FINAL REPORT

ECONOMIC BENEFITS ANALYSIS

Umatilla Basin Regional Aquifer Recovery Assessment

Task 1.K

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Optimizing Water Resources Through Technology

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1.0 EXECUTIVE SUMMARY

The Oregon Water Resources Department (OWRD) has designated four Critical Groundwater Areas (CGAs) in the Umatilla Basin due to their documented overdraft (OWRD 2003). As a result, use of additional groundwater for irrigation in these areas has been curtailed causing adverse impact to the economies of Umatilla and Morrow counties. Additionally, surface water sources within the Umatilla Basin are unavailable for further appropriation between June 1 and October 31 as defined in Oregon Administrative Rules (OAR) 690-507-0070. To increase water availability, an assessment is being completed to evaluate the feasibility of diverting water during high winter and spring flow periods from the Columbia and Umatilla Rivers and storing it in shallow sediment and deeper basalt aquifers. The stored water will be used for irrigation and to achieve environmental and other benefits. The objective of this report is to evaluate the economic benefits of selected engineering alternatives identified in this feasibility assessment.

Two separate economic analyses were performed. The first analysis includes a description of the economic structure of the Basin (consisting of Umatilla and Morrow Counties), identification of the sectors that constitute the economic engine of the region, and estimates of the economic contribution of agricultural industry (consisting of farm production, agricultural services, and food processing) to the Basin and the State's economies. The following summarizes the key findings of the first analysis:

- Contrary to the counties in other eastern parts of the State, the Basin relies on employment as its main source of income. In 2006, earned income accounted for 65% of total personal income, which is consistent with the State's average of 65%.
- The Basin's 2006 per capita personal income (PCPI) of $25,254 represents 76% of Oregon's PCPI and 69% of the national PCPI.
- Farm production, frozen food manufacturing, vegetable canning and drying, cheese manufacturing, mining, utilities, transportation, warehousing, and manufacturing sectors constitute the economic base (or engine) of the basin. This implies that these sectors provide the core employment and income on which the rest of the local economy depends. This report estimated that these sectors accounted for more than 50% of the Basin's total jobs.
- The Basin's farm production accounted for 12% of Oregon's 2006 total farm sales (or $536 million). In 2006, the Basin ranked first in production of grains ($102 million), hay and silage ($62 million), field crops ($75 million), vegetable ($58 million), and livestock production ($95 million) among the other 34 counties of Oregon.
- In 2006, agricultural industry of the basin accounted for 21% (or $1.4 billion) of the Basin's total direct value of output and 22% (or 10,090 jobs) of the Basin's total direct employment. In the same period, the Basin's growers and food processors together exported more than $1,027 million to domestic and foreign markets. The $1,027 million accounted for 42% of total Basin's export.

- Including the secondary effects, in 2006, agriculture industry accounted for 27% of the Basin's total value of output ($1.8 billion), 30% of the Basin's total private employment (14,326 jobs), and 16% of the Basin's total labor income ($697 million).
- In 2006, the agricultural industry of the Basin, directly and indirectly, supported about 19,000 jobs in Oregon.
- In 2006, the agricultural industry of the Basin, directly and indirectly, generated about $2.6 billion in economic activities and $1.1 billion in personal income in Oregon.
- Majority of economic contribution of agriculture industry is attributed to the Basin's irrigated agriculture.

The second economic analysis assesses the economic benefits of the engineering alternatives, whose findings will be summarized further below. Please note that the engineering alternatives evaluated in this report are conceptual feasibility-level options and necessary data for a detailed economic analysis, such as cost-benefit analysis, are not yet determined. The focus of this economic benefits analysis is to provide information to stakeholders to evaluate the potential benefits of the proposed alternatives relative to their implementation cost.

In accordance with federal principles and guidelines for evaluation of federal water resources projects, this economic benefits analysis was performed from both National Economic Development (NED) and Regional Economic Development (RED) perspectives. Additionally, for comparison purposes, the costs and benefits presented in this report are expressed as annual values in 2006$.

Three Supply, Storage, Recovery, and Distribution (SSRD) systems have been developed for this project (IRZ 2009). The SSRD system 1 includes seven options to import Columbia River water for beneficial uses in the Ordnance Gravel and Butter Creek Basalt CGAs. Option 1 was developed to supply the full irrigation and other needs of approximately 100,000 AF per year (AF per year). Options 2 and 3 provide 55,000 AF. Additionally, this analysis includes evaluation of the economic benefits associated with supplying the full water need in the three CGAs (Full Project) subject of this feasibility assessment. Based on early analysis, the total need had been estimated at approximately 160,000 AF. Table ES-1 displays the annual total water withdrawals from the Columbia River, the proposed annual allocation of stored water for irrigation, river flow augmentation, municipalities & domestic use, and basalt aquifer replenishment for the three options.

Table ES-1: Annual Withdrawals and Allocations of Imported Water for the Engineering Alternatives

Alternatives	Total Withdrawal (AF)	Proposed Allocation of Stored Water (AF)			
		Irrigation	River Flow Augmentation	Municipals & Domestic	Basalt Aquifer Replenishment
SSRD 1 – Options 2&3	55,000	37,000	14,000	600	3,300
SSRD 1 – Option 1	100,000	68,664	24,000	1,000	6,166
Full Project	158,330	113,664	27,000	7,000	10,666

Economic Benefit Analysis from the NED Perspective: The Economic and Environmental Principals for Water and Related Land Resources Implementation Studies (P&G) requires that a project should be undertaken if the water diverted for the project has a positive direct net value. The direct net value is a measure of net contribution to NED (social welfare) and is calculated by subtracting total costs from total benefits (broadly stating it includes salaries and net profits). For the engineering alternatives in this analysis, it implies that the direct contribution to the national economy of the water diverted for irrigation, enhancing stream flows for fish migration and spawning in the Umatilla River, municipal, and groundwater replenishment should be weighed against the net value of the Columbia River water for instream uses such as hydropower production, fish enhancement program, recreational activities and other uses. If the federal funding is used to finance the project, then the construction and operation and maintenance (O&M) costs should be included in the calculation. If the sum of net direct value of Columbia River water diverted exceeds the total cost of the project, this implies the proposed project should be undertaken from NED prospective.

This report uses the following methodologies to estimate the direct net value of diverted water for alternative uses:

- Using a residual value method based on enterprise crop budget, the economic value of irrigation water for the Basin was estimated to be approximately $95/AF.
- Using alternative cost of water delivery for flow augmentation in the Umatilla River, and documented water exchanges for instream use in Washington and Oregon, the economic value of stored water for flow augmentation in the Umatilla River was estimated to range between $85 and $124 per AF, with a mid-range of $104/AF.
- Based on the opportunity cost of the stored water, the economic value of water stored for aquifer replenishment was estimated to be approximately $95/AF.

- Using the wholesale value of water for municipalities in the Western States, the economic value of stored water for municipal use was assumed to be approximately $234/AF.

Based on the above information, the direct net value of diverted water from the Columbia River for SSRD 1 system Options 2&3, Option 1, and the Full-Project were estimated to be $99, $99, and $103 per AF, respectively.

Among alternative instream uses of the Columbia River water diverted for aquifer recharge in the CGAs, only hydropower use has been found to have a measurable economic impact. The foregone hydropower generation for the SSRD 1 system Options 2&3, Option 1, and the Full-Project were estimated to be $4.13, $4.22, and $4.44 per AF of diverted water, respectively. Comparing the instream uses of the Columbia River water to the diversions associated with each option shows a significant net gain of between $95 and $99 per AF .

If federal financing is sought is sought for this project, construction and O&M costs should also be included in NED calculation. Using 50 years as a planning horizon and 2.44% discount rate (current U.S. Treasury Real Long-Term Rate), the annualized initial capital costs for the SSRD 1 system Options 2&3, Option 1, and the Full-Project were estimated to be $26, $33, and $33 per AF, respectively. Realizing an O&M cost of $90, $87, and $85 per AF for the three options, respectively, the total annualized project costs (sum of annualized initial capital cost and annual O&M cost), for the three options are estimated at $116, $120, and $118 per AF, respectively.

Table ES-2 displays the total benefits and total costs of the UBAGR for three project options. It indicates that total project costs for three project options exceed their respective total benefits.

Table ES-2: Total Annual Benefits and Total Annual Costs

Alternatives	Annual Total Benefit ($/AF)	Annual Total Cost* ($/AF)	Net NED ($/AF)
SSRD 1 – Options 2&3	$ 99	$120	($21)
SSRD 1 – Option 1	$ 99	$124	($25)
Full Project	$103	$122	($19)

* Total cost includes the annual project cost plus hydropower lost.

The following points should be considered before making a conclusion regarding the economic feasibility of the project from the NED perspective:

- There are other direct benefits of the proposed project that were not included in the NED benefit estimates such as: a) potential lower pumping costs as a result of an increase in aquifer water table, b) cost savings by irrigators, municipalities, and residential users as a result of a decreased need to deepen wells, c) potential improvement in ground water quality, d) potential increase in recreation and fishery activities in the Umatilla River, e) potential economic benefits of accumulated stored water as a result of proposed aquifer replenishment program (in drought years, the accumulated stored water could be used for irrigation, municipalities/domestic uses, and the flow augmentation program in the Umatilla River).

- The cultural value of potential improved fish population, as a result of a potential increase in flow augmentation in the Umatilla River.
- Given that the project would contribute a significant portion of stored water for non-commercial use for fisheries resources and aquifer replenishment, it is desirable to evaluate the project using a lower discount rate and/or longer planning horizon as argued by Platt (2008).
- The NED account emphasizes economic efficiency and is neutral to distributional impact of a project. However, economic efficiency, although an important objective, is not the sole objective of the stakeholders or the State. How a project would contribute to a region's economy in terms of output, employment, and labor income might be as important as economic efficiency.

Economic Benefits Analysis from the RED Perspective: The economic benefits of the three engineering alternatives were evaluated based on their direct and indirect contribution to the Basin's economy in terms of output (or business activities), employment, and labor income. The total economic impact is the sum of the direct impacts and secondary impacts (or ripple effects). The direct impacts, included in the analysis, are the increases in farm production and induced regional direct value-added activities beyond the farm gate. The regional economic impacts were estimated using the IMPLAN input-output model of the Basin developed by MIG Group. IMPLAN has been widely used to measure regional economic impacts. The key benefits from the RED analysis are summarized in Table ES-3 and explained below:

- The increase in regional business activities ranges from $116 to $344 million, depending on the alternative. Of this, $80 to $239 million are from direct impacts and $36 to $105 million are the result of secondary impacts.
- The alternatives add between 679 and 2,074 jobs (330-1,040 jobs are direct and 349-1,034 jobs are indirect).
- The annual regional labor income (employee compensation plus proprietor's income) will increase $24-$72 million.
- Assuming a 7 percent marginal tax rate, the increase in annual State tax revenue is $1.7-$5 million.

Table ES-3: Regional Economic Impacts

Alternatives	Output (Business Activities) (2006$)		Labor Income* (2006$)		Employment (# of jobs)	
	Direct	Total	Direct	Total	Direct	Total
SSRD 1 – Options 2&3	$80,635,422	$116,265,246	$12,573,426	$24,150,857	330	679
SSRD 1 – Option 1	$144,770,763	$208,720,310	$ 22,656,434	$ 43,452,201	606	1,233
Full Project	$239,020,310	$344,264,806	$37,346,288	$71,600,591	1,040	2,074

* Labor income consists of employee compensation plus proprietor's income.

Since the change in labor income reflects the net contribution of a regional resource to the Basin's social welfare, this report has used the change in labor income to calculate the Basin's direct value of irrigation water. The Basin direct value for irrigation water, for the SSRD 1 Options 2&3, Option 1, and Full Project were estimated to be approximately $340, $330, and $328 per AF, respectively. The Basin total value of irrigation water (including the secondary impact) was estimated to be $652, $633, and $629 per AF, respectively.

The Basin benefits of diverted water for a combination of irrigation, fishery, municipal/domestic and aquifer replenishment for the SSRD 1 Options 2&3, Option 1, and Full Project were estimated to be around $264-$502, $257-$489, and $256-$486 per AF, respectively. The range is due to lack of a general agreement among economists as to whether to include direct regional impact or total regional impact (direct plus the secondary impact) in calculating the regional economic benefits of a project. Since the secondary economic impact usually takes more than a year to have its full impact, then incorporating the total secondary impact in economic benefit analysis will overstate the annual contribution of the project. For this reason, a mid-range of direct value of irrigation water and total value of irrigation water are used in this report to represent the regional value of irrigation water for the selected engineering alternatives.

Table ES-4 compares the annual total Basin benefit with the total annual cost for the SSRD 1 Options 2&3, Option 1, and Full Project. It shows that for all three options, the total annual benefit significantly outweigh the total annual cost. Based on the assumed discount rate and planning horizon, these alternatives are economically feasible from the RED perspective.

Table ES-4: Basin Total Annual Benefits and Costs

Alternatives	Total Annual Benefit ($/AF)	Total Annual Cost* ($/AF)	Net RED ($/AF)
SSRD 1 – Options 2&3	$383	$116	$267
SSRD 1 – Option 1	$373	$120	$253
Full Project	$371	$118	$253

* Total cost excludes the hydropower loss since it is incurred outside of the Basin.

2.0 INTRODUCTION

The Umatilla Basin consists of Umatilla and Morrow counties (hereafter is referred to as the Basin). The Basin is a rural community located in the north eastern half of Oregon, bordered by the Columbia River to the north and the Blue Mountains to the south. The region is comprised of 5,245 square miles of land area. Elevations in the region range from 200 feet (ft) at the Columbia River to over 6,000 ft in the Blue Mountains.

The Basin climate is semi-arid, with hot, dry summers and wet winters with low to moderate temperatures. The region is semi-arid due to the influence of mountains in the Coast Range and the Cascade Range. Annual basin precipitation amounts range from 8 inches near the Columbia River to more than 12 inches near the Blue Mountains. Most of the precipitation in the basin occurs from October through March with very little rain falls during the summer months. The major stream in the basin is the Umatilla River, which is a tributary of the Columbia River, joining it just below the McNary Dam.

Water is the wealth of the Basin. Water is essential to Basin's agriculture and its related value-added industries, power generation, fish resources and its cultural identity. Development of a vast network of irrigation infrastructure through the years has made the Basin the bread basket of Oregon. In 2006 (due to exceptionally high prices in 2007 and 2008, we determined 2006 is the most comparable period for this study), the Basin accounted for 12% of Oregon's total farm sales (or $536 million). The Basin grows over 20 crop varieties including a number of high value crops such as potatoes, onions, sweet corns, green peas, peppermints, and carrots among others. Nearly all of the Basin's row crops and fruit trees are irrigated. The majority of the high value crops are used by local food processors to produce variety of products. Vegetable processing has become a major industry in the Basin. The Basin has also a significant beef and dairy industry. The livestock industry in the southern part of the Basin relies heavily on local production of alfalfa and field corn, and byproducts from local food processors.

In 2006, the Basin ranked first in production of grains ($102 million), hay and silage ($62 million), field crops ($75 million), vegetable ($58 million), and livestock production ($95 million) among the other 34 counties of Oregon. Agriculture industry, including farm production and food processing, constitutes the economic base of the Basin. The 2006 estimates show that agriculture contributed over 21% (or $1.4 billion) of the Basin's total direct value of output and 22% (or 10,090 jobs) of the Basin's total direct employment. In the same period, the Basin growers and food processors together exported more than $1,027 million to domestic and foreign markets. The $1,027 million accounted for 42% of the Basin's 2006 total export. These exports represent new income to the Basin and Oregon's economy. The resultant income is subject to spending and re-spending, which leads to further gains in economic activity throughout the Basin. When considering these secondary effects, in 2006, agriculture industry accounted for 27% of total business activities ($1.8 billion), 30% of the Basin's total private employment (14,326 jobs) and 16% of the Basin's total income ($697 million).

To this end, the reliability and availability of a water supply is essential for future economic development and retention of economic base of the region. Due to overdraft of the aquifers in the area, OWRD designated four CGAs in the Basin (OWRD 2003). There are 63,489 acres of farmland within the four CGAs which are irrigated with groundwater pumped from alluvial and basalt aquifers. The total amount of certificated irrigation groundwater rights for this acreage is 190,466 AF (OWRD 2008). However, due to declining levels of water in the alluvial and basalt aquifers in the CGAs, the curtailed volume of groundwater rights adds up to a total of 127,038 AF or 67% of the total groundwater rights. Currently, around 33% of the water right holders are allowed to use water for irrigation. Approximately, more than 21,000 acres of Basin's irrigated lands that had relied on water from Umatilla Basin groundwater has been converted to dryland farming. Water shortage problem however is not confined to irrigators only. Several cities in the Basin rely heavily on groundwater as a source of water supply and would like to have access to alternative secure sources of water supply to meet their growing water demand. The CGAs are presently closed to further appropriation of groundwater other than for exempt and stock watering uses. Additionally, surface water sources from the Columbia River and its tributaries within the Umatilla Basin are not available for further appropriation between April through September. Due to higher land values and concerns about environmental issues and the costs, the potential to construct large surface reservoirs is not currently a feasible option. Since, there is no alternative to ground water immediately available, according to OWRD (2003), the conjunctive use of groundwater and surface water is the most viable solution to water supply problems in the Basin.

To enhance irrigation water supplies in the CGAs, OWRD has begun a technical assessment of the feasibility of artificially recharging the aquifers in the Basin by diverting water from the Columbia River during high flow months. As planned, the aquifer recharge project would use existing private and public infrastructure to divert water to the CGAs where it would be stored in the alluvial and basalt aquifers that would serve as underground storage. The stored water will then be used for irrigation, municipal/residential uses, increased stream flow in the Umatilla River, and aquifer replenishment.

3.0 OBJECTIVES

Table 1 shows the various engineering design options currently being considered as part of SSRD systems 1, 2, and 3 (IRZ 2009). Three options were selected in this economic analysis including the SSRD system 1 Option1, Options 2&3, and the Full Project. The Full Project corresponds to the importation and use of the combined diversions envisioned by the three SSRD systems.

Table 1: Engineering Designs and Potential Annual Allocations of Stored Water

SSRD System	System Option	Total Withdrawal (AF)	Proposed Allocations of Stored Water (AF)			
			Irrigation	Umatilla River Flow Augmentation	Municipal & Domestic	Basalt Aquifer Replenishment
1	1	100,000	68,664	24,000	1,000	6,166
1	2&3	55,000	37,000	14,000	600	3,300
1	4&5	45,000	30,000	11,500	475	2,700
1	6&7	25,000	19,610	3,092	1,000	1,461
2		25,000	20,000	3,000	-	2,000
3		33,500	25,000	-	6,000	2,500
Full Project**		160,000	113,664	27,000	7,000	10,666

The purpose of this report is to assess the potential economic benefits derived from the implementation of the recharge project. However, understanding and identifying the economic forces that shape the Basin economy are necessary to develop a rational strategic plan for the Basin's resources and its economic future. For this reason, this study performs two separate economic analyses, as follows:

- The first analysis focuses on the past and current economic conditions in the Basin, identifies the sectors that constitute the economic base of its economy, and provides the role of agriculture on the economies of the Basin and Oregon.
- The second analysis focuses on the potential economic benefits of the recharge project from national and Basin perspectives. From the national perspective, the analysis estimates the direct net value of diverted water from the Columbia River for the aquifer recharge project. This is achieved by estimating the direct net value of the Columbia River water for alternative uses such as irrigation, hydropower, recreation, fish resources, and municipalities. From Basin perspective, the study will identify the direct and indirect economic impacts of the aquifer recharge project on the Basin's economy. The impacts will be defined in terms of changes in Basin employment, income, and economic activities.

It should be noted that the aquifer recharge project is a feasibility-level assessment. Thus, the necessary data are not yet fully available for a more detailed cost-benefit analysis. The focal point of this report is to provide information for policy makers to evaluate the potential benefits and weigh them against the costs of the project for further investigation of the proposed project.

4.0 ECONOMIC PROFILE OF THE BASIN

This section first provides an economic profile of the Basin in terms of population trends, personal per capita trends, and employment trends. The section follows with a discussion of economic condition of the Basin in 2006 and identifies the important industries within the Basin based on a) their direct contributions to the Basin economy's in terms of economic output, earned income, and employment and, b) an economic base analysis. For equivalent comparison, all costs and benefits presented in this report are expressed as annual values in 2006$.

