Columbia-Snake River Irrigators Association Technical Review

DATE: November 30, 2006

TO: Eastern Washington Legislators, Water Resources Program Staff, and Interested Parties

FROM: Darryll Olsen, Ph.D., CSRIA Board Representative

SUBJECT: Review of Eastern Washington Water Conservation and Management Projects, and Recommendations for Project Selection & Development

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The attached review represents an initial description of the types and likely amounts (acre-ft.) of water attainable from Eastern Washington water conservation and management projects, related to irrigated agriculture; recommendations also are included for project selection criteria and development.

In summary, the following is highlighted:

Potential Water Quantities and Costs:

- Throughout Eastern Washington, irrigation scheduling and monitoring could yield as much as 435,000 acre-ft. annually; most Columbia-Snake River direct pumpers already do this measure as a Best Management Practice (BMP). The estimated costs of irrigation scheduling and monitoring are about $10-30/acre-ft. annually.
- The available amount of water "savings" from conversions to more efficient irrigation systems would likely exceed 200,000 acre-ft. The capital costs of these measures vary widely, about $50 to $1,300 (or about $10-140/acre-ft. annually).
- There are numerous opportunities for canal lining and/or enclosure (some with pressurizing systems) that are in the $70-140/acre–ft. range (annual $).
- The potential to use groundwater recharge for tributary enhancement—at site-specific locations–may be highly significant to deal with water temperature and quality issues; and that may offer more environmental benefits than general flow improvements. The costs of these measures, for many sites, are likely in the $20-$40/acre-ft, range, annually.
- Site-specific water diversion transfers can have significant benefits, with costs at about $100/acre-ft. (annual $ costs with power included).
- The state Conservation District's general inventory suggests that a wide range of water conservation projects are available, with savings yielding about 250,000 acre-ft., with mid-range costs from about $60-175/acre-ft.

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Review of Water Conservation And Management Projects For Eastern Washington

With Recommendations for Project Selection Criteria and Development

Prepared for

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Introduction and General Overview

In May 2006, the Columbia-Snake River Irrigators Association (CSRIA) contracted with IRZ Consulting (IRZ) and the Franklin County Conservation District to evaluate, at a cursory level, the water conservation potential in Eastern Washington. This project resulted from an agreement between CSRIA and Washington State Department of Ecology (WDOE) that would result in the approval of new water rights, provided that Columbia River stream flows are not reduced during the critical months of July and August (CSRIA-Ecology VRA 3-28-2006). To meet these criteria, CSRIA and WDOE would pursue water conservation and management measures to offset the new water uses.

Initially, we investigated acquiring potential water conservation measures from other Northwest States. The states of Oregon and Idaho offer potential conservation projects. The state of Oregon allows the additional development of 75% of conserved water (25% of the conserved water is donated to the river/in-stream) and the state of Idaho does not appear to preclude conservation and transfers. However, due to potential political issues of inter-state transfers, the abundance of potential conservation measures in Washington, and the limited time and scope of this project, those out-of-state measures were not pursued.

The 2003 Farm and Ranch Irrigation Survey (2003 Census) indicates that there are about 1.8 million acres of irrigated land in Washington State. The Washington State Water Resources Association (WSWRA) indicates about 1.2 million acres are within irrigation districts, irrigation companies, and other state districts. The 2003 census indicates that about 80% use sprinkler systems (highest in the nation), 5% (99,000 acres) use Drip and 15% (268,000 acres) are in gravity flow systems.

Almost all of these irrigated acres are within eastern Washington. There are about 464,000 irrigated acres in the Yakima Valley (USBOR website), 539,000 in the Columbia Basin Irrigation Project (USGS, 2000), 12,000 in the Walla Walla Basin (WSWRA), and another 28,000 in the Wenatchee Basin (WSWRA).

The 2003 Census shows that the average water application was about 2.0 ac-ft/acre for sprinkler irrigation and 2.9 ac-ft/ac using flood irrigated water in Washington State. These figures appear low, but do not account for any transmission losses, and a wide variation in crop duties. Typical duties in the Yakima Basin are about 5 ac-ft/ac in the Rosa, Sunnyside, Kittitas, and Wapato Districts (including transmission losses).

It appears that the decision to irrigate is still fairly “unscientific.” Sammis and Mexal (1998) indicated that less than 1% of the respondents to their survey use a scheduling service for irrigation decisions in Washington State. Nevertheless, the rate of water conservation adoption has increased dramatically in recent years.

From the above discussion, there appears to be an abundance of potential conservation measures. For example, the conversion from 0.25 million acres of flood irrigated lands to center pivots would save about 0.9 ac-ft/ac/year, or about 241,000 ac-ft/ year according to Census of Agriculture figures. Or if irrigation scheduling and monitoring were universally done on an additional 1.0 million irrigated acres, 100,000 acre-ft/year of water could be saved- assuming a conservatively low 10% water savings (BPA 2004-2005 study by Quantec).

Water Conservation Opportunities

Water conservation opportunities have in recent years been recognized as a viable solution to water shortage, a new way to extend water availability and in some cases develop more available water for others to utilize. Water conservation opportunities can be categorized as following:

- Watershed-wide conservation opportunities
- District-wide conservation opportunities
- On-Farm-wide conservation opportunities

Watershed-Wide Conservation Opportunities

Watershed-wide water conservation includes those measures that can be applied generally by the communities and/or local/state governments in a larger scale and may include the following:

- Water-harvesting techniques
- Proper watershed management, planning and monitoring
- Water-exchange
- Groundwater recharge
- Increase efficiency of existing reservoirs
- Education, incentives and training

In our experience, water-exchanges (between points of diversions **and water systems**, between districts, **and other** etc.) and groundwater recharge (shallow aquifer recharge, **S**AR, etc) are among the projects with the largest potential for short-term water availabilities (1-3 years).

District-Wide Conservation Opportunities

District-wide conservation opportunities include all those measures that are under the control of a District Manager (i.e. reservoirs, canal, pumping station, etc.). In general, the following measures will gain efficiency and capture more water through conservation:

- Identify and eliminate physical water losses
    a. Seepage losses
        i. Canal lining, Conversion to pipeline
    b. End of the canal spills
        i. Re-regulating reservoir, pump-back, automation
    c. Evaporation
        i. Mostly minimal but in cases requires engineering solutions
- Total Pressurized System: conversion of the entire open canal to pressurized system
- Automation: including wireless monitoring and control of the irrigation systems to eliminate waste, reduce costs and conserve water.
- Variable Speed Drives Pumps: to match the exact needs water users
- Flow Measurements: to accurately inventory water usage before any management and conservation can occur.
- Water-Scheduling: this includes canal/pipeline and delivery scheduling to maximize water conservation rather than traditional on-demand delivery system.

