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THE ECONOMIC IMPACT OF A POSSIBLE IRRIGATION-WATER SHORTAGE IN THE ODESSA SUB-BASIN OF ADAMS AND LINCOLN COUNTIES

By

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The Economic Impact of a Possible Irrigation-Water Shortage in Odessa Sub-Basin of Adams and Lincoln Counties

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ABSTRACT

The Columbia Basin Project (CBP) was one of the single largest projects undertaken by the Bureau of Reclamation. The venture, which started in the 1930s in Central Washington, did not entirely turn out as expected. In fact, almost half of the proposed irrigable area, located mainly in the north eastern portion of the original plan, doesn't have any water supply from the project for irrigation purposes. The Odessa Sub-area is one of those areas. The land in this area is fertile and produces very high quality potatoes. Over the last couple of decades, production in this Odessa sub-region has been possible primarily because of irrigation based on deep wells. However, the underground water is drawing down and crop production may shut down as a result. Therefore, an economic threat on the economy of the Columbia Basin is in the offing, unless alternative water sources are negotiated. In this paper, we will mainly explore the regional economic impacts of the possible production losses of crops produced in the Odessa Sub-area of Lincoln and Adams Counties. In Section A, we briefly discuss the current status of the Columbia Basin Project. In Section B, we discuss ground water level decline issues. In Section C, we enumerate the economic impacts of a possible reduction in crop production in Odessa Sub-regions of Adams and Lincoln Counties. Summary and conclusions are in the final section.

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SECTION A: COLUMBIA BASIN PROJECT, WHERE WE STAND NOW!

Earlier Days:

Completed in 1941 Grand Coulee Dam (GCD) was a multipurpose project. The major project objectives are hydropower, irrigation, flood control, wildlife enhancement and other recreational uses. However, if the history could be followed with more minute details, we could examine the political thinking behind these objectives.

The 1930's was marked by depression and a diverse political objective. In 1932 Hoover, the outgoing President, was wary of opening new lands to irrigation for agricultural purposes. He was apprehensive about the consequences of agricultural surplus generated from expansion of irrigable land following the GCD construction. However, when President Roosevelt took office priorities changed and the drop in employment nationally became the political focus. Roosevelt foresaw dam construction as a mechanism for putting people to work so he authorized a project which involved a low dam at Grand Coulee. Its main purpose was to generate power, and the initial plan had no provisions for irrigation. As time passed, around mid-30s, irrigation, especially for the "Dust Bowl" refugees, gained in priority along with other issues. President Roosevelt's plan was to shift those "Dust Bowl" refugees to the "Planned Promised Land" of the Northwest, where irrigation could be a good option for these people to lead a better life.

In some early project authorization documents "CBP" referred to both GCD and the CB Irrigation Project. However, over time, people have come to refer to the irrigable area of the project as CBP. GCD has come to mean the portion of the overall project that deals with Hydroelectric Power, flood control, and recreational benefits associated with Lake Roosevelt. A

key feature of the basin is the Columbia plateau that contains the land served by the project's irrigation command area. The plateau was a semi-arid, sparsely vegetated area of nearly 100,000 sq. miles.

The US Army Corps of Engineers (ACE) and the US Bureau of Reclamation planned both GCD and CBP. The ACE reports, known as Butler Report (named after Major Butler), were officially completed in 1932 and later were followed by the feasibility report released by the Reclamation Bureau. The plans outlined in these studies provided the background for the actual construction of the dam and the irrigation project. Revenue from power generation was the main theme for both the reports. They found that unless power revenues were generated, the cost of irrigation development in Columbia Plateau would be too high for the farmers. In fact, both of the reports indicated postponement of irrigation development until the power generation was well underway.

The Butler report explored multiple methods for irrigating the Columbia Basin area through the construction of GC Dam. Their plan, which also closely resembled the Reclamation Report Plan, outlined a total irrigation area of almost 1.2 Million acres of land (precisely 1,199,430 acres), out of which 1,034,110 acres would be irrigated from the dam water and the remaining 140,520 acres irrigated by diverting water from the Priest Rapids Reservoir downstream.[1] Unlike the Reclamation Report, the Butler Report gave more priority to water for irrigation purposes rather than water for power generation, while, the Reclamation Report urged for assurance of substantial power revenue before proceeding with any further comprehensive irrigation development.

[1] Page 2-4, *WCD Case Studies*, GC Dam And CBP, 2000.

Incidentally, CBP is the single largest reclamation project in the U.S. As of now, the total amount of officially irrigable land within the project area is 1,095,000 acres - 660,794 acres of the area are being irrigated. The project consists of several dams, reservoirs, and it covers a huge amount of land through its extensive delivery system network. To facilitate water delivery within Washington State, the Bureau developed 14 storage reservoirs, 7 diversion dams, 39 major pumping plants, 795 miles of water carriage facilities inclusive of canals, pipeline and tunnels, and 3,913 miles of distribution facilities made of open and pipe laterals. In addition to this, they have also installed 3,500 miles of agricultural drainage for prevention of ground water buildup.[2]

On August 10, 1951, the first test water flowed into the main canal of Banks Lake toward the Columbia Basin Farmland. Between 1950 and 1958, irrigation service became available annually for 50,000 to 65,000 irrigable acres of new land, followed by a rather slow but steady growth of around 5000 acres in the 1960's and 1970's. The later slow growth of development of irrigable land had a positive effect because it allowed time for development of markets to absorb the increased production.

The next major shift in CBP came in the year 1969. After almost 20 years of being operated by the Government, responsibility for operation maintenance of the irrigation system was transferred to the three project irrigation districts, namely Quincy, East Columbia and South Columbia Basin Irrigation District (CBID). However, the federal government kept responsibility for the remainder of the project, including the maintenance and operation of GC Pumping Plant, Banks Lake, the Main canal and the Pothole Reservoirs. According to the 2000 records, Quincy

[2] Page 17, *Washington*, Bureau of Reclamation, US Department of the Interior, 1983.

CBID is the largest district, serving 246,415 acres of land, followed by South CBID, covering 219,817 acres of land and East CBID, serving 151,596 irrigable acres of land (Table1). Besides these three irrigation districts is a fourth district, which is primarily a groundwater pumping district, known as Grant County Black Sand Irrigation District serving 30,500 irrigated acres.[3]

Table 1. CBP, Irrigation Data, year 2000[4]

	Total District Acres	Irrigable Acres	Agricul-tural Acres	Non-agricul-tural Acres	Multi-cropped Acres	Acres Irrigated by Sprinkler	Acres Irrigated but not Harvested	Acres not Irrigated
Quincy CBID	760,000	246,415	233,300	2,977	6,236	182,452	3,319	5,432
South CBID	810,000	219,817	212,377	2,272	9,213	200,314	7,290	3,203
East CBID	740,000	151,596	140,610	4,382	0	94,645	786	4,730

During this period there was a tremendous growth in value of agricultural output in this region and a shift in production type. There was also a change in cropping pattern; different agricultural products emerged compared to what was predicted initially. The CBP plays a significant role in respect to the State of Washington total agricultural product. In 1992, CBP produced 12% of the state's production and for some crops its contribution is even more. Going by 1992 USBR crop report, CBP contributed toward 17% of Washington's production of apples, 28% of its potato production, and 32% of its hay production.[5] In the most recent Crop and Water Data (BOR, USDOI, 2000) the picture remains almost the same (Table 2A & 2B).

[3] *Crop and Water Data*, page 14, US DOI, BOR , 2000; "The Story Of the CBP," US DOI, BOR, 1978; page 2-9; *WCD Case Studies*, "GC Dam And CBP," 2000.
[4] Source : *Crop and Water Data*, BOR, USDOI, 2000.
[5] Page 3.1-4, *WCD Case Studies*, "GC Dam and CBP," 2000.

Table 2A. Selective Crop Production: CBP, 4-Counties, State of WA, Year 2000

Year 2000	Quincy CBID	South CBID	East CBID	Total CBP	4-Counties	WA State
Apple (ton)	354,371	269,982	46,288	670,641	NA	2,678,105
Total Potato (Cwt)	10,525,201	15,410,045	9,752,316	35,687,562	68,875,000	105,000,000
Alfalfa Hay (ton)	340,343	512,262	230,921	1,083,526	1,524,000	2,350,000
Wheat (Bu)	2,913,844	785,953	2,362,465	6,062,262	64,981,000	164,880,000

Source: http://www.nass.usda.gov/wa/rlsetoc.htm#histcoest.

Table 2B. Summary of Selective Crop Production - Percentage

Year 2000	Quincy CBID	South CBID	East CBID	Total CBP	4-Counties	WA State
Apple	13.23	10.08	1.73	25.04	NA[6]	2,678,105 (ton)
Total Potato	10.02	14.68	9.29	33.99	65.60	105,000,000 (Cwt)
Alfalfa Hay	14.48	21.80	9.83	46.11	64.85	2,350,000 (ton)
Wheat	1.77	0.48	1.43	3.68	39.41	164,880,000 (Bu)

Source: http://www.nass.usda.gov/wa/rlsetoc.htm#histcoest .