4.1 Population Trends in the Basin

Given the premise that people "follow the job," population changes provide insight into how economy performs and how it has performed over time. The 2006 population count for the Basin totaled 85,053 persons (Table 2). In 2006, population of Umatilla and Morrow Counties located in the Basin, ranked 13th and 29th, respectively, among Oregon's 36 counties.

From 1980 to 2006, the population of the Basin increased by 28% or 18,434 persons (Table 2). Within the same period, the population of Oregon has risen by 40% (1,059,540 persons). During 1980-2006, the compounded annual population growth for the Basin was 0.9% (Table 2), while during the same time, Oregon has experienced 1.3% compounded annual growth rate.

The population trends for the Basin and Oregon are presented in Figures 1 and 2. Figure 1 compares the Basin and Oregon population trends using 1980 as a base year (assuming their respective populations in 1980 are equal to 100). Figure 2 shows the annual percentage population changes from 1980 to 2006.

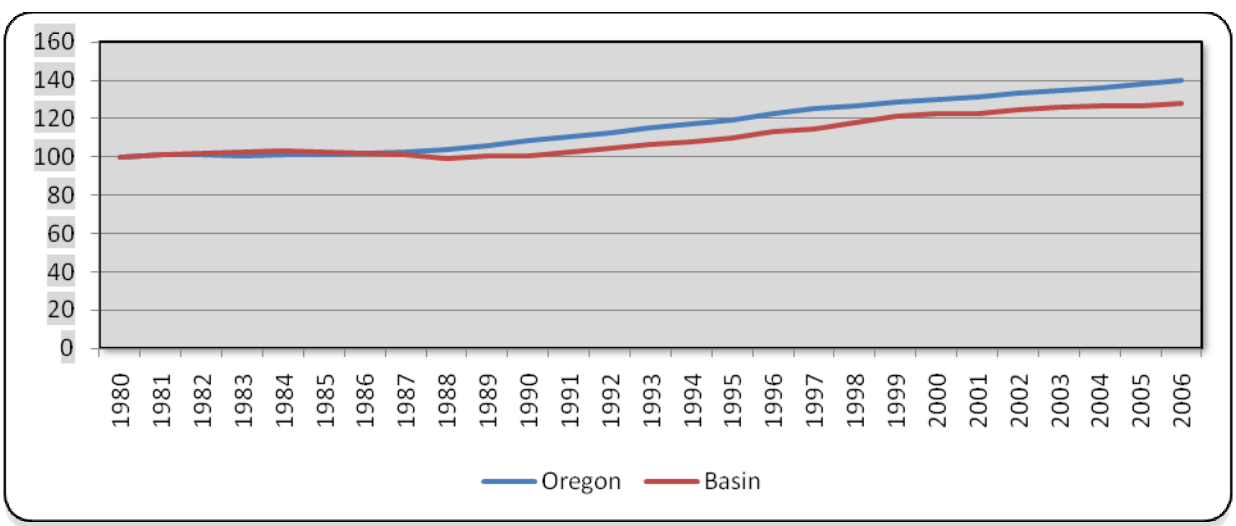
As indicated in Figures 1 and 2, in 1980s, the Basin experienced a decline in population. However, during the 1990s, as a result of economic development and growth, the region regained population lost in 1980s. The region had experienced 22% increase in population during 1990s, while the State had a population increase of 20%. In 2000s, the region's population increased by 4%, while the State population increased by 8%. Although, the population growth in 2000s was slower than the State average, the Basin performed better compared with many counties in central and eastern Oregon that have been dealing with the population declines.

Table 2: Population Trends in the Basin and Oregon, 1980-2006

	Basin	Oregon
POPULATION, persons		
1980	66,619	2,641,218
1990	66,989	2,858,757
2000	81,752	3,431,530
2006	85,053	3,700,758
Change in Population from 1980 to 2006	18,434	1,059,540
% Change in Population		
from 1980 to 2006	28	40
from 1980 to 1990	1%	8%
from 1990 to 2000	22%	20%
from 2000 to 2006	4%	8%
Compounded Annual Growth Rate from 1980 to 2006	0.9%	1.3%

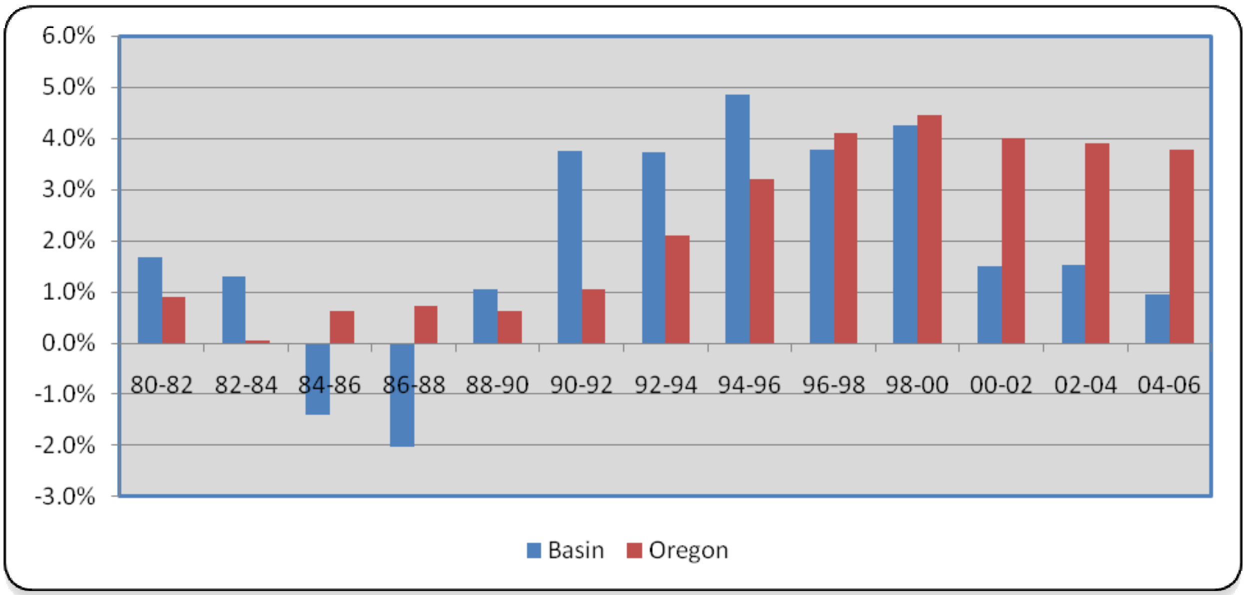
***Source**: U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

Figure 1: Population Trends in the Basin and Oregon, 1980-2006



***Source**: U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

Figure 2: Annual Percentage Changes in Population of the Basin and Oregon, 1980-2006



Source: *Regional Economic Information Services (REIS)*

4.2 Economic Trends in the Basin

Economic changes and population changes are closely linked to each other. Full understanding of the population changes requires knowledge of the change in economic conditions in terms of income and employment. This section discusses the recent trends in income and employment in the Basin and Oregon.

4.2.1 Personal Income Trends

Personal income is generally seen as a key indicator of economic vitality and well being of the residents. Personal income can come from two sources: (1) labor or earned income, consisting of wages and salaries, other labor income and proprietors' income and (2) non-labor income, which includes transfer payments (e.g., Social Security, Medicare, food stamps, unemployment insurance) and interest (or investment) income (consisting of dividends, interest and rent).

The Basin and Oregon's PCPI and their respective PCPI trends are presented in Table 3. Total personal income received by Basin's residents in 2006 was $2,135 million. On a per capita basis, Basin's 2006 PCPI of $25,254 was significantly below the statewide average of $33,299. The Basin's 2006 PCPI represents 76% of Oregon's PCPI, and 69%, of the national PCPI. During 1980-2006, PCPI for the Basin increased by 157%, while PCPI for the State of Oregon increased by 229%. As it is shown in Figure 3, the Basin's PCPI lagged behind in 1980s. For the duration of 1995-2006, the annual rates of PCPI growth for the Basin was 3.5% (Table 3). At the same time, Oregon's PCPI has increased by 3.9% annually. During 2000-2006, the Basin and the State's PCPI grew at the same rate (2.9%).

Table 3: Summary of PCPI Trends for the Basin and Oregon, 1980-2006

		Basin	Oregon
PCPI			
	1980	$9,818	$10,113
	990	$14,675	$18,010
	2000	$21,297	$28,096
	2006	$25,254	$33,299
% Change in PCPI			
	from 1980 to 2006	157	229
	from 1980 to 1990	49	78
	from 1990 to 2000	45	56
	from 2000 to 2006	19	19
Compounded Annual Growth Rate			
	from 1980 to 2006	3.7	4.7
	from 1995 to 2006	3.5%	3.9%
	from 2000 to 2006	2.9%	2.9%

***Source**: U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

Table 4 presents total personal income, PCPI, labor income, transfer payments and investment income in 2006 for the Basin, selected counties in Oregon, and the State. Three major conclusions can be drawn from the information presented in Tables 2 and 3.

1. There exists a substantial income disparity between the eastern and western counties of the State. For example, in 2006, the PCPI of the Basin and Sherman County represented only 61% and 47% of Clackamas County's PCPI, respectively; while in 1980 their PCPIs represented 79% and 171% of Clackamas. In 2006, Morrow, Umatilla and Sherman Counties' PCPI ranked 30th, 31th and 36th, respectively, among Oregon's 36 counties.
2. As a result of recent economic development initiatives, the Basin's PCPI has fared much better in 1990s and 2000s. Nevertheless, these counties have not been able to overcome the persistent gap in per capita personal income with the State and western counties of the State.

3. There is a large variation in shares of sources of income among counties in Oregon. In general, smaller regions are more dependent on transfer payment and to a lesser degree on investment income as sources of income. However, about 65% of the Basin's personal income comes from labor income, which is at the same level as the State's. This implies that the Basin is more dependent on employment for their source of income, thus, could be more susceptible to economic downturn.[1/]

Table 4: Total Personal Income, PCPI, and Sources of Income for Selected Counties in Oregon, 2006

Selected Counties	Total Personal Income ($mil)	(PCPI ($)	PCPI, % of State	Labor Income, % of Total	Transfer Payment, % of Total Income	Dividends, Interest & Rent, % of Total Income
Clackamas*	$15,371	$41,378	124%	70%	11%	19%
Columbia*	$1,455	$30,174	91%	69%	17%	14%
Multnomah*	$26,483	$38,529	116%	68%	13%	19%
Washington*	$18,608	$36,259	109%	74%	10%	16%
Wallowa	$189	$28,112	84%	50%	24%	26%
Sherman	$32	$19,550	59%	28%	40%	31%
Gilliam	$41	$23,889	72%	37%	27%	37%
Basin	**$2,135**	**$25,254**	**76%**	**65%**	**20%**	**16%**
Oregon	**$122,909**	**$33,299**	**100%**	**65%**	**15%**	**20%**

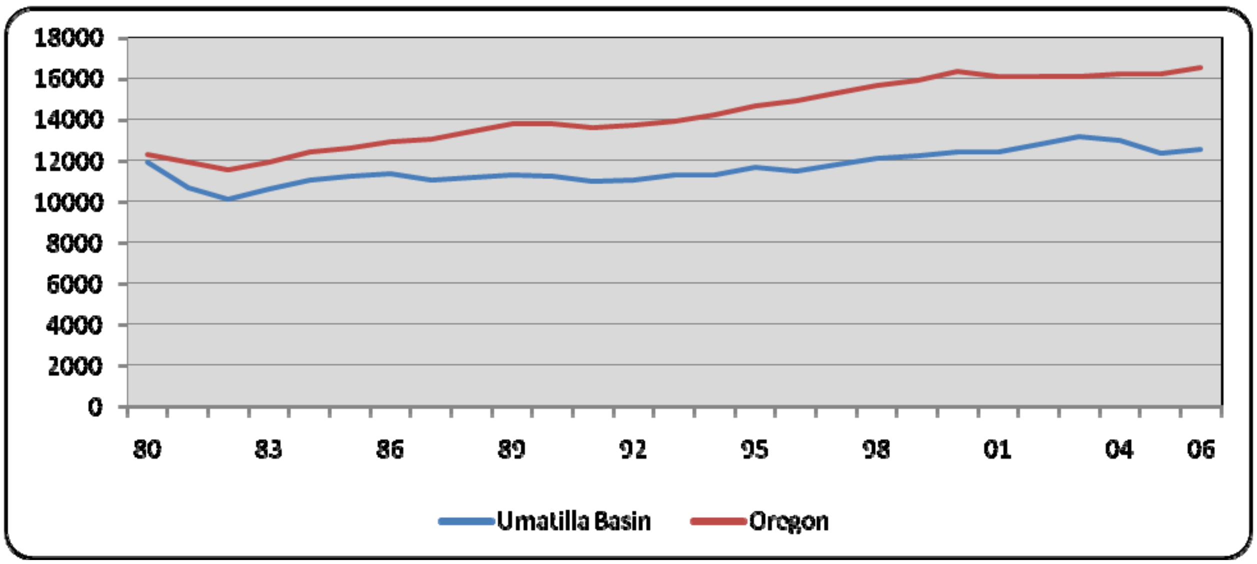
* Identifies the counties located in western parts of Oregon, mainly the counties around Portland, OR. Other counties are located in eastern half of Oregon along the Columbia River.

[1/] Transfer payments and investment income can have a stabilizing effect on the economy and could be considered counter-cyclical to an economic downturn. It should also be noted that high transfer payments in a region may imply presence of a poor economic condition.

***Source**: U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

Figures 3 and 4 show the PCPI trends and the annual percentage changes in real terms[2/] for the Basin and Oregon, from 1980 to 2006, respectively. From 1980 to 2006, the real PCPI in the Basin and Oregon changed by 5% and 35%, respectively. Furthermore, during the same periods, the average real PCPI in the Basin and Oregon changed by -0.1% and 1.7%, respectively. It implies that as the rest of the State has enjoyed an increase in their standard of living in terms of their purchasing power, the purchasing power of residents of the Basin has declined.

Figure 3: Real PCPI Trends in the Basin and Oregon, 1980-2006

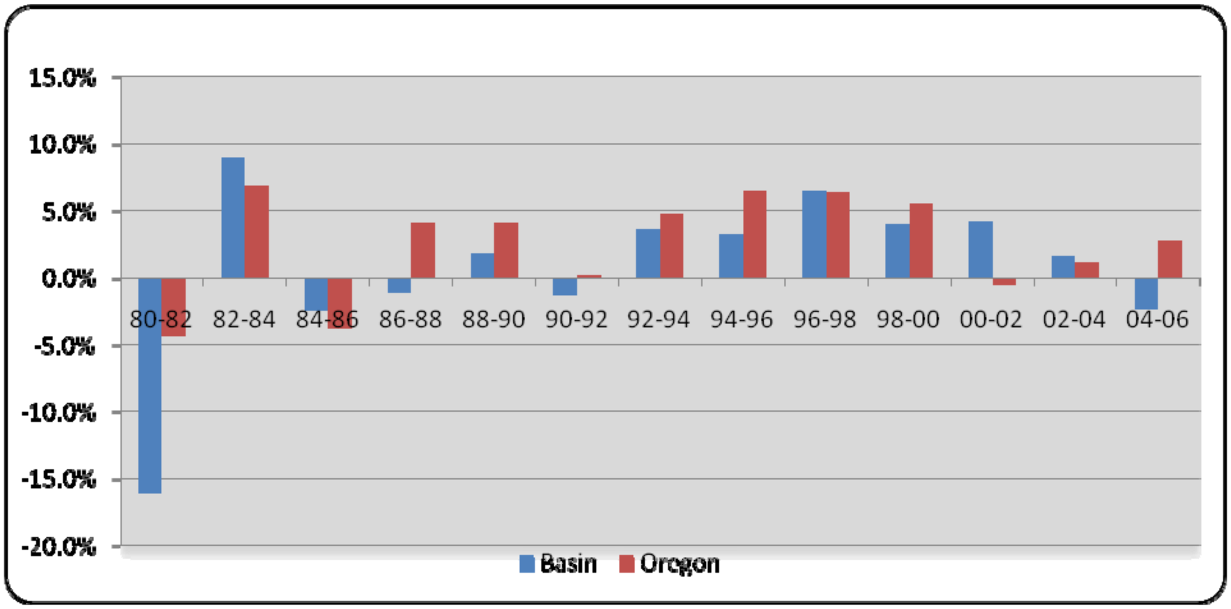


***Source:** U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

When analyzing the trend from 1980 to 2006, Figure 4 also reveals that the economy of the Basin has generally been more exposed to economic variations than the State economy as a whole. This is due to the heavy reliance of the region in 1980s on dryland farming, which is inherently more unstable than other economic sectors. However, as Figure 4 shows, the extent of variations in income has declined in 1990s and 2000s. As will be discussed later in this report, this can be attributed to less reliance of the economy on agriculture production sector and more on food processing and transportation manufacturing and power generation sectors.

[2/] Real per capita personal income is based on a constant 1995 dollar. It represents the PCPI after removing the effects of inflation.

Figure 4: Annual Percentage Changes in Real PCPI in the Basin and Oregon, 1980-2006



Source: *U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

4.2.2 Employment Trends

Employment is one of the most important economic variables in determining the health of an economy. Wages earned by employees are engines of economic growth. In 2006, total employment (consisting of wage and salary employees and proprietors) for the Basin was at 45,355 (Table 4). Between 1980 and 2006, the total employment in the Basin and Oregon changed by 34% and 70%, respectively. It implies that during 1980-2006, the Basin's employment growth lagged significantly behind the statewide employment growth.

The employment trends for the Basin between 1990 and 2006 shows a strong turnaround in growth (Table 5 and Figure 5). Between 1990 and 2006, total employment in the Basin and Oregon increased by 1.7% and 2.2%, respectively. The employment growth rates in the 1990s' and 2000s' indicate that the Basin fared better compared with the rest of the State. Between 1995 and 2006, the Basin had an annual employment growth rate of 0.6%, while the State had experienced a 1.5% annual growth rate (Table 5).

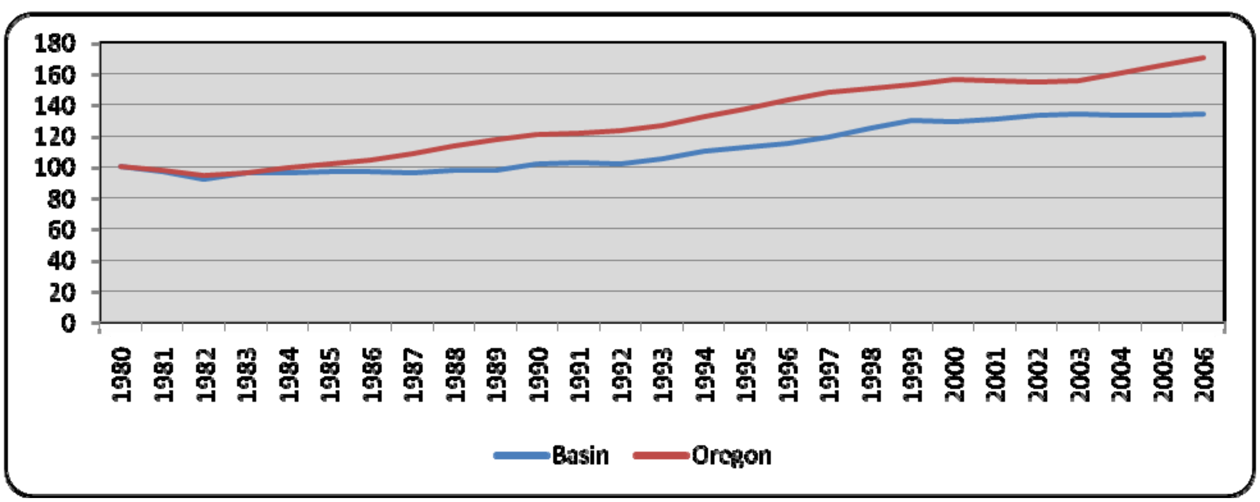
Figure 6 shows the changes in relative importance of farm, nonfarm private and government (or public) sectors' employment to the overall economy of the Basin from 1980 to 2006. It shows that farm employment from 1980 to 1992 declined, but in later parts of 1990s and early 2000s, farm employment stabilized its role throughout. As Figure 6 reveals, the employment in public and non-farm private sectors had significant up-trends in 1990s. However, in 2000s, the non-farm private employment growth leveled off and grew at a much lower rate. During the same period, employment in public sector grew at a faster rate than non-farm private sector but at a much slower rate compared to 1990s.