On-Farm Water Conservation Opportunities

On-Farm water conservation refers to all measures that are directly under the control of the individual grower. Growers generally respond to water conservation techniques based on their own economic. As such, one-size fits all approach does not generally work well. However, a conservation program that are based on a menu of voluntary and/or incentive based conservation measures has the largest chance of success. Following list some of the potential on-farm conservation measures

- On-farm efficiencies by eliminating/reducing
    a. Seepage and leaks
    b. Evaporation Losses
    c. Deep Percolation Losses
- Irrigation Scheduling
    a. ET based data
    b. Soil moisture monitoring
    c. Aerial infrared
- Optimizing existing irrigation system
    a. Engineering audits
    b. Pumps, pipeline, canals, laterals optimization
- Conversion to more efficient irrigation system
    a. Flood to sprinklers
    b. Sprinklers to drip
    c. Low pressure pivot w/drop tubes, LEPA,
    d. double pivot, precision sprinklers, etc.
- Low water-use crop rotation and/or conversion
- Precision farming
- Education
    a. Providing timely crop evapotranspiration to growers

b. Conduct irrigation workshops and training
c. Provide in-field hands-on training
d. Conduct demonstration projects
e. Provide incentives such as soil moisture sensors and related equipments

Efficiency Evaluation

To evaluate conservation opportunities of any irrigation system/district, the following must be determined:

- What are the total water Losses?
- What is On-Farm Efficiency?
- What is District Efficiency?
- What is Overall Efficiency?

Using existing data from farms/districts, crop/weather data, the daily crop water requirements, water delivery to farms, and operational spills, the existing irrigation efficiencies can be determined. Percent efficiency for each measure can be calculated based on the following formulas:

% On-Farm Efficiency = (Total Crop Water Requirement) / (Total Delivery to the Farms)

% District Efficiency = (Total Delivery to the Farms) / (End of canal Spills + Total Delivery to the Farms)

% Overall Efficiency = % Farm Efficiency x % District Efficiency

Based on these formulas, the Farm, District and Overall efficiencies can be calculated. This analysis would allow what, and by how much, each efficiency component can be improved. To more accurately quantify conservation potential, detailed analysis of each irrigation district/system can be made.

Methodology - Conservation Data Collection

IRZ employed several different methods to identify and evaluate potential conservation projects on irrigated lands including:

- **Meetings with Bureau of Reclamation and WSWRA officials.** Memorandums were written of these meetings (Appendix 1). These meetings resulted in a series of good leads to pursue during the course of this project. However, both groups also provided some cautions including the difficulty of protecting transfers, the new economics of water transfers (including wine growers paying top dollar) and the political difficulties of approving transfers. Both of these groups recommended further discussions with the Kennewick Irrigation District as their preferred conservation measures based on the above realities.

- **Emails and mailings.** The WSWRA 2006 member handbook provides email of many of their members. An email questionnaire was developed and sent to those districts that had provided email addresses. Letters were sent to all districts in the 2006 handbook. A copy of the letter is provided in Appendix 2. A database that is based on the 2006 handbook was also developed. This database included the development of basic information regarding each district, such as acres served, diversions, and duties. ***Only one email response and one letter response were received at the time of this report.***

- **Internet searches.** Several districts have websites that provide information regarding their conservation activities. Outstanding examples include Kennewick Irrigation District (http://www.kid.org/) and the Columbia Irrigation District (http://www.columbiairrigation.com/). In addition, numerous other websites such as the Bureau of Reclamation and James Waldo, an attorney with Gordon, Thomas, Honeywell (http://www.co.yakima.wa.us/tricnty/YakimaBasin.htm) provided useable information (Yakima Priority).

- **IRZ phone calls.** The phone calls have been the most useful means to date (outside of IRZ's own personal knowledge) to receive the required project information. This is not surprising- in most market surveys, a response from mass marketing means, such as emails and letters, are typically less than 1%. In addition, one respondent seemed upset that they had to complete the surveys. However, most people contacted would talk about their projects and would develop additional information after being re-assured about the validity of the project.

- **IRZ conservation plan and information.** Over the years, IRZ has completed many conservation plans or has performed project work for several districts including Kennewick Irrigation District and, several districts in Walla Walla county, Okanagan county, etc. Data from these reports were included in this report after we contacted the owners of the information. Personal meetings were held with MVID,

- **Conservation District's information.** Franklin Conservation Districts provided IRZ with a spreadsheet of possible projects completed by Franklin Conservation Districts as well as other Districts in the region. This spreadsheet was summarized and the result of potential water savings amounts and costs is enclosed in the appendix 3 at the end of this report.

- The Franklin County Conservation District provided a copy of data collected by Conservation Districts throughout Eastern Washington to CSRIA and IRZ Consulting. We summarized the data from the spreadsheet provided and the results suggest that a wide range of water conservation projects are available, with savings yielding about 250,000 acre-ft., with mid-range costs from about $60-175/acre-ft. (annual $).

- **Washington Fish and Wildlife.** IRZ contacted the Washington Department of Fish and Wildlife and obtain input about water conservation projects of interests to the WF&W. A summary of their request is included in this report.

- **Global conservation approach.** Based on data from the 2003 Farm and Ranch Irrigation Survey, we collected relevant data and conducted a global calculation of conservation potentials.

Based on the methodology discussed above, it is clear that (to-date) that the materials evaluated to-date are largely from the best established/best managed irrigation districts that have already conservation plans. These districts have the manpower to develop websites and respond to questionnaires. And, many of these districts have already implemented the most cost-effective measures in their plan.

As a result, it is likely that some of the best remaining conservation measures may be found in small districts that did not respond. As a result, some efforts should be made to contact all of the districts to truly develop "the best" projects.

The following tables lists the data source listed alphabetically used in this report.

Table-Conservation Inventory Data Sources:

AHTANUM IRRIGATION DISTRICT 1	EASTSIDE IRRIGATION DISTRICT 1	Kittitas Reclamation District (KRD) 4
Ahtanum Irrigation District (AID) 3	Ecology 3	Lake Chelan Reclamation District 4 LAKE CHELAN RECLAMATION DISTRICT 1
Asotin County Conservation District	Ecology WDOE 4	Lincoln County Irrigation District 2
Badger Mountain Irrigation District BADGER MOUNTAIN IRRIGATION DISTRICT 1	ELLENSBURG WATER COMPANY 1 ELLENSBURG WATER COMPANY 4	LOWDEN IRRIGATION DISTRICT 4 LOWER SQUILCHUCK IRRIGATION DISTRICT 1
Benton Conservation District 3	ENTIAT IRRIGATION DISTRICT 1	LOWER STEMIL T IRRIGATION DISTRICT 1
Benton County Conservation District 2	Franklin County Conservation District 2 FRANKLIN COUNTY IRRIGATION DISTRICT 1	
Benton Irrigation District 2		MILLERDALE IRRIGATION DISTRICT 1
Brewster Flat Irrigation District 4	Garden City Ditch 2	MOAB IRRIGATION DISTRICT 1
BREWSTER FLAT IRRIGATION DISTRICT 1 BRIDGEPORT BAR IRRIGATION DISTRICT 1	Gardena Farms 2 GARDENA FARMS IRRIGATION DISTRICT 4	MODEL IRRIGATION DISTRICT 1 MOSES LAKE IRRIGATION 1
BRIDGEPORT IRRIGATION DISTRICT 1	GRANDVIEW IRRIGATION DISTRICT 4	MOSES LAKE IRRIGATION 4
BUENA IRRIGATION DISTRICT 1	Grant County Conservation District 2	Mud Creek Ditch 2
Bureau of Reclamation (BOR) 3	Greater Wenatchee Irrigation District 4 GREATER WENATCHEE IRRIGATION DISTRICT 1	MUD CREEK IRRIGATION DISTRICT 1
Bureau of Reclamation (BOR)- YRBWEP 4		NACHES SELAH IRRIGATION DISTRICT 1
CARNHOPE IRRIGATION DISTRICT 1	GREEN TANK IRRIGATION DISTRICT 1	Naches-Selah Irrigation District 2
Cascade Irrigation District 2	HEARN IRRIGATION DISTRICT 1	Naches-Selah Irrigation District 4
CASCADE IRRIGATION DISTRICT 1	HELENSDALE RECLAMATION DISTRICT 1	NACHES-UNION IRRIGATION DISTRICT 1
CHELAN FALLS IRRIGATION DISTRICT 1	HIGHLAND IRRIGATION DISTRICT 1	Nile Valley Ditch Association 2
CHELAN RIVER IRRIGATION DISTRICT 1	HUTCHINSON IRRIGATION DISTRICT 1	NORTH DALLES IRRIGATION DISTRICT 1 NORTH SPOKANE IRRIGATION DISTRICT 1
City and Port of Grandview) 3	HYDRO IRRIGATION DISTRICT 1	
City of Ellensburg 3	Icicle Irrigation District 4	North Yakima Conservation District 2 North Yakima Conservation District (NYCD) 3
City of Ellensburg 3	ICICLE IRRIGATION DISTRICT 1	
City of Sunnyside 3	ISENHART IRRIGATION DISTRICT 1	Okanogan County Conservation Distric 2
City of Yakima 3	Kennewick Irrigation District 4	OKANOGAN IRRIGATION DISTRICT 1
City of Yakima 3	Kennewick Irrigation District 3	OKANOGAN IRRIGATION DISTRICT 4
CLINE IRRIGATION DISTRICT 1	Kennewick Irrigation District 2	Old Louden Ditch 2 ORCHARD A VENUE IRRIGATION DISTRICT 1
Columbia Irrigation District 2	KENNEWICK IRRIGATION DISTRICT 1	
COLUMBIA IRRIGATION DISTRICT 1	KIONA IRRIGATION DISTRICT 1	ORCHARD IRRIGATION DISTRICT 1 OROVILLE-TONASKET IRRIGATION DISTRICT 1
COLUMBIA WATER & POWER DISTRICT 1	Kittitas County Conservation District 2 Kittitas County Conservation District (KCCD) 3	OROVILLE-TONASKET IRRIGATION DISTRICT 4
Consolidated Irrigation District 4		
CONSOLIDATED IRRIGATION DISTRICT 1	Kittitas County Water Purveyors (KCWP) 3	PALISADES IRRIGATION DISTRICT 1
Douglas County Conservation District 2 EAST COLUMBIA BASIN IRRIGATION DISTRICT 1	KITTITAS RECLAMATION DISTRICT 1 Kittitas Reclamation District (KRD) 3	Palouse County Conservation District 2 PASADENA PARK IRRIGATION DISTRICT 1
1-WSWRA **2-Conservation District**	**3-Yakima Priority** **4-IRZ Phone Contacts**	

Table-Conservation Inventory Data Sources:

PESHASTIN IRRIGATION DISTRICT 1 QUINCY-COLUMBIA BASIN IRRIGATION DIST 1 Roza Irrigation District 2 Roza Irrigation District 4 Roza Irrigation District 3 ROZA IRRIGATION DISTRICT 1 SELAH-MOXEE IRRIGATION DISTRICT 1 SELAH-MOXEE IRRIGATION DISTRICT 4 SEQUIM DUNGENESS VALLEY WATER USERS 1 SEQUIM PRAIRIE TRIIRRIGATION COMPANY 1 SOUTH COLUMBIA BASIN IRRIGATION DIST 1 South Naches Irrigation District 2 South Yakima Conservation District 3 STEMILT IRRIGATION DISTRICT 1 Sunnyside Irrigation District 2 SUNNYSIDE VALLEY IRRIGATION DISTRICT 1 Sunnyside Valley Irrigation District (SVID) 3 Tapteal Greenway Association 3 TERRACE HEIGHTS IRRIGATION DISTRICT 1 Touchet East/West Ditch TOUCHET VALLEY IRRIGATION DISTRICT 1 TreeTop, Inc. 3 TRENTWOOD IRRIGATION DISTRICT 1 Tri-County Water Resources Agency 3 Union Gap Irrigation District 4 Union Gap Irrigation District 4 UNION GAP IRRIGATION DISTRICT 1 VERA WATER AND POWER 1 Walla Walla County Conservation District 2 WALLA WALLA WATER & POWER DISTRICT 1 Wapato Irrigation Project 1 Wapato Irrigation Project 4 Washington Department of Fish and Wildlife (WDFW) 3 Washington State Water Resources Association 4	Wenas Irrigation District 2 WENATCHEE HEIGHTS RECLAMATION DIST 1 Wenatchee Reclamation District 4 WENATCHEE RECLAMATION DISTRICT 1 WENATCHEE-CHIWAWA IRRIGATION DIST 1 WEST END IRRIGATION DISTRICT 1 Westside Irrigation District WESTSIDE IRRIGATION DISTRICT 1 WHITE SALMON IRRIGATION DISTRICT 1 Whitestone Irrigation District 4 WHITESTONE RECLAMATION DISTRICT 1 WOLF CREEK RECLAMATION DISTRICT 1 WOLF CREEK RECLAMATION DISTRICT 4 Yakama Nation 3 Yakama Nation Fisheries 3 YAKIMA RESERVATION IRRIGATION DIST 1 YAKIMA- TIETON IRRIGATION DISTRICT 1 Yakima Valley Conference of Governments 3 Yakima-Tieton Irrigation District 4 ZILLAH IRRIGATION DISTRICT 1	
1-WSWRA **2-Conservation District**	**3-Yakima Priority** **4-IRZ Phone Contacts**	

Global Potential Water Conservation

To get a global sense of potential water conservation, we used the database compiled in the 2003 Farm and Ranch Irrigation Survey, and did a cursory attempt at quantifying global water conservation measures in Washington State. Conservation measures for each type of irrigation system were evaluated. The results are presented in the table below. A total potential water savings of **885,000 ac-ft** is possible from few fairly straight forward efficiency measures. These measures exclude any savings from canal lining or conversion to pipeline.

Global Potential Water Conservation Washington-State

	Gravity	Sprinkler	Drip
Acres by category --->	268,122	1,450,274	98,768
WATER SAVINGS (Ac-ft)			
Irrigation Scheduling conservation (ac-ft) [1]	**134,061**	**435,082**	**29,630**
Total cost of conservation $/yr	$ 2,681,220	$ 14,502,740	$ 987,680
Cost of Conservation $/ac-ft/year	$ 20	$ 33	$ 33
Conversion to more efficient Sprinkler (ac-ft) [2]	**201,092**		
Total cost of conservation $	$ 93,842,700		
Cost of Conservation $/ac-ft	$ 467		
Conversion to low pressure pivot (ac-ft) [3]		**33,161**	
Total cost of conservation $		$ 1,768,560	
Cost of Conservation $/ac-ft		$ 53	
Conversion from wheel line to pivot (ac-ft) [4]		**51,906**	
Total cost of conservation $		$ 57,673,125	
Cost of Conservation $/ac-ft		$ 1,111	
Total Water Savings (Ac-ft)		**884,931**	

[1] 10% savings based on 2005 BPA study by Quantec/IRZ
[2] 50% conversion rate and efficiency increase from 50% to 80%
[3] increase efficiency from 80% to 90%
[4] 25% conversion rate with increase efficiency from 75% to 90%

Types of Conservation Projects to Fund

In this section, we briefly discuss the types of irrigation projects and provide some estimates of conserved water savings based on the literature and our own experience. In addition, we provide some generic costs and the resulting unit cost/ac-ft of conserved water drawn from our experience and those that have submitted potential projects for review. These costs have not been reviewed by IRZ and should be viewed as very preliminary.