Economic conditions in the CBP area verify that the scenario envisioned by the planners has been realized, at least partially. Today agribusiness scattered over the area of CBP thrives. According to a study by Dr. Darryll Olsen (made in 1996), the "basic sectors" of agriculture, agricultural services, and food processing account for 30% to 50% of all the income in the counties in which CBP is located. Total income from the basic sectors of the CBP area, according to this study, is almost $617 Million. There was also some multiplier effects from investment made in the basic sectors. According to the Olsen study, these sectors generate between 1.5 to 1.7 dollars of total income within the local area for each dollar produced by the basic sectors.

[6] For the year 2000, apple production data was not available for county level. The respective counties in the "4-Counties" set up are Adams, Grant, Franklin and Lincoln. Data source, http://www.nass.usda.gov/wa/rlsetoc.htm#histcoest .

Also, because of CBP, land value has increased over the time periods. This increase in land values resulted in substantial local social benefits. Between 1990 and 1992, these increased land values, in 1998 dollar terms, provided about $8,250,000 in funding to local services like schools and hospitals. In fact, the increase in land value has been much greater than what was originally expected. The Butler Report originally predicted an increase in land value of about $440,476,000 or $370 per acre, for the entire 1.2 million acres (precisely 1,199,400) of land. However, today, the increased per acre assessed value of CBP land due to irrigation is about $870 million, more than double what was predicted for its acreage value. The total area currently receiving CBP water is 660,800 acres. Thus, using the $870 rate, this represents an aggregate increased value of $574,896,000, which is almost 30% higher than projected on half as much land included in the original area to be irrigated.[7]

Irrespective of all the detailed plans, today the picture is much different than what had been projected during the Final stages of Estimation in 1968. From the original plan, approximately 1,200,000 acres of land, only 560,000 acres are currently receiving CBP water. Slightly less than 50% of the proposed original, has been developed by the Bureau of Reclamation. The remaining 100,000 acres of farmed land is being developed mainly by private individuals primarily because of the advancement in irrigation technology, like the introduction of the Center-Pivot sprinkler. The major reason for such a shortfall of planned acreage irrigation is attributed to non-completion of the Second Half of the project.

[7] Darryll Olsen. "The Columbia Basin Project: Project Operation and Economic Benefits." *The Pacific Northwest Project*, 1996.

Delay of the Second Half:

As noted previously, during 1950s the CBP exhibited rapid development. However, in the following decade the rate of irrigation block development slowed down considerably. The already existing irrigation facility, which was incidentally at its full capacity, was unable to irrigate new land. Thus, as a solution to this possible mismatch of demand and supply CBP moved into its "Second Half". Construction of the Second Bacon Siphon and Tunnel was planned, along with some possible extensions of East Low Canal, which was already serving some area of the eastern side. During the late 60s and early 70s, Congress appropriated funds for the necessary construction; but the Bureau of Budget cut them. Finally, in 1976, once the funding became secured and the way was cleared; construction of the Second Bacon Siphon was started and completed in 1980.[8] Completion of Second Bacon Siphon cost the state of Washington almost $15 million, which, given the non-completion of the project, eventually became a sunk cost.[9]

During 1984, when Reclamation started reviewing the development of the Second Half, initially there were two alternative proposals; one was the completion of the entire project and full development of the second-half lands, the second was the enlargement and extension of the East Low canal. The second alternative turned out to be the preferred option. When completed it would be able to irrigate 87,000 acres of land, mainly in the East District. Of course, a third alternative of "no further action" was considered as well.

[8] "Grand Coulee: Harnessing a Dream." Pitzer, P.C., 1994.
[9] Whittlesy et al. "Water Project Supply: How they Develop and Grow." Illahee, Vol. 11, 1&2, 1995.

Failure to complete the entire second phase (over 500,000 additional acres) was due to economic reasons. The second half would have required a huge amount of public investment. Some economic studies calculated that when the projected benefits from the proposed increased irrigation were compared with projected costs, the project might not pass a benefit-cost test. For example in 1982, Findeis and Whittlesey evaluated the economic viability of the completion of East High Project[10] (EHP). They concluded "if irrigation is undertaken in either the EHP or the HHH, and especially in EHP, development will need to be heavily subsidized by the public sector. In return, taxpayers will receive the additional output, employment, and income generated throughout Washington State. However, because of the competitive nature of water use in the state, the economic gains from the irrigation that could have been achieved in the past will be progressively eroded away if electricity rates increase in the future. As electricity energy becomes scarcer, public investment in other public capital alternatives will most likely be more beneficial to long-run economic growth in Washington State than irrigation development".[11]

Also, in recent years, legal issues regarding restoring and dealing with water rights have arisen. In 1993, at the request of Northwest Power Planning Council and National Marine Fisheries Service, the Bureau of Reclamation put on a moratorium and suspended the issuance of additional water service contracts and groundwater licenses. Since then, CBP's irrigated acreage remains at present levels. Recently the Bureau has lifted the 1993 moratorium, thus making it

[10] In their evaluation report they have also included HHH, Horse Heaven Hills along with EHP. However, in particular, they found economic feasibility for the completion of EHP is bleaker than HHH. "Project Completion Report, Competition between Irrigation and Hydropower water use in Washington State", J.L. Findeis & N. Whittlesey, 1982. *OWRT Project Number: A-100-WASH.*

[11] Page 192, Findeis & Whiilesey, 1982, *OWRT Project Number: A-100-WASH.*

possible for the Columbia Basin Project to compete with other claims on Columbia River water, such as the Tri-Cities and the Black Rock reservoir.

This brings us to the Odessa Sub-area. Irrigated farming in this area is primarily dependent on ground water usage, and because of this reliance on groundwater, the ground water levels in this area are dropping. In the following section we briefly outline the genesis of the ground water development in the Odessa Sub-area.

SECTION B: EARLIER HISTORY OF GROUND WATER USAGE

The irrigation network of the Columbia Basin Project was the main source of surface water for irrigation of the Central Washington region. However, since the 1960's, along with the development of the Columbia Basin Project, another type of irrigation technique using ground water from privately funded wells also started to develop.

In 1945, the state of Washington enacted a law to regulate public groundwater (Chapter 90.44 RCW), which later in 1985, was revised to include provisions for identifying and designating groundwater management areas in order to protect groundwater quality, to assure groundwater quantity, and to effectively manage water resources to meet future needs (RCW 90.44.130 and 90.44.400). Also in 1985, the Department of Ecology (Ecology) publicized regulations (Chapter 173-100 WAC) to implement RCW 90.44.130 and 90.44.400. These regulations, revised in 1988, establish guidelines, criteria, and procedures for designating groundwater management areas.

Anticipating a ground water problem, in 1969, the state of Washington publicized a rule (Chapter 508-14 WAC) to curtail groundwater development in a defined area of the Columbia Basin project known as the Quincy Basin, comprising mostly the north-west portion of the area under CBP. Following completion of the groundwater investigation, Ecology identified a "practical groundwater management unit in the Quincy Basin area" and in 1973 promulgated regulations (Chapter 173-124 WAC) to establish aerial boundaries and depth zones for that groundwater management unit. In 1988, WAC 173-124 was revised and the Quincy Groundwater Management Sub-area was formally designated.

Next to the selection of Quincy Basin unit, another groundwater management unit, the Odessa Groundwater Management Sub-area, was subsequently designated by Chapter 173-128A WAC for the region of roughly 1800 sq. miles under the Columbia Basin Project, commonly known as "Odessa Area" or "Odessa-Lind Area." The area extends from Odessa on the North to Lind on the South, and from the East Low Canal on the west to Ritzville on the East. This area is semi-arid with a higher precipitation on its Eastern side than that on its West. At the same time, the western part of this Odessa Area is bordering the fully completed portion of Columbia Basin Project.

Besides the division of Quincy and Odessa Groundwater Management, 508-14 WAC was then revised to define the boundaries of the area remaining in the Columbia Basin project outside the formally designated Quincy and Odessa Groundwater Management Sub areas (WAC 508-14-030 [3]). Instead of giving it any name, they designated the area by a number. The area then

became informally known as the 508-14. It occupies parts of Franklin, Grant, and Adams Counties, primarily the southern portion of CBP.