Table 5: Summary of Employment Trends in the Basin and Oregon, 1980-2006

		Basin	Oregon
Total Employment			
	1980	33,837	1,353,361
	1990	34,499	1,638,149
	2000	43,750	2,110,915
	2006	45,355	2,232,693
% Change in Employment			
	from 1980 to 2006	34%	70%
	from 1985 to 1996	2%	17%
	from 1995 to 2006	27%	29%
	from 2000 to 2006	4%	9%
Annual Rate of Growth			
	from 1980 to 2006	1.1%	2.1%
	from 1990 to 2006	1.7%	2.2%
	from 2000 to 2006	0.6%	1.5%

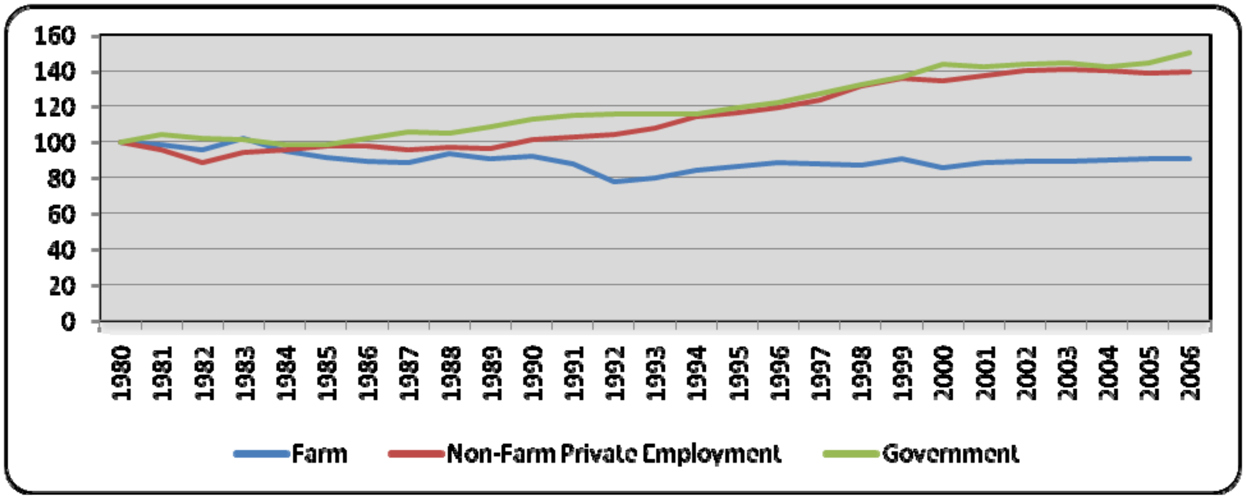
Source: *U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

Figure 5: Employment Trends in the Basin and Oregon, 1980-2006



Source: *U.S. Bureau of Economic Analysis, Regional Economic Information Services (REIS)*

Figure 6: Farm, Non-Farm Private and Government Employment Trends in the Basin, 1980-2006



***Source**: .S. Bureau of Economic Analysis, Regional Economic Information Services (REIS*

Table 6 shows the share of total employment among selected industries in the Basin in 1995 and 2006. In 2006, Services, Government, Trade, Agriculture, Manufacturing and Trade sectors accounted for 33%, 17%, 16%, 13%, and 11% of the total employment in the Basin. Compared to 1995, the total employment in the Basin increased by 17.4% (6,821 jobs). Significant gains in the share of employment in the Basin occurred in Services sector (by 47.4% or 6,340 jobs), Agriculture sector (by 12.7% or 1,741 jobs), and Government sector (by 3.9% or 1,389 jobs), whereas major losses in the share of employment occurred in Construction sector (by -73.0% or -1,235 jobs) and Trade sector (by -40.5% or -2,262 jobs).

Table 6: Percent of Employment by Industry in the Basin, in 1995 and 2006

	1995	2006	%Change	Change
Agriculture	13.7%	15.5%	12.7%	1,741
Mining	0.0%	1.0%	100.0%	460
Construction	4.6%	1.2%	-73.0%	(1,235)
Manufacturing	15.4%	12.5%	-18.7%	(274)
Trade	19.1%	11.4%	-40.5%	(2,262)
Transportation, Communications & Utilities	5.0%	4.4%	-12.6%	52
Finance, Insurance and Real Estate	3.8%	3.8%	0.0%	256
Services	22.2%	32.6%	47.4%	6,340
Government	16.1%	16.8%	3.9%	1,389
TOTAL	**39,180**	**46,001**	**17.4%**	**6,821**

***Source:** Minnesota Implan Group, Inc. 1995 and 2006*

4.3 Economic Description of the Basin

Earlier sections of this report examined population, income and employment trends in the Basin. This section discusses the economic condition of the Basin in 2006 and identifies the important industries within the region in terms of total output, direct employment, etc.

Table 7 describes the economic condition of the Basin in 2006 in terms of industry's direct output (sale or business activities), direct employment, direct earned income, direct labor income and [direct] indirect business taxes.[3/]

4.3.1 Direct Economic Output [4/]

In 2006, the output sales from all economic activities in the Basin totaled $6.6 billion (Table 7).

- The Manufacturing sector was the largest sector in terms of its contribution to the Basin's direct economic output and accounted for about 45% ($2,989 million) of the region's total 2006 economic output. Within the Manufacturing sector, Transportation Equipment subsector (mainly automobile and light truck manufacturing, and travel trailer and camper manufacturing) accounted for 64% of the total output of Manufacturing sector and 29% ($1,915 million) of the region's total economic output. Food Processing (mainly its Vegetable Processing, Fruit and Vegetable Canning and Drying, and Cheese Manufacturing subsectors) accounted for 28% of the total output of Manufacturing sector and 13% ($833 million) of the region's total economic output.
- The second largest economic sector was Government sector which accounted for 9% ($577 million) of total 2006 economic output. State and local government accounted for 88% of the 2006 Government output and 8% of the region's total economic output.
- The third largest contributor to the Basin's total output was the Agriculture sector, which includes Farm Production, Forestry and Agricultural Services. In 2006, Agriculture sector accounted for 8% ($516 million) of the region's total business activity. The Farm Production sector, however, accounted for 62% (or $318 million) of Agricultural output value. Within the Farm Production sector, Vegetables, Livestock and Food Grains were the most important subsectors and accounted for 2% ($122 million), 1% ($77 million) and 1% ($71 million) of the region's total output, respectively.
- Utility sector was the fourth largest economic sector in terms of its contribution to the region's total output. However, the power generation subsector of the Utility sector accounted for 98% of Utility sector's total output.

[3/] Direct output or employment or earned income is defined as the output or employment or earned income generated by a specific industry. These are the direct contribution of industries to the economy; it excludes indirect and induced impacts (or secondary impacts) which will be discussed later in this report.

[4/] Due to potential double counting problem, the use of output (sales) as an economic indicator of the importance of a sector to overall economy should be interpreted with caution.

- Retail trade sector was the next important sector in the region and accounted for 4% (or $252 million) of the region's 2006 total output (Table 7).

4.3.2 Direct Employment

Employment in the Basin totaled 46,002 in 2006, which includes wage and salary earners plus proprietors.

- The Government sector was the largest employer in the region and accounted for 17% (or 7,885 jobs) of region's 2006 total employment.
- Agriculture sector was the second largest employer in the region. It accounted for 15% of total direct employment in the region (over 7,022 jobs) and 18% of non-government employment. Farm Production subsector, however, accounted for 60% of Agriculture sector's 2006 total employment. Agricultural and Forestry services accounted for 4% (or 1,772 jobs) of region's 2006 total employment.
- The third largest employer in the region was the Manufacturing sector, which accounted for 13% (5,823 jobs) of the region's 2006 total jobs. Nearly 43% of the employment in the Manufacturing sector was in Food Processing subsector, which accounted for 2,487 jobs. Transportation Equipment and Wood Product subsectors were the other large employers within the manufacturing sector.
- Retail trade sector accounted for 9% (or 4,184 jobs) of the region's employment and was the fourth largest employer in the County.

4.3.3 Direct Earned Income

The other economic indicator used to measure the importance of an industry to an economy is the earned income. Earned income is the sum of all wage and salary payments that are made to workers, plus the profits accruing to sole proprietors, plus payments made to investors in the forms of dividends, interests, or rents. Broadly speaking, the earned income, plus indirect business taxes (known as value-added account) represent the net addition an industry contributes to the economy.[5/]

If all of the earned income generated by an industry is paid to local residents, then the generated earned income represents the net wealth added to the local economy. However, if the majority of owners of capital (lenders, stockholders, partners, and proprietors) within a given industry, are not local residents (this is usually the case for capital-intensive industries such as utility industry), one can expect that a significant portion of the earned income (e.g., the profit component of the earned income) to leak out of the local economy. In an industry such as agriculture, where the majority of owners of capital and the workers are usually local residents, most of the earned income is expected to remain in the local economy. This is important since only the money that remains in the local economy stimulates the economy through spending and re-spending processes. Consequently, one should be cautious in interpreting the contribution of an industry based on the magnitude of its earned income. To get a good

[5/] An industry's value-added is defined as the difference between the final value of products (or services) and the value of the materials and inputs used to produce (or render) them.

picture of an industry's relative contribution to the local economy based on earned income, it is necessary to have information concerning the residency of owners/operators and workers in the industry. For this reason, only the labor income component of the earned income is used in identifying the role of an economic sector to the general regional economy.

Table 7: The Economy of the Basin in 2006, in million $

	Total Output		Employment		Earned Income		Labor Income	Ind. Bus. Tax
Agriculture	**516**	**8%**	**7,022**	**15%**	**240**	**5%**	**106**	**8.3**
Farm Production	318	5%	4,190	9%	176	4%	58	4.8
Food Grains	71	1%	1,982	4%	33	1%	2	1.3
Vegetables	122	2%	1,089	2%	79	2%	28	1.2
Livestock	77	1%	894	2%	6	0%	9	1.6
Forestry & Logging &Fishing	70	1%	166	0%	22	0%	5	1.5
Agriculture and Forestry Serv.	52	1%	1,772	4%	36	1%	34	0.5
Mining	**62**	**1%**	**305**	**1%**	**28**	**1%**	**1**	**1.9**
Utilities	**301**	**5%**	**510**	**1%**	**206**	**4%**	**49**	**35.1**
Power Generation & Supply	294	4%	495	1%	204	4%	48	34.5
Construction	**169**	**3%**	**1,526**	**3%**	**69**	**1%**	**43**	**0.9**
Manufacturing	**2,989**	**45%**	**5,823**	**13%**	**424**	**9%**	**282**	**11.4**
Food Processing	833	13%	2,487	5%	171	3%	100	5.2
Frozen Food Mnf.	546	8%	1,895	4%	127	3%	72	3.5
Fruit & Veg. Canning & Drying	64	1%	142	0%	14	0%	7	0.4
Cheese Mnf.	90	1%	121	0%	7	0%	6	0.6
Wood Products	111	2%	561	1%	38	1%	23	0.6
Mobil Home Mnf.	54	1%	352	1%	20	0%	13	0.3
Transp. Equipment	1,915	29%	2,264	5%	179	4%	139	4.7
Light truck Mnf.	1,695	26%	1,225	3%	127	3%	88	4.0
Travel Trailers &Campers	194	3%	964	2%	48	1%	47	0.6
Wholesale Trade	**101**	**2%**	**906**	**2%**	**53**	**1%**	**37**	**14.8**
Transportation and Warehousing	**362**	**5%**	**2,946**	**6%**	**213**	**4%**	**140**	**7.8**
Rail Transportation	106	2%	325	1%	64	1%	38	2.0

Truck transportation	111	2%	754	2%	55	1%	41	1.3
Warehousing and storage	30	0%	446	1%	22	0%	18	0.2
Retail Trade	**251**	**4%**	**4,184**	**9%**	**127**	**3%**	**91**	**34.5**
Information	**62**	**1%**	**350**	**1%**	**22**	**0%**	**12**	**2.5**
Finance and Insurance	**130**	**2%**	**1,009**	**2%**	**78**	**2%**	**30**	**1.9**
Real Estate and rental	**100**	**2%**	**917**	**2%**	**51**	**1%**	**5**	**9.8**
Professional-scientific &tech	**88**	**1%**	**986**	**2%**	**38**	**1%**	**21**	**0.8**
Management of companies	**1**	**0%**	**8**	**0%**	**0**	**0%**	**0**	**0.0**
Administration & waste services	**220**	**3%**	**2,299**	**5%**	**123**	**2%**	**83**	**7.5**
Educational srvs	**6**	**0%**	**249**	**1%**	**2**	**0%**	**2**	**0.0**
Health & social services	**245**	**4%**	**4,045**	**9%**	**137**	**3%**	**102**	**1.9**
Arts-entertainment & recreation	**12**	**0%**	**410**	**1%**	**5**	**0%**	**3**	**0.7**
Accommodation & food services	**116**	**2%**	**2,456**	**5%**	**49**	**1%**	**33**	**6.4**
Other services	**143**	**2%**	**2,166**	**5%**	**68**	**1%**	**34**	**3.3**
Government	**577**	**9%**	**7,885**	**17%**	**517**	**10%**	**459**	**0.1**
Federal	68	1%	1,001	2%	58	1%	50	0.0
State & Local	510	8%	6,884	15%	459	9%	409	0.1
Other	**186**	**3%**	**-**	**0%**	**139**	**3%**	**0**	**25.1**
TOTAL	**6,638**	**100%**	**46,002**	**100%**	**4,962**	**100%**	**3,157**	**244**

Source: *Minnesota Implan Group, Inc., 2006 IMPLAN Database. Some numbers may not add due to rounding.*

Table 7 shows the earned income, labor income[6/] and indirect business taxes[7/] generated by the Basin's economic sectors in 2006. The total earned income, labor income, and indirect business tax in the Basin was estimated to be around $4,962 million, $3,157 million and $244 million, respectively.

- Government (federal, and state and local) sector had the largest earned income in the Basin, it accounted for 10% (or $517 million) of the Basin's 2006 total earned income. State and local sector accounted for more than 97% (or $459 million) of government sector's earned income.

[6/] The labor income includes the wages and salaries paid by employers, as well as benefits, such as health and life insurance, retirement payments, and non-cash compensation.

[7/] Indirect business taxes include property and other taxes and fees, except taxes on profits or income.

- Manufacturing sector generated the second largest earned income ($424 million or 9% of the region's total earned income), while its contribution to labor income and indirect business taxes were $282 million (or 9% of the Basin's total labor income) and $2.2 million (or 5% of the Basin's 2006 total indirect business taxes), respectively.
- The Agriculture sector was the third largest contributor, accounted for $240 million or 5% of the Basin's total earned income. It generated $106 million of labor income (or 3% of the Basin's total labor income) and contributed $8.3 million to the Basin's indirect business taxes (more than 3% of the region's total indirect business taxes).
- The Utility sector was the fourth largest contributor to the region's earned income and accounted for $206 million or 4% of the Basin's total 2006 earned income. Its contribution to labor income and indirect business taxes were $49 million (or 2% of the region's total labor income) and $35million (14% of the Basin's indirect business taxes), respectively. Utility sector was by far the largest contributor to the Basin's 2006 indirect business tax.

4.3.4 Economic Base of Basin

Direct economic output, employment, earned income and labor income are important in identifying the role of an economic sector in the general regional economy. Frequently, these measures cannot be used in identifying the sectors that constitute the engine or economic base of the economy. For this reason, regional economists use other economic measures to identify sectors that are the prime sources of regional economic growth and development.

Regional economic theory states that a regional economic growth and development is driven by economic activities that import money into the region through the sales of goods and services to firms and/or households outside of local region. An economic sector that brings money into the economy, through export activities, would initiate spending and re-spending process in the economy which would contribute to the region employment, income and growth. Hence, the sectors that bring money to the region are considered engines or the economic bases of the economy.[8/]

In general, an economy can be divided into "basic or primal or export activities" and "non-basic or non-primal" sectors. Basic sectors are the industries that sell outside the region (domestic and/or foreign) a large portion of their goods and services. By emphasizing export, these industries bring "new wealth" to the local economy. Non-basic sectors sell goods and services to the region's basic industries and local residents. The spending and re-spending of dollars generated in a basic sector create multiplier effects, which in turn support the non-basic sectors of the economy.

Several methods have been used to identify the basic and non-basic sectors of an economy. However, the location quotient (LQ) approach is the most popular and frequently used technique in economic base analysis (Crone, et. al.).

The location quotients identify the basic and non-basic sectors of a local economy by comparing the economic structure of that economy with a reference economy (usually state and/or nation). If the local economy has relatively less economic activity in a particular sector compared to the reference economy, that suggests the good or service is being imported from other regions. If the local economy has relatively more economic activity in a particular sector compared to the reference economy, that suggests the good or service is being exported to other communities.[9/] This comparison can be done using various measures of economic activity, such as employment, income, or retail sales. However, the standard unit of measurement used in LQ is employment for which the data is readily available.

LQ compares the share of total employment in a particular industry or sector in a local economy to its share at the national or state level. In other words, LQ compares the relative importance of an industry in a region to its relative importance at the national or state level. The quotient is determined by dividing the region industry's share of total employment by the same industry's share of total employment at the national or state level. If the location quotient exceeds one, then exports are indicated. Industries with location quotients less than or equal to one are assumed to be industries serving local markets only. The greater the LQ value above or below 1.0, the stronger the suggestion of exporting or importing becomes. For example, a location quotient of 1.50 indicates that 50% percent of the employment in the sector is related to the export activities. In general, all employment of sectors with location quotients greater than 2 is attributed to export activities. The sectors having LQs less than 0.75[10/] imply that the current level of economic activities in these sectors are not sufficient to meet local demands and thus goods and services from these sectors must be imported. This could indicate either a comparative disadvantage in these sectors compared to a reference economy or that these might be industries to consider for future expansion.

Table 8 shows the 2006 location quotients of major economic sectors in the Basin. It shows that based on North American Industry Classification System (NAICS) 2 digit aggregation level, only agriculture, mining, utilities, transportation and warehousing sectors constitute the economic base of Basin (Using LQ score of 1.50 as a cut off). However, at a lower level of aggregation, in addition to the above sectors, a few of manufacturing subsectors (frozen food manufacturing, fruit and vegetable canning and drying, cheese manufacturing, wood products, and transportation truck manufacturing) also make up the economic base of the Basin's economy (all with LQ > 2). In general, goods-producing sectors constitute the economic base of the Basin's economy. The construction, wholesale trade, retail trade, finance and insurance, government and a few other sectors have LQ <1, are largely non-export sectors (non-basic sectors). As noted above, the employment and income of non-basic sectors largely depend on the ability of basic sectors exporting activities (this is largely true if an economy has small transfer payments relative to size of the economy).

[7/]The importance of an industry can also be measured by the extent its goods and services are used as inputs in the production of other locally produced goods and services, and/or used as final goods and services by the local residence. The greater a basic sector's reliance is on locally produced goods and services, the greater its impact on the local economy. A decrease in imports (or import substitution expansion) has the same stimulative effect as an increase in exports. Increased exports increase the flow of money into the economy and decreased imports decreases the flow of money out of the economy.

[9/] http://www.epa.gov/greenkit/pdfs/howto.pdf

[10/] Due to potential errors with LQ analysis, it is difficult to make a broad conclusion on a sector with LQ between 0.75 and 1.25 without a more detailed study.

Estimating the contribution of economic base to the whole economy is beyond the scope of this report (see Waters et. al for a detailed description of economic base analysis). However, in this report, two other measures, net-trade balance and export-dependent employment, are used to highlight the importance of the major sectors that constitute the economic base of the Basin as identified in Table 8 (for sectors having LQ >2). The net-trade balance identifies how much "new money" an economic base sector brought to an economy. The net-trade balance for a sector reflects the difference between the value of goods and services exported (domestic and foreign) and the value of goods and services purchased by the sector from outside the region (Ziari et. al).[11/] The export-dependent employment is the number of jobs created, directly and indirectly, resulting from the export activities. The export-dependent employment was calculated by noting the employment impact of a sector's export activities using Basin's input-output model.[12/] The export values, net-trade balances, and export-dependent employment for major economic base sectors are presented in Table 8. Following summarizes the findings:

- The economic base sectors as identified in Table 8 accounted for $2,655 million of Basin's total export (81% of total), $671 million of net-trade balance, and 15,000 jobs (33% of total employment).
- In 2006, light truck manufacturing, frozen food manufacturing, power generation, travel trailer and campers manufacturing, and vegetables sectors exported $1,232 million, $522 million, $250 million, $149 million, and $101 million, respectively. These sectors accounted for 69% of 2006 total Basin export.
- In 2006, frozen food manufacturing, power generation, rail transportation, vegetable sectors and food grains sectors had net-trade balances of $246 million, $210 million, $82 million, $74 million, and $38 million, respectively. These sectors together brought more than $650 million of "new money" into the Basin's economy.
- Export activities by frozen food manufacturing, light truck manufacturing, food grains, vegetables, and travel trailers and campers manufacturing sectors accounted for 3,831, 2,501, 2,036, 1,385, and 1,235 jobs, respectively.[13/]
- Low export activities of livestock and agricultural services sectors (both having LQs > 2) indicate that most of their production are used in support of other goods produced locally (for example, the region's livestock activities support the local cheese manufacturing sector, this accounts for a large employment contribution of cheese manufacturing sector).