Irrigation Scheduling

Cost for scientific irrigation scheduling (SIS) is about $8 to $10 per acre per year (Gibb Evans, IRZ Irrigation Manager). The latest BPA studies (2004-2005 Quantec/IRZ) attribute 10% water savings and 13% energy savings through the use of scientific irrigation scheduling technologies. As a result, water savings could amount to nearly ½ acre-ft./year/acre for a flood-irrigated field (at a duty of 5 acre-ft./acre) for a total price of about $20.00 per acre-ft of water. As discussed above, for gravity irrigation approximately 134,000 acre-ft/year of water could be made available each year at a cost of $2.7 million per year. Water savings for sprinkler system would be 435,000 ac-ft per year at a cost of $14.5 million per year or $33 per ac-ft per year.

Irrigation scheduling can also be done on a watershed basis. For example, typical on-farm irrigation scheduling can be used in conjunction with short and long ranged weather forecasting and a river operations model to predict and potentially lower irrigation district diversions on a district wide or watershed wide basis. This type of scheduling can result in a substantial savings of water: Cornish and Mackin (2006) reported a 19% water savings in Sri Lanka using irrigation scheduling on a watershed basis (http://www.fao.org/docrep/W4367E/w4367e0w.htm).

Clearly at these prices, irrigation scheduling is the most cost effective conservation measure available. This can be clearly seen through the growth of irrigation scheduling in the market-place. For example, IRZ's irrigation scheduling services offered in eastern Washington and Oregon has grown from 10,000 acres in 1984 to over 400,000 acres in 2006.

However, there are some limitations to irrigation scheduling, particularly if done at the farm level (as opposed to the irrigation district level). The irrigation district generally holds the water right to divert water (rather than the individual farm). In addition, there would be very little market incentive for an individual or a district to sign over any saved water to the funding organization. Often the incentive for irrigation scheduling is a longer irrigation season or more water used in the later portions of the irrigation season (if the water right is available).

However, even a longer season is not a total drawback. For example, more water used by a district with stored water in July and August would result in higher stream-flows during those desired months.   In addition, groundwater return flows and associated stream flows could be higher in those desired months depending on the location of the water use.

As a conclusion of this discussion, irrigation scheduling should be pursued on a systematic basis throughout the system. To be truly effective, an agreement would be needed to transfer the water savings into a viable and protected water right. A market incentive would need to be pursued so that the water right grantee would have sufficient incentive to participate in such a program.

Groundwater Recharge

The effectiveness of groundwater recharge to enhance river flows on the Columbia River is indisputable. The most definitive system-wide evaluation was made by the United State Geological Survey (USGS, 2000). They reported that Columbia River recharge and base flows increased from about 6,566 cubic feet per second (cfs) to 10,205 cfs due to surface water supplied irrigation. The following figure shows the estimated recharge.

As can be seen in the Figure 1, the estimated recharge from the Columbia Basin, Yakima, Umatilla, and Walla Walla Rivers appears to be approximately equal to the natural recharge from the Blue and Cascade Mountains.

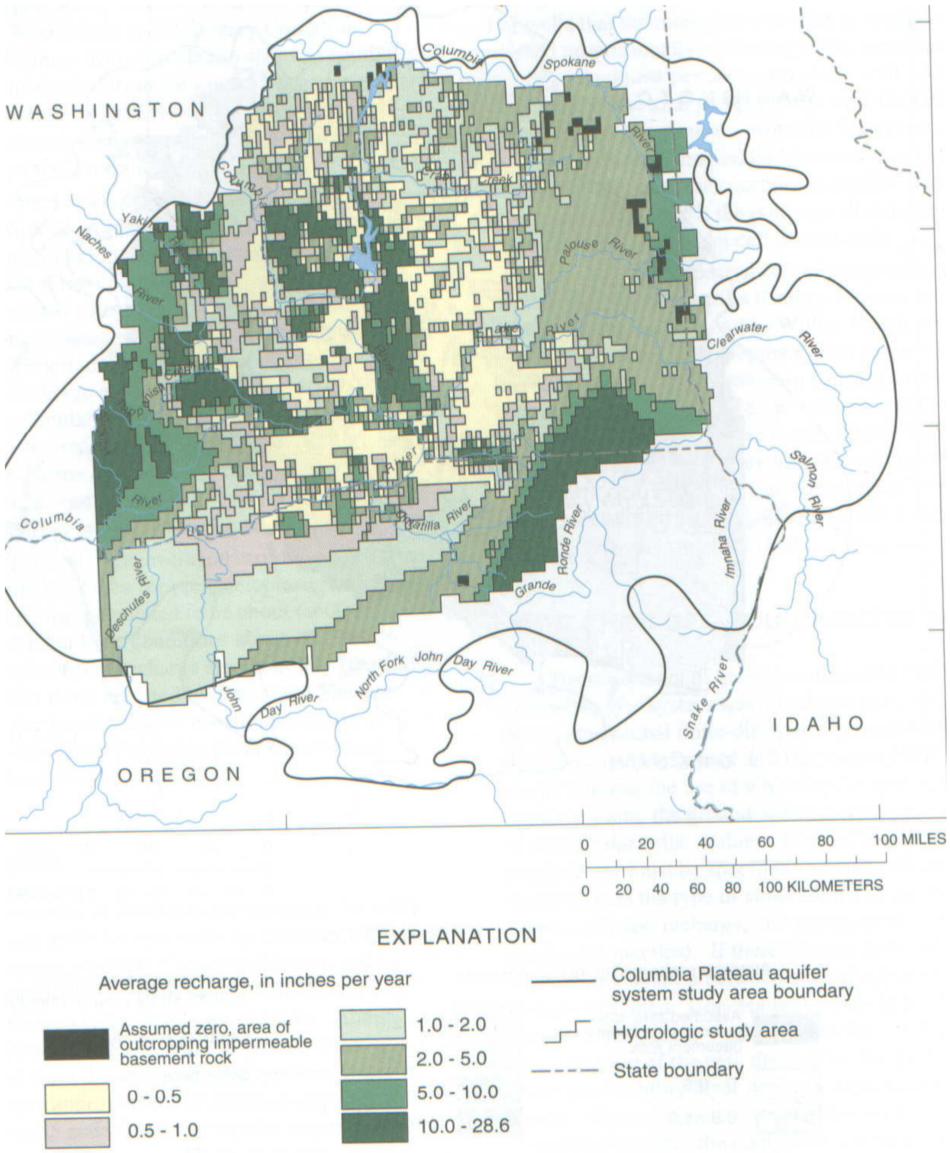

Figure 1. Average recharge in the 1980's. *Source (USGS 2000, Figure 8).*

The following figure-2 shows some groundwater recharge sites that have been suggested on the Walla Walla River.