The early days of settlement in the Odessa area could be traced back to 1880's, and while groundwater was used, its use was limited. Initially it was used primarily for domestic needs and stock uses, and only later for irrigation. In earlier days most of the wells were, on average, 6 inches in diameter and were cased through the unsolicited materials overlying the basalt. The depth of penetration varied according to the water depth. In the coulees, the wells that penetrated only a few feet of basalt yielded enough water for all needs. While in the higher elevations of the area, wells were drilled to depths ranging from 100 to 200 feet. However, in Crab Creek Valley, because of the presence of sufficiently permeable saturated alluvium, shallow dug wells turned out to be good enough for all purposes. In the beginning, all these domestic wells were fitted with windmill powered plunger pumps and they were installed directly atop the casings, or bolted to concrete or plank foundations. Over time, technology changed and people started replacing their old technology of windmill powered plunger pumps by the electric driven option, and older pumps were replaced by submersible versions. Because most of these submersible pumps yield more water than the old plunger type, draw down in the wells became larger.[12]

Until the 1960's, dry land farming was practiced exclusively for wheat, when for the first time, through the use of Sprinkler technology, wheat growers discovered the remarkable impact of supplementary water on crop yield. Since then, wells with diameters as great as 16 inches are drilled to a depth ranging from 200 to 700 feet. The pumps for these wells are run by an electric

[12] Page 13 & 2, A. A. Garrett, "Ground Water Withdrawal in the Odessa Area," USGS, Water Resource Division, 1968.

motor having power up to 200 HP. Generally, the large capacity "deep wells" are made for irrigation, and "shallow wells" are for domestic purposes. However, sometimes because of the large yield found in some domestic wells, some irrigation wells were also located next to those domestic wells. Although the wells were expensive, the economic returns were high. Various reasons could be cited behind such economic gain. Electricity was cheap, an outcome of CBP, and the land quality, along with farming technique, resulted in high yields. Economic incentives to use groundwater became so lucrative that between the 1960's and the 1970's, pumpage of ground water increased almost tenfold (Table3).

Table 3. Ground Water pumpage at Odessa Sub-area, in acre-feet

		Grand Ronde	Wanapum	Over Burdened Unit	Total		Grand Ronde	Wanapum	Over Burdened Unit	Total
1960	Adams	1,980	5,920	50	7,950	1970	16,480	34,190	0	50,670
	Franklin	100	1,800	0	1,900		700	3,450	0	4,150
	Grant	2,150	2,590	1,340	6,080		9,030	15,420	2,110	26,560
	Lincoln	1,430	2,400	100	3,930		15,840	9,360	550	25,750
		5,660	12,710	1,490	19,860		42,050	62,420	2,660	107,130
1975	Adams	49,560	46,360	0	95,920	1984	78,590	42,920	0	121,510
	Franklin	700	2,400	0	3,100		3,970	8,730	0	12,700
	Grant	17,910	18,520	1,150	37,580		26,350	17,970	370	44,690
	Lincoln	25,070	11,230	0	36,300		24,940	8,650	0	33,590
	Total	93,240	78,510	1,150	172,900		133,850	78,270	370	212,490

Source: D.R. Cline & C.A. Collins, Ground Water Pumpage from Columbia Plateau.

Ground water in the Odessa–Lind Area is part of a large system that covers much of east-central Washington. The groundwater moves slowly down gradient towards the southwest and toward the Columbia and Snake River. "Contrary to belief, surface water bodies to the North, such as Roosevelt Lake and Spokane River, cannot be the source of ground water because they

are 600 to 900 feet lower than ground water levels on the plateau just to the south."[13] Most of the groundwater is contained within layered basalt rocks. These layers are generally dense and limit the vertical movement of water. However, between the layers, many porous zones occur that contain broken basalt or sediment. These zones permit the movement of the groundwater and yield water to most of the large production wells in the area. Pumping takes place during the 7 months in the spring, summer and fall, peaking during July and August, and stops for the five winter months. Most of the replacement water, necessary for water level rise, moves into the area by lateral underground flow, which is slow depending upon the gravity and sometimes is restricted by the rock material through which the water flows.

Ground water pumpage, mostly for irrigation, increased from the central Washington project area, from about 25,000-acre feet of water in 1963 to about 387,000-acre feet in 1977, causing continuing water level declines in parts of the Odessa-Lind Area. The number of large capacity wells in the project area increased from 170 in 1963 to 618 in 1977. Few wells in 1967 were deeper than 1000 feet, but by 1977 many were deeper. Most of the water pumped in 1967 was from the wells tapping Wanapum Basalt, but by 1977 most was from wells tapping both the Wanapum Basalt and the underlying Grand Ronde Basalt aquifers.[14] In response to concerns regarding water level decline in 1968 Washington Department of Ecology (DOE) adopted a policy of deferring all new permits to drill new wells. However, after doing some economic and geological studies, in 1975 DOE revoked the existing ban on groundwater withdrawals[15] and started issuing new permits. Those permits were issued subject to the constraint that withdrawals

[13] Odessa Lind Area, Luzier et al., "Ground Water Survey," WA State Department of Water Resources, Water-Supply Bulletin No. 36.
[14] Denzel R. Cline. "Ground-water Levels and Pumpage in East-Central Washington, Including the Odessa-Lind Area, 1967 to 1981," USGS in cooperation with the Washington State Department of Ecology.
[15] Page 13 &16, Whittlesey et al. Report No. 27, Washington Water Research Center Report, 1976.

of water were not to cause decline in the water level in excess of 10 feet per year, the limit suggested by 1974 DOE Study.

In general, the ground water in this area came from a big aquifer, underlying most of the area and was accessible from virtually any of the irrigable lands in the Odessa-Lind Area. Possibilities of effective recharging of water were assumed to be almost zero, and in fact, in the deeper aquifer water was estimated to be two to seven thousands years old, and pumping out of the deeper aquifer resulted in constant depletion of the water level.

Over the years, Columbia Basin Project water and well irrigation together culminated into an interesting situation. Wells in some areas of the Odessa-Lind area dried up completely. At the same time, however, irrigation water coming through the network of canals and ditches built for the Columbia Basin project eventually infiltrated into the ground where it started commingling with natural groundwater.[16] The result of recharging was most pronounced in the southern side of 508-14 area, where the groundwater system throughout much of the basin now has a large component of "artificially stored" water that was not present before the Columbia Basin project began. According to a study conducted by the United States Geological Survey (USGS Water-Resources Investigations Report 96-4086),[17] the volume of groundwater in storage in the Pasco Basin, which includes the southern half of the 508-14 Area, has increased by approximately five million acre-feet since the project began. The vast majority of the increase is the result of seepage from water delivery canals and ditches and from infiltration of irrigation

[16] George Schlender, John Covert, Keith Stoffel. "Report to the Legislature: Allocating Accumulated Columbia Basin Groundwater," DOE, 2002, http://www.ecy.wa.gov/pubs/0311002.pdf.
[17] Joel E. Dysart and Stephen J. Rheaume. "Induced Infiltration from the Rockaway River and Water Chemistry in a Stratified-drift Aquifer at Dover, New Jersey," US DOI, USGS; 1999.

water, but groundwater levels have also risen locally within the Pasco Basin as a result of the formation of reservoirs behind dams constructed on the Columbia and Snake Rivers. USGS WRI Report 86-4086 includes estimates of the volumes of “naturally occurring” and “stored” groundwater in the Pasco Basin. It also includes data that demonstrates by the late 1980s, the volume of groundwater flowing into and out of the Pasco Basin (and the southern half of the 508-14 Area) had nearly reached equilibrium, and groundwater levels had essentially stabilized. The Columbia Basin project water imported into the Pasco Basin (and the southern half of the 508-14 Area) has resulted in some benefits, including an increase in the volume of water available for beneficial use and a decrease of nitrate concentrations in groundwater as a result of dilution. On the other hand, the imported irrigation water has raised groundwater levels throughout much of the Pasco Basin which has had some negative effects, including an increase in slope instability and a decrease in the amount of arable land as a result of water ponding in areas with poor drainage. In order to deal with allocation of groundwater that has accumulated as a result of the importation of surface water from the Columbia Basin project, in 2002, the Washington State legislature enacted SHB 2874 to amend Chapter 89.12 RCW, with the intent to authorize the Department of Ecology to enter into agreements with the United States Bureau of Reclamation (USBR) to allocate groundwater permits within the geographic area of the WAC 508-14. The legislature, through passage of SHB 2874, required Ecology to report annually in December on progress to implement the legislation.

The situation was complicated in the 1990s when the Bureau of Reclamation and the Washington State Department of Ecology both put moratoriums on new withdrawals from the Columbia River to protect fish under the federal Endangered Species Act. However, the

moratoriums were lifted in November 2003, and the push to gain access to the Columbia Basin Irrigation Project water gained momentum. According to local farmers, the deep wells draw down of the aquifer threatens the area and the long-term viability of the agriculture sector in the region.

The Columbia Basin includes more than 2,000 farms that grow more than 60 crops, including most of the state's potato production. The basin is a major producer of apples, grapes, hay, wheat and other grains, stone fruit, corn, mint and vegetables. The region is home to major processing plants that depend on the crops produced nearby. "The annual Farm Gate value of agriculture in the basin is estimated at about $3 billion, more than half of the nearly $5.8 billion value estimated for the entire state in 2003."[18] According to Senator Maria Cantwell, completion of the Second Phase project could cost $400 million and take several years. Funding is also critical to upgrade the project's existing infrastructure. Congressman Doc Hastings, R-Wash., has included $250,000 in a bill that includes Bureau of Reclamation's 2005 budget. The money is earmarked for an appraisal of the Odessa Sub-Area situation. Cantwell pledged her support on the Senate side. "Sen. Patty Murray, D-Wash., also supports the funding request," said Judy Olsen, Murray's Eastern Washington director. The federal funding, if approved, would be added to per-acre pledges from farmers and landowners in the region. According to Alice Parker, Columbia Basin Development League Executive Secretary in Moses Lake, the league hopes to raise $300,000 in private pledges and is well on the way towards its goal. According to the Columbia Basin Development League, switching to surface water would dramatically reduce

[18] Senator Maria Cantwell's estimate, October 29, 2004, Peggy Steward, http://www.capitalpress.info/Main.asp?SectionID=67&SubSectionID=619&ArticleID=13186 .

demands on groundwater, which in turn will help to recharge the aquifer over time, allow farmers to diversify crops while stimulating the economy, attract new processors and create jobs.