[11/] In addressing the relative importance of basic sector, a comparison between the percent of the export money that would be spent on local goods and services, and the percent of proprietors' income that would remain in local economy, should also be incorporated into the analysis. This kind of economic analysis can be performed using input-output and Social Accounting Modeling techniques.

[12/] Next section provides a brief discussion of input-output modeling technique.

[13/] The export-dependent employment estimations as presented in Table 8 ignore the induced economic activities (e.g., transportation, wholesaling activities, etc) beyond the farm gate and/or factory plant and hence they should be considered as conservative estimates (next section discusses this issue).

- The analyses of net-trade balances and export-dependent employment indicate that the farm production and food processing sectors exhibit healthy inter-industry linkages that allow less import of goods and services and higher regional job creation opportunities.

The above analysis identified the Basin's competitive strengths with respect to the state's economy and driver industries that constitute the engines of the Basin. It also estimated the extent of their direct and indirect contributions to their respective economies. From an economic development perspective, these are sectors that regional policy makers are to focus and be apprehensive that any policy change that adversely affects these sectors would also negatively impact the employment and income in other sectors of the economy. Therefore, retention and/or expanding these sectors should be the priority of the regional policymakers.

Table 8: Location Quotients, the Basin vs. Oregon

	% of Total Employment		Location Quotient	Export ($mil)	Net Trade Balance ($mil)	Export Dependent Employment (# of jobs)
	Basin	OR				
Agriculture	15.3%	4.5%	3.4			
Farm Production	9.1%	2.9%	3.2			
Food Grains	4.3%	0.2%	18.9	64	38	2,036
Vegetables	2.4%	0.2%	15.0	101	74	1,385
Livestock	1.9%	0.7%	2.7	0.3	(40)	
Forestry & Logging &Fishing	0.4%	0.7%	0.5			
Agriculture and Forestry Serv.	3.9%	1.0%	4.0	9	(3)	361
Mining	0.7%	0.3%	2.0	45	30	382
Utilities	1.1%	0.2%	4.9			
Power Generation & Supply	1.1%	0.1%	7.4	250	210	800
Construction	3.3%	6.2%	0.5			
Manufacturing	12.7%	9.6%	1.3			
Food Processing	5.4%	1.0%	5.4			
Frozen Food Mnf.	4.1%	0.3%	15.1	522	246	3,831
Fruit & Veg. Canning & Drying	0.3%	0.2%	2.0	72	36	384
Cheese Mnf.	0.3%	0.0%	10.1	42	19	564
Wood Products	1.2%	1.5%	0.8			

Sawmill	0.4%	0.4%	1.1			
Mobil Home Mnf.	0.8%	0.1%	7.1	53	26	478
Transp. Equipment	4.9%	0.8%	6.0			
Light truck Mnf.	2.7%	0.1%	24.2	1,232	(175)	2,501
Travel Trailers &Campers	2.1%	0.1%	17.4	149	48	1,235
Wholesale Trade	2.0%	3.9%	0.5			
Transportation/Warehousing	6.4%	3.3%	1.9			
Rail Transportation	0.7%	0.1%	6.1	88	82	614
Truck transportation	1.6%	1.1%	1.5	18	18	214
Warehousing and storage	1.0%	0.3%	2.8	10	10	198
Retail Trade	9.1%	10.8%	0.8			
Information	0.8%	1.8%	0.4			
Finance and Insurance	2.2%	3.7%	0.6			
Real Estate and rental	2.0%	3.9%	0.5			
Professional-scientific &tech	2.1%	5.7%	0.4			
Management of companies	0.0%	1.3%	0.0			
Administration & waste services	5.0%	5.5%	0.9			
Educational srvs	0.5%	2.1%	0.3			
Health & social services	8.8%	10.4%	0.8			
Accommodation & food services	5.3%	6.8%	0.8			
Other services	4.7%	5.6%	0.8			
Government	17.1%	12.1%	1.4			
TOTAL	**46,002**	**2,264,537**	**NA**	**2,655**	**671**	**14,983**

Source: *Minnesota Implan Group, Inc., 2006 IMPLAN Database*

5.0 AGRICULTURAL ECONOMY IN THE BASIN AND OREGON

The preceding analysis shows that the farm production, food processing (mainly frozen food manufacturing, vegetable canning manufacturing, and cheese manufacturing), transportation and warehousing, and public utility sectors constitute the economic bases of the Basin. Furthermore, a large portion of food processing activities is dependent on farm products produced in the Basin. A significant portion of transportation and warehousing activities in the region can also be attributed to the agriculture sector and its value-added industries (food processing). For the purpose of this report, the farm production, food processing, and agricultural services sectors are lumped together and presented as an agriculture industry. In this section, a detailed description of the agriculture industry will be provided.

5.1 Farm Production

Harvested crop acreage and gross farm values and their respective share of Basin's total crop acreage and farm values for 2006 are presented in Table 9. In 2006, harvested crop acreage (irrigated and dryland) in the Basin was 617,920 acres accounting for about 21% of Oregon's total harvested crop acreage. The Basin has approximately 200,000 acres of irrigated cropland. Most of the irrigated land is located in northern parts of Umatilla and Morrow Counties near the Columbia River.

As is shown in Figure 7 and Table 9, the region hosts a variety of high value crops. However, the southern part of Morrow and Umatilla Counties is still almost exclusively dryland farming and livestock production.[14/] In 2006, approximately, 73% of the Basin's harvested cropland (or 435,700 acres) was allocated to wheat production. From 435,700 wheat acres, around 40,000 acres of it was irrigated (Oregon Agricultural Information Network). Irrigated wheat is usually used as a crop rotation for high value crops (i.e. potatoes)

Crop acreage in the Basin is focused primarily on the production of high value crops. The majority of the region's potatoes, field corn, alfalfa, vegetables and tree fruits are irrigated. High value crops grown are potatoes (23,000 acres), alfalfa hay (58,000 acres), and onions (8,300 acres). Other vegetable crops grown in the Basin are watermelon, carrots, green peas, sweet corn and asparagus. The Basin also has the world's largest hybrid poplar plantation.

[14] In recent years, a large cattle operation in Northern portion of Morrow County was established, which provides the necessary raw materials for a cheese plant located in the Port of Morrow industrial park.

5.2 Trends in Gross Farm Sales and Crop Acreage, the Basin

Figure 8 shows that the crop acreages in the Basin and the State have been decreasing since 1997. From 1997 to 2006, the crop acreages in Basin and State have decreased by 10% and 19%, respectively. Excluding the grain crops, the crop acreage in Umatilla Basin, however, increased by 3%. Examination of the acreages in the Basin shows there has been a shift from grain production (mainly wheat) to higher value crops and hay crops.

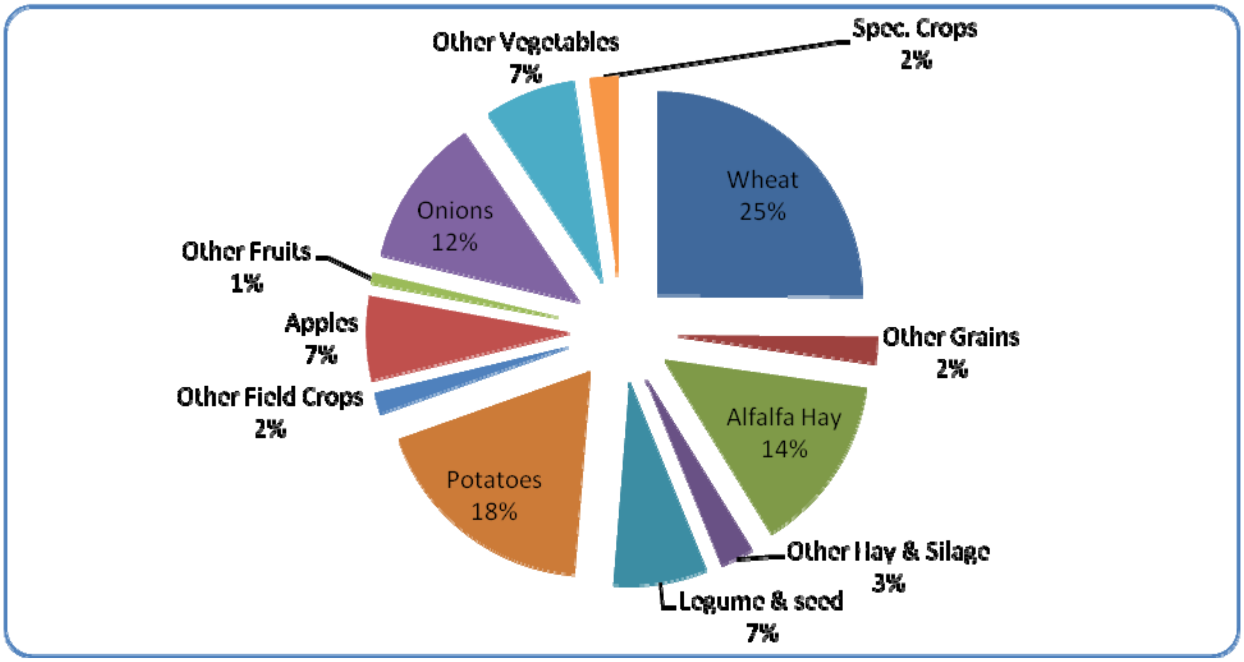
Table 9: Crop Acreage and Value of Agricultural Production in the Basin, 2006

	Crop Acreage	% of Region	Value of Production ($000)	% of Region
CROP PRODUCTION	617,920	100%	$ 540,811	100%
CROP GRAIN	449,050	73%	$ 102,582	29%
Wheat	435,700	71%	$ 94,684	26%
Barley	2,700	0%	$ 204	0%
Oats	650	0%	$ 44	0%
Corn for Grain	10,000	2%	$ 7,650	2%
HAY & FORAGE	75,150	12%	$ 62,503	17%
Alfalfa Hay	58,000	9%	$ 52,800	15%
GRASS & LEGUMES	18,378	3%	$ 24,989	7%
Kentucky Bluegrass	7,620	1%	$ 9,055	3%
Tall Fescue	4,290	1%	$ 7,079	2%
Perennial Ryegrass	4,320	1%	$ 7,386	2%
FIELD CROPS	32,542	5%	$ 74,716	21%
Potatoes	23,000	4%	$ 69,000	19%

Peppermint for Oil	4,000	1%	$	3,825	1%
TREE FRUIT & NUTS	3,762	1%	$	28,373	8%
Apples	2,386	0%	$	25,053	7%
Wine Grapes	836	0%	$	1,876	1%
VEGETABLES	12,460	2%	$	57,547	16%
Onions	8,300	1%	$	44,403	12%
Sweet Corn	1,930	0%	$	1,467	0%
Lima Beans	1,685	0%	$	1,515	0%
Other Vegetables	545	0%	$	10,161	3%
SPECIALTY PROD.	NA		$	8,820	2%
LIVESTOCK			$	98,426	27%
Cattle & Calves			$	95,415	27%
Others			$	3,011	1%
NOT DISCLOSED	26,573	4%	$	82,856	23%

Source: *2006 Oregon County and State Agricultural Estimates.*

Figure 7: Relative Share of the Basin's Value of Crop Production, 2006



Source: *2006 Oregon County and State Agricultural Estimates.*

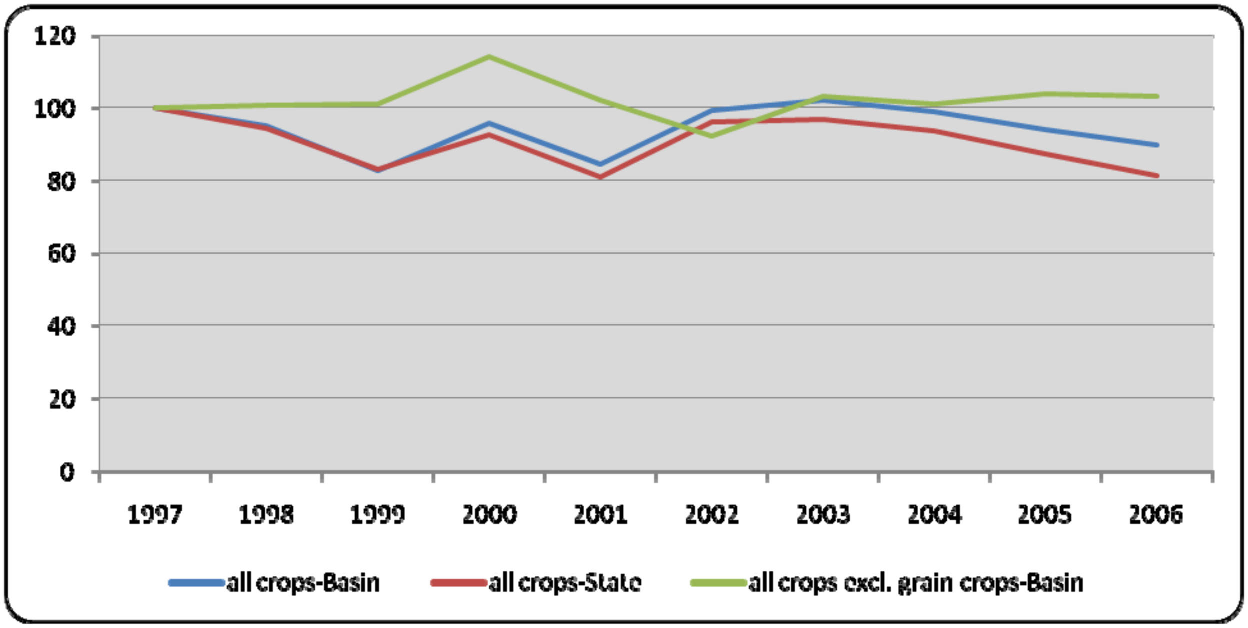
The trends overtime in the value of the Basin for grain crops, all crops excluding grain crops, all crops, and livestock production are presented in Figure 9. It shows that there been a significant variability in production value of grain crops, while excluding grain crops, the variability in total production value of other crops was significantly lower. Given the decline in grain acreages in recent years (Figure 8), the increase in production value of grain crops can be attributed to dramatic increases in grain prices in recent years. The value of production for grain crops, all crops excluding grain crops, and all crops, compared to 1997, increased by 131%, 124%, and 117%, respectively.

Livestock production has shown a dramatic increase in production in the last few years, increasing from $44 million in 1997 to $159 million in 2006, an increase of over 257 percent. The increase in livestock production can be directly attributed to an opening of a new cheese manufacturing.

5.3 Importance of the Basin Agriculture to Oregon Agriculture

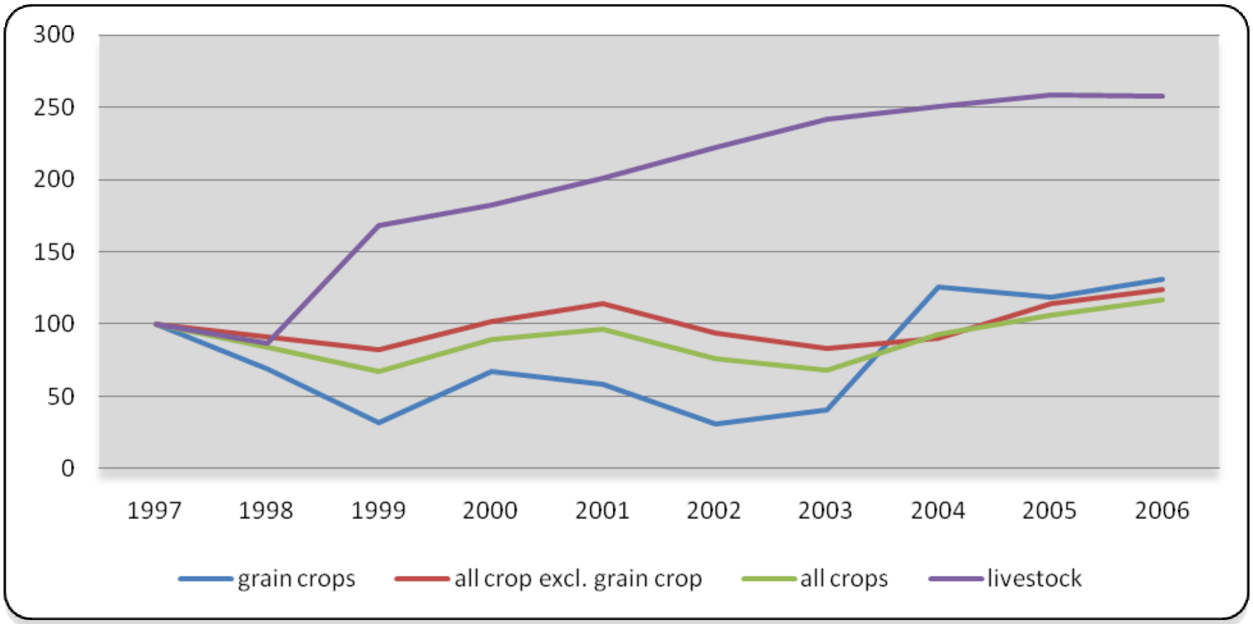
Table 10 presents the 2006 gross farm sales, percent of State's sales and State ranking by commodity group for the Basin. As is shown in Table 10, Basin's agriculture is very important to Oregon's agriculture and the State's economy. In 2006, the Basin's gross farm sales accounted for 12% of the State's total gross farm sales (or $536 million), which ranked second after Marion County. From $536 million, crop and livestock farm sales accounted for $377 million (or 12% of State's total crop sales) and $159 million (14% of all animal products sold in the State), respectively.

Figure 8: Trends in Crop Acreage, the Basin and Oregon, 1997-2006



Source: *Oregon County and State Agricultural Estimate, various years. Oregon Agricultural Information Network (ONIA), http://oregonstate.edu/oain/.*

Figure 9: Trends in Value of Production, the Basin, 1997-2006



Source: *Oregon County and State Agricultural Estimate, various years. Oregon Agricultural Information Network (ONIA), http://oregonstate.edu/oain/.*

In 2006, the Basin's grain production was valued at $102 million which accounted for 48% of state's total value of grain production. The Basin's field crop production accounted for 35% ($75 million) of the State's 2006 field crop production. In the same year, the vegetable crops production in the Basin accounted for 17% ($58 million) of total State's vegetable sales. Hay and silage, grass and legume seeds, tree fruits and nuts, and specialty products production in the Basin accounted for 20% ($62 million), 5% ($25 million), 10% ($29 million), and 1% ($9 million) respectively, of the State total gross farm sales. Cattle and Calves value was at $95 million, representing 15% of cattle and calves sales of the State.