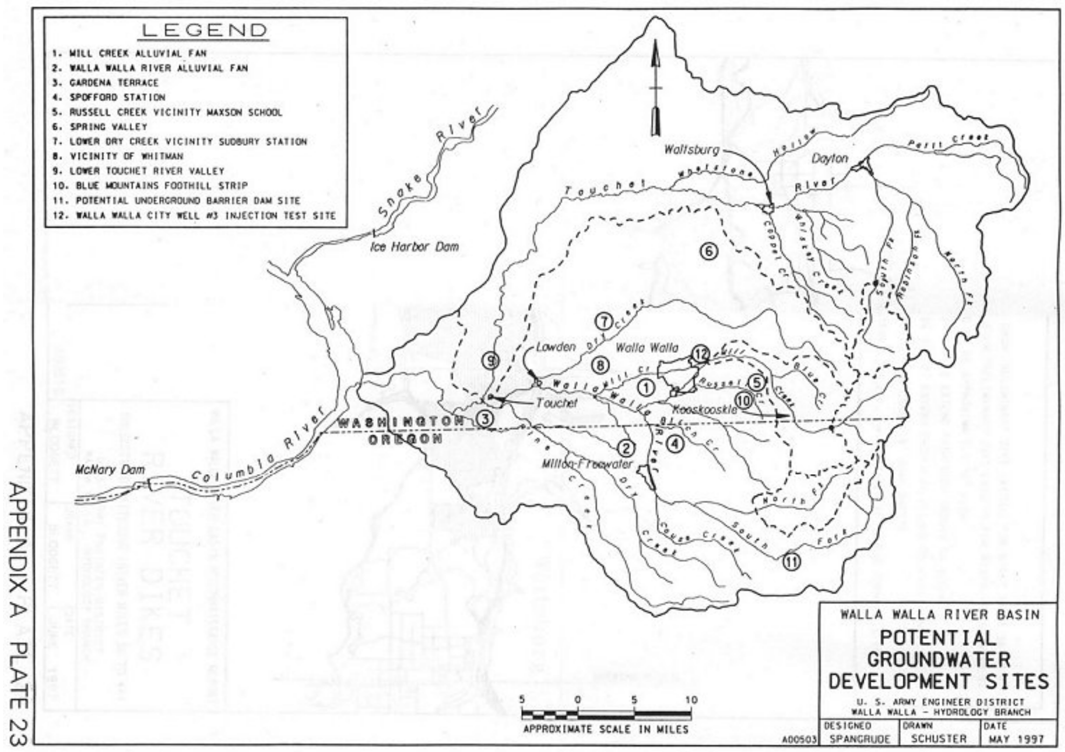

Figure 2. Source US Army Corps of Engineers.

As can be seen in the above figure, there are numerous sites for groundwater recharge in the Walla Walla watershed.

In a five years recharge study by IRZ (2005, Echo Meadows Recharge Project prepared for BPA) determined that groundwater recharge is suitable in many other watersheds including the Yakima, Walla Walla, Okanagan and other river basins.

The cost for groundwater recharge can also be quite reasonable. Westland Irrigation District (WID) in Eastern Oregon proposed a groundwater recharge project with a cost of $356,000 for 10,000 ac-ftof water ($35.60/acre-feet). Based on WID estimates, this cost would presumably be lower in outlier years.

However, there are some limitations to groundwater recharge that are similar to irrigation scheduling. Again, if groundwater recharge is done on a farm level, (as opposed to the irrigation district level) there are problems with water rights. Like irrigation scheduling, there would be very little market incentive for an individual or a district to sign over any recharge water to the funding organization.

Presumably, an incentive for groundwater recharge could be a longer irrigation season or more water used in the later portions of the irrigation season (if the water right is available).

The location of the recharge would also have to be done so that the groundwater return flow is seen in the desired months. As a conclusion of this discussion is that groundwater recharge, like irrigation scheduling, should be pursued on a systematic basis throughout the system. To be truly effective, an agreement would be needed to transfer the water savings into a viable and protected water right. A groundwater model could be used to show the July and August stream flow improvements. And, a market incentive would need to be pursued so that the water right grantee would have sufficient incentive to participate in such a program.

Washington Fish and Wildlife Projects

IRZ Contacted Paul Lariviere and Mike Livingston of WF&W 509.545.2057. F&W identified the following two projects for our consideration:

1- Sulfur Creek which is a drain from the Sunnyside/Roza Irrigation districts. The drain runs about 30-40 cfs but has poor water quality. They want to pump the drain into a wetlands for natural treatment (also groundwater recharge). Costs for solar pumps and piping has been identified at about $1.5 to $2.0 million. With this system, annual cost of operations are low, regulatory acceptance is high. The tribe also indicated they are interested in this project.

2- First Creek, tributary to Swauk Creek.with great habitat. They want to eliminate surface water diversions and use solar powered wells to provide water to users. This would eliminate main canal and losses. They don't have an estimate of prices or water savings.

On-Farm Efficiencies/Conversion to Center Pivots and/or Drip Irrigation

Although as discussed above most irrigation in Washington has already converted to sprinklers, there is still a substantial amount of conserved water available through conversion to center pivots and other more efficient systems. For example, there are a substantial number of acres within Kittitas Reclamation district that are flood irrigated and have a high water duty.

The costs for conversion are highly variable depending on the size of the existing fields, access to pressurized deliveries and the topography of the fields. Capital present day costs are estimated at about $700-$1300 per acre. This equates to a present day cost of about $175 to $325 million on a system-wide basis for a water savings of 75,000 ac-ft per year.

Although these costs are considerably higher than irrigation scheduling and groundwater recharge, the chance of implementing these systems and transferring the water rights may be more straight-forward. This is partially because the potential cooperator will achieve considerable labor cost savings through conversion. However, downstream water users that rely on groundwater return flows will likely contest these transfers. As a result, an additional premium of water or money will have to be devoted to river flows and downstream users for these types of projects.

Irrigation District Efficiencies: Conversion of Laterals to Pressurized Systems

Based on Kittitas Reclamation District and others the estimated construction cost for conversion of lateral canals to a pressurized system is also about $700 to $1300 acre feet. If system delivery losses are about 25% and are equally divided between the main canals and the laterals, then the expected conservation and costs would be similar to the on farm efficiencies discussed above. Benefits and drawbacks are essentially similar to on-farm conversions. However, unlike the on farm efficiencies, CSRIA/DOE would be negotiating with the entity that actually controls the water right. In addition, it is probably easier to document the water savings with these system efficiencies because the district would actually divert less water, particularly during the critical months of July and August.

Irrigation District Efficiencies: Lining of Main Canal Systems

There is probably no greater water conservation measure than canal lining because nearly all of a districts' water is concentrated in one spot, prior to distribution. However, the potential water savings and associated cost is highly variable depending on the type of soil, depth of water in the canal, and the existing lining. Because the water savings are so great, many districts have already lined their main canal systems. For example, the Yakima-Tieton Irrigation districts lined 210 miles of distribution canals in 1986.