There are approximately 170,000 total irrigated acres, which include 35,611[19] acres of irrigated potato land in this Odessa Sub-area. The ground water below this particular area is declining. Besides the water level issue among the growers in this region, "water rights issue" could also become a serious matter of concern. It may happen that the farmers may start taking legal action against each other in order to prevent water level declines in their own ground water, which they think is being caused by water usage in nearby fields. If farmers start moving to the courts the situation will be a loss-loss situation rather than a win-win. At the same time, DOE doesn't have enough manpower to keep an eye on the wells and water usage by the farmers. In order to make it a win-win situation, some would argue that additional extraneous water supply is necessary. Unless the growers of this area can find alternative sources of water, potato production in Odessa Sub-area could diminish or even cease to exist. If production in the Odessa Sub basin were to stop, the economic impact on the entire economy may be significant. In the following section, we will examine alternative possible economic impacts of loss of crop production in the Odessa Sub area.

SECTION C1: THE COLUMBIA BASIN ECONOMY INCLUDING THE ODESSA SUB-AREA

An economic impact analysis at regional level requires a detailed illustration of economic data at regional level, a proper economic methodology, and a necessary tool to implement that

[19] 35,611 acres of irrigated potato land comprised of some deep well land, which is actually beyond the geographical map of Odessa Sub Area. Potato acreage estimate obtained from Paul Stoker of the Columbia Basin Ground Water Management Area.

methodology using those data sets. In this regard we have used an economic impact assessment modeling system known as IMPLAN. Apart from its operational flexibility, IMPLAN has a very reliable and detailed disaggregated state and county level data for up to 528 industries and commodities, featuring its employment, output, value added and institutional demand, which are some of the necessary elements to make regional social accounts complete. In addition, it shows the regional "Use Matrix" (matrix showing input absorption by these industries) and the corresponding regional "Make Matrix" (matrix showing all primary and by-products produced in these industries) at the regional level. IMPLAN also gives detailed employee compensation by industry, indirect business tax, proprietary income and other property type income generated by each industry in the regional economy. Basic demographic features, starting from the county level to national level, are also available from IMPLAN[20] data set.

Table 4. Basic Demographic Features, County and State level, State of WA.

	WA State	Adams	Franklin	Grant	Lincoln	4-Counties Total
Population	5,894,121	16,428	49,347	74,698	10,184	150,657
No. of HH	2,272,261	5,217	14,870	25,207	4,180	49,474
Personal Income ($M)	184,517.689	334.209	932.083	1,507.484	223.919	2,997.696
Average HH Income ($)	81,204	64,062	62,682	59,804	53,569	60,591
Average HH Size	2.59	3.15	3.32	2.96	2.44	3.05
area (Sq. Miles)	66,581	1,925	1,242	2,676	2,311	8,155
Population/Sq. Mile	89	9	40	28	4	18

Data Source: IMPLAN, year 2000.

Table 4 shows basic demographic and income data for Washington State and the four counties in the regional economy. The average Household (HH) personal income is higher at the state level than it is in the county or regional level. At the regional level Personal Income is

[20] Minnesota IMPLAN Group, Inc.

defined as "the income received by all persons from working (participating in production), from government and business transfer payments, and from interest, dividends and rent. Personal Income is the sum of net earnings by place residence, rental incomes of persons, personal dividend payments, personal interest income, and transfer payments. Examples of transfer payments are Social Security payments, Medicare payments, unemployment insurance payments and veterans' pensions. Personal income is measured before the deduction of personal income taxes and other personal taxes."[21]

The local economy of four-counties has a more agrarian economic base, in comparison to the state level economy (2000 data, source: IMPLAN). While 36.44% of total employees (Table 5a and Table 5b) of the Local economy are involved in Agriculture and food related sectors, the corresponding figure for the overall state level is only 6.94%.

Table 5a. Overall pattern of Industry Output, employment etc., Regional Level.

4-Counties	Industry Output (m$)	Employ-ment	% of Total Counties Employment	Employee Compen-sation (m$)	% of Total Employee Compensa-tion	Average Wage ($)	Total Value Added (m$)	% of Total Value Added
1. Farm Products	1,336	14,073	17.70	115.18	6.55	8,185	384	11.48
2. Other Agricultural related	219	5,430	6.83	45.39	2.58	8,359	157	4.69
3. Food Processing	1,112	4,243	5.34	156.69	8.91	36,931	280	8.38
4. Other food related	181	5,223	6.57	73.53	4.18	14,076	120	3.58
Food & Agriculture (1-4)	2,848	28,970	36.44	390.79	22.21	13,490	940	28.13
Rest of the Economy	3,981	50,539	63.56	1,369	77.79	27,082	2,403	71.87
Total	6,829	79,509	100.00	1,759.47	100.00	22,129	3,343	100.00

[21] http://niip.wsu.edu/cgi-bin/broker.exe .

Table 5b. Overall pattern of Industry Output, employment etc., State Level.

WA State	Industry Output (m$)	Employ-ment	% of Total Counties employment	Employee Compen-sation (m$)	% of Total Employee Compensa-tion	Average Wage ($)	Total Value Added (m$)	% of Total Value Added
1. Farm Products	4,766	71,092	1.98	896.10	0.69	12,605	1,863	0.87
2. Other Agricultural related	3,450	66,023	1.84	783.63	0.60	11,869	2,589	1.20
3. Food Processing	10,277	42,409	1.18	1,571.97	1.21	37,067	2,652	1.23
4. Other food related	11,623	270,280	7.54	4,993.95	3.84	18,477	7,807	3.63
Food & Agriculture (1-4)	30,116	449,804	12.55	8,245.65	6.34	18,332	14,912	6.94
Rest of the Economy	341,553	3,133,146	87.45	121,863	93.66	38,895	200,067	93.06
Total	371,669	3,582,950	100.00	130,108.52	100.00	36,313	214,978	100.00

Data Source for Table 5A & B: IMPLAN, Year 2000.

Besides employment generation, agriculture and food related sectors are also very important for trade reasons. The region is a significant exporter of agriculture and food related products (Table 6).

Table 6. Overall Trade Pattern.

4-Counties, Year 2000	Total Exports (m$)	Total Imports (m$)	Trade Balance (m$)
Farm Products	873.18	166.61	706.58
Greenhouse and Nursery Products	18.25	2.59	15.66
Forestry Products	2.12	2.38	-0.26
Agricultural- Forestry- Fishery Services	0.36	14.65	-14.29
Landscape and Horticultural Services	0.07	5.37	-5.31
Food Processing	1,078.22	296.95	781.27

Source: IMPLAN, Year 2000.

Potato production is one of the most important agricultural crops in the Odessa Sub-area. Over 35, 000 acres of land in this region are used for potato production. The yields are above the state average. The quality of potato is high and virtually all of these potatoes go to potato

processing plants and are made into frozen potato products. Potatoes grown in this area can be stored in the raw form for many months allowing potato-processing plants to operate on a year-around basis. Potatoes grown in other areas of the Columbia Basin, on the lighter soils and older ground tend to have a shorter storage life and are used first by the processing plants.

An Economic Impact Analysis

In the following section we will examine the economic consequences on the Lincoln and Adams counties regional economy that would result from potential losses in crop production in the deep well area of those two counties. We will measure the potential loss of regional sales and regional employment, including ripple effects, if deep well production were to drop by 10 percent in those two counties. The 10 percent figure is chosen for lack of a clearly better alternative figure. The economic model is linear so those wishing to examine the economic impact of a 20 percent reduction in production could simply multiply the 10 percent impact results by a factor of two.

The economic impact will be summarized for two alternative scenarios. In Scenario 1, crop production in the sub-area portions of Adams and Lincoln counties is assumed to be reduced by 10 percent. All irrigated crops production in the sub-area of the two counties are assumed to be reduced by 10 percent as a consequence of an assumed shortage of deep well water. In Scenario 2, in addition to the impact in Scenario 1, we assume that potatoes formerly produced in the Odessa Sub basin of the two counties cannot be replaced by production in any other region or county and this leads to the loss of processing of those potatoes into frozen potato

product in the two-county region. In this scenario the regional economic impact is most damaging to the regional economy.

SECTION C2: ECONOMIC IMPACTS

In a regional economy, production loss in any industry has two major impacts on that economy. First, a loss occurs in the payments that the industry pays to buy the intermediate inputs such as fertilizer and fuel. This could be considered as payment to the inputs or the monetized value of gross absorption. At the same time, industry loses payment to the primary inputs, which are capital and labor, or the "value-added" impact. In our case, value-added impacts are comprised of four factors: Indirect Business taxes, Property incomes, Proprietary income, and Employee Compensation.

Under the above circumstances, the regional economic impact mainly consists of two major effects – direct and secondary.

