical facilities and operational requirements of the water management system also produce some barriers to water transfers. Transfers that would shift water from out-of-stream use to instream flow, or shift the diversion of water from one location to another must be accommodated by the operational constraints of the Yakima Project and, perhaps, by one or more irrigation districts. Reclamation has obligations to manage reservoirs according to established protocols and Federal reclamation laws and to ensure that instream flows meet established targets. Irrigation districts typically seek to keep water levels high in their systems during the irrigation season to avoid damage that can occur when canals dry out and to maintain sufficient pressure to move water efficiently. Some districts have policies that can restrict the transfer of water outside its boundaries or from irrigation to other uses. The system has only a limited capacity to accommodate transfers that would send water to a point of diversion upstream, as would occur, for example, if water were transferred from the Sunnyside Valley Irrigation District to the Roza Irrigation District. Because of these constraints, most transfers to provide water for an out-of-stream use occur within an irrigation district or send water downstream. Such transfers typically provide instream flow benefits to fish and wildlife as they move water to the new, downstream point of diversion.

Similar factors can impede conservation. Many water-right holders are concerned that, under current water laws, even the investigation of conservation opportunities may undermine their rights. The concern arises from the requirement to use water beneficially or relinquish the right to the water and some fear that, if they acknowledge there exists an opportunity to conserve water use, this may be seen as an indication that they are not putting the water to beneficial use, and trigger actions that would lead to relinquishment. Other limitations can arise from financial concerns. A farmer, irrigation district, or municipal/industrial water user might lack sufficient financial resources and/or would incur unacceptable financial risk to implement conservation measures (NRC, 2004; Schaible, 2000).

Uncertainty and Risk

Risk is the probability that a decision will generate an outcome less desirable than intended; sometimes it can be quantified, but often it remains lost in uncertainty. Uncertainty and risk are economically undesirable, and, all else equal, decisions that reduce them are preferred over those that do not.

Major concerns about risk and uncertainty have been expressed regarding habitat for salmon and steelhead, especially during critical times and conditions, and for irrigators, especially during times of drought for those who have invested in orchards and other perennial crops (Huppert et al., 2004; National Research Council, 2004). Withdrawals of surface water increase the risk to salmon and steelhead, but the levels of risk are understood only in broad, qualitative terms and, therefore, water management decisions in the Yakima basin necessarily must be made in the face of uncertainties. To avoid risks to salmon and steelhead that are unacceptable within the current regulatory climate, if additional withdrawals are allowed, they should be terminated during periods during periods when habitat conditions are critical for fish conservation (National Research Council, 2004).

Farmers and others often take steps to reduce or compensate for the risk of water shortage. Some farmers apply more water than crops require to reduce the risk crops will become stressed between irrigations, for example (Willis and Whittlesey, 1998). The greatest risk and uncertainty occurs during period of drought, and farmers and water management agencies have demonstrated an extensive ability to adapt to drought. Farmers leave land fallow, shift water from low- to high-value crops, and obtain water from emergency sources, such as wells that have been authorized by Ecology for use during a drought. Ecology and other agencies can lower minimum streamflow requirements, allow emergency wells, and lease water from irrigators to increase streamflows. Markets also can adjust to compensate for the reduction in water supply: a decline in the production of an irrigated crop, for example, can lead to an increase in the price farmers receive for what they do produce, so that the percentage drop in revenues is less than the percentage drop in production.

Additional uncertainty and risk accompany anticipated changes in climate, which some research indicates may raise air temperatures and diminish runoff in spring and summer in the Yakima River basin, reducing the availability of water to meet the demands for irrigation, instream flows, and other uses (Mastin and Sharp, 2006). Such findings indicate there may be increased risks associated with droughts, and particularly the risks associated with high-value water uses, such as instream flows to provide habitat for at-risk fish and other aquatic species, and irrigation to sustain perennial crops. As these risks rise, so too will the potential gains from transferring water from lower-value uses to higher-value uses in an expeditious manner, via conservation, groundwater storage, and/or market-based reallocation of water.