The costs to line a canal appear to be about $1-3/square foot of canal using a variety of materials such as geotextiles and shotcrete (USBOR, 2001 this may be 30-50% higher today). Water savings may be as little as 10% for a canal that is dug in tight material or more than 50% in porous material such as in the Wolf Creek main canal in Okanagan County prior to pressurization.

Wolf Creek's canal appears to have cost about $16.00/square foot to pressurize. However, due to the high leakage of this canal, it appears that this water conservation only cost about $66.00/ac-ft/year.

With some of these costs and savings discussed above in mind, a canal lining conservation project that diverts 1,000 ac-ft/day with 25% losses would lose about 37,500 ac-ft in a 150 day irrigation season. If the canal was 10 miles long and 50 feet wide, it would cost about $16.5 million dollars at $2.50/foot to line the canal, resulting in a conservation cost of about $88.00/ac-ft. However, as discussed above, this cost could substantially higher if the water savings were not as great or construction costs were much higher or the canal much longer.

Selected Water Conservation Projects to Fund

Based on our preliminary research we have identified several high value conservation and cost-effective project listed below. As discussed above, the best projects to fund may not yet have been identified because of the methodology employed by us and others to date. Refinement will need to be made based upon further contact. In addition, some of the projects discussed below may not be possible because they will require a willing seller (some of the entities may seek other funding and donate their conservation to "the river"). Other projects, while appearing to be cost effective now, may require other projects to be previously implemented such as a canal lining prior to piping of laterals. In addition, the most cost effective projects such as irrigation scheduling and groundwater recharge will probably require an agreement with WDOE prior to realizing the water conservation savings by CSRIA. But we highly recommend the development of irrigation scheduling and monitoring, as an operational (O&M) project for the Eastern Washington region.

Evaluation Criteria

To evaluate a ranking of conservation projects the following criteria were developed as presented below. Each criterion was quantified by a factor representing the magnitude of its impact. The greater the factor, the greater the impact on the score. Table 1 summarizes these factors.

Table 1. Evaluation Criteria Factors.

Criterion	Factor	Impact
Capital Costs	0 to 20	Negative
Annual Costs	0 to 20	Negative
Quantity of Water	0 to 20	Positive
Acceptance by Effected Community	0 to 20	Positive
Acceptance by Regulatory Agencies	0 to 20	Positive
Environmental Benefits	0 to 20	Positive
Place of Application	0 to 10	Positive

The capital costs factor represents an initial estimated order of magnitude by those making the initial cost estimates and should be refined. Higher annual costs are generally associated with alternatives need to be done each year such as groundwater recharge. If the acceptance by regulatory agencies was too low, the alternative was excluded from further analysis. The same rationale would apply to the effected communities (a successful protest of a water rights transfer would exclude the alternative from further analysis. The ability of the project to improve the environment was included to show that a project should have environmental benefits, as well as water savings, to be successful. This means that a project that improves water quality, such as best fertilizer management practices, should be considered.

Even though a ranking system is devised and presented for this report, it is still subjective. Ranking are based on the evaluators' experience, expertise, local knowledge, and regulatory experience. Nevertheless, this type of evaluation is a good starting point for any future project.

Table 2. Conservation Project Evaluation Matrix

	Capital$/Save Ratio	Maintanace $/yr	Quantity-saved Ac-ft (x1000)	Acceptance	Regulatory	Environmental Benefits	Place Aquifer	Score
Project	0-20	0-20		0-10	0-10	0-20	0-10	(Q+A+R+E)-(C+A)
Pump Station/Phase II/KID	20	5	20.0	10	10	20	10	45.0
Groundwater Recharge Within Irrigation Dist.	10	10	30.0	5	5	15	5	40.0
Lining-Piping/South Naches	10	3	14.9	10	10	5	10	36.9
Ahtanum Canal/Wapato	5	2	1.5	10	10	10	10	34.5
Lateral 1-245/Wapato	5	2	1.5	10	10	10	10	34.5
East Lateral/Wapato	5	2	0.5	10	10	10	10	33.5
Re-regulation Reservoir/Naches Selah	5	5	8.0	10	10	5	10	33.0
Groundwater Recharge/CLWID	5	2	2.0	10	10	10	7	32.0
Irrigation Scheduling/Wapato	3	10	15.0	10	5	5	7	29.0
Tailwater Reuse/Cascade Irrigation District	5	5	2.0	10	10	5	10	27.0
Groundwater Recharge/ Walla Walla	3	10	5.0	10	5	10	10	27.0
Tailwater Reuse/Westside Irrigation District	5	5	0.5	10	10	5	10	25.5
Valve farm regulation/Okanogan Irrigation District	7	5	2.0	10	10	10	5	25.0
Lateral Piping/Roza Irrigation District	7	5	0.6	10	10	10	5	23.6
Total Quantity of Water Savings ac-ft/year			**103,500**					

Capital=Capital cost (relative) of alternative
Maintenance=Annual cost of maintenance
Quantity=Quantity of water available for alternative in acre-feet
Accept.=Community acceptance from those impacted by alternative
Environ.=Environmental benefits to project
Regulatory=Regulatory acceptance of alternative
Place=Place that water may be applied in aquifer
Score=Numerical score for alternative based on criteria

The place of application factor was ranked with the most advantageous location to complete the project, such as an upstream tributary generally improving river flows all of the way downstream receiving a 10 and the less desirable locations receiving a lower score.

The capital and annual costs are negative factors (subtracted from the score) while all the other factors are positive (added to the score). A perfect score with this matrix is 90 points (all positive scores and no negative scores). Table 2 shows the matrix score for the measures.

Description of Selected Water Conservation Projects

Following is a description of the projects that were evaluated in the above table:

Pump Station-Alternative 5, KID: This project is proposed by the Kennewick Irrigation District and is probably the most ambitious water conservation project (on the effected reach) for the Yakima River Basin. It consists of replacing an existing canal system with a pumping station delivery system. Other elements consist of Columbia River waters to be used in lieu of Yakima River water rights for water service delivery, using a Columbia River pump station. As mush as 400 cfs of Yakima River flows will be maintained in the river at a cost of $30,000,000 to $40,000,000. The project excels due to very high environmental benefits and relatively low costs. Detail water conservation analysis and benefits are yet to be quantified.

Groundwater Recharge within Irrigation Districts. Groundwater recharge projects have been proposed and demonstrated to enhance river flows by many entities. IRZ Consulting recently completed a five-years recharge pilot project /study prepared for Bonneville Power Administration (2005 Echo Meadows Recharge Project), which concluded that upon full implantation, the base-flow of Umatilla River would be doubled to quadrupled during the critical months of July, August and September. At the same time, the recharge water is cold and can reduce river water temperature by upward of 8 degrees. Water for recharge is normally withdrawn during winter and/or high flow shoulder months.

Capital costs are low, because the existing infrastructures within irrigation districts are used. Maintenance costs are moderate, because recharge would have to be done each year. Acceptance by the cooperator and the regulatory community would be high. The drawbacks include regulatory and finding ideal sites.

We recommend selecting three recharge sites in Yakima, Walla Walla and Okanogan Basins. Each recharge site can add upward of 10,000 ac-ft of water per year for a total of 30,000 ac-ft. The implementation cost will be approximately $200,000 to $300,000 per site per year or $20 to $30 ac-ft per year. Regulatory and environmental assessment costs are not included.