Direct effects: the changes in economic activity that takes place in the directly affected industry. For our case, this involves the impacts on the agricultural industries.

Secondary effects: these changes in economic activity emanate from the subsequent ripple effect of changes in directly affected industry spending. There are two types of secondary effects – indirect and induced.

Indirect effects are the changes in sales, income, or employment within the region connected through "backward-link" to the industry of concern. These "backward-linked" industries are those who supply goods and services to our direct industry. For example, the decreased sales of the fertilizer industry or the drop in agricultural services resulting from a decreased production in the potato industry.

Induced effects reflect the change in sales within the region resulting from changes in household spending of the income earned in potato and supporting industries. Employees in the potato industry and the supporting industries base their consumption spending on the income they earn from these industries.

The above mentioned economic impacts are estimated in this study with the aid of a regional input-output model of Adams and Lincoln. The model was generated from the IMPLAN data and modeling system and represents the regional economy in 2003.[22]

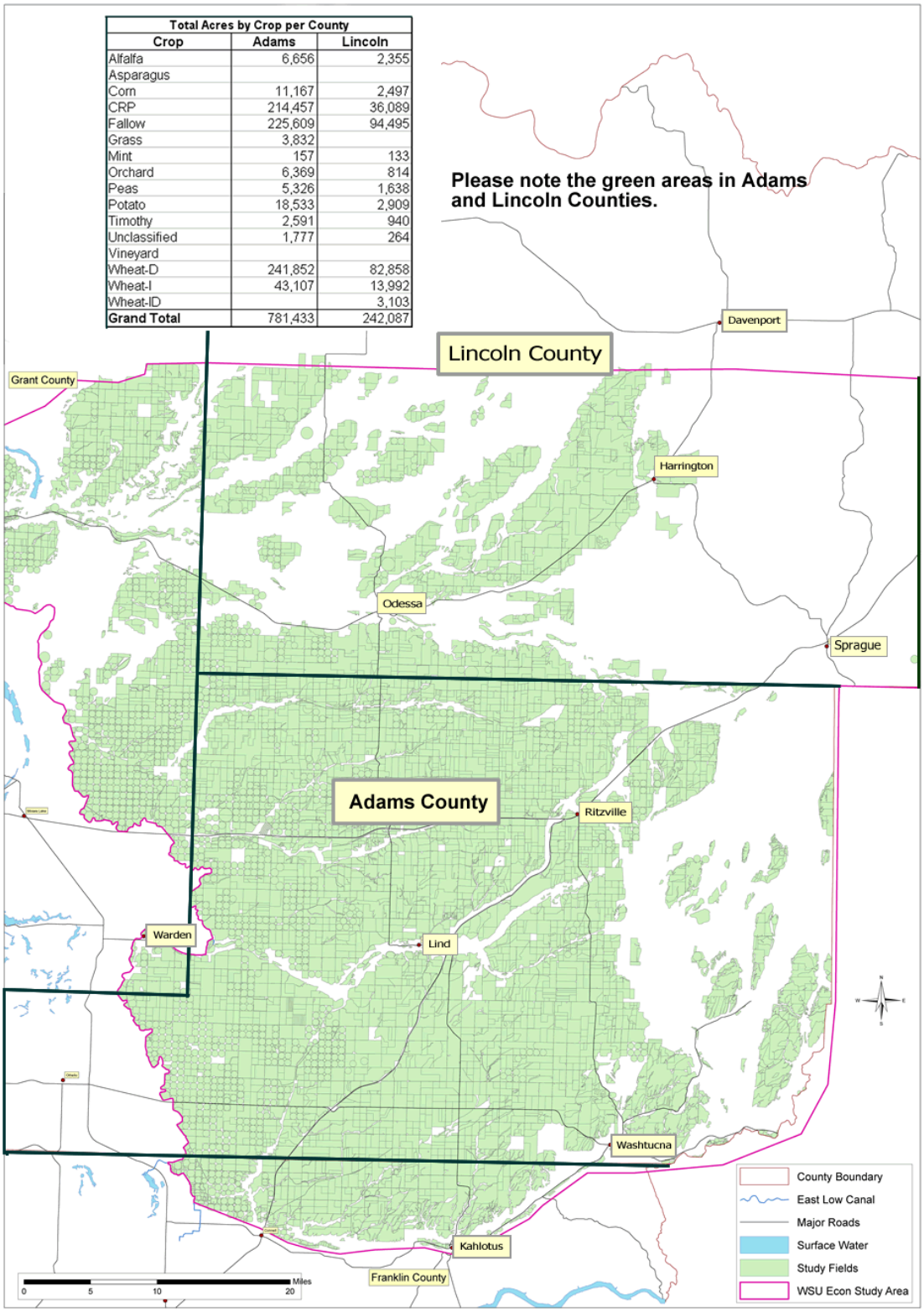
Scenario 1. The Economic Impact of a 10 Percent Loss of Crops Produced in the Odessa Sub-Region of Adams and Lincoln Counties

In the Odessa Sub-area of the two Counties roughly 1,023,000 acres of land are being farmed or are in CRP (Figure 1). Of course, much of the land is fallow or in dryland wheat. The use of this land is not a focus of this study. We are interested in the irrigated crops produced in the region and the value of those crops.

[22] Minnesota IMPLAN Group, Inc.

Figure 1: The Odessa Deep Well Region in Adams and Lincoln Counties

Total Acres by Crop per County		
Crop	Adams	Lincoln
Alfalfa	6,656	2,355
Asparagus		
Corn	11,167	2,497
CRP	214,457	36,089
Fallow	225,609	94,495
Grass	3,832	
Mint	157	133
Orchard	6,369	814
Peas	5,326	1,638
Potato	18,533	2,909
Timothy	2,591	940
Unclassified	1,777	264
Vineyard		
Wheat-D	241,852	82,858
Wheat-I	43,107	13,992
Wheat-ID		3,103
Grand Total	781,433	242,087



Source: Mark Nielson, Franklin Conservation District

In order to do this we took the acreage figures for irrigated crops from Figure 1, assumed representative yields for the county (or state level estimates if county yield data were unavailable) to get estimated total production of each irrigated crop. Then we multiplied these production estimates by the average producer price to obtain the farm gate value of the irrigated crops produced in the Odessa region of Adams and Lincoln Counties. Individual crops were aggregated into categories consistent with the agricultural industries in the Input-Output Model for the combined regional economies. Ten percent of the estimated irrigated crop values are summarized in Table 7.

Table 7. Value of Irrigated Crops Produced in the Odessa Region of Adams and Lincoln Counties.

	Adams (10 Percent of Total Industry Output) Producer Value
Grain Farming	$2,164,601.22
Vegetable	$8,502,599.44
Fruits	$3,949,416.90
Others	$3,566,703.45
	Lincoln (10 Percent of Total Industry Output) Producer Value
Grains	$685,833.69
Vegetables	$985,820.19
Fruits	$504,513.36
Others	$125,039.75
	Combined (10 Percent of Total Industry Output) Producer Value
Grains	$2,850,435
Vegetables	$9,488,420
Fruits	$4,453,930
Others	$3,691,743

Source: Mark Nielson, Franklin Conservation District and Author's Calculations

Grains represent mainly wheat, but also some corn. Approximately $28 million of irrigated grains were produced in the region. Most vegetables produced are potatoes ($95 million). Fruit produced is primarily apples ($44 million), and Others is mostly alfalfa, timothy, and mint ($36 million). In total, slightly over $200 million of irrigated crops are produced in the region.

A summary (sales (output), employment and regional income) for the regional economy of Adams and Lincoln counties combined is summarized in Table 8. Output represents industry sales in 2003 measured in farm gate value or factory gate value. Employment is measured as the number of full and part time jobs in each of the industries. Employee compensation is a measure of gross wages (including social security contribution by employer and employee). Proprietors' income is returns to labor and capital for business organizations not organized as corporations. Other property income is the returns to capital, including depreciation allowances, for firms organized as corporations. Indirect business taxes are the sum of taxes paid on inputs purchased by the industry, including fuel taxes, other excise taxes, and property taxes.

The regional economy depicted in the Total row of Table 8 has roughly 14,500 full and part time jobs. Grain farming is a big part of the agricultural industry, as is vegetable production (potatoes) and fruit production. Frozen food manufacturing (frozen potato products) is an important part of the agribusiness complex as are other types of food manufacturing.