ENVIRONMENTAL CONSEQUENCES

All three of the State Alternatives have the potential to increase the value of the goods and services society derives from the Yakima River basin's water and related resources. Each alternative would likely have a positive impact on the jobs and incomes of those directly associated with it, but the impacts on the overall economy are likely to be mixed: in general shifting water from lower-value to higher-value uses would boost the economy, but some sectors and individuals associated with goods and services whose supply would decline might be adversely affected. Each of the alternatives could affect the distribution of costs and benefits associated with the basin's water resources and alter the relationship between the resources and the economy, with the actual effects determined by how the alternative would be implemented. Each of the alternatives likely would reduce uncertainty and risk associated with the basin's water resources by improving the supply of water available to produce higher-value goods and services.

ENHANCED WATER CONSERVATION ALTERNATIVE

A general assessment of conservation opportunities in this region indicates that irrigation-related conservation projects and programs, if chosen and implemented wisely, probably would yield substantial net economic benefits (Schaible, 2000). Similarly, research elsewhere indicates that conservation projects and programs in the municipal-industrial sector have the potential to satisfy considerable future growth in that sector's demand with net economic benefits (Gleick et al., 2003; National Research Council, 2004). The Enhanced Water Conservation Alternative would aim to increase the likelihood that conservation would yield net economic gains sooner rather than later by lowering legal, financial, and/or institutional barriers that otherwise would impede the extent and speed of conservation efforts in the basin.

The scope and design of specific demand management programs and investments in infrastructure would determine their costs, benefits, and net benefits (or net costs); their impacts on jobs and income; the distribution of costs and benefits; their interaction with the economy; and the levels of risk and uncertainty they generate for affected parties.

Construction Impacts

The construction costs of enhanced water conservation projects are estimated to be approximately $405 million, in 2007 dollars. The scope and design of specific projects would determine their costs, benefits, and net benefits (or net costs); their impacts on jobs and income; the distribution of costs and benefits; their interaction with the economy; and the levels of risk and uncertainty they would generate for affected parties. The expenditure of funds on conservation projects would generate some jobs and incomes, but these would be offset, locally, statewide, or nationally, to the extent that the funds would not be spent on other things in the basin, State, or Nation. Short-term impacts also may arise from the 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. To yield substantial, future expansion in conservation activity, the actions taken under this alternative would have to overcome the legal, financial, and other hurdles that have impeded the adoption of conservation measures in the past. This might occur by using public funds to diminish the financial risk a water right holder would face by undertaking a conservation investment, or by reducing the likelihood that, by accepting public funds for a conservation project, a farmer would have to relinquish control over some of the saved water to be used as instream flow.

Long-term Impacts

A general assessment of conservation indicates that irrigation-related conservation projects and programs in the region, if implemented wisely, probably would yield substantial net economic benefits (Schaible, 2000). Research elsewhere shows similar benefits from potential urban conservation projects and programs (Gleick et al., 2003; National Research Council, 2004). The Enhanced Water Conservation Alternative is intended to yield net economic gains sooner rather than later, by lowering legal, financial, and/or institutional barriers that otherwise would impede the extent and speed of conservation efforts in the basin.

The scope and design of specific demand management programs and investments in infrastructure would determine their costs, benefits, and net benefits (or net costs); their impacts on jobs and income; the distribution of costs and benefits; their interaction with the economy; and the levels of risk and uncertainty they would generate for affected parties. Substantial expansion in conservation activity probably would require overcoming the legal, financial, and other hurdles that have impeded conservation in the past. This might occur by using public funds to diminish the financial risk a water right holder would face by undertaking a conservation investment, or by reducing the likelihood that, by accepting public funds for a conservation project, a farmer would have to relinquish control over some of the saved water to be used as instream flow.

With enhanced water conservation, an existing set of goods and services would be produced with less water and the conserved water would be used to produce a new set of goods and services. The value of the new set will depend on the circumstances of each specific conservation project or program. The value of marginal (incremental) changes in the supply of water to produce different goods and services is discussed above, in association with Tables 2 and 3.

Enhanced conservation projects and programs would have distributional effects if their benefits would accrue to one group while their costs would be borne by another. General taxpayers might incur some or all of the costs of a project, for example, but the benefits would accrue to the farmer(s) who would realize an increase in the supply of water for irrigation and to anglers and others who would enjoy the benefits of increased streamflows and improved habitat for salmon. Enhanced conservation projects and programs probably would not alter the general structure of the economic activity and social organization linked to the basin’s water resources. They might reduce uncertainty and risk associated with the movement of water resources through the basin by reducing the amount of water that would percolate into the ground and later appear somewhere else and, instead, increase the likelihood that the water would be more directly controlled by water managers.