Table 10: Gross Farm Sales, the Basin and Oregon – 2006

	Sales ($ mil)	% of State	Rank	Total State Sales ($ mil)
Grains	102	48%	1	214
Hays & Silage	62	20%	1	313

Grass & Legume Seeds	25	5%	7	483
Field Crops	75	35%	1	214
Tree Fruits & Nuts	29	10%	5	277
Vegetable Crops	58	17%	1	333
Specialty Products	9	1%	15	1,309
ALL CROPS	377	12%	2	3,269
Cattles and Calves	95	15%	1	636
All ANIMAL PRODUCTS	159	14%	1	1,163
TOTAL GROSS SALES	536	12%	2	4,432

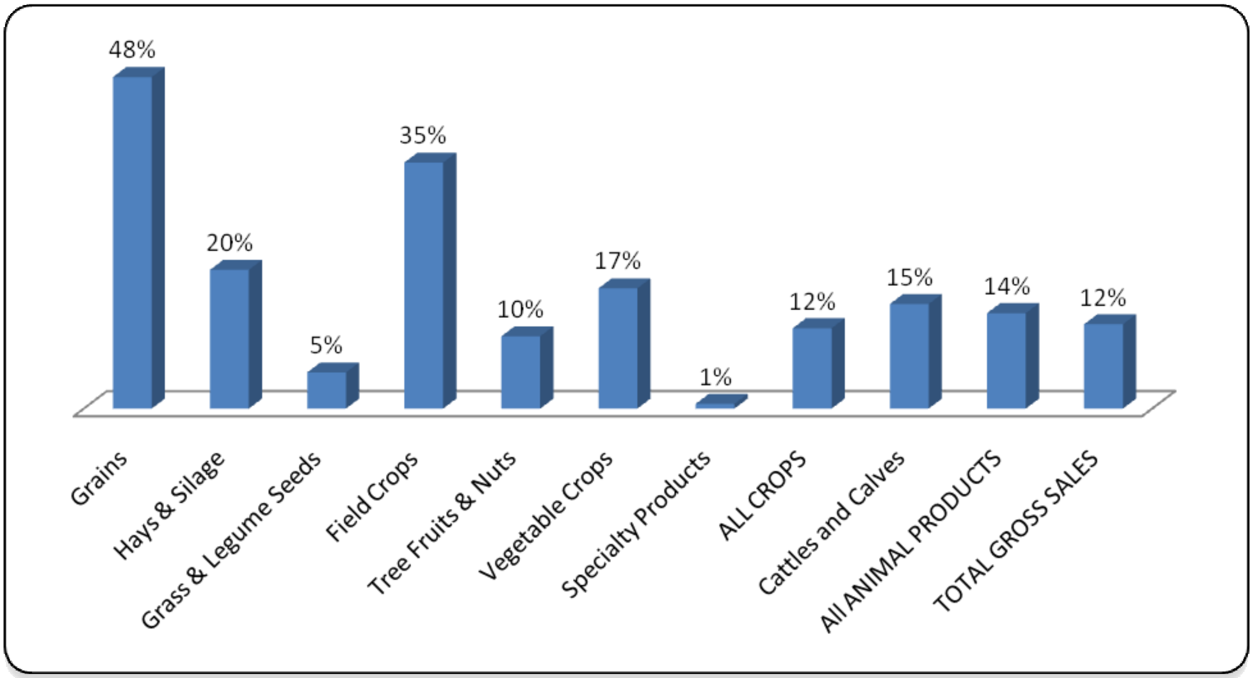
***Source**: 2006 Oregon County and State Agricultural Estimates.*

Table 10 also shows that the Basin's grain production, hay and silage, field crops, vegetable crops, cattle and calves sectors ranked first in the State in terms of 2006 gross farm sales. The Basin's gross farm sales of tree fruits and nuts, and specialty products ranked 5 and 15 in the State, respectively.

5.4 Basin Farm Production and Its Related Value-added Activities

In addition to the direct impact of farm production on the region's industrial output, income and employment, a vast network of support infrastructure has been built around the production of high-value crops (e.g. potatoes, green peas, alfalfa, carrots, onions, etc.). The increased production of high-value crops has stimulated the development of food processing plants in western Umatilla County and northern end of Morrow County. Food processing has become a major industry, producing frozen, canned, dehydrated fruits and vegetables. In 2006, the vegetable processing sector alone, which is highly dependent on locally produced farm products, accounted for 9% (or $610 million) of the Basin's industrial output and 5% (or 2,037 jobs) of the Basin's private employment (Table 7). French fries, dehydrated potatoes, dehydrated onions, frozen peas, frozen sweet corn, frozen carrots, etc. are the major food products produced in the Basin. As a result of a new cheese manufacturing plant, the livestock production in the Basin increased drastically. The value of cheese production in the Basin in 2006 accounted for 20% of the State's cheese production.

Figure 10: Relative Share of the Basin in State Gross Farm Sales, 2006.



Source: *1996 Oregon County and State Agricultural Estimates*

The role of agriculture industry (farm production, agricultural services and food processing) is significant and constitute a major component of the Basin's economy. The combined value of direct output from farm production, agricultural services and food processing sectors accounted for more than 20% (or $1.35 billion) of the Basin's 2006 total economic output (Table 7). In 2006, 9,509 jobs were directly employed in agricultural industry, representing roughly 21% of total employment (25% total private employment, excluding government) in the Basin (Table 7). The agriculture industry directly accounted for $411 million income (or 8% of the Basin 2006 earned income).

In order to fully capture the role of agricultural industry in the economy, the additional forward linkages (induced direct business activities beyond the farm and/or factory gate as a result of agricultural industry's production) should also be taken into account. Major forward linkages for agricultural industry within the Basin are transportation, warehousing, and wholesale trade sectors. However, specific data on economic relationship between these sectors to agricultural industry are not readily available. In the next section, this report uses IMPLAN database to estimate the linkages between agricultural industries and transportation, warehousing, and wholesale trade sectors.

The primary direct economic impacts that are generated by agriculture industry also create additional business activities through secondary or multiplier effects--stemming from the impacts of spending and re-spending of the new money (export activities). The resulting business activities further contribute to personal income, business income, federal tax revenue, State tax revenue, property tax revenue and saving. So, in determining the role of agriculture in the regional economy, it is necessary to consider both the direct and indirect (secondary) impacts. This is accomplished in next section.

5.5 Economic Impacts of the Agricultural Industry on Economy of the Basin [15/]

In this section, the economic impact of agriculture industry on the Basin's economy will be discussed. The economic impacts are estimated using the economic measures that include the changes in business output (sales), employment, and value-added. These are the economic indicators that are conventionally utilized within standard regional economic impact analysis.

In regional economic impact analysis, the economic impacts are categorized into three types: direct, indirect, and induced.[16/] In case of agriculture industry,

- Direct or Primary Impacts are the jobs, sales, and incomes generated by local businesses operating within agriculture sectors of the Basin.
- Indirect Impacts are the additional jobs, sales, and incomes generated in the economy as a result of local firms selling goods and services to the local businesses operating within agriculture sectors.
- Induced Impacts are additional jobs, sales, and incomes generated as individuals employed (directly or indirectly) by businesses operating within the agriculture sectors buy goods and services from local firms.

The total economic impact for each economic measure is the sum of the combined direct, indirect, and induced impacts.

Total economic impact estimates are compiled using Input-Output (I-O) models of Basin provided by Minnesota Implan Group, Inc (IMPLAN).

The direct economic contributions of farm production, food processing and agricultural services and transportation and warehousing are presented in Table 11. The direct impacts for farm production, food processing and agricultural services are directly derived from Table 7. However, as pointed out in the previous section, additional activities within the local economy are made beyond the farm gate and food processing factory gate that should be taken into account in impact analysis. Additionally, the extent to which wholesale trade, transportation, and warehousing sectors' businesses are directly tied

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[15 /] Agriculture industry generally includes as farm production, food processing, and agricultural services (Ziari, H and D. Olsen, Tanjunkio, et al.). In other studies agricultural industry also includes transportation, warehousing, wholesale trade (Sorte and Weber).

[16/] The indirect and induced effects are also called the secondary or multiplier effects.

to agriculture industry beyond the farm gate and food processing factory gate are not directly available. However, in a recent study of economic impact of agriculture on Oregon, Sorte and Webber suggested using retail margins, as provided in IMPLAN database, to estimate the direct induced impacts of agricultural industry, beyond the farm gate and processing factory gate, on transportation and warehousing, and wholesale trade activities. Since the marketing margins, as provided by the IMPLAN database, are the same at the State and the County levels, the approach makes sense at the State level or for a larger economic area, but it might overestimate at the County level. For this reason, only 50% of total impacts of the value added activities beyond the farm gate and processing factory gate associated with the agricultural industry were considered in this report.

Table 11: Direct Economic Impacts of Agriculture on Economy of Basin, 2006$

	Output ($mil)	Employment (# of jobs)	Value-added ($mil.)
Farm Production	465	5,250	212
Agricultural Services	52	1,772	37
Food Processing	833	2,487	176
Trans.& Warehousing	17	103	9
Wholesale Trade	70	626	49
TOTAL AGRICULTURE	1,437	10,238	483

Source*: Minnesota Implan Group, Inc. 2006 IMPLAN Database*

The total economic impacts of agricultural industry, in terms of sales, employment and value-added, on overall economy of the Basin are presented in Table 12.[17/] The 2006 estimates show that the agricultural industry generated $1.44 billion in direct business activity. The total regional impact of this output was estimated to be $1.872 billion, which accounted for 28% of Basin's total business activity. Ripple or secondary effects represent an additional $401 million in sales that was distributed throughout the Basin's economy. This implies that many other local establishments are heavily dependent on income and jobs generated by agricultural industry.

[17/] To avoid the double counting problem, the backward linkage between food processing and farm production sectors was eliminated prior to the estimation. The double counting problem stems from the fact that a large portion of food processing outputs accounts for the purchase of locally produced agricultural raw materials. Hence, adding the outputs from these two sectors would grossly overestimate the direct output impact on total economy. It should be noted that employment and income figures are free of problem of double counting.

Table 12: Total Economic Impacts of Agricultural Industry on Economy of the Basin, 2006$

	Agriculture Industry				
	Basin Total	Direct Impact	Total Impact	% of Total Economy	% of Total Private Sectors*
Sales (Output) ($million)	6,638	1,420	1,821	27%	30%
Employment (# of jobs)	46,000	10,090	14,326	31%	38%
Value-added ($million)	4,962	483	697	14%	16%

** Private sectors include all sectors excluding Federal, State and Local government sector.*

The same $1.420 billion direct output, directly and indirectly, generated $4.962 billion of value-added in the form of wages, salaries, profits and indirect business taxes and created 14,326 jobs (10,090 jobs directly and 4,236 jobs indirectly). In 2006, the Basin's agriculture industry provided 31% of Basin's jobs and 14% of Basin's total value-added. Excluding the government sector, Basin's agricultural industry accounted for 30% of the total business activities of the Basin and 38% of its total jobs (Table 12).

5.6 Economic Impacts of the Basin Agricultural Industry on Economy of Oregon

The direct economic impacts as presented in Table 11 were used to estimate the total economic impact of the Basin's agricultural industry on Oregon's economy. Prior to estimating the economic impacts, two adjustments of IMPLAN database were made. The first adjustment accounted for sectoral differences in output and earning per worker in the Basin and the State. So as to get the same output per worker, the IMPLAN model for the State was modified to reflect the same worker productivity as the Basin. The second adjustment was related to the direct induced impacts of agricultural industry, beyond the farm gate and processing factory gate, on transportation and warehousing, and wholesale trade activities. The direct impacts of transportation and warehousing, and wholesale trade were estimated using the method as discussed in the previous section. Furthermore, as discussed before, to avoid double counting, regional purchasing coefficients for agricultural sectors are set to zero so as to eliminate the backward linkages among agriculture sectors.

Table 13 shows the total economic impacts of Basin's agricultural industry on Oregon's economy. As shown in this table, the Basin's agricultural industry contribution to the State's 2006 economy included $2.6 billion in economic activities, 18,853 jobs, and $1.1 billion in value-added.

Table 13: Total Economic Impacts of the Basin Agricultural Industry on Economy of Oregon, 2006$

	Agriculture Industry			
	Total Oregon	Direct Impact	Total Impact	% of Total Economy
Sales Output ($million)	$ 92,350,597	$1,489	$2,559	0.0%
Employment (# of jobs)	$ 2,264,537	10,323	18,853	0.8%
Value-added ($million)	$ 48,818,936	513	1,083	0.0%

6.0 ECONOMIC BENEFITS

Ideally, in calculating the economic benefits of a project, both positive and negative impacts of a project from direct and indirect sources should be included in the analysis. This provides a complete picture of the net contribution of the project to the region's social welfare.

The Economic and Environmental Principals for Water and Related Land Resources Implementation Studies, commonly known as the P&G, is the government's principal planning document for water resource projects and lays out the factors the government must consider when calculating the benefits and costs of water resource projects. The P&G require that a project should be undertaken if the water diverted for the project has a positive direct net value. For the aquifer recharge project, it implies that the direct contribution to the national economy of the water diverted for irrigation, enhancing stream flows for fish migration and spawning in the Umatilla River, municipal, and groundwater replenishment should be weighed against the cost of construction and the opportunity costs of the Columbia River water for hydropower production, fish enhancement program, recreational activities and other uses.

For evaluation from the national perspective, the Federal P&G mandate that secondary (or regional) benefits are to be excluded in deriving the economic benefits. However, state and regional decision makers typically want to know how the proposed project can affect their state and county economics. It is therefore important to determine the economic impact of the project on regional economy in terms of regional income and employment from direct and indirect sources.

For the above reasons, the economic impacts of the aquifer recharge project are evaluated from both the national and regional perspectives. The first analysis is known as National Economic Development (NED) or economic efficiency analysis, and the second is known as Regional Economic Development (RED) or regional economic impact analysis.

6.1 National Economic Development (NED) Analysis

To date the detailed information about the scale of operation, timing of construction, sources of funds and temporal allocation of artificially stored water among potential water users have not been fully determined yet. This prevents us from a detailed cost and benefits analysis in this project. Hence, the economic analysis of the proposed project from a national prospective will be conducted based on the direct net economic value[18/] of the diverted water from the Columbia River. The direct net economic value can be estimated for alternative uses of water. The direct net value is a measure of net contribution to national economic development (social welfare) and is calculated by subtracting total costs from total benefits. By estimating the value of water for alternative uses in a standard unit (i.e., in per acre foot of water) it provides the necessary information for decision maker to compare the relative benefits of alternative uses of water. Furthermore, all values are expressed as annual values in 2006$, for equivalent comparison.

For the purpose of this study, the procedure first calls for identifying the direct impacts (positive and negative impacts) of the proposed project, and then estimating the direct economic value for each impact.

The potential direct impacts of the aquifer recharge project are as follow:

1) It would increase the production of agricultural products;
2) It has potential to decrease fish population in the Columbia River;
3) It has potential to increase fish population in the Umatilla River;
4) It would increase water supply for cities/residential in the Basin;
5) It could decrease the regional hydropower production capacity;
6) It has potential to reduce/increase the water flow in the Columbia River during months of October-March/ (April-September);
7) It has potential to reduce the recreational activities in the Columbia River;
8) It has potential to reduce the navigational activities in the Columbia River;
9) It has potential to increase recreation and fishery in the Umatilla River.

In the next sections, the potential direct impacts of the aquifer recharge project will be discussed.

6.1.1 Direct Economic Value of Irrigation Water

Water is used as one of the several inputs in production of agricultural outputs. Where water is sold in well functioning markets, market price would reflect the value of water. The market price would then reflect the maximum amount individuals are willing to pay for the water. However, water transactions for surface water supplies are rare in the many parts of country. In the absence of market prices, economists use various economic techniques, such as production function, farm crop budget, land price differential between dryland and irrigated lands, mathematical programming, and hedonic property

[18/] In economic literature also referred to as "economic benefit," "economic value," or "net economic benefit".

value to estimate the economic value of irrigation water indirectly; see Young (1996) for a description of the valuation methods and Gibbons (1986) for a summary of the resulting value estimates. In this study, the farm crop budget technique, also known as a residual imputation technique, is used to estimate the economic value of irrigation water for the Basin. This method is widely used for valuing irrigation water and is consistent with NED Principles and Guidelines for evaluating federal water project that ask for use of farm crop budgets as the basis of evaluation.

Based on the farm crop budget technique, the difference between the revenue (crop price multiplied by crop yield) and total crop production cost, divided by actual water use is recognized as economic value of irrigation water. This approach can be used to estimate the value of irrigation water for short run, long-run, and for an individual crop, or for multiple crops.[19/] The total production crop cost, from a long-run irrigation water valuation perspective, includes the cost of all inputs, other than raw water, which are used in the production of a specific crop. To correctly estimate the value of irrigation water from NED prospective, the opportunity costs of all resources including land, labor and management should also be included in the calculation of crop production cost.

Table 14 presents the data used to estimate the economic value of irrigation water for the Basin. Following discusses the procedures used in developing the data:

- Crop mix: The proposed crop mix presented in Table 14 is the average of actual crop mixes from 2004-2008 that was used by local farmers. Crop mixes were provided by IRZ Consulting, Hermiston, OR. It is based on 46,000 irrigated acres within CGA area and reflects the cropping pattern we can expect on newly developed irrigated lands, if the aquifer recharge project is implemented.[20/]
- Crop Prices: The crop prices are average crop prices from 2000 to 2007 in the Basin. The crop prices were obtained from Oregon State University (OSU) database. The prices were brought forward to 2006$ using consumer price index as provided by Bureau of Labor Statistics (BLS). Green peas price was not available on OSU database, thus, it was developed with consultation with growers in the Basin. Yield and crop price for carrot were obtained from Washington State University Agricultural Extension Services.
- Crop Yields: The crop yields for all crops, except wheat, green peas and carrots, were obtained from OSU database. The crop yields are crop average yields from 2000 to 2007. Crop yield for irrigated wheat was provided by IRZ Consulting. Crop yield for irrigated wheat crop, as provided by OSU and NASSA, reflected the average yield with partial and full irrigation practices and not reflective of fully irrigated wheat yield in the Basin.
- Crop Production Costs: Data for crop production costs were obtained from crop enterprise budgets developed by Washington State University Cooperative Extension

[19/] To compute the short run value, only the variable costs are subtracted; for the long run value, fixed costs are also subtracted. Long run values are appropriate for long run planning such as the aquifer recharge project.

[20/] Because of a large disclosed acres in OSU database (more than 26,000 acres in 2006; most of them irrigated croplands), IRZ data seemed to be more appropriate.

Services for Columbia Basin Project for various years.[21/] The costs were brought forward to 2006$ by producer price index for farm crops as provided by Bureau of Labor Statistics.[22/]

- Crop Water Use: These are the actual average crop water use in the area. They were obtained from historical data maintained by IRZ Consulting.

Based on the data presented in Table 13, the economic value of irrigation water in the Basin was estimated to be around $84/AF. This estimate is higher than estimates provided by Huppert et al. for the Columbia River Initiative (CRI) Project. They estimated $11/AF for irrigation water diverted from the Columbia River for the Columbia Basin Project (CBP) and $45-$60/AF for non-CBP area. The higher estimate in this report is attributed to the higher value crops grown within the Basin, the higher crop yields and the lower crop water usage. The higher crop yields and the lower crop water use are due to a combination of high efficiency irrigation systems and state of the art water conservation management practices in the Basin. However, our estimate is consistent with a recent study by Olsen and White. Based on irrigated versus non-irrigated land values and available water marketing information, they estimated the annual direct net value for irrigation to be about $90/AF., with a range of about $56-124/AF.

Table 14: Crop Mix, Crop Prices, Crop Yields, Total Production Cost, and Crop Water Use, Basin

Proposed Crop Mix	Crop Mix (%/ac)	Unit	Crop Yields (/ac)	Crop Prices ($/unit)	Crop Revenue $/ac	Total Cost $/ac	Crop Water Use AF
Alfalfa hay	24%	ton	7.5	117	878	1,065	3.03
Field Corn	12%	bu	230	2.92	672	835	2.9
Potatoes	16%	cwt	611	5.1	3,116	3,038	3.2
Onions	12%	cwt	639	7.8	4,984	2,695	2.8
Wheat	11%	bu	125	4.13	516	597	2.4
Sweet Corn, proc.	6%	ton	9	83	747	700	1.75
Green Peas, proc.	6%	ton	3.85	225	866	683	1.75
Peppermint for Oil	8%	lb	130	9	1,170	*	3.3

[21/] The crop budgets developed for Umatilla Basin by OSU are out of date.

[22/] The negative values that will result from the difference between crop revenue and total production cost (Table 14) do not imply that growing these crops is not profitable. Two factors should be considered. First, because of crop rotation requirements, the profitability of the whole farming is relevant not the individual crop. Second, the crop returns above the costs are economic returns not the accounting return; the opportunity cost of land, labor, and management are included in the total cost calculation (these costs are not out of pocket expenses).

Grass Seed	7%	lb	0.91	1,775	1,615	**	2.4
Other Veg. Crops –carrots	12%	ton	23	51.0	1,174	1,083	2.1
Wheat/fallow-dryland	0%	bu	50.06	4.13	207	255	0

* Crop budget for grass seed was not available, for calculation of economic value of irrigation water it was added to alfalfa hay acreage.