Table 8. Output, Employment and Value Added in Adams and Lincoln Counties, 2003

	Industry	Industry Output*	Employ-ment	Employee Compensa-tion*	Proprietor Income*	Other Property Income*	Indirect Business Tax*	Total Value Added*
3	Vegetable and Melon Farming	81.340	470.863	19.852	2.780	37.507	1.038	61.178
4	Fruit Farming	60.000	468.000	24.000	1.500	10.500	1.700	37.700
6	Other Crop Farming	61.219	272.301	8.793	1.293	27.919	1.587	39.592
11	Animal and Poultry Production	49.790	318.958	4.828	0.051	0.251	1.366	6.496
14	Agricultural Support Service	16.237	715.119	13.023	1.596	-2.903	0.159	11.876
19	21 Mining	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	22 Utilities	11.698	21.968	1.693	0.768	4.726	1.226	8.413
33	23 Construction	36.197	372.725	8.732	3.649	2.120	0.178	14.680
60	Frozen Food	181.732	651.501	27.241	0.000	26.267	1.261	54.769
89	Other Manufacturing	14.056	92.135	2.079	1.292	1.063	0.059	4.493
390	42 Wholesale Trade	78.223	848.893	32.046	1.298	13.293	12.859	59.495
392	Other Transportation	10.933	81.974	4.473	1.181	1.576	0.311	7.541
394	Truck Transportation	24.924	268.435	5.961	2.469	2.707	0.255	11.392
401	44-45 Retail Trade	51.525	1,096.049	18.804	4.842	6.726	7.796	38.168
413	51 Information	5.471	56.233	1.003	0.000	0.430	0.098	1.531
425	52 Finance & Insurance	35.357	275.823	7.837	2.156	15.270	0.394	25.658
431	53 Real Estate & Rental	9.811	111.208	1.285	1.231	3.236	0.828	6.580
437	54 Professional-Scientific & Tech Svcs	15.587	195.488	6.044	1.984	0.979	0.159	9.167
451	55 Management of Companies	0.000	0.000	0.000	0.000	0.000	0.000	0.000
452	56 Administrative & Waste Services	3.703	54.466	0.768	0.296	0.351	0.080	1.494
461	61 Educational Svcs	0.213	5.863	0.113	0.001	0.001	0.002	0.118
464	62 Health & Social Services	48.646	1,115.304	20.007	5.242	5.686	0.359	31.293
475	71 Arts-Entertainment & Recreation	7.408	216.545	0.512	2.074	1.181	0.551	4.318
479	72 Accommodation & Food Services	22.537	542.216	6.365	0.473	2.082	1.075	9.995
482	81 Other Services	28.190	812.907	8.806	3.141	1.672	1.055	14.675
495	92 Government & Non NAICS	199.642	2,895.121	105.096	0.000	46.484	7.589	159.169
497	Grain Farming	136.302	2,430.699	5.830	3.678	58.104	3.334	70.946
502	Other Food Manufacturing	53.120	106.001	3.310	0.327	1.778	0.238	5.654
	Totals	1,243.862	14,496.798	338.504	43.323	269.006	45.558	696.390

Source: IMPLAN regional economic model of Adams and Lincoln counties.
*Millions of dollars

Table 9 shows the economic impact of the loss of 10 percent of irrigated crop production in the Odessa area of the two Counties. Notice that the direct impact (effect) includes the loss of crop production as well as the in-region trucking and marketing activities that those crops would have generated. The indirect effect, as noted previously, shows the ripple effect from the loss of input purchasing by the agricultural industries, and the trucking and marketing industries. The induced effect shows the impact of the loss in household consumption due to the loss of payrolls associated with direct and indirect effects.

Table 9. Output Impact (10 percent reduction in crop production in the Odessa area—Adams and Lincoln Counties)

		Output Impact $			
Industry Code	**Industry**	**Direct ($)**	**Indirect ($)**	**Induced ($)**	**Total ($)**
3	Vegetable and Melon Farming	-9,262,254	-112,921	-9,877	-9,385,052
4	Fruit Farming (AGG)	-4,347,767	-64,564	-7,857	-4,420,188
6	Other Crop Farming (AGG)	-3,603,747	-54,332	-3,638	-3,661,717
11	Animal and Poultry Production (AGG)	0	-33,783	-15,418	-49,201
14	Agricultural Support Services (AGG)	0	-722,079	-2,047	-724,125
19	21 Mining (AGG)	0	0	0	0
30	22 Utilities (AGG)	0	-47,002	-50,749	-97,751
33	23 Construction (AGG)	0	-31,724	-14,018	-45,741
60	Frozen Food (AGG)	0	-147	-15,435	-15,583
89	Other Manufacturing (AGG)	0	-144,703	-9,596	-154,299
390	42 Wholesale Trade (AGG)	-2,084,108	-533,618	-285,888	-2,903,613
392	Other Transportation (AGG)	-6,867	-172,071	-24,031	-202,969
394	Truck Transportation	-1,966,927	-309,922	-40,795	-2,317,644
401	44-45 Retail Trade (AGG)	0	-24,462	-424,167	-448,629
413	51 Information (AGG)	0	-24,899	-34,170	-59,068
425	52 Finance & Insurance (AGG)	0	-113,156	-154,567	-267,723
431	53 Real estate & Rental (AGG)	0	-98,754	-47,355	-146,108
437	54 Professional- Scientific & Tech Svcs	0	-91,873	-71,652	-163,525

		Output Impact $			
Industry Code	**Industry**	**Direct ($)**	**Indirect ($)**	**Induced ($)**	**Total ($)**
451	55 Management of Companies (AGG)	0	0	0	0
452	56 Administrative & Waste Services	0	-27,285	-19,050	-46,335
461	61 Educational Svcs (AGG)	0	-20	-2,564	-2,584
464	62 Health & Social Services (AGG)	0	-496	-417,110	-417,606
475	71 Arts- Entertainment & Recreation	0	-3,689	-48,377	-52,066
479	72 Accommodation & Food Services	0	-15,484	-229,698	-245,182
482	81 Other Services (AGG)	0	-101,678	-221,354	-323,031
495	92 Government & non NAICs (AGG)	0	-242,314	-820,646	-1,062,960
497	Grain Farming (AGG)	-2,781,755	-157,133	-9,575	-2,948,464
502	Food Manufacturing (AGG)	0	-400	-35,937	-36,338
10001	Institutions (AGG)	-737	0	0	-737
	Total	-24,054,162	-3,128,509	-3,015,569	-30,198,240

Source: Author's Estimates

The loss of regional employment is estimated by the figures summarized in Table 10. Counting indirect and induced effects, the total job loss is about 295 jobs. Since the model is linear we can multiply this result by a factor of ten to estimate the economic impact of complete elimination of all irrigated crop production in the region. The resulting 2,950 jobs lost represents roughly 20 percent of the 14,496 total jobs in the two counties.

Table 10. Employment Impact (10 percent reduction in crop production in the Odessa area—Adams and Lincoln Counties)

		Output Impact (jobs)			
Industry Code	**Industry**	**Direct ($)**	**Indirect ($)**	**Induced ($)**	**Total ($)**
3	Vegetable and Melon Farming	-53.6	-0.7	-0.1	-54.3
4	Fruit Farming (AGG)	-33.9	-0.5	-0.1	-34.5
6	Other Crop Farming (AGG)	-16.0	-0.2	0.0	-16.2
11	Animal and Poultry Production (AGG)	0.0	-0.3	-0.1	-0.4
14	Agricultural Support Services(AGG)	0.0	-36.3	-0.1	-36.4
19	21 Mining (AGG)	0.0	0.0	0.0	0.0
30	22 Utilities (AGG)	0.0	-0.1	-0.1	-0.2
33	23 Construction (AGG)	0.0	-0.4	-0.1	-0.5
60	Frozen Food (AGG)	0.0	0.0	-0.1	-0.1
89	Other Manufacturing (AGG)	0.0	-0.4	-0.1	-0.5
390	42 Wholesale Trade (AGG)	-22.6	-5.8	-3.1	-31.5
392	Other Transportation (AGG)	0.0	-1.1	-0.2	-1.3
394	Truck Transportation	-21.2	-3.3	-0.4	-25.0
401	44-45 Retail Trade (AGG)	0.0	-0.5	-9.4	-10.0
413	51 Information (AGG)	0.0	-0.3	-0.4	-0.6
425	52 Finance & Insurance (AGG)	0.0	-0.7	-1.0	-1.7
431	53 Real estate & Rental (AGG)	0.0	-1.0	-0.5	-1.6
437	54 Professional- Scientific & Tech Svcs	0.0	-1.1	-0.9	-2.0
451	55 Management of Companies (AGG)	0.0	0.0	0.0	0.0
452	56 Administrative & Waste Services	0.0	-0.4	-0.3	-0.7
461	61 Educational Svcs (AGG)	0.0	0.0	-0.1	-0.1
464	62 Health & Social Services (AGG)	0.0	0.0	-7.5	-7.5
475	71 Arts- Entertainment & Recreation	0.0	-0.1	-1.4	-1.5
479	72 Accommodation & Food Services	0.0	-0.4	-5.6	-6.0
482	81 Other Services (AGG)	0.0	-1.5	-5.7	-7.2
495	92 Government & non NAICs (AGG)	0.0	-1.2	-1.0	-2.2
497	Grain Farming (AGG)	-49.7	-2.8	-0.2	-52.7
502	Food Manufacturing (AGG)	0.0	0.0	-0.2	-0.2
10,001	Institutions (AGG)	0.0	0.0	0.0	0.0
	Total	-197.0	-58.9	-38.6	-294.6

Source: Author's Estimates

The impact on value added is summarized in Table 11. The loss in total income (value added) is roughly $20 million with most of the loss occurring in the agricultural industries and the trucking and marketing industries.