MARKET-BASED REALLOCATION OF WATER RESOURCES ALTERNATIVE

Construction Impacts

The only construction activities involved with this alternative would be the construction of new irrigation facilities where water rights are transferred from irrigating one place to irrigating another. The impacts for new construction would be similar to the Enhanced Water Conservation Alternative, but on a smaller scale.

Long-term Impacts

Market-based transfers of water likely would increase the economic well-being of those who participate in them because a transaction would occur only if both the buyer and the seller expected it would increase their respective welfare. Transactions would also probably increase the value of goods and services directly derived from water resources, because those derived by the buyer would have greater value than those that otherwise would be derived by the seller. The regional economic effects of water transfers probably would be discernible only if the transactions altered a large enough portion of a given activity occurring at a specific place and time in the basin to alter the overall structure of related activities. For example, transfers that markedly improved fish habitat, stream-related recreational opportunities, and other amenities might trigger noticeable adjustments in economic activity and housing patterns by influencing the location decisions of households that place a high value on the amenities

Under current laws and regulations, a proposed water transfer would receive approval from the State and Reclamation only where it would have no detrimental effect on other existing water rights or on the operation of the Yakima Project. This requirement defines the general characteristics of approvable transfers for the foreseeable future. In most instances, water that would be transferred would come from someone who has the right to divert a quantity of water from a stream at a given place and given time and to consume a portion, with an obligation to return the remainder back to the stream. Under an agreement transferring the water to another party, the user no longer would divert the water at that time and place. The portion of the water that otherwise would have been return flow would, instead, continue downstream only as far as the next diversion point for another water right. The portion that otherwise would have been consumed would flow downstream to the mouth of the river (and to the mouth of the Columbia River), if it is being converted to instream flow, or to the new diversion point, if it is being converted to an out-of-stream use.

There is insufficient information available at this time to quantify the amount, location, timing, and changes in water use that will be seen in the basin. The available information does, however, provide some useful insights. Some of this information is specific to the basin; some is derived more generally from the experience of water transfers in western states.

The potential size of irrigator-to-irrigator trades in the basin is illustrated by an analysis of the cropping patterns and economic conditions of the mid-1990s (Scott et al., 2004). The analysis found that, during drought years, farmers in the basin seek to transfer water from lower-value crops (mint, asparagus, sweet corn, other vegetables, alfalfa hay, other hay, wheat, other grain, pasture, and miscellaneous) to higher-value crops (apples, other tree crops, grapes, hops, and timothy hay). Table 4 shows the amount of water typically used in each of the basin's major irrigation districts to irrigate each category of crop. With the exception of Roza and Tieton Irrigation Districts, the amount used to irrigate low-value crops exceeds the amount used to irrigate high-value crops.

Table 4. Typical On-Farm Demand for Water to Irrigate High- and Low-Value Crops, by Irrigation District (acre-feet per year, April-September)

Crop	Roza	Kittitas	Sunnyside	Tieton	Wapato	Kennewick	Total
High Value[a]	190,680	73,785	148,670	97,620	112.400	8,320	560,415
Low Value[b]	91,495	147,765	252,766	17,573	293,420	23,445	897,518
Total	282,175	221,550	401,436	115,193	405,820	31,765	1,457,939

Source: Scott et al., 2004.
[a] Apples, other tree crops, grapes, hops, and timothy hay.
[b] Mint, asparagus, sweet corn, other vegetables, alfalfa hay, other hay, wheat, other grain, pasture, and miscellaneous.

The analysis found that, during a drought year in which water deliveries to proratable irrigators would be half of the entitlements, proratable irrigators growing high-value crops might seek as much as 205,000 acre-feet of water to fill the gap. To obtain the water, they might pay $200 per acre-foot, on average, or $40 million total, to obtain water from farmers that otherwise would irrigate low-value crops. The increase in the value of their crops would be offset by the loss of output on lands left fallow by sellers of water, and the net increase in crop value would be about $20 million. This net increase would be about 1.5 percent of the total value of all farm products in the basin, and about 6.6 percent of farmers' total net farm income in the basin. Insofar as farmers with proratable water rights grow about two-thirds of the higher-valued crops in the basin, it appears likely that they would realize most of the direct benefits of the transfers (Scott et al., 2004).