** Crop budget was not available for peppermint for oil, in calculation it was added to other vegetable crops.

In measuring NED benefits as defined in the P&Gs, the benefits comparison should be "with versus without" project. Hence, the economic value of irrigation water should reflect the difference between economic return with the project and without the project. Currently, the curtailed lands in CGAs are mostly in dryland wheat/fallow or low-value crop production. Based on the difference between "with" and "without" project, the economic value of irrigation water for the aquifer recharge project was estimated to be around $95/AF. [23/]

6.1.2 Economic Impact on Fish Enhancement Program and Recreation Activities

As planned, the aquifer recharge project would divert water from the Columbia River's McNary and John Day pools- during high-flow winter months and store the water in the aquifers for later use for irrigation, municipalities/domestic, stream flows for fish migration and spawning in the Umatilla River. The change in water flow in Columbia River can affect the level of downstream pools. Levels in streams and lakes can directly affect the quality of boating experiences, success at sport fishing, scenic beauty, and suitability for swimming and wading; they have long term effects on the viability of fish and wildlife habits (Loomis, 1998).[24/] Furthermore, some biologists argue that inadequate flows shorten the angling season and impede the reproduction of fish (especially, smolt survival rate). Thus, the project has potential to impact the recreational activities and fish resources in Umatilla River and the Columbia River. Potential economic impacts of the UBARG Project on recreational activities and fish resources on the Columbia River and Umatilla River are discussed below.

6.1.2.1 Impacts on the Columbia River

Water diversion from the Columbia River can have potential adverse impacts on fishing and non-fishing recreational activities[25/]. However, a measurable adverse economic impact depends on the timing of diversion and the quantity of water diverted. In this section, we discuss whether the water diversion has a measurable economic impact on the recreational activities, so as to include it into the economic analysis.

[23/] Since, the potential impact of aquifer replenishment program on water tables has not yet been quantified, the estimate for irrigation value does not include the potential savings to irrigators to the gradual decline in pumping lifts.

[25/] Non-fishing recreational activities include boating, picnicking, swimming, etc.

The impact of the proposed project on the non-fishing recreational activities depends on its impact on the reservoir level on the affected pools, mainly McNary Pool and John Day Pool, and the flow rate. The aquifer recharge project intends to divert at most 100,000 +/- AF of water from Columbia River during winter periods (Table 1). Table 15 shows the monthly minimum, mean and maximum water flows from 1960-1999 in John Day Dam. It also shows the current monthly water withdrawals (withdrawals w/o project column). When the water diversion proposed for aquifer recharge project is added to the existing water diversions during January, February and March months, the flow rates do not show significant changes on those months. The increase in withdrawals as a result of aquifer recharge project would increase January, February and March withdrawals from 0.2%, 0.17%, and 1.8% to 0.8%, 0.7% and 2.2% of Columbia River minimum flows, respectively. It implies that 100,000+/- acre-ft of water withdrawal is too small to have a measurable effect on the flow rate and reservoir levels on the affected pools. Hence, the aquifer recharge project cannot adversely affect the non-fishing recreational activities on John Day and upstream pools.

Table 15: Water Flows and Water Withdrawals, Columbia River, 1960-1999

Month	Water Flows, 1960-1999			Withdrawals			Percent of		
	Maximum	Mean	Minimum	w/o UBAGR project	w/ aquifer recharge project	Total	max.	mean	Min.
Jan	16,200	9,690	5,430	10.8	33	44	0.3%	0.5%	0.8%
Feb	18,200	9,500	5,740	10	33	43	0.2%	0.5%	0.7%
Mar	20,400	11,100	6,200	110	34	144	0.7%	1.3%	2.3%
Apr	19,800	12,100	5,920	597	0	597	3.0%	4.9%	10.1%
May	29,400	17,200	8,110	765	0	765	2.6%	4.4%	9.4%
Jun	34,700	19,000	7,120	792	0	792	2.3%	4.2%	11.1%
Jul	21,400	12,500	5,110	850	0	850	4.0%	6.8%	16.6%
Aug	13,400	8,390	5,420	793	0	793	5.9%	9.5%	14.6%
Sep	9,260	6,420	4,280	498	0	498	5.4%	7.8%	11.6%
Oct	10,400	6,910	5,430	274	0	274	2.6%	4.0%	5.0%
Nov	9,280	7,340	5,170	12.3	0	12	0.1%	0.2%	0.2%
Dec	15,100	8,870	5,210	11.7	0	12	0.1%	0.1%	0.2%

Source: *Water flows and withdrawals are obtained from National Research Center: Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival.*

The level of fishing recreational activities depends on the fish population, which in turn is a function of smolt-adult survival rate throughout the river system. Many studies have focused on identifying the relationship between river flow rate, survival of out-migration smolts, and smolt-adult survival rate.[26/] These studies show that the reduced flows could adversely affect survival rates of salmon and steelhead populations that are listed as threatened or endangered species under the Endangered Species Act.[27/] To protect and enhance the survival of out-migration smolts, federal agencies set monthly target flow rates in Columbia River system.

Table 16 shows the monthly 50% exceedance flows[28/], monthly target flows and monthly water availability, and proposed monthly water diversion in AF for aquifer recharge project. As it is shown in Table 15, the Columbia River has sufficient water available to meet the aquifer recharge project of 100,000 AF withdrawals and target flows for fish enhancement programs. The 100,000 AF diversion accounts for 1.3% of total water availability as presented in Table 15. The proposed water diversion during Jan, Feb, and Mar would account for 5%, 3%, and 3% of water availabilities net of target flows during Jan, Feb, and Mar, respectively. Furthermore, as presented in Table 16, there is a small amount of water withdrawals by other users during Jan, Feb, and Mar. In a technical review of the aquifer recharge project by HDR, it was concluded that it is unlikely that the proposed diversions would interfere with the fisheries migration times in the Columbia River when flows are in the order of >416,000 AF during the periods when diversion is proposed.

Another important factor that should be considered is that the system operation of the Columbia River also minimizes any cumulative impact of water withdrawal on seasonal flow requirements for fish migration and recreational activities. This is because the system planners typically retain enough water in the reservoirs through the seasons to provide flows necessary for fish migration, irrigation, municipal and industrial water use, and flood control. Once water requirements by users other than power are met, the water will then be allocated to optimize the power production. The large amount of annual runoff of the Columbia River, coupled with flexibility, in scheduling water releases from storage and

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26/ Flow rate influences both the travel time for migrant fish and the water temperature. Both of them can affect the survival rate and the fish population.

27/ In a recent study of the Columbia River, a panel of scientists concluded that "within the body of scientific literature reviewed as part of this study, the relative importance of various environmental variables on smolt survival is not clearly established. When river flows become critically low or water temperatures excessively high, however, pronounced changes in salmon migratory behavior and lower survival rates are expected." (National Research Center). Based on their conclusion, the relationship between flow rate and smolt-adult survival rate might not be strong on an average year.

28/ 50% exceedance flow is the stream flow rate derived statistically from flow records that represents the monthly-averaged flow value with a 50 percent probability of being exceeded in any given year; Oregon Water Resource Department (2002) uses the 50% exceedance natural flow values to evaluate the availability of water for appropriation for storage projects in Oregon.

filling reservoirs, allow the system planners to meet the flow requirements. We believe that the potential cumulative adverse economic and environmental impacts of the proposed project on the fish enhancement programs and recreational activities in the Columbia River, on average, would be too small to be measurable. Therefore, the diversion from the Columbia River would not have any measurable economic impact on recreational activities needs to be incorporated into the economic analysis.

6.1.2.2 Impacts on Umatilla River

Based on the current proposed plan, the aquifer recharge project would allocate some of the artificially stored water to instream flow augmentation in Umatilla River. In this section, the economic benefits of flow augmentation will be discussed.

Table 16: Monthly 50% Exceedance Flows, Target Flows and Water Availability, Proposed Monthly Water Diversions, AF

Month	50% Exceedance Flows (AF)	Target Flows* (AF)		Water Availability (AF)	Proposed Water Diversion** (AF)
		Bonneville	McNary		
Jan	6,486,480	6,652,800	None	624,324	33,000
Feb	6,860,700	6,652,800	None	999,167	33,000
Mar	6,943,860	6,652,800	None	1,028,856	34,000
Apr	7,858,620	6,652,800	10,810,800	N/A	None
May	10,353,420	None	10,810,800	N/A	None
Jun	10,769,220	None	10,810,800	N/A	None
Jul	6,943,860	None	8,316,000	N/A	None
Aug	5,322,240	None	8,316,000	N/A	None
Sep	4,490,640	None	None	4,490,640	None
Oct	4,615,380	None	None	457,380	None
Nov	5,239,080	6,652,800	None	N/A	None
Dec	6,070,680	6,652,800	None	3,742	None

* Target flows are the level identified in the NOAA Fisheries FCRPS BA and Biological Opinion;

** The 100,000 AF water withdrawal is the maximum amount that is considered, and the monthly diversion rate is the potential pumping schedule so as to minimize the adverse impact on the flow rate in the Columbia River.

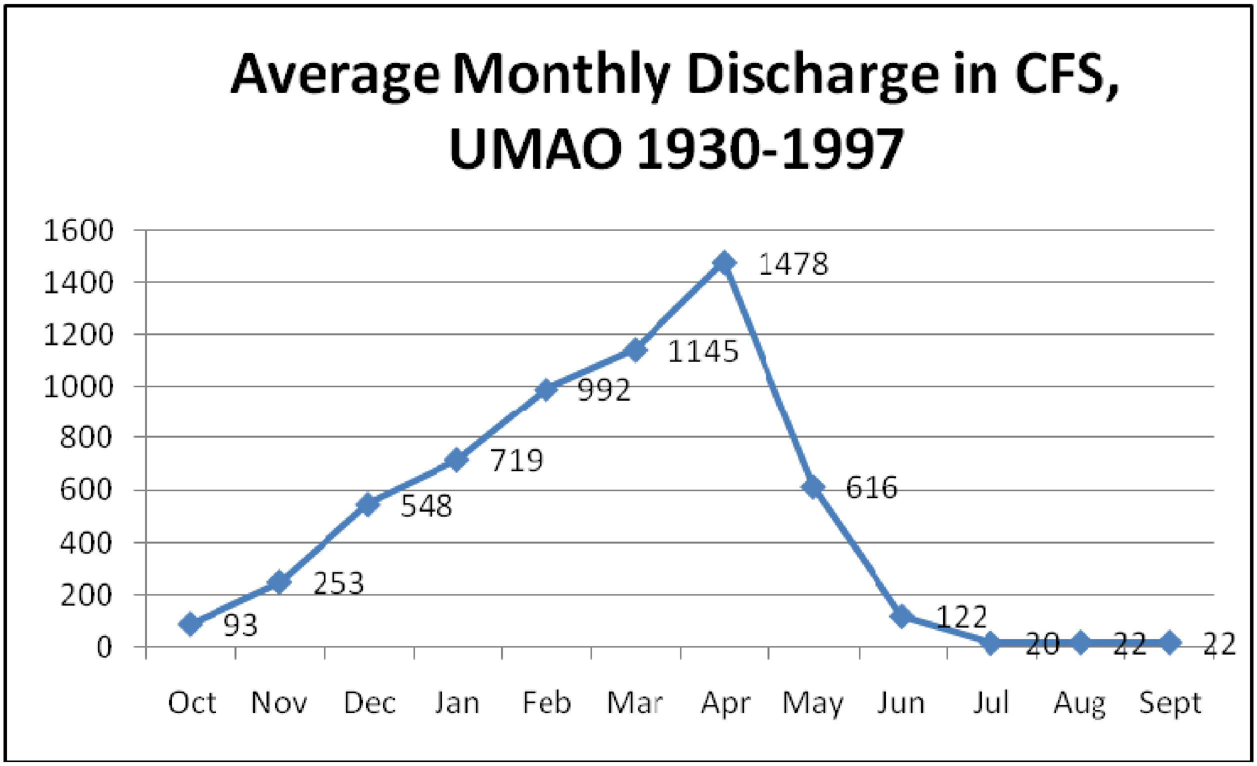
***Source**: OWRD December 2007. Water availability is estimated by subtracting the target stream flows from the 50% exceedance stream flow.*

Background Information - The Umatilla River is a tributary of the Columbia River, joining the Columbia just below McNary Dam. It originates on the slopes of the Blue Mountains at nearly 5,500 ft in elevation and its drainage basin is 3,714 square miles.

Water development for irrigation using Umatilla River water has a long history. The first large irrigation canal was constructed in 1903. In 1905, Bureau of Reclamation (BOR) undertook the Umatilla Project, for purpose of irrigating 60,000 acres of land. Four irrigation districts are supported by six diversion dams and two reservoirs, Cold Springs and McKay Reservoirs. The reservoirs were designed to store spring run-off for use during the crop growing season.

Figure 11 shows the average monthly discharge for the period 1930-1997 for USGS gauging station at UMAO, which is located near the mouth of the Umatilla River (river mile 2.1) or confluence with the Columbia River. Flows in the Umatilla River are heavily dependent on winter snowpack, as characterized by high peaks during the early spring and often extremely low flows in the summer. Average monthly discharge at UMAO varies from 1,478 cubic feet per second (cfs) in April to 20 (cfs) in July for the period of record of 1930-1997. The average annual discharge of 474 cfs is, however, lower than the natural discharge due to summer diversions for irrigation. (Umatilla County Critical Groundwater Task Force, p.24).

Figure 11: Average Monthly Discharge in CFS, Umatilla River



Source: *Umatilla County Critical Groundwater Task Force. 2008. Umatilla Sub-Basin 2050 Water Management Plan. Prepared for Umatilla County, Oregon.*

Historically, inadequate flow during the summer months and migration conditions were contributor to the extirpation of salmon and decline of summer steelhead trout populations in the Umatilla River. To address the inadequate migration conditions, Umatilla Basin Project (UB Project) was authorized and funded by the U.S. Congress in 1988. The project includes the diversion and conveyance infrastructure needed to deliver Columbia River water to irrigation districts in exchange for an equivalent amount of Umatilla River water left instream.

In addition to the water exchange program, the UB Project also incorporated fish passage improvements, habitat restoration, trapping and transportation of adults and juveniles. Phase I of the project involves pumping water, up to 5,821 AF (140 cfc), from the Columbia River into the West Extension Irrigation District system, to offset diversion of Umatilla River water when flows in that river drop below target values. Phase II of the project involves exchanging up to 9,980 AF (or 240 cfs) of Umatilla River and McKay Reservoir water for Columbia River water for use by the Stanfield and Hermiston Irrigation Districts. This results in water, which had historically been diverted from live flow and from McKay Reservoir releases, being retained for instream uses. As a result, in 2003, approximately 65,000 AF of water were used to maintain instream flow in the Umatilla River below McKay Creek (Umatilla County Critical Groundwater Task Force). Phase III of the UB Project, which would involve a complete exchange of water in the Umatilla River used by Westland Irrigation District with Columbia River has not been funded yet.

The Umatilla Basin Project has partially restored Umatilla River stream flows and allowed three stocks of salmon to be reintroduced and partially recovered (Umatilla County Critical Groundwater Task Force). Currently, the Umatilla River supports populations of spring and fall Chinook salmon, resident rainbow, and anadromous rainbow trout (steelhead) among other species. Coho salmon were extirpated, but have been reintroduced. The river supports tribal and sport fisheries for spring Chinook and steelhead.

Although, the UB Project has restored some of the instream flow conditions in the Umatilla River, still the instream flow may not be adequate during summer months and especially in low-flow years. There will be years in which there is simply not enough water available to meet recommended flows. As discussed before, the decrease in flow is due partly to natural reduction in snow pack and runoff and partly to summer irrigation withdrawals. Significant flow augmentation occurs from McKay Reservoir. However, during parts of the summer this flow augmentation is largely withdrawn from the Umatilla River before it reaches the Columbia River. Observed summer flows increase dramatically downstream of the McKay Creek confluence, where nearly 200 cfs of McKay Reservoir water enters the Umatilla River (Oregon Department of Environmental Quality 2001). Umatilla River flows then decrease dramatically due to irrigation diversions (IRZ Consulting Technical Memorandum, 2008). As a result, the allocation of water for fish enhancement program under the aquifer recharge project can have the potential to improve aquatic habitat, through an increase in instream water and lower stream temperature on average-flow years, especially during the low-flow years when there might not be enough water available to meet recommended flows.

Economic Value of River Flow Augmentation – The value of instream use in maintaining habitat for aquatic organisms could be large, but it is a very difficult problem to estimate. This problem is summarized by xx, "Economists attempting to evaluate the economics of fish and wildlife programs are faced with some of the most difficult of economic analyses. One is trying to address the benefits of the various program measures. ….., the effects of measures on fish and wildlife are often unknown. Ecological systems are complex, poorly understood, and difficult to predict. Even if biologists could predict the effects of measures on salmon, valuing the increased numbers of fish would be a difficult economic problem. Commercial harvest values of salmon are not too difficult to determine. However, valuing the recreational harvest involves indirect measurement of value through surveys based on contingent value or travel cost methods to determine willingness to pay or willingness to be compensated. Even more difficult to quantify, are existence values of natural resources like fish and wildlife or the religious and ceremonial value of salmon for northwest Indian tribes."[29/] Although, it is difficult to estimate directly the value of allocating the artificially stored water for instream use, this report uses other alternatives (discussed below) to compare the cost of achieving the same flow augmentation effects using different water delivery systems. This would give us some sense of magnitude of the economic contribution of the aquifer recharge project.

[29/] Economists characterize the values placed by society on environmental and natural resources as *use value*, where a natural resource is directly used or experiences by individuals, and *nonuse value or passive use*, where individuals may place a value on the current or potential existence of an environmental service, even though they may not directly use or consume it. There is also *option value* which reflects the values some individuals who currently are non-users but are willing to pay now for probable future use. Option value lies between use and non-use values. It should be noted that there is considerable controversy among economists on how to measure the nonuse and option values.

Impact on Recreational Activities: If we assume the fish in stream would benefit if instream flows were increased by selected amounts, then we can estimate the value of instream water by its impact on recreational activities across the Columbia River system using the procedures as described by Huppert et. al. or Economic Technical Report for the Yakima River Basin. Unfortunately, the potential impact on fish population as a result of increase in Umatilla River's instream flows is not yet known, so we do not provide a number. However, to get a sense of magnitude of its impact, the values of fish for various recreational activities within Columbia River System are presented in Table 17.

Table 17: Values of Recreational Activities in Columbia River Basin

Study	Site Description	Recreational Activity	Value/fish
Economic Technical Report for the Yakima River Basin (2008)*	Pacific Ocean	Commercial:	
		Coho Salmon	$ 8.07
		Spring Chinook Salmon	$ 25.57
	Pacific Ocean	Fall Chinook Salmon	$ 25.57
		Sport:	
		Coho Salmon	$118.54
		Spring Chinook Salmon	$101.49
		Fall Chinook Salmon	$101.49
	Yakima River	Ceremonial & Subsistence:	
		Coho Salmon	$ 3.89
		Spring Chinook Salmon	$ 28.20
		Fall Chinook Salmon	$ 10.97
Olsen, Richards, Scott (1991)**	Columbia River Basin	Salmon & Steelhead	$ 78.58
Layton, Brown, & Plummer (1999)**	Columbia River Basin	Salmon & Steelhead	$144.43

* Use Value only. ** Total Value (use and non-use values).

Source*: adopted from "Economics Technical Report for the Yakima River Basin." Bureau of Reclamation, Technical Series No. TS-YSS-23, January 2008.*

Water Acquisition for Instream Use: Water acquisition involves the purchase or lease of irrigated land or water rights for instream water use. For the purpose of this report, one can use the water acquisition cost for instream use as a proxy for valuing water for flow augmentation in Umatilla River. Jeager and Mikesell documented water acquisitions for instream use in Oregon and Washington (Table 18). But, due to a) small number of the transactions, b) small quantity of water involved and c) lack of comparability to the site, their water market transactions has a limited use for this report. Because of dominance of high value crops in the Basin, the irrigated land values and hence water right values in the Basin are many times greater than the values Jaeger and Mikesell documented in their report for Oregon.[30/] However, interestingly the average water rights value for Washington locations as presented in Table 18 ($72.86 in 2000$ or $84.50 in 2006$) is comparable to the irrigation value estimated for the Basin in previous section of this report. Nevertheless, the number of transactions documented in report for Washington was small (Table 18), but the volume of water traded was significant to support $84.50 as a potential value of instream use.