Table 11. Total Value Added Impact (10 percent reduction in crop production in the Odessa area—Adams and Lincoln Counties)

		Output Impact ($)			
Industry Code	**Industry**	**Direct ($)**	**Indirect ($)**	**Induced ($)**	**Total ($)**
3	Vegetable and Melon Farming	-6,966,356	-84,930	-7,428	-7,058,715
4	Fruit Farming (AGG)	-2,731,847	-40,568	-4,937	-2,777,351
6	Other Crop Farming (AGG)	-2,308,830	-35,557	-2,705	-2,347,092
11	Animal and Poultry Production (AGG)	0	-4,149	-2,783	-6,932
14	Agricultural Support Services (AGG)	0	-576,582	-1,620	-578,201
19	21 Mining (AGG)	0	0	0	0
30	22 Utilities (AGG)	0	-33,835	-36,498	-70,332
33	23 Construction (AGG)	0	-14,208	-6,064	-20,272
60	Frozen Food (AGG)	0	-44	-4,652	-4,696
89	Other Manufacturing (AGG)	0	-43,388	-3,894	-47,282
390	42 Wholesale Trade (AGG)	-1,585,147	-405,863	-217,443	-2,208,453
392	Other Transportation (AGG)	-5,817	-125,634	-16,168	-147,620
394	Truck Transportation	-899,001	-141,652	-18,646	-1,059,299
401	44-45 Retail Trade (AGG)	0	-18,047	-312,809	-330,856
413	51 Information (AGG)	0	-9,134	-9,012	-18,146
425	52 Finance & Insurance (AGG)	0	-74,389	-100,880	-175,269
431	53 Real estate & Rental (AGG)	0	-67,704	-31,542	-99,246
437	54 Professional- Scientific & Tech Svcs	0	-51,822	-42,805	-94,627
451	55 Management of Companies (AGG)	0	0	0	0

		Output Impact ($)			
Industry Code	**Industry**	**Direct ($)**	**Indirect ($)**	**Induced ($)**	**Total ($)**
452	56 Administrative & Waste Services	0	-10,339	-8,144	-18,483
461	61 Educational Svcs (AGG)	0	-7	-1,449	-1,456
464	62 Health & Social Services (AGG)	0	-222	-286,192	-286,413
475	71 Arts- Entertainment & Recreation	0	-2,206	-28,508	-30,714
479	72 Accommodation & Food Services	0	-7,990	-100,716	-108,706
482	81 Other Services (AGG)	0	-43,551	-113,708	-157,259
495	92 Government & non NAICs (AGG)	0	-77,852	-571,559	-649,411
497	Grain Farming (AGG)	-1,447,679	-81,786	-4,984	-1,534,449
502	Food Manufacturing (AGG)	0	-59	-5,517	-5,577
10001	Institutions (AGG)	0	0	0	0
	Total	-15,944,676	-1,951,517	-1,940,662	-19,836,855

Source: Author's Estimates

In the next scenario we assume that the loss of crop production has implications for potato processing as well. As expected, should this be the case the regional economic loss becomes larger and more widespread.

Scenario 2. The loss of irrigated crop production, including $9.38 million of potatoes and the associated loss of the frozen-potato processing industry

There are large frozen-potato product processing industries situated in Adams County. These industries depend on raw potatoes as their primary input. In the first scenario, we assumed that these industries won't be affected because as their supply of potatoes from the Odessa Sub-area goes down that supply is replaced by potato production elsewhere in the Columbia Basin. In the second scenario, it is assumed that as potato production in the Odessa Sub-area goes down

the frozen-potato processor is unable to replace the potatoes supplied from the Sub-area and has to reduce their production as a result. Under this assumption, the regional economic impact is greatly increased because of the lost value added and employment associated with potato processing.

The potatoes produced in the Odessa Sub-area are high in quality, high in dry matter (specific gravity), which is a requirement for frozen-potato products, and are very desirable as they are suitable for long term storage, so virtually all the potatoes grown in the area are utilized by this industry. From Table 12, we see that an average 21 million Cwt of potatoes are produced in the entire Odessa Sub-area. The input-output production function (Table 12) for frozen product transforms the value of the raw potato into approximately $324.891million worth of frozen-potato product at the factory gate.[23]

An important point to note in Table 12 is that roughly $97 million of potato input is transformed into $324 million of frozen potato product. Additionally, $40 million of trucking business, $7.5 million of railroad business, and $27 million of wholesale trade business are directly associated with the frozen-potato industry's production. Following the IMPLAN estimate, 72% of railroad service, 74% of trucking and 58% of wholesale business is being locally supplied.

[23] "Production Function Source: The Economic Impact of Potato Production and Processing in Washington State," Masters Thesis by Nick Beleiciks, WSU, 2005.

Table 12. Value of frozen potato product.

Total 4 county (in Odessa Sub-Area) Potato Production	21,188,545 Cwt
8% tare	1,695,084 Cwt
Remaining after 8% tare	19,493,461 Cwt
Value of potato after 8% tare @ $5 /Cwt	$97.46 Million
Value of Frozen Potato	$324.891 Million
Railroad business associated with frozen potato product	$7.49 Million
Trucking business associated with frozen potato product	$40.81 Million
Wholesale Trade associated with frozen potato product	$26.66 Million

Quite naturally, the potato is the main input for frozen-potato product industry. It constitutes roughly 30% of the required input cost for the frozen product industry. Thus $9.38 million of lost potatoes in Adams and Lincoln County when translated into input into the frozen-product industry generates an estimated $30.6 million of frozen product industry production. This is part of the direct impact in Table 13.

The estimated economic impact of the crop loss in Odessa basin of Adams and Lincoln Counties, and the associated loss of potato processing is summarized in Table 13. The largest direct impact is the loss of $30.64 million in frozen food manufacturing (Industry 60). There is no direct effect from the loss of potato production because of the assumption that all of that lost production is reflected in the reduction in frozen-potato processing. The indirect effect stemming from the lost processing includes the lost potato production (see Industry 3 in the indirect column of Table 13).

Table 13. Output Impact Including Potato Processing (10 percent reduction in crop production in the Odessa area—Adams and Lincoln Counties)

					Aggregated Report	
	Industry	**Direct***	**Indirect***	**Induced***	**Total***	**Deflator**
3	Vegetable and melon farming	0	-1,364,890	-16,457	-1,381,347	1.00
4	Fruit Farming (AGG)	-4,347,767	-971,467	-13,095	-5,332,329	1.00
6	Other Crop Farming (AGG)	-3,603,747	-96,749	-6,064	-3,706,560	1.00
11	Animal and Poultry Production (A	0	-369,185	-25,696	-394,882	1.00
14	Agricultural Support Service (AGG)	0	-534,132	-3,411	-537,543	1.00
19	21 Mining (AGG)	0	0	0	0	1.00
30	22 Utilities (AGG)	0	-232,515	-84,575	-317,090	1.00
33	23 Construction (AGG)	0	-73,132	-23,365	-96,497	1.00
60	Frozen Food (AGG)	-30,646,318	-68,538	-25,724	-30,740,580	1.00
89	Other Manufacturing (AGG)	0	-229,270	-15,994	-245,264	1.00
390	42 Wholesale Trade (AGG)	-4,187,729	-3,067,497	-476,466	-7,731,693	1.00
392	Other Transportation (AGG)	-6,561	-432,808	-40,054	-479,423	1.00
394	Truck transportation	-1,879,169	-1,314,054	-67,996	-3,261,218	1.00
401	44-45 Retail trade (AGG)	0	-203,061	-706,942	-910,003	1.00
413	51 Information (AGG)	0	-82,026	-56,950	-138,976	1.00
425	52 Finance & insurance (AGG)	0	-356,424	-257,592	-614,015	1.00
431	53 Real estate & rental (AGG)	0	-129,880	-78,922	-208,802	1.00
437	54 Professional- scientific & tech sv	0	-254,390	-119,421	-373,811	1.00
451	55 Management of companies (AG	0	0	0	0	1.00
452	56 Administrative & waste services	0	-97,431	-31,752	-129,183	1.00
461	61 Educational svcs (AGG)	0	-71	-4,275	-4,346	1.00
464	62 Health & social services (AGG)	0	-714	-695,237	-695,950	1.00
475	71 Arts- entertainment & recreation	0	-14,591	-80,643	-95,234	1.00
479	72 Accommodation & food services	0	-114,665	-382,846	-497,511	1.00
482	81 Other services (AGG)	0	-324,660	-368,974	-693,634	1.00
495	92 Government & non NAICs (AGG	0	-574,211	-1,367,913	-1,942,124	1.00
497	Grain Farming (AGG)	-2,781,755	-147,380	-15,961	-2,945,096	1.00
502	Food Manufacturing (AGG)	-24,489	-408,553	-59,891	-492,933	1.00
10001	Institutions (AGG)	-4,047	0	0	-4,047	1.00
	Total	-47,481,581	-11,462,292	-5,026,216	-63,970,090	

Source Author's Estimates

*2003 Dollars - if results are deflated and aggregated, then deflators displayed are set to 1.0 (results have been deflated).