An earlier analysis examined the general parameters of potential transactions that would transfer water from irrigation to instream flow (Willey and Diamant, 1994). The authors reasoned that irrigators would be willing to lease water for instream flow if the amount they would receive from the lease were to exceed the amount they would earn if, instead, they used the water to irrigate crops. The authors considered two general situations in which water might be leased from farmers. The first involved farmers who own the land they farm and they assumed that a farmer would have to receive compensation covering the sum of the rental value of their irrigated acreage, the fixed cost they would incur regardless of whether or not they irrigate the land, their forgone net profit from the irrigated crops, and their water-related cost. The second involved land being rented to farmers and they assumed the owners would require compensation greater than the amount they otherwise would receive if they rented the land to a farmer, plus the owner's water-related cost. The data showed that water could be leased most cheaply from lands that grow pasture, silage, or hay. Based on crop patterns, irrigation patterns, prices, and other conditions of the late 1980s and early 1990s, Willey and Diamant concluded that almost 100,000 acre-feet of water could be leased from such lands for about $30 per acre-foot and an additional 150,000 acre-feet could be leased for about $50 – $60 per acre-foot.

Table 5 shows the Willey and Diamant calculations of the potential cost (in the dollars of the early 1990s) to secure enough water from low-value irrigation to increase instream flows in the basin, for aggregate increases of 600, 900, 1,200 and 1,500 cubic feet per second (cfs). Most of the water could be obtained for $30.60 per acre-foot; the last increment would cost $52.29 per acre-foot. The annual payment would be about $500,000 for 600 cfs of water, up to more than $2 million for 1,500 cfs. The two columns at the right of the table show the present value of the annual payments over a 10-year and 30-year period. In each instance, the present value is the single amount that has a value equivalent to the stream of annual values. To compute the present values, the authors discounted future amounts using a nominal interest rate of 8 percent per year to account for the fact that, all else equal, payments in the future have less value than the same payments today. The numbers indicate, for example, that it would be possible to obtain 600 cfs of water per year for about $3.4 million under a 10-year lease, and for about $5.7 million under a 30-year lease.

Table 5. The Financial Cost, Estimated in 1994, of Acquiring Water through a Water Market for Instream Flows in the Yakima Basin

Instream Flow Increase (cfs)	Quantity of Water[a] (acre-feet)	Water Price[b]	Annual Payment[c]	10 Year Present Value[d]	30 Year Present Value[d]
600	**49,896**	**$30.60**	**$503,850**	**$3,380,873**	**$5,672,232**
900	**74,844**	**$30.60**	**$755,755**	**$5,071,310**	**$8,508,348**
1,200	**99,792**	**$30.60**	**$1,007,700**	**$6,761,746**	**$11,344,464**
1,500	**124,740**	**$52.29**	**$2,152,476**	**$14,443,289**	**$24,232,109**

Source: Willey and Diamant (1994)

[a] Based on flow increases for a six-week period.

[b] Price per acre-foot, in the dollars of the early 1990s.

[c] Annual payment based on lease occurring every 1 on 3 years (e.g., 49,896 X $30 X 0.33 = $494,000).

[d] Based on 8 percent nominal interest rate.

These analytical findings give a rough, preliminary indication of the amount of water that might be available in the basin for instream flows, and the potential costs to give the farmers supplying the water higher net earnings than they would receive from using the water to irrigate low-value crops. This analysis does not take into account operational factors that might interfere with the potential transfers or changes in market conditions over the past 15 years or so. Thus, to detail the potential for market-related transfers to increase instream flows, further investigation is needed to discern the current and anticipated future amounts of the water used to irrigate low-value crops, the location of this water, the potential compensation required to induce farmers to transfer the water to instream flow, and the operational feasibility of each potential transfer.