Table 18: Water Rights Transaction to Augment Streamflows (in 2000 $)

Selected Locations	Current Use	Contract Type	Consumptive Use (AF/year)	Price Paid	Cost/AF
<u>Oregon Locations</u>					
Deschutes River, Squaw Creek	Pasture	Purchase	417.19	$ 42,900	$ 6.17
Deschutes River, Squaw Creek	Pasture	Purchase	308.08	$ 44,352	$ 8.64
Hood River, Fifteenmile Creek	Wheat	Purchase	71.76	$ 26,307	$ 22.00
				Average:	**$ 9.16**
Umatilla River, E. Birch Creek	Hay	one-year lease	238.5	$ 2,500	$ 10.48
John Day River, Hay Creek	Hay	one-year lease	248.8	$ 14,500	$ 58.28
Umatilla River, Couse Creek	Wheat/Pea	one-year lease	1065.9	$ 23,800	$ 22.33
				Average:	**$23.19**
<u>Washington Locations</u>					
Teanaway River, Kittitas County	na	Purchase	302	$ 300,000	$ 59.60
Teanaway River, Kittitas County	na	Purchase	121	$ 160,000	$ 79.34
Big Creek, Kittitas County	na	Purchase	113	$ 150,000	$ 79.64
				Average:**	**$ 72.86**

*A 6% discount rate was used by the authors to compute annualized cost of permanent acquisitions.
** Other water transactions in Washington State reported by Jaeger & Mikesell were in order of 2 AF, hence, was not reported here.

Source: *Jaeger and Mikesell.*

<u>*Cost of Alternative Sources of Water*</u>: In this approach, the value of instream water is estimated by identifying the cost of providing the same amount of instream water using different methods of

[30/] Due to time constraints, this report did not look at new water right transactions in Umatilla Basin.

delivery. The cost of alternative sources of water can be utilized in context of instream valuation in two ways. Under assumption of a benefit/cost ratio equal or greater than one, the cost of alternative delivery reflects the present value of future benefits of the project. Or, in benefit-cost analysis, one can deduct the cost of alternative delivery of water from the cost of the proposed project and assign a zero value for instream use value.

Since it is costly to develop an engineering design for alternative way of obtaining the water for instream use in Umatilla River, this report uses secondary data for this purpose. For the purpose of this report, we considered the UB Project and Salmon Creek Project in Washington.

The mission of UB Project (UBP) was discussed briefly in the previous section. It appears that the UB Project may be the best alternative to estimate the cost of alternative sources of water for instream use. But the project is convoluted with economics, politics, tribal water rights, and cultural value of restoring the salmon run in the Umatilla River. These made it very difficult to analyze the project features in totality, given the time and budgetary constraint, to achieve the goal of estimating the cost of alternative sources of water. Nevertheless, some cost estimates, provided below, can provide insights into the value that the society, through political process, has assigned to the instream value of water in the Umatilla River.

- First nine years of Phase I and II is estimated to cost $56 million.
- The cost of pumping water from the Columbia River for Phase I and II is estimated at $1.5 million per year.
- Phase III originally was estimated to cost $65 million, but, presently some estimate the cost to be around $220 million.

Salmon Creek Project was initiated with collaboration between the Okanogan Irrigation District and the Colville Confederated Tribes to restore anadromous fish to Salmon Creek, a tributary of the Okanogan River in Northern Washington. Salmon Creek drains about 167 square miles on the eastern slopes of the North Cascade Range in Okanogan County. Conconully Reservoir and Salmon Lake, about 15 miles upstream of the Okanogan River, together provide 23,500 AF of storage space. Long term historical average runoff above Conconully dam is estimated to be 21,700 AF, ranging from 1,500 to 67,000 AF. Controlled releases from Conconully Reservoir are diverted 4.3 miles above the Okanogan confluence for irrigation of about 5,000 acres within the Okanogan Irrigation District. Primary crops are apples, pears, alfalfa, pasture, and urban yards and gardens. It was estimated that 7,122 to 9,737 AF of water, in addition to what the watershed naturally provides would be required to meet the seasonal needs of irrigators and the year-round life cycles of steelhead and spring Chinook in the creek.[31/]

Okanogan River water exchange project costs are presented in Table 19. The $1,716/per AF (in 2000 dollar) presents the cost of exchange project from regional perspective. From national perspective, the total cost of the Salmon Creek exchange project is estimated to be $2,032/AF (in 2000 dollar), which includes costs of Salmon Lake dam and feeder canal improvements paid by U.S. taxpayers (Northwest Power Planning Council, 2000).

[31/] The information on Salmon Creek Project was obtained from Northwest Power Planning Council, 2000.

Table 19: Per AF Cost Estimate for Salmon Creek Project, 2000$

Acre-Feet	Capital Cost	O&M Cost	Present Value of Total Cost	$/AF
7,234	$6,825,000	$298,845	$12,415,515	$1,716

***** The present value of total cost includes the capital cost plus the present value of O&M cost discounted at 4% (assuming a planning horizon of 50 years).

***Source**: Northwest Power Planning Council, 2000*

According to the analysis made by Independent Economic Analysis Board (IEAB), the Salmon Creek Project appears to be cost-effective relative to water acquisition. In other words, it would cost the project $2,032/ per AF to achieve the same objective if the water was purchased from irrigators or other sources. In economics, the market value reflects the annualized values of capital (purchased price of water). The annualized value of $2,032, using a 4% discount rate and 50 years planning horizon, is $110/AF (or $128 AF in 2006 dollar).

Based on the above analysis, the allocation of artificially stored water for instream use in Umatilla River is estimated to be within a range between $84.50/AF and $128/AF. However, these values do not imply the economic value of recreational activities as a result of increase instream flows for fisheries. It simply states that, without the aquifer recharge project, it would cost a range between $84.50/AF and $128/AF to achieve the same flow augmentation objective. If the cost is incurred by the U.S. tax payers, then the range between $84.50/AF and $128/AF for instream use is consistent with the NED account and could be considered the economic value of allocation of artificially stored water for instream use in Umatilla River.

6.1.3 Direct Impact on Hydropower Production

Water withdrawal from the John Day pool for the aquifer recharge project reduces hydroelectric power generation capacity in downstream hydroelectric projects. The reduction in power output can be measured by calculating the net water withdrawals and assigning a power cost to the foregone energy. As discussed before, as planned, the artificially stored water in aquifers will be used for irrigation, municipal/domestic uses, and Umatilla River flow augmentation program. So, some of the water withdrawals from John Day pool will be returned to the Columbia River through Umatilla River. Table 20 shows the water withdrawal, water return and hydropower lost for three alternative project options.

The annual value of the foregone hydropower generation attributed to the aquifer recharge project for SSRD 1 Option 2&3, SSRD 1 Option 1, and Full-Project options were estimated to be $227,050 ($4.13/AF), $421,530 ($4.22/AF), and $703,469 ($4.44/AF) of diverted water, respectively.

Table 20: Water Withdrawals, Expected Return Flows, and Expected Net Energy Lost

	Proposed Diversion (AF)	Return Flows to John Day Pool			Net Diversion (AF)	Cost ($/AF) *	Lost Hydro-power
		Irrigation (1.8%)*	River Flow Augmentation (100%)	Municipal & Domestic (90%)*			

SSRD 1 Option 2&3	54,900	666	14,000	540	39,694	$5.72	$227,050
SSRD 1 Option 1	99,830	1,236	24,000	900	73,694	$5.72	$421,530
Full-Project	158,330	2,046	27,000	6300	122,984	$5.72	$703,469

* These information were obtained from Huppert. et al. The energy cost per acre foot is based on average price forecast for 2004-2024. This is a cumulative cost through the Columbia River system.

6.1.4 Direct Impact on Aquifer Replenishment

A major impetus for the aquifer recharge project is to replenish the aquifer and reverse ground water declines in existing domestic and municipal, and irrigator wells in CGWAs. As planned, under SSRD 1 Option 2&3, SSRD 1 Option 1, and Full-Project options, annually 3,300, 6,166, and 10,666 AF of artificially stored water would be allocated for aquifer replenishment. The aquifer replenishment would also have other positive impacts:

- It would reduce the pumping lifts and hence pumping costs for irrigators, municipalities and domestic users.
- It is possible that if the aquifer recharge project is implemented, it would not be necessary to deepen existing wells.
- It has potential to improve ground water quality.

The specific wells within CGWAs that might be positively affected by an increase in water level are not yet determined. Hence, the economic benefit of decline in pumping lifts and other potential indirect benefits are not included in the analysis. Studies by Richard and Bredehoeft, and also by Donovan, et al. however show that the lower energy cost for pumping, as a result of increase in water level can be economically significant.

Traditionally, techniques for quantifying the economic value of ground water resources include:[32/]

- Contingent valuation, which essentially involves asking people how much they would pay to maintain the resources or services dependent on it under carefully specified conditions.
- Hedonic pricing, e.g. obtaining a measure of the value of groundwater through differences in the value of lands with and without access to it.
- Loss analysis, estimating the value of groundwater as equivalent to the total social costs incurred when drought or depletion constrain economic activity.
- Averting behavior in which the value of groundwater is estimated by the investments made to avoid water shortage.

[32/] http://www.fao.org/docrep/005/y4502e/y4502e00.HTM, visited Feb 12, 2009.

- Substitution, the value of groundwater as equivalent to the least cost alternative source of supply for meeting the same set of services.
- Derived demand and production cost analysis, essentially estimating the contribution of water to profits within a given set of economic activities.

The last technique is the most appropriate for evaluating the value of allocating artificially stored water for the aquifer replenishment. For the purpose of this analysis, the relevant alternative use of water is for irrigation. Based on this assumption, the value of water for aquifer replenishment is set at $95/AF (this is the value of irrigation water that was estimated earlier). Since other direct and indirect benefits that may result from aquifer replenishment plan were not included in the analysis, the $95/AF should be considered as the lower limit of the range.

6.1.5 Direct Impact on Municipal and Domestic Uses

The alluvial and shallowest basalt aquifers are the main sources of domestic water for rural residents in the area. As planned, some of artificially stored water will be tapped for allocating to municipal/domestic uses. Depending on engineering design options, between 0 to 7,000 AF of stored water is planned to be allocated for municipal/domestic uses.

Estimating the economic value of water for the municipal/domestic use is a difficult task. The difficulty mainly arises due to the role of water in human life and the lack of substitution for the water. Compared to the other users of water, many municipalities, facing a severe water supply constraint, are willing and also able to pay significantly higher prices for the water. In general, the economic value of water for municipal use can be obtained through a) use of demand elasticity[33/], b) analysis of regional water market transactions, c) the opportunity costs of the alternative uses of the water, and e) the cost of obtaining additional water through alternative sources of supply. Additionally, the value of water for a city needs to be estimated within overall context of alternative water supply sources, capital and maintenance costs associated with alternative water supplies, expected water demand and supply conditions, and availability of alternative sources of financing.

A direct estimation of value of the water allocated for the municipal/domestic uses under the aquifer recharge project is beyond the scope and budget constraint. Nevertheless, for the purpose of this report, the value of artificially stored water allocated for municipal/domestic use was assumed to be the value of municipal water used by the Bureau of Reclamation for Yakima Storage Project (Bureau of Reclamation, 2008).

In a recent study of Yakima Storage Project, the Bureau of Reclamation used a $235.66 per acre-foot wholesale price of municipal water to value the annual supply of municipal water (obtained from 2006 M&I Water Rate Survey Data, Bureau of Reclamation, Contract Services Office, 2006). The report assumed that the municipalities in search of municipal water could obtain the water at wholesale rates which was estimated to be $235.66.

[33/] It is mainly used for estimating the value of potable water rather than raw or untreated water in a river or groundwater.

Based upon records of water transactions in the Pacific Northwest, Huppert, et. al. valued municipal and industrial (M&I) water at between 0 and $452 per acre-foot.[34] As noted in their report, the marginal value of water for M&I use is higher than the marginal value for irrigation. So, the water for M&I should be valued between $95 and $452 per acre-foot ($95 is the value of irrigation water estimated earlier in this report). To this end, $235.66 for valuing water for municipalities used in this report seems to be reasonable.

6.1.6 Direct Impact on Navigation

Based on discussion in section 5.1.2.1, the UBGAR Project would be unlikely to have a measurable impact on hydrology of the Columbia River system to affect the navigation system. Thus, no economic analysis of impact on navigation was performed.

6.1.7 Values of Alternative Uses of Columbia River Diversion Water ($/AF)

As discussed previously, the aquifer recharge project is still in appraisal-level investigation phase and some of the relevant information for a detailed cost-benefit analysis is not currently available. The focal point of the report, however, is to provide an approximation of the total costs and benefits from the aquifer recharge project, without making an exact conclusion. To accomplish this task, this section provides the costs associated with the project and summarizes the project benefits as estimated in previous sectors (see Table 21).

Initial capital costs, and annual operation and maintenance costs (O&M) for alternative project options are estimated by IRZ Consulting. The initial capital costs for SSRD 1 Option 2&3, SSRD 1 Option 1, and Full-Project options were estimated to be $42, $100, and $156 million, respectively.

The annual operation and maintenance costs (including the annual energy cost) for SSRD 1 Option 2&3, SSRD 1 Option 1, and Full-Project options were estimated to be around $5.2, $9.0 and $14.0 million, respectively. Since the sources of funding and terms of financing are not yet known, the project capital cost for alternative options were annualized using two planning horizons (30 and 50 years) and three alternative discounting rates (0%, 2.44%, and 4.88%). The discount rate, 4.88%, is the rate used by BOR in 2008 study of Yakima Project (BOR, 2008), 2.44% is U.S. Treasury Real Long-Term Rates on March 15 2009[35/]. Capital costs, annualized capital costs for alternative planning periods and discount rates, and total annual costs per acre-foot for SSRD 1 Option 2&3, SSRD 1 Option 1, and Full-Project options are presented in Table 21. All per acre-foot costs are in 2006$.

Table 21: Initial Capital, O&M, and Total Annual Project Cost for Various Planning Horizons and Discount Rates

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[34/] The value of $0/AF reflects a 2002 transaction in Washington when a private individual donated 25 AF of water to the Town of Granger.

[35/] http://www.ustreas.gov/offices/domestic-finance/debt-management/interest-rate/real_ltcompositeindex.shtml

	SSRD 1 Option 2&3 Capital Cost: $42 mil Annual O&M Cost $5.2 mil			SSRD 1 Option 1 Capital Cost: $100 mil Annual O&M Cost:$9 mil			Full Project Capital Cost: $156 mil Annual O&M Cost: $14 mil		
	Annualized Cost (2006$)		Total Annual Costs*	Annualized Cost (2006$)		Total Annual Costs*	Annualized Cost (2006$)		Total Annual Costs*
	$	$/AF	$/AF	$	$/AF	$/AF	$	$/AF	$/AF
30 years									
0%	1,340,996	24	115	3,192,848	32	118	4,980,843	31	116
2.44%	1,906,745	35	125	4,539,869	45	132	7,082,196	45	129
4.88%	2,581,323	47	138	6,146,007	62	148	9,587,771	61	145
50 years									
0%	804,598	15	105	1,915,709	19	106	2,988,506	19	104
2.44%	1,401,470	26	116	3,336,833	33	120	5,205,460	33	118
4.88%	2,162,933	39	130	5,149,840	52	138	8,033,750	51	135

* Total annual cost includes the annualized capital cost plus annual O&M cost

Table 22 summarizes the benefits and costs of the aquifer recharge project in $/AF. The economic values of the aquifer recharge project were estimated to be $**99**, $**99**, and $**103**, depending on the project options.

It should be noted that the economic analysis provided in this section is based on NED account which ignores the regional economic benefits of the project (will be discussed in next section). Furthermore, NED account as presented in Table 22, does not include other benefits such as lower energy costs for pumping due to a decrease in pumping lift for municipalities and irrigators, and a decreased need to deepen wells, and improvement in water quality.

Table 22: NED Project Benefits, Project Costs under Varying Planning Horizons and Discount Rates ($/AF, 2006$)

	SSRD 1 Options 2&3	SSRD 1 Option 1	Full-Project
PROJECT BENEFITS			
Regional Value of Irrigation Water	$ 95	$ 95	$ 95

Instream Value-Umatilla River*	$104	$104	$104
Municipal/Domestic Use	$236	$236	$236
Value of Water for Aquifer Replenishment	$ 95	$ 95	$ 95
NED Benefit	$ 99	$ 99	$103
PROJECT COSTS			
Total Annual Direct Cost			
		30 years	
0% discount rate	$115	$118	$116
2.44% discount rate	$125	$132	$129
4.88% discount rate	$138	$148	$145
		50 years	
0% discount rate	$105	$106	$104
2.44% discount rate	$116	$120	$118
4.88% discount rate	$130	$138	$135
Hydropower Lost	$4.15	$4.22	$4.22

* $104 for instream use is the mid-range estimates of value of water for instream use based on "water exchange for instream use" and "alternative water delivery system" methods as discussed in previous section.

As revealed in Table 22, total project costs for three project options, for varying planning horizon and discount rates, exceed their respective total benefits.

There are few points that have to be considered before drawing a conclusion regarding economic the feasibility of the project from NED perspective.

- There are other direct benefits of the proposed project that were not included in the NED benefit estimates such as:[36/]
  a) Potential lower pumping costs as a result of an increase in aquifer water table.
  b) Savings by irrigators, municipalities and residential users as a result of a decreased need to deepen wells.
  c) Improvement in ground water quality.

[36/] As previously mentioned in this report, studies have shown that the economic value of some of these benefits can be significant.

d) Potential increase in fishery and non-fishery recreation activities in the Umatilla River.

e) Potential economic benefits of the accumulated stored water as a result of proposed aquifer replenishment program (in drought years, the accumulated stored water could be used for irrigation, municipalities/domestic uses, and flow augmentation program in the Umatilla River).

- The cultural and religious value of potential improved fish population, as a result of an increase in flow augmentation in Umatilla River, as planned by the aquifer recharge project.
- Given that the project would contribute a significant portion of stored water for non-commercial use such as flow augmentation and aquifer replenishment; it is desirable to evaluate the project using a lower discount rate and/or longer planning horizon as argued by Platt (2008).
- NED account emphasizes on economic efficiency and is neutral to distributional impact of a project. However, economic efficiency, although an important objective, is not the sole objective of a county's or state's policymakers. How a project would contribute to a region's economy in terms of output, employment, and income might be as important as economic efficiency, per se.

In the next section, the aquifer recharge project will be evaluated from RED perspective.

6.2 Regional Economic Development (RED) Analysis

In the previous section, the economic analysis of the aquifer recharge project was performed from a National Economic Development (NED) (or economic efficiency) perspective. However, economic efficiency, although an important objective, is not the sole objective of a County or State policymakers. In this section, the contribution of the aquifer recharge project is examined from a RED perspective. Focus of this section is on how the proposed project would contribute to the region's economy in terms of output, employment and labor income.

The regional economic impact analysis of a project requires identifying the economic impacts the project would have in the region. The regional impacts are sum of NED impacts that accrue to the region, plus transfer of income from outside the region resulting from implementation of the proposed project. The measurable income transfers for the proposed project are as follow:

1. Increase in regional economic activities beyond the farm gate such as transportation, packaging, processing, wholesale trade, etc.
2. Transfer of money to the region for construction, operation, and maintenance, depending on who will finance the project.
3. Secondary or ripple effects as a result of NED benefits, 1 and 2.

The regional economic impact of the aquifer recharge project on the Basin was performed using an input-output modeling technique. The input-output model or inter-industry model is the most commonly used method of quantifying regional economic impacts. The input-output model is a mathematical tool that traces the linkages of inter-industry purchases and sales of an economy (with or without household economic behavior). The input-output model then uses the economic linkages to estimate the total economic impact (direct, indirect and induced) on a regional economy resulting from a direct impact in a particular sector. Input-output analysis can provide not only an accounting of direct impacts but also provides estimates of indirect effects and induced changes throughout the regional economy. The inclusion of indirect and induced effects in the economic analysis recognizes the potential social and economic impacts as a result of changes in economic activity.

In this report, the economic impact analysis was performed using a non-survey economic input-output model called IMPLAN (IMpact analysis for PLANning). IMPLAN was originally developed by the U.S. Forestry Service. It was further developed at the University of Minnesota, and is currently being maintained by the Minnesota Implan Group (MIG). A detailed discussion of the IMPLAN regional model is provided in MIG. IMPLAN is designed to establish input-output models for a state, a county, or group of states/counties in the United States. IMPLAN estimates the local production, local consumption, export, import and local inter-industry trade data using the available regional and national data sources.