The employment impact associated with Scenario 2 is summarized in Table 14. As expected, the largest direct job loss is in the frozen-potato product industry, with an estimated loss of 110 jobs (see Industry 60). Indirect job losses are concentrated in the Agricultural Support Industry (Agricultural Services – Industry 14), and Wholesale, and Transportation industries, as well as the agricultural industries. This ripple effect ist reflected the backward linkages between potato processing and the agricultural sectors. As these industries are diminished, agricultural services, wholesale, and transportation are negatively affected as well. The Indirect job loss reflects the reduced household spending associated with the reduced payrolls that accompany the loss of crop production and food processing. As shown in Table 14 most of these jobs are in the commercial and service sectors. For example, in the induced column of Table 14 job losses are relatively high in retail trade, health services, and accommodations and food services. Total job loss for the regional economy is estimated to be 465 jobs or roughly 3.2 percent of the total jobs in the economy (see Table 8). The jobs impacts for assumed larger reductions in crop production can be scaled proportionally.

Table 14. Employment Impact Including Potato Processing (10 percent reduction in crop production in the Odessa area—Adams and Lincoln Counties).

	Industry	Direct*	Indirect*	Induced*	Total*
3	Vegetable and melon farming	0.0	-7.9	-0.1	-8.0
4	Fruit Farming (AGG)	-33.9	-7.6	-0.1	-41.6
6	Other Crop Farming (AGG)	-16.0	-0.4	0.0	-16.4
11	Animal and Poultry Production (A	0.0	-1.9	-0.2	-2.1
14	Agricultural Support Service (AGG)	0.0	-26.8	-0.2	-27.0
19	21 Mining (AGG)	0.0	0.0	0.0	0.0
30	22 Utilities (AGG)	0.0	-0.4	-0.2	-0.6
33	23 Construction (AGG)	0.0	-0.9	-0.2	-1.1
60	Frozen Food (AGG)	-109.9	-0.2	-0.1	-110.2
89	Other Manufacturing (AGG)	0.0	-1.3	-0.2	-1.5
390	42 Wholesale Trade (AGG)	-45.4	-33.3	-5.2	-83.9
392	Other Transportation (AGG)	0.0	-2.7	-0.4	-3.1
394	Truck transportation	-20.2	-14.2	-0.7	-35.1
401	44-45 Retail trade (AGG)	0.0	-4.5	-15.7	-20.2
413	51 Information (AGG)	0.0	-0.9	-0.6	-1.5
425	52 Finance & insurance (AGG)	0.0	-2.2	-1.7	-3.9
431	53 Real estate & rental (AGG)	0.0	-1.4	-0.9	-2.3
437	54 Professional- scientific & tech sv	0.0	-3.0	-1.5	-4.5
451	55 Management of companies (AG	0.0	0.0	0.0	0.0
452	56 Administrative & waste services	0.0	-1.4	-0.5	-1.8
461	61 Educational svcs (AGG)	0.0	0.0	-0.1	-0.1
464	62 Health & social services (AGG)	0.0	0.0	-12.5	-12.5
475	71 Arts- entertainment & recreation	0.0	-0.5	-2.3	-2.8
479	72 Accommodation & food services	0.0	-2.8	-9.3	-12.1
482	81 Other services (AGG)	0.0	-4.6	-9.4	-14.0
495	92 Government & non NAICs (AGG	0.0	-2.5	-1.7	-4.1
497	Grain Farming (AGG)	-49.7	-2.6	-0.3	-52.6
502	Food Manufacturing (AGG)	-0.1	-1.2	-0.3	-1.6
10,001	Institutions (AGG)	0.0	0.0	0.0	0.0
	Total	-275.2	-125.2	-64.4	-464.9

Source: Author's Estimates
*Number of jobs.

The estimated total loss in total regional income is roughly $30 million (Table 15). Value added is defined as the sum of employee compensation, proprietors' income, other property

income, and indirect business taxes paid by industries. Total value added for the regional economy is estimated at $696 million. This is a rough gage of the economic surplus (income) generated in the region.

Table 15. Value Added Impact Including Potato Processing (10 percent reduction in crop production in the Odessa area—Adams and Lincoln Counties)

					Aggregated Report	
	Industry	**Direct***	**Indirect***	**Induced***	**Total***	**Deflator**
3	Vegetable and melon farming	0	-1,026,565	-12,378	-1,038,943	1.00
4	Fruit Farming (AGG)	-2,731,847	-610,405	-8,228	-3,350,480	1.00
6	Other Crop Farming (AGG)	-2,308,830	-62,571	-4,508	-2,375,910	1.00
11	Animal and Poultry Production (A	0	-104,872	-4,638	-109,510	1.00
14	Agricultural Support Service (AGG)	0	-426,438	-2,699	-429,137	1.00
19	21 Mining (AGG)	0	0	0	0	1.00
30	22 Utilities (AGG)	0	-167,178	-60,825	-228,002	1.00
33	23 Construction (AGG)	0	-33,045	-10,108	-43,153	1.00
60	Frozen Food (AGG)	-9,235,988	-20,656	-7,753	-9,264,397	1.00
89	Other Manufacturing (AGG)	0	-77,807	-6,491	-84,298	1.00
390	42 Wholesale Trade (AGG)	-3,185,136	-2,333,101	-362,394	-5,880,631	1.00
392	Other Transportation (AGG)	-5,557	-310,012	-26,949	-342,519	1.00
394	Truck transportation	-858,890	-600,599	-31,078	-1,490,567	1.00
401	44-45 Retail trade (AGG)	0	-149,809	-521,346	-671,155	1.00
413	51 Information (AGG)	0	-28,168	-15,019	-43,188	1.00
425	52 Finance & insurance (AGG)	0	-240,558	-168,120	-408,677	1.00
431	53 Real estate & rental (AGG)	0	-89,376	-52,568	-141,945	1.00
437	54 Professional- scientific & tech sv	0	-141,358	-71,342	-212,700	1.00
451	55 Management of companies (AG	0	0	0	0	1.00
452	56 Administrative & waste services	0	-37,262	-13,574	-50,837	1.00
461	61 Educational svcs (AGG)	0	-26	-2,415	-2,441	1.00
464	62 Health & social services (AGG)	0	-319	-477,017	-477,336	1.00
475	71 Arts- entertainment & recreation	0	-8,815	-47,522	-56,337	1.00
479	72 Accommodation & food services	0	-57,113	-167,869	-224,982	1.00
482	81 Other services (AGG)	0	-131,544	-189,540	-321,084	1.00
495	92 Government & non NAICs (AGG	0	-188,292	-952,737	-1,141,030	1.00
497	Grain Farming (AGG)	-1,447,679	-76,708	-8,308	-1,532,694	1.00
502	Food Manufacturing (AGG)	-5,971	-25,580	-9,195	-40,746	1.00
10001	Institutions (AGG)	0	0	0	0	1.00
	Total	-19,779,898	-6,948,177	-3,234,622	-29,962,697	

Source: Author's Estimates

*2003 Dollars- if results are deflated and aggregated, then deflators displayed are set to 1.0 (results have been deflated).

SUMMARY AND CONCLUSIONS:

Essentially, a regional economic impact analysis helps to trace the impact of an economic shock, and the adjustment made by the economy as the economy adjusts to that shock. In our case, the economic shock is the possible loss of crop production from the deep wells in the Odessa Sub-area located in Adams and Lincoln. We have assumed that ten percent of the irrigated crop production is lost. It should be recognized that this is just a ball park figure because it is not at all clear just how irrigated production in the area will change in the future or how the mix of crop production will change. The ten percent impact figures in this report can easily be scaled upward, or possibly downward, to reflect alternative loss scenarios.

The regional economy for which we developed an economic input-output model represents Adams and Lincoln counties in Washington State. Each county contains part of the Odessa Sub-area that is subject to irrigated crop loss due to deep well water shortage or increased cost. We have shown how the overall vigor of the local economy would be affected after the economy is assumed to have completely adjusted to assumed possible losses in irrigated crop production. To measure this loss we simulated the number of job losses and losses of total regional income in individual industries under two alternative scenarios.

In Scenario 1 we assumed that the hypothetical loss of ten percent of the irrigated crop production in the Odessa Sub-area was replaced by potato production elsewhere in the region for frozen potato processing. As a result, the negative regional impact from the loss of frozen potato

processing is not reflected in Scenario 1. The estimated regional impact was a loss of 295 jobs and a loss of regional income of $19.8 million.

In Scenario 2, we assumed that the frozen-potato product industry in the region was unable to find substitute potato production for the potatoes lost from the Adams-Lincoln County Odessa Sub-area. The overall impact on the economy is more severe than in the first scenario because of the loss of frozen-potato product production in addition to the loss of crop production and loss of potatoes produced. The estimated regional impact is a loss of 465 jobs (roughly 3.2 percent of total region jobs) and a loss of regional income of $30 million.

Since the regional economic input-output model is linear, the results for either Scenario 1 or Scenario 2 may be scaled up or down according to severity of anticipated water shortage. For example, if we were to assume that all deep well irrigation in the Odessa Sub area were to cease and we wanted to make the additional assumptions associated with Scenario 2, then the estimated resulting estimated job loss in the two counties would be 4,650 jobs or about 32 percent of total jobs in the two counties.

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