The preceding discussion reports the results of analyses that have estimated farmers' net earnings from irrigating crops and assumed that, if they were offered a higher amount, they would be willing to voluntarily transfer the water to another. Too few transactions have occurred in the Yakima River basin to provide a reliable basis for determining if these estimates reliably reflect actual practice to date or what the prices of transactions might be in the future. Table 6, however, illustrates the prices that might materialize in the Yakima River basin by providing a rough overview of the prices of transactions that have taken place throughout the Western States between 1987 and 2005. The data come from a source that reports many, but not all water transactions in the West. All prices are reported as the amount per acre-foot of water per year. The mean price urban consumers paid to lease water from farmers on annual basis is $114 per acre-foot. When they purchased water, they paid an amount that is equivalent to $4,366 per acre-foot per year into perpetuity. The transactions reported in Table 6 come from both drought and non-drought years; transactions in drought years are expected to have higher prices and those in non-drought years to have lower prices. Most of the transactions have occurred in other states, primarily California and Colorado.

Table 6. Representative Water Transfer Prices (per acre-foot per year) in Western States, 1987-2005, by Sector

	Agriculture-to-Urban		Agriculture-to-Agriculture	
	Leases	**Sales**	**Leases**	**Sales**
Mean Price	$114	$4,366	$29	$1,747
Median Price	$40	$2,643	$10	$1,235
Number of Observations	189	1,013	178	169

Source: Brewer et al., 2007.

The data in Table 6 show several patterns. Buyers pay more to purchase than to lease water, presumably because a purchase provides greater assurance that water will be available in the future. Urban buyers have paid more than farmers for water.

The data underlying Table 6 also provide additional, rough indications of the patterns of transfers that might evolve in the Yakima River Basin (Brewer et al., 2007). The data show that prices in Washington generally have been lower than those in other states, although the number of transactions is small and, therefore, unable to support solid comparisons. Across the West, the number of transactions, especially the number of leases, is growing. Furthermore, across the western states between 1987 and 2005, agriculture was the source of water for more than three-quarters of all the transactions and 60 percent of all the water transferred, when measured in terms of annual flow. Agriculture-to-urban transfers accounted for more than half of the reported transactions, but only 19 percent of the total amount of water transferred. Intra-agriculture transfers made up 15 percent of the transfers and 23 percent of the annual amount of water that was traded. Transfers from agriculture for environmental purposes accounted for only 7 percent of the transactions, but 19 percent of the annual amount of water traded.

Trends in the Yakima basin and elsewhere indicate it is reasonable to expect the number of transactions in the basin will increase over the foreseeable future. The rate of increase, by type and location, will be influenced by numerous factors that will shape the future demand for and supply of water. These include, but are not limited to, the incidence and severity of drought, the reliability of drought forecasts, population and economic growth in the basin and among outside groups with an interest in the basin's water resources, and trends in the population of salmon and other species dependent on instream flows. The evolution in transactions also will be influenced by social and institutional factors that effect parties' willingness to participate in transactions. Currently, there is widespread belief that this willingness is impeded by barriers, such as lack of familiarity about how the transaction process operates and about the potential gains and risks associated with transactions, low levels of trust in Ecology and other governmental agencies, the absence of an institutional structure that promotes transactions on a continual and reliable basis, and the existence of a transfer-approval process that can be lengthy and expensive.

Growth in the number of transactions will occur only as more parties see that participating in them is likely to yield sufficient economic gain that it warrants the time and effort required to make them work. This outcome can occur through three fundamental pathways that increase the benefits to be gained from a transaction, lower the costs, and/or make more people aware of and give them more confidence in reliable institutions that promote transfers. The benefits will increase as potential buyers become willing to pay more to lease or purchase water rights. An increase in the value of higher-value crops relative to the value of lower-value crops, for example, would, all else equal, raise the willingness of those that produce the former to buy water from those that produce the latter. A major increase in development, such as a new industrial plant, subdivision, or resort, would introduce to the basin new demands willing to pay far more for water than many farmers can from irrigating crops. A decline in the populations of salmon and steelhead might increase the amounts resource managers would be willing to pay to improve instream flows.

The extent to which the number of transfers and the amount of water transferred rise beyond current levels would be determined largely by the success of efforts to overcome the legal, economic, and socio-cultural barriers to transfers (Roundtable Associates, no date). The direct socioeconomic consequences of lowering the barriers would be largely determined by the specific characteristics of the approaches taken to do so and the timing and extent of their implementation. Either public or private efforts to lower the barriers by providing pre-application technical review of proposed transfers, registry and monitoring of executed transfers, and/or other services probably would accelerate market activity. Funding by public or non-profit entities might provide extra inducement stimulus for transactions insofar as they would underwrite the costs of transactions and, in essence, subsidize the participants in transactions. Significant increase in transfers probably could not occur unless Ecology received additional funding to process them and/or processing responsibility were shifted to another entity (Roundtable Associates, 2007). In general, some additional public funding probably would be required to facilitate additional transfers, insofar as more transactions would require more effort by Ecology, Reclamation, and the court to execute their responsibilities to see that the transfers comply with existing laws and regulations.