IMPLAN is a "demand-driven" input-output model. In other words, to analyze economic impacts of a particular economic impact scenario, it is necessary to determine what the net changes would be in upstream sectors (e.g. changes in upstream sectors' final demands: increase in exports of the product and/or increase in personal income) or expenditures made within a regional economy. Then, IMPLAN traces back their impacts to downstream sectors through their backward linkages. So, the first step in impact analysis using an input-output methodology is to identify the positive and negative direct impacts of a policy change on the affected resources. The next step is to quantify the direct economic impacts on affected economic sectors. The third step is to convert the direct economic impacts into net change in "final demand" or purchases made within a regional economy. IMPLAN then uses the changes in the final demand on affected economic sectors or purchases made within the regional economy to measure the total impact of an economic impact scenario on a local economy.

Among NED benefits, only farm production has a measurable impact on the Basin's economy. Majority of the economic impacts of hydropower production and fish resources, resulting from the proposed project, will occur outside the Basin. Hence, the regional impact analysis in this report focuses on farm production, regional value-added agricultural activities induced by the increase in farm production, and construction, and operation and maintenance costs.

6.2.1 Direct Economic Impact of Farm Production

As stated above, the first step in regional economic impact analysis is to identify the direct impacts of the proposed project on the local economy. In estimating the farm impact, it is important to identify the expected crop mix on newly irrigated lands. Table 23 shows the engineering designs currently under investigation and their respective potential water withdrawal and water allocation for irrigation. To limit the scope of analysis, this report only considers the SSRD 1 Option 2&3, SSRD 1 Option 1, and Full Project.

Table 23: System Design, Water Withdrawal, and Irrigation Water

SSRD* System	System Option	Total Withdrawal (AF)	Water Allocated for Irrigation (AF)
1	1	100,000	68,664

1	2&3	55,000	37,000
1	4&5	45,000	30,000
1	6&7	25,000	19,610
2		25,000	20,000
3		33,500	25,000
Full-Project**		160,000	113,664

* SSRD denotes Supply, Storage, Recovery, and Distribution systems envisioned for the project.

** Full Project denotes the restoration of full water right allocations to the irrigators in the CGAs. It consists of the SSRD 1 system for Ordnance Gravel and Butter Creek CGAs, SSRD 2 system for the Stage Gulch CGA south of the Umatilla River, and SSRD 3 system east of the Umatilla River.

Based on average crop water use, as specified in Table 14, impacted irrigated lands under SSRD 1 Option 2&3, SSRD 1 Option 1, and Full Project options, will be 12,701, 23,563, and 39,007 acres, respectively. Based on discussions with the growers in the Basin, the historical crop mix, as presented in Table 14, deemed to be appropriate for SSRD 1 system Options 2&3; and they believe that the local food processors can absorb the additional farm production under SSRD 1 system Options 2&3. However, they argue that the market demand might not exist for sweet corn, green peas, peppermint for oil, and grass seed, if newly irrigated lands are significantly greater than 12,701 acres. Hence, for SSRD 1 system Option 1 and Full Project options, the historical crop mix is adjusted in the following way. The current acreage allocated to sweet corn, green peas, peppermint for oil, and grass seed under SSRD 1 system Options 2&3 were maintained, but the remaining irrigated lands under SSRD 1 system Option 1 and Full Project options were allocated to other crops included in the historical regional crop mix. The demand for alfalfa hay, potato, onion and wheat are large enough so that the additional acres proposed in this project would not affect their respective demand conditions.

Expected crop mix and the farm-gate production values for SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full-Project options are presented in Table 24.[37/] The total annual farm-gate production value for SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full-Project options are estimated to be $22.5, $43.1, and $71.3 million, respectively. They represent the direct regional contribution of the aquifer recharge project at the farm gate.

Table 24: Farm Gate Production Values

	SSRD 1 Option 2&3 12,701 acres	SSRD 1 Option 1 23,561 acres	Full-Project 39,006 acres

[37/] Farm-gate production value refers to receipts by growers for sales of raw commodities at their farm gates prior to any additional handling or processing.

	Proposed Crop Mix (%/ac)	Farm Gate Production Value $	Proposed Crop Mix (%/ac)	Farm Gate Production Value ($)	Proposed Crop Mix (%/ac)	Farm Gate Production Value ($)
Alfalfa hay	24%	$2,514,760	28%	$5,382,433	28%	$8,909,893
Field Corn	12%	$1,023,584	14%	$2,190,813	14%	$3,626,596
Potatoes	16%	$6,332,319	18%	$13,553,293	18%	$22,435,650
Onions	12%	$7,596,405	14%	$16,258,862	14%	$26,914,356
Wheat-full irrigation	11%	$721,247	13%	$1,543,712	13%	$2,555,407
Sweet corn, pro.	6%	$569,250	3%	$569,279	3%	$942,364
Green Peas, proc.	6%	$377,214	3%	$373,244	3%	$617,855
Peppermint for Oil	8%	$1,188,796	4%	$1,188,855	4%	$1,967,989
Grass seed	7%	$1,436,049	4%	$1,436,120	4%	$2,377,304
Other Veg. crops	4%	$595,922	2%	$595,952	2%	$986,518
TOTAL	106%	**$22,355,547**	**103%**	**$43,092,562**	**103%**	**$71,333,930**

* The crop yields and crop prices are used in the calculation of farm gate production values are presented in Table 14.

6.2.2 Direct Economic Impact of Value-added Activities beyond the Farm Gate

The contribution of the aquifer recharge project to the local economy does not, however, stop at the farm-gate. Additional marketing activities (i.e., processing, transportation, drying, storage, wholesaling, and so on) occur before the farm products are shipped out of the region. The study of historical marketing patterns of regional crop production indicates that a large portion of the high-value crops grown in the Basin are used as intermediate inputs in other locally produced goods (e.g., frozen and dehydrated vegetable products, alfalfa cubes, distilled oil, etc.).

Incorporating the forward linkages into the economic impact analysis requires information concerning the extent to which the increased crop production would stimulate economic activities in other sectors of local economy. The extent of induced activity beyond farm gate is difficult to quantify. To limit the scope of the analysis, this report assumes that market demand is not a limiting factor for crops included in the crop mix, and the local food processors have the capacity to expand and hence import substitution effect is ruled out.

The direct regional impacts of farm production, as a result of the aquifer recharge project, are estimated based on the following procedures:

- Distributions of additional farm production among various outlets are made based on the historical marketing patterns of crop production in the region and growers inputs and previous studies. Specifically,

- o Based on a study by Holland and Jun Ho Yeo, this report assumes 12% of potato production will be used for fresh potato market and the remaining will be absorbed by local food processors.
- o Based on a study by Ziari, et. al., it is assumed that 25% of onion production is exported for fresh onion market and remaining will be shipped to local food processors.
- o Sweet corn, green peas and other vegetable crops is assumed to be utilized by local food processors.
- o It is assumed all other crop production will be absorbed by domestic and/or foreign markets.

- The value of processed product at the factory gate was calculated based on gross absorption coefficient (GAC) value used by Huppert et.al. The GAC is the value of a farm product (e.g. potato) for each dollar value of processed food (i.e., french fries).
- Value-added activities beyond the farm gate and factory gate, such as transportation and wholesaling, were estimated using the procedure discussed in section 4.4.
- It was assumed that the newly irrigated lands are currently in dryland wheat-fallow production.

Tables 25, 26, and 27 present the direct impact of farm production for SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full-Project options, respectively. Each table shows how each farm product affects different economic sectors of the local economy. For example, under CL5-6 option, farm gate production value of potato is estimated to be $6.3 million. Out of $6.3 million, $0.76 million is exported to fresh potato market (identified in IMPLAN as Vegetable sector) and the remaining are shipped to local food processors (identified in IMPLAN as Frozen and Dehydrated food product sector). The value of potato before leaving the factory gate is $29.6 million. The additional economic activities beyond farm gate and factory gate were estimated to be $0.31 for transportation sector and $1.29 million for wholesaling sector.

The total direct economic impacts of the aquifer recharge project are estimated to be $81, $145, and $239 million annually for SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full-Project options, respectively.

Table 25: Direct Impact of Farm Production, 2006$ (SSRD 1 Options 2&3, 12,701 acres)

Crops\Economic sectors	Grain Farming*	Vegetable *	All Other Crops Farming*	Frozen & Dehydrated *,**	Transportation *	Wholesale trade*
Alfalfa hay			2,514,760		69,299	115,868
Field Corn	1,023,584				28,207	47,162
Wheat	721,247				19,875	33,231
Potatoes		759,878		29,640,643	309,696	1,290,722
Onions		1,899,101		30,304,808	347,560	1,371,349

Sweet corn, proc.				3,027,927	29,498	128,277
Green Peas, proc.				2,006,458	19,547	85,003
Peppermint for Oil			1,188,796		32,760	54,774
Grass seed			1,436,049		39,573	66,166
Other Veg. crops				3,169,798	30,880	134,287
Wheat-dryland[***]	(1,311,359)				(36,137)	(60.421)
TOTAL, $	**433,472**	**2,658,980**	**5,139,605**	**68,149,634**	**926,895**	**3,326,838**

[*] Indicate the economic sectors as identified in IMPLAN.

[**] Due to the lack of information, we allocated vegetable crop production to a combined sector of frozen food manufacturing, and vegetable canning and drying manufacturing sectors.

[***] It represents the crop production value without the aquifer recharge project.

Table 26: Direct Impact of Farm Production, 2006$ (SSRD 1 Option 1, 23,563 acres)

Crops\Economic Sectors	Grain Farming*	Vegetable *	All Other Crops Farming*	Frozen & Dehydrated *,**	Transportation*	Wholesale Trade*
Alfalfa hay			5,382,433		148,324	247,996
Field Corn	2,190,813				60,372	100,942
Wheat	1,543,712				42,540	71,127
Potatoes		1,626,395		63,440,944	662,854	2,762,580
Onions		4,064,716		50,471,154	603,696	2,325,467
Sweet corn, proc.				3,028,078	29,499	128,283
Green Peas, proc.				1,985,339	19,341	84,108
Peppermint for Oil			1,188,855		6,038	54,776
Grass seed			1,436,120		39,575	66,169
Other Veg. crops				3,169,798	87,350	134,287
Wheat-dryland***	(2,432,917)				(67,044)	(112,097)
TOTAL, $	1,301,608	5,691,111	8,007,408	122,095,313	1,699,590	5,975,734

* Indicate the economic sectors as identified in IMPLAN.

**Due to the lack of information, we allocated vegetable crop production to a combined sector of frozen food manufacturing, and vegetable canning and drying manufacturing sectors.

***It represents the crop production value without the aquifer recharge project.

Table 27: Direct Impact of Farm Production, 2006$ (Full Project, 39,006 acres)

Crops\Economic Sectors	Grain Farming[1]	Vegetable *	All Other Crops Farming *	Frozen & Dehydrated *,**	Transportation *	Wholesale Trade*
Alfalfa hay			8,909,893		245,530	410,523
Field Corn	3,626,596				99,938	167,095
Wheat	2,555,407				70,419	117,740
Potatoes		2,692,278		105,017,934	1,097,265	4,573,079
Onions		6,728,589		83,548,195	999,338	3,849,497
Sweet corn, proc.				5,012,575	48,832	212,355
Green Peas, proc.				3,286,461	32,016	139,229
Peppermint for Oil			1,967,989		9,995	90,675
Grass seed			2,377,304		65,511	109,534
Other Veg. crops				3,169,798	87,350	134,287
Wheat-dryland***	(2,432,917)				(67,044)	(112,097)
TOTAL, $	3,749,086	9,420,867	13,255,186	200,034,963	2,756,195	9,804,016

*Indicate the economic sectors as identified in IMPLAN.

** Due to the lack of information, we allocated vegetable crop production to a combined sector of frozen food manufacturing, and vegetable canning and drying manufacturing sectors.

*** It represents the crop production value without the aquifer recharge project.

6.2.3 Regional Economic Impacts

To estimate the regional economic impacts for each project option, the direct regional economic impact estimates (final demand estimates) from Tables 25, 26, and 27 were entered into the Umatilla Basin Input-Output model. Table 28 presents the direct and indirect regional economic impacts of the aquifer recharge project in terms of economic activities (output), labor income and employment (# of jobs) for different project options.[38/]

[38/] The regional economic impacts were estimated based on the following assumptions: a) no induced activities in regional livestock sector; b) local food processors have the capacity to absorb additional farm production; c) increase in farm production would not affect the local farm prices; d) financing arrangement has not yet been

SSRD 1 Option 2&3:

Under this project option, the aquifer recharge project would stimulate regional economic activities by $116 million. Of this, $81 million is direct impact and $36 million is indirect impact. The $116 million additional economic activities would create 679 jobs (330 jobs directly and 349 jobs indirectly). The project would increase the labor income by $24 million (13 million directly and $11 million indirectly). Using a 7% marginal tax rate, State tax revenue could increase by $1.7 million annually.

SSRD 1 Option 1:

Under this project option, the aquifer recharge project would stimulate regional economic activities by $209 million. Of this, $145 million is direct impact and $64 million is indirect impact. The $209 million additional economic activities (sales of all products,) would create 1,233 jobs (606 jobs directly and 627 jobs indirectly). The project would increase the labor income by $43 million (23 million directly and $21 million indirectly). Using a 7% marginal tax rate, State annual tax revenue could increase by $3 million annually.

Full- Project:

Under this project option, the aquifer recharge project would stimulate regional economic activities by $344 million. Of this, $239 million is direct impact and $105 million is indirect impact. The $344 million additional economic activities would create 2,074 jobs (1,040 jobs directly and 1,034 jobs indirectly). The project would increase the labor income by $72 million (37 million directly and 34 million indirectly). Using a 7% marginal tax rate, State tax revenue could increase by $5 million annually.

6.2.4 Regional Direct Economic Benefits of Irrigation Water

Regional value of irrigation water can be calculated using value-added or labor-income (personal income) measures. Both measures provide the net contribution of a regional resource to the region's social welfare. Value-added is calculated by adding the labor income, other property income (interest, dividend, rent, etc) and indirect business taxes. Since it is difficult to estimate what percentage of other property income remain in the local economy, labor income is a better measure of how the welfare of the Basin's citizens is affected by the change in availability of irrigation water. To this end, this report used the labor income to measure the regional value of irrigation water.

Table 28 displays the change in direct and secondary regional labor income as a result of implementing the aquifer recharge project. The regional direct value for irrigation water, for SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full Project options were estimated to be around $340/AF, $330/AF, and $328/AF, respectively. The regional total value of irrigation water (including the secondary impact) for SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full Project options were estimated to be around $652/AF, $633/AF, and $629/AF, respectively.

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determined, hence was not included in the analysis; and e) impacts on regional recreational activities and hydropower production are assumed to be small, thus not included in the analysis.

Table 28: Regional Economic Impacts of the aquifer recharge project, 2006$

Project Options	Output		Labor Income*		Employment (# of jobs)	
	Direct	Total	Direct	Total	Direct	Total
SSRD 1 Options 2&3	$80,635,422	$116,265,246	$12,573,426	$24,150,857	330	679
SSRD 1 Option 1	$144,770,763	$208,720,310	$ 22,656,434	$ 43,452,201	606	1,233
Full Project	$239,020,310	$344,264,806	$37,346,288	$71,600,591	1,040	2,074

***** Labor income consists of employee compensation plus proprietor's income.

Economists usually use the change in labor income including the secondary impact to measure the regional value of irrigation water. However, the secondary impact usually takes more than a year to have its impact be fully absorbed by the economy. Since, this report presents all costs and benefits in annual basis, then including the secondary impact would overstate the potential value of irrigation water. To this end, the report uses the midrange of the change in direct and total labor income as presented above, to estimate the regional value of irrigation water for equivalent comparison. Using the Mid-range value, the regional value of irrigation water, for SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full Project options were estimated to be around $496/AF, $481/AF, and $478/AF, respectively.

Summary of regional project benefits, projects costs under varying planning horizons and discount rates are presented in Table 29. Due to the lack of information, the same discount rates and planning horizons were used. The regional benefits of diverted water for a combination of irrigation, fishery, municipal/domestic and aquifer replenishment for County-Line#5&6, County-Line#7, and Full-Project were estimated to be around $383/AF, $373/AF, and $371/AF, respectively.[39/]

[39/] The potential regional economic impacts of instream use for recreation and fishing, municipal/residential, and aquifer replenishment

Table 29: Summary of Regional Project Benefits, Project Costs under Varying Planning Horizons and Discount Rates, for Alternative Project Options, ($/AF, 2006$)

	SSRD 1 Options 2&3	SSRD 1 Option 1	Full-Project
PROJECT BENEFITS			
Regional Value of Irrigation Water	$ 496	$ 481	$ 478
Instream Value-Umatilla River*	$ 104	$ 104	$ 104
Municipal/Domestic Use	$ 236	$ 236	$ 236
Value of Water for Aquifer Replenishment	$ 95	$ 95	$ 95
Regional Benefit	**$ 383**	**$ 373**	**$ 371**
PROJECT COSTS			
Total Annual Cost			
		30 years	
0% discount rate	$ 115	$ 118	$ 116
2.44% discount rate	$ 125	$ 132	$ 129
4.88% discount rate	$ 138	$ 148	$ 145
		50 years	
0% discount rate	$ 105	$ 106	$ 104
2.44% discount rate	$ 116	$ 120	$ 118
4.88% discount rate	$ 130	$ 138	$ 135
Hydropower Lost	$ 4.15	$ 4.22	$ 4.22

* $104 for instream use is the mid-range estimates of value of water for instream use based on "water exchange for instream use" and "alternative water delivery system" methods as discussed in previous section.

Based on information given in Table 29, net RED benefits of the aquifer recharge project are summarized in Table 30. It indicates that for all three options, the total annual benefits significantly outweigh the total annual cost. Based on the assumed discount rate and planning horizon, the aquifer recharge project has potential to become economically feasible from regional economic development perspective.

6.2.5 Regional Economic Impacts of Construction, Operation and Maintenance Cost

Since the financing aspects of initial capital requirements and annual O&M and energy costs are not yet determined, the regional economic impacts of construction and O&M costs are not estimated at this time.

Table 30: Net RED for Aquifer Recharge Project, ($/AF, 2006$)

	Discount Rate		
	0%	**2.44%**	**4.88%**
30 years			
SSRD 1 system Option 3	$ 268	$ 258	$ 245
SSRD 1 system Option 1	$ 255	$ 241	$ 225
Full Project	$ 255	$ 242	$ 226
50 years			
SSRD 1 system Option 3	$ 278	$ 267	$ 253
SSRD 1 system Option 1	$ 267	$ 253	$ 235
Full Project	$ 267	$ 253	$ 236

7.0 SUMMARY AND CONCLUSIONS

The main objective of this report was to assess the economic benefits of the aquifer recharge project for three alternative engineering options, namely SSRD 1 system Options 2&3, SSRD 1 system Option 1, and Full-Project (all three Critical Ground Water Areas). Each project option identifies the annual total water withdrawals from the Columbia River, the annual allocation of stored water for irrigation, river flow augmentation, municipalities & domestic use, and basalt aquifer replenishment.

The economic benefits analysis for the project was performed from National Economic Development (NED) and Regional Economic Development (RED) perspectives.

NED analysis shows that the alternative uses of the water, as proposed by the aquifer recharge project, compared to the instream uses of the Columbia River water, provides a significant direct net gain to the society (in range of $95-$99 AF) . However, when taking into account the project cost, the total cost exceeds the economic benefits of the project. As explained in the report, there are additional potential benefits that need to be incorporated into NED analysis before drawing a conclusion regarding the economic feasibility of the project. A complete NED analysis, which includes these potential benefits, requires additional data that are not yet developed at an appraisal-level engineering investigation phase.

From RED prospective, the economic benefits of the aquifer recharge project were evaluated based on its direct and indirect contribution to the Basin's economy in terms of output (or business activities), employment, and labor income. The direct impacts included in the analysis are the increase in farm production and induced regional direct value-added activities beyond the farm gate. The regional economic impacts were estimated using the IMPLAN input-output model of the Basin. If the aquifer recharge project is implemented, the project would increase regional business activities by $116-$344 million, would add 679-2,074 jobs, and would increase annual regional labor income (employee compensation plus proprietor's income) by $24-$72 million, depending on the project options. The RED analysis shows that the total annual benefits significantly outweigh the total annual project costs, for all three project options. Based on the assumed discount rate and planning horizon, the aquifer recharge project has potential to become economically feasible from regional economic development perspective.

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