Lining-Piping/South Naches Irrigation District: This Project involves piping and pump/pressurizing of an irrigation system (1,811 acres). The Irrigation District has worked with North Yakima Conservation District (NYCD) to produce a CWCP funded through DOE's Ref. 38 Program. The Irrigation District currently is working with the WA Dept. of Agriculture in a CIDWMP process too. This project was recorded by the NYCD. The projected water savings seems overly optimistic or is not based on an annual savings.

Main Canal Reline/Wapato Irrigation Project: These three canal lining projects have essentially the same amount capital costs ($200,000) each for the same amount of water savings (approximately 1500 ac-ft/year). Each project is to essentially repair a major break in the main canal and reline or pipe the reach. For an annual capital cost of $40,000 for each canal, the water conservation savings could be as little as $27.00 per ac-ft with very little maintenance costs. Acceptance by the cooperator and the regulatory community would be high because each canal is breached and causes significant problems because of the breach. Each project provides a substantial amount of conservation water savings.

Re-regulation Reservoir/Naches –Selah Irrigation District: Lined 55 Ac-ft Reservoir to buffer flows coming from the Main Canal at Mile 15 into the piped laterals. Reservoir required to eliminate spills from the ends of the laterals. On demand service would be possible for all district users. Reservoir would include a pump station and automation to maintain flows in the main canal and piped system. Estimated capital cost of $320,000 for 900 ac-ft of water savings. For an annual capital cost of $64,000 the water savings could be as little as $71.00 ac-ft with very little maintenance costs. Acceptance by the cooperator and the regulatory community would be high because tailwater water quality problems are a big concern by WDOE. The small amount of water savings is the only drawback of this project.

Irrigation Scheduling/Wapato Irrigation Project: This project is proposed by the Wapato Irrigation Project and consists of irrigation scheduling throughout the project. This project has a low capital cost, however it would have to be done each year for the water savings. Acceptance by the cooperator and the regulatory community would be high, because Wapato proposed the project and would probably not be protested by any entity. The large amount of water savings is the best feature of this project.

Groundwater Recharge/ Walla Walla: These projects have been proposed by many entities in the Walla Walla Basin including the Walla Walla Basin watershed Council and the Corps of Engineers. Capital costs are low because existing infrastructure is used. Maintenance costs are moderate because it would have to be done each year. Acceptance by the cooperator and the regulatory community would be high, because this project is the "cause celebre" by WDOE, Department of Water Resources, and CTUIR. The drawback includes some of the recharge sites are in Oregon and it is not yet been possible to apply recharge water to groundwater and then extract the same amount of water downstream. On the other hand, stream flow on an important river is enhanced. The moderately high amount of water savings is the best feature of this project.

Tailwater Reuse/Westside Irrigation District: This project is proposed by the Westside Irrigation District and consists of irrigation tailwater reuse by a single cooperator. This project has an estimated capital cost of $320,000 for 900 ac-ftof water savings. For an annual capital cost of $64,000 the water savings could be as little as $71.00 ac-ft with very little maintenance costs. Acceptance by the cooperator and the regulatory community would be high because tailwater water quality problems are a big concern by WDOE. The small amount of water savings is the only drawback of this project.

Valve- Farm Regulation/ Orrville-Tonasket Irrigation District: This project consists of measuring and regulating irrigation deliveries to individual farms. Approximately 600-600 valves would be needed at a cost of $50.00 to $1000 for each valve. This project has an estimated capital cost of $325,000 for 1500 ac-ft of water savings (Costs and benefits extremely preliminary, but district seems willing to discuss both). For an annual capital cost of $65,000 the water savings could be as little as $43.00 ac-ft with very little maintenance costs. Acceptance by the cooperator and the regulatory community may be high. The small amount of water savings is the only drawback of this project.

Lateral Piping/Roza Irrigation District: The Roza Irrigation District tries to pipe about 10-12 miles of laterals each year at a construction price of $1.2 million per year. Average conservation is estimated at 600 ac-ft/year through this project. For an annual capital cost of $240,000 for each years of lateral lining, the water conservation savings would be approximately $400 per ac-ft with very little maintenance costs. Acceptance by the cooperator and the regulatory community would be high. However, this district receives only interruptible water. Each year's project provides a moderate amount of conservation water savings.

Description of Related Water Conservation Projects

Methow Valley Irrigation District (MVID): In a meeting with MVID (September 2006), officials, they may have upward of 600 to 1000 Ac-ft of water per year available for leasing at a cost of $50 to $100 per ac-ft per year. Also presently a study is underway to document even more conservation measures within this District.

Gardena Irrigation District: In a study conducted by IRZ and a personal meeting with the irrigation manager (July 2006), he identified the following water conservation measures.

South Laterals: Convert 29,000 feet of earthen canal serving about 2400 acres to pipeline. The estimated savings is about 8 cfs or roughly 2,000 ac-ft per year. The cost of the project is $1.7 million or $850/ac-ft, or $68/ac-ft/yr assuming 30 years life and 7% interest rate.

North Laterals: Convert 29,000 feet of earthen canal serving about 2500 acres to pipeline. The estimated savings is about 12 cfs or roughly 3,000 ac-ft per year. The estimated cost of the project is $1.7 million or $570/ac-ft, or $46/ac-ft/yr assuming 30 years life and 7% interest rate.

Touchet Irrigation District: In a study in 2003 IRZ Consulting identified conservation measures within this district. In a personal meeting (July 2006) the irrigation manager identified 21,000 feet of open ditch to be converted to pipeline. The estimated savings is about 3.52 cfs (1.72 cfs seepage and 1.5 cfs spill) or roughly 870 ac-ft per year. The estimated cost of the project depending on alternate selected ranged from $850,000 to $1.4 million or $988 to $1,600/ac-ft., or $80 to $130/ac-ft/yr assuming 30 years life and 7% interest rate.

Sulfur Creek Project : This is a drain from the Sunnyside/Roza Irrigation Districts. The drain runs about 30-40 cfs but has poor water quality. They want to pump the drain into a wetlands for natural treatment (also groundwater recharge). Costs for solar pumps and piping has been identified at about $1.5 to $2.0 million. With this system, annual cost of operations are low, regulatory acceptance is high. The tribe also indicated they are interested in this project. Washington Fish and Wildlife identified this as a priority.

Water Conservation Inventory Conclusions

This review suggests that there is an abundant amount of potential water conservation projects in Eastern Washington. The inventory of water savings documented in this report ranged from 100,000 ac-ft to nearly 900,000 ac-ft at varying levels of cost-effectiveness. In our survey, it also was determined that irrigation communities in general are very willing and eager to implement cost-effective water conservation measures. The benefits from implementing these measures could be tangible for CSRIA members and the State of Washington.

Some of the conservation measures are much readily available and more cost-effective to implement than others (the low hanging fruits) and should be pursed immediately and deliberately. This report identified and ranked a dozen of such high-value conservation projects.

However, there are several significant obstacles that remain. They are primarily regulatory and market based. The regulatory environment is probably the most significant drawback. Irrigators are concerned that improvements will simply result in less available water for them, because they are concerned that the WDOE may simply appropriate the conserved water for stream flows with no significant deemed benefits to water-right holders. This may not be a simple taking of the water, but is conveyed by the WDOE resurveying and re-certifying the water rights in the district.