It may be possible to build on the successes of the WTWG and construct a more comprehensive set of institutions that facilitate reliable, efficient water transfers. With increased funding from Federal, State, or private sources, for example, Ecology and/or another entity could expand from occasional, limited efforts to acquire water for instream flows and establish and publicize a multi-year program that can give potential sellers time to become familiar with and develop trust in the program’s operations. Similarly, a more robust program than exists today might emerge to facilitate transactions involving any and all potential buyers, not just those seeking to increase instream flows. Further research is required to determine in greater detail how the different approaches to lowering barriers would affect costs and benefits, jobs and incomes, the distribution of impacts, the socioeconomic structure, and uncertainty and risk.

The value of transactions during future drought years could total $45 million, assuming transactions would affect the flow of 225,000 acre-feet of water and the average value of each transaction would be $200 per acre-foot. The overall value of water transactions over the next 20-50 years could total up to $173 million. This estimate assumes transactions aimed at increasing instream flows would total 1,000 to 14,000 acre-feet of water per year, transactions for irrigation would total 10,000 to 20,000 acre-feet per year, and transactions to increase municipal water supplies would total up to 40,000 acre-feet per year, at prices ranging from $250 to $4,400 per acre-foot. Further research is required to determine in greater detail how the different approaches to lowering barriers would affect costs and benefits, jobs and incomes, the distribution of impacts, the socioeconomic structure, and uncertainty and risk.

GROUNDWATER STORAGE ALTERNATIVE

Construction Impacts

With the surface recharge approach, construction costs over 10-20 years would total $54 million to $164 million. With direct injection, the total construction costs would be $60 million over the same period.

Long-term Impacts

The costs and benefits of storing water underground would be determined by several factors. The overall costs would be determined largely by the individual costs of acquiring and protecting the injection site, constructing the recharge, retrieval, and treatment facilities, and operating the facilities. The costs of electricity and labor are likely to be major components of the operating costs. Also important will be the opportunity costs of the water, land, and other resources that would be used by this alternative, e.g., the value of the water-related goods and services that otherwise would be produced but would be lost when water is injected underground.

The benefits would be determined by the willingness of users to pay for the goods and services that would be derived from the water. The water might provide services similar to insurance when it lies underground, insofar as it would be available to satisfy unmet demands. In addition, it might actually flow to the surface and/or be retrieved and produce goods and services, such as aquatic habitat, irrigation, or water for municipal-industrial uses. See Section 5.14.1 of the Yakima River Basin Water Storage Feasibility Study Draft EIS for a discussion of the potential willingness to pay for the marginal value of, additional supplies of water. All else equal, the greater the uncertainty regarding the ability of surface water flows to meet future demands, the greater would be the benefits of storing water underground so it would be available to meet unmet demands. It might produce other goods and services on its own, by migrating close to the surface, or close enough to the surface, to provide goods and services associated with wetlands, increased instream flows, etc. Stored water that migrated to a stream might provide water quality benefits, by cooling streamflows, for example. All else equal, the greater the uncertainty regarding the availability of water to be stored and, once stored, its availability to be retrieved, the greater would be the costs and the smaller would be the benefits.

Further research is required to describe cost options and their respective impacts on economic benefits, jobs and incomes, the distribution of impacts, socioeconomic structure, and uncertainty and risk.

SUMMARY OF COSTS FOR THE STATE ALTERNATIVES

Table 5.22 of the DEIS summarizes the estimated costs associated with the State Alternatives and the potential flows that could result from each alternative.

Table 7. Cost Comparison of State Alternatives

Alternatives		Construction Cost	Construction Duration	Cost per Acre/Foot for instream flow
No Action				
Enhanced Water Conservation		$405 million	10 years	$10,125[a]
Market-Based Reallocation of Water Resources[b]	Drought Years Lease[c]	$45 million	1 Year	N/A
	Nondrought Years Purchase[c]	Up to $173 million	20–50 years	$250–$4,400[d]
Groundwater Storage Alternative	Surface Recharge	$54 – 164 million	10-20 years	$1,190 – 3,636/af
	Direct Injection [e]	$65 million [e]	10-20 years	$5,078

POTENTIAL IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Implementing any of the State Alternatives would result in water being shifted from the production of lower-value goods and services to the production of higher-value goods and services. The production of lower-valued goods and services, such as hay, would decline. If the impact on the supply of a good or service is large enough, the prices consumers pay for these goods and services in the relevant markets would rise. Conversely, the supply of the higher-valued goods and services would increase and, if the effect is large enough, the prices consumers pay for them would fall.

The shift in the production of water-related goods and services might alter the pattern of related economic activity. A shift in the production of irrigated crops from one area to another, and from one crop to another, for example, might alter the pattern of farm-related traffic, and the pattern of food processing activities. Such shifts could economically strand plant, equipment, and infrastructure associated with the lower-valued crops. Conversely, they might cause excess wear and tear on the plant, equipment, and infrastructure associated with the higher-value crops. Similar effects might occur with the transfer of water to produce goods and services other than irrigated crops.

The fields that otherwise would produce the lower-value goods and services would be left fallow or converted to other uses. When a landowner sells the water rights appurtenant to a parcel, the market value of that parcel might rise or fall, depending on the new use of the land. Such a rise or fall might have a parallel impact on the property taxes local governments receive from the land.

Public and/or private funds used to implement one of the State Alternatives would not be available for other uses. Similarly, labor, land, and other resources would not be available for other uses. The Yakima River basin's economy is dynamically robust, however, and probably would adjust quickly, seeking to minimize the alternative's negative effects and maximize its positive impacts. The Enhanced Water Conservation and the Market-Based Reallocation of Water Resources Alternatives probably would not yield negative impacts requiring mitigation for those participating in them because participation would be voluntary. Negative impacts on third parties might require mitigation, however. For example, if the transfer of water from a farm were to cause workers on the farm to lose employment, the workers might require financial or other assistance, beyond what is available through existing assistance programs and institutions.

POTENTIAL MITIGATION MEASURES

The type of mitigation, if any, that would be appropriate for each of the alternatives would be determined by future socioeconomic conditions and by the specific steps that would be taken to implement the alternative. Mitigation typically would be warranted only insofar as an alternative would reduce the supply of one set of goods and services (to increase the supply of another) and the reduction harmed one or more individuals, businesses, landowners, or other interest group. Mitigation might involve compensation, by providing unemployment benefits if the fallowing of land were to cause farm workers to lose their jobs, for example. Or, it might involve the provision of substitutes for the reduced goods and services. If construction associated with groundwater storage were to impinge on existing habitat or infrastructure roads, for example, replacements might be built

REFERENCES

Brewer, J., R. Glennon, A. Ker, and G.D. Libecap. 2007. Water Markets in the West: Prices, Trading, and Contractual Forms. National Bureau of Economic Research Working Paper No. 13002. March 2007.

Brown, T.C. 2004. The Marginal Economic Value of Streamflow from National Forests. U.S. Forest Service, Rocky Mountain Research Station. Discussion Paper. DP-04-1, RMRS-4851. December 28, 2004.

Daily, G.C. 1997. Nature's Services: Societal Dependence on Natural Ecosystem. Washington, D.C.: Island Press.

Fluharty, D.L. 2000. Characterization and Assessment of Economic Systems in the Interior Columbia Basin: Fisheries. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Gen. Tech. Rep. PNW-GTR-451. April 2000.

Gleick, P., D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K.K. Cushing, and A. Mann. 2003. Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute. November 2003.

Houston, L.L., J.D. Kline, and R.J. Alig. 2002. Economics Research Supporting Water Resource Stewardship in the Pacific Northwest. U.S. Department of Agriculture, Forest Service. PNW-GTR-550. July 2002. Obtained August 28, 2007, from website: http://www.fs.fed.us/pnw/pubs/gtr550.pdf#search=%22water%20externalities%20columbia%20river%22

Huppert, D., G. Green, W. Beyers, A. Subkoviak, and A. Wenzl. 2004. Economics of Columbia River Initiative: Final Report to the Washington Department of Ecology and CRI Economics Advisory Committee. University of Washington and Seattle University. January 12, 2004.