The second concern is market based. No district will conserve water without a substantial benefit to the district. This benefit could be a longer irrigation season, ease of management from on-demand deliveries, increased productivities, cost-sharing, incentives, etc. For a successful implementation of conservation projects these concerns must be addressed.

Lastly, the above obstacles seem to dictate a hybrid menu driven approach to seeking additional water. Since the WDOE has much concern regarding water quality and stream restoration, CSRIA may seek to fund/help fund stream restoration projects with significant environmental projects such as KID's Phase II in exchange for Columbia River water rights. This is could be a tangible and less difficult way to proceed with some projects, to offset insignificant flow impacts from new Columbia River water rights. However, the cost/benefits of restoration projects can be better quantified with newer methods, and the possibility of environmental benefits may be higher through this approach than by the more direct approach of conservation/transfer of water.

And for eastern Washington region, Conservation Districts in collaboration with private industries may be the best vehicle to deliver water conservation measures and should be sufficiently funded for this effort.

Appendix 1

CSRIA- Contact Report

Date: 6/20/06
Persons Contacted: Jerry Jacoby, BOR and Stan Eisley DOE/BOR

Narrative of visit to BOR in Yakima. They were aware of our project. They talked about the Roza District having 5.4 feet of duty largely in pipeline with center pivots. Implies large duty with lower efficiency—therefore large losses. Crops are vineyards and orchards- imply high value crops.

Ellensburg Area- in some area as much as 24 ac-ft of duty (not a verified number) due to gravelly soil.

They discussed the role of Washington State Water Resources as a high priority contact. Tom Myrum, director 360.754-0756.

Suggested contact James Trull, Sunnyside District Manager 509.837.6980.
Don Schramm is asst. manager at Sunnyside
Suggested contact Ron Van Gundy, Tom Monroe, Roza District 509.837.5141.

Mentioned city of Yakima having interest in groundwater recharge. This would likely be an aquifer storage and recovery project.

There best potential contacts were the Kennewick Irrigation District (Manager Kenneth Hasbrouck 509.925.6158) and the Columbia Irrigation District (Manager Larry Fox (509.586.6118). These districts rely on return flows and are far downstream on Yakima. These downstream districts may protest conservation transfers because of that through the Water Transfer Working Group (WTWG).
http://www.ecy.wa.gov/programs/wr/ywtwg/ywtwg.html

Stan Eisley (DOW/BOR/WTWG) implied that they may have a say in transfers. He had biologist opinions about fish and streamflows- even mentioned gravel moving flood flows as important.

He said that temporary transfers were commonly done and recommended those. However, he mentioned that the transfers from the Sunnyside to the Roza District went for $100.00/ac-ft/year. The Roza district had high value wine crops to protect.

He said contact Don Huller, DOE-Columbia River Supervisor (509) 454-5255

Stan and Jerry are members of YRBWEP. Their measures require 2/3 of conservation savings go to the river and 1/3 to user. They gave us the Basin Plan.

He also mentioned the “Morton Provision” to a (house/senate bill?) that precludes transfers out of the Methow Valley. If this is the case, this would probably preclude any of our work in the Methow. He also mentioned the Okanagon as a possibility because of certain apple orchards going out of business due to less demand.

Persons Contacted: Tom Myrum and Michael Schwisow, Washington State Water Resources Association (WSWRA).

Narrative: Visited the WSWRA in Olympia. They were aware of our project. They voiced concerns about any on-farm measures being acceptable (such as conversions to center pivots) because the irrigator cannot commit their savings- may be through a district.

They (like BOR) talked about the Ellensburg Area (Kittitas Reclamation District (Manager Kenneth Hasbrouck 509.925.6158) and (Cascade Irrigation District (Manager Anthony Jantzer 509.962.9583)) - as much as 24 feet of duty (not a verified number) due to gravelly soil

They (like BOR) mentioned the Kennewick Irrigation District and talked about their canal/power plant/hydraulic pump delivery system (Manager Kenneth Hasbrouck 509.925.6158).

They (like BOR) mentioned the Columbia Irrigation District (Manager Larry Fox (509.586.6118). They mentioned that their canal was 1890 vintage and may be a good candid for conservation.

They mentioned the USGS/Yakima Basin groundwater study as a pending/important study. They said that there is competition for conservation measures and mentioned the prices of temporary transfers (like BOR).

They said that Sunnyside is very aggressive in conservation.

They said that Orville-Tonasket has already pipe delivery system.

They suggested following the results of Bob Montgomery in the Walla Walla watershed. His report develops 16,000 ac-ft of savings.

They mentioned the Wenatchee Reclamation District (Superintendent Rick Smith

They mentioned that the Judge Redden decision in the Snake River will affect our project in Idaho.

They mentioned the importance of Washington House Bill 2860.

They gave me three copies of their 2006 directory! I scanned this and turned it into a text file for mailings, etc.

Appendix 2

CONTACT FORM: CSRIA Conservation Inventory Measure

IRZ CONSULTING

505 EAST MAIN, HERMISTON, OREGON 97838 OFFICE (541) 567-0252 FAX (541) 567-4239

Irrigation District/ Official Contact:

Phone:

Email:

Introduction Statement: I work for IRZ (an irrigation consulting firm) on a project to evaluate conservation/mitigation measures for the Columbia and Snake River Irrigation Association (CSRIA) and the Washington Department of Ecology.

CSRIA and WDOE are looking for cost-effective conservation measures for funding. Can you take the time to answer the following questions?

What is your district's water duty?
How is your district irrigated? Short description of water source, water right, diversions, canals, types of irrigation.
Do you have a conservation plan?
What are your top priorities for funding? (Please provide a short description of the measure, the expected costs, and the expected water savings).
Would you be willing to further discuss these measures with us? (IRZ: acting for CSRIA and WDOE).

Call me with any additional comments. Thank you for your time and attention.

Sincerely;

James Graham

IRZ Consulting
541-567-0252

Appendix 3

Summary of Data from Conservation Districts

Franklin Conservation District provided a copy of data collected by Conservation Districts throughout Eastern Washington to CSRIA and IRZ Consulting. We summarized the data from the spreadsheet provided and the results are presented in the table below.

Conservation District	Number of Project	Estimated Water Saving [1] Total Ac-Ft	Estimated Cost [1] Total $	Cost $/Ac-Ft
Asotin County	10	75	171,000	2,280
Benton County	10	15,000	14,000,000	933
Douglas County	34	5,800	24,266,000	4,184
Franklin County	1,050	12,000	21,515,000	1,793
Grant/Franklin County	4,080	78,400	124,818,000	1,592
Kititas County	20	88,700	95,000,000	1,071
Lincoln County	38	Na	30,000	na
Okanogan County	1	900	240,000	267
Walla Walla County	36	13,500	6,000,000	444
Palouse County	15	Na	90,000	na
North Yakima County	15	41,300	107,000,000	2,591
	5,318	255,675	$393,130,000	1,538

[1] Please be advised that water savings and cost estimates are very crude and will need to be verified. Some of the costs are a mixture of capital costs and annual cost. Also some of the water saving and cost estimates may have been updated since IRZ acquired the spreadsheet.