Independent Economic Analysis Board. 2005. Economic Effects from Columbia River Basin Anadromous Salmonid Fish Production. Northwest Power and Conservation Council. IEAB 2005-1. December 2005.

Isley, S. 2007. Summary Table: Yakima River Basin Water and Land Acquisitions. June 18, 2007.

Johnson, K.P. and J.R. Kort. 2004. “2004 Redefinition of the BEA Economic Areas.” Survey of Current Business November: 68-75.

Mastin, M.C. and W. Sharp. 2006. Comparison of Simulated Runoff in the Yakima River Basin, Washington, for Present and Global Climate-Change Conditions. In *Proceedings: Third Federal Interagency Hydrologic Modeling Conference*. Reno, Nevada. Subcommittee on Hydrology, a Subcommittee of the Advisory Committee on Water Information. 2006. Obtained September 17, 2007, from website: http://wa.water.usgs.gov/projects/yakimawarsmp/data/9EKT2_03_approved.pdf

Montgomery Water Group, Inc. 2002. Reliability of Surface Water Supply for Irrigation Yakima Project Water Users. January 2002.

National Resources Council of the National Academies (NRC). 2004. Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival. Washington, DC: The National Academies Press.

National Resources Council of the National Academies (NRC). 2005. Valuing Ecosystem Resources: Toward Better Environmental Decision-Making. National Academies Press.

Partridge, M. and D. Rickman. 2003. "The Waxing and Waning of Regional Economies: the Chicken-Egg Question of Jobs Versus People." Journal of Urban Economics 53: 76-97.

Roundtable Associates. 2003. Water Exchange in the Yakima Basin. October 6, 2003. Obtained September 27, 2007, from website: http://www.roundtableassociates.com/ywe/WB% 20Final/Yakima%20Water%20Bank%20ver%205.1%20(Final%20Draft).pdf

Roundtable Associates. No date. Water Exchange in the Yakima Basin: Additional Speaker Notes in Brackets. Obtained September 28, 2007, from website http://www.roundtableassociates.com/ywe/WB%20Final/YWE%20Presentation%20Script%20with%20notes.doc.

Schaible, G.D. 2000. "Economic and Conservation Tradeoffs of Regulatory vs. Incentive-based Water Policy in the Pacific Northwest." Water Resources Development 16 (2): 221-238.

Scott, M.J., L.W. Vail, J. Jaksch, C.O. Stockle, and A. Kemanian. 2004. "Water Exchanges: Tools to Beat El Nino Climate Variability in Irrigated Agriculture." Journal of the American Water Resources Association 40: 15-31.

U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources. 1991. National Economic Development Procedures Manual: Overview Manual for Conducting National Economic Development Analysis. IWR Report 91-R-11. October 1991.

U.S. Department of Commerce, Bureau of Economic Analysis (BEA). 2006. Local Area Personal Income. Tables CA1-3, CA25, and CA45. Obtained September 27, 2007, from website: http://www.bea.gov/bea/regional/reis/.

U.S. Water Resources Council. 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. March 10, 1983.

Washington State Department of Ecology (Ecology). 2006. *2006 Report to the Legislature: Water Banking in Washington State*. December.

Washington Water Trust. No date. "Projects." Obtained September 25, 2007, from website: http://www.thewatertrust.org/

Willey, Z. and A. Diamant. 1994. Restoring the Yakima River's Environment: Water Marketing and Instream Flow Enhancement in Washington's Yakima River Basin. Environmental Defense Fund. March 1994.

Williams, G.W. and O. Capps, Jr. 2005. An Assessment of Future Markets for Crops Grown Along the Columbia River: Economic Implications of Increases in Production Resulting from New Agricultural Water Rights under the Columbia River Initiative. September 2005.

Willis, D.B. and Whittlesey, N.K. 1998. "The Effects of Stochastic Irrigation Demands and Surface Water Supplies on On-Farm Water Management." Journal of Agricultural and Resource Economics 23: 206-224.

Zhang, S. 2004. An Evaluation of Probable Benefits and Costs for the Proposed Rule to Establish the Columbia River Water Resources Management Program. Washington State Department of Ecology No. 04-11-032. December 2004.