

Yakima River Basin Study

Agricultural Water Conservation Technical Memorandum

U.S. Bureau of Reclamation
Contract No. 08CA10677A ID/IQ, Task 4.10

Prepared by

Anchor QEA



U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office



State of Washington
Department of Ecology
Office of Columbia River

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1.0 Agricultural Water Conservation Measures

This technical memorandum describes potential agricultural water conservation measures for irrigation water delivery systems in the Yakima River Basin. It includes a summary of conservation projects that were previously identified, potential conservation measures with and without the Integrated Water Resources Management Plan, and ongoing water conservation efforts that are paid for outside of the Yakima River Basin Water Enhancement Project (YRBWEP). Potential water conservation measures include lining or piping existing canals or laterals, constructing reregulation reservoirs on irrigation canals, installing gates and automation on irrigation canals, improving water measurement and accounting systems, installing higher efficiency sprinkler systems, implementing irrigation water management practices and other measures to reduce seepage, evaporation and operational spills.

1.1 Water Conservation Measures Previously Identified

Water conservation projects were previously identified in the Final Planning Report/Environmental Impact Statement Yakima River Basin Water Storage Feasibility Study (Reclamation 2008) and Final Environmental Impact Statement Yakima River Basin Integrated Water Resource Management Alternative (Ecology 2009).

In the Water Storage Feasibility Study, the No Action Alternative described a series of water conservation projects that Reclamation intended to implement through the Yakima River Basin Water Conservation Program (YRBWEP Phase II) even if proposed water storage projects are not implemented. These projects, in seven irrigation districts, included piping and lining, reregulation reservoirs, and changes in points of diversion to improve instream flow.

The Integrated Water Resource Management Alternative identifies a more aggressive approach to implementing water conservation projects. The Enhanced Water Conservation Element of the Integrated Water Resource Management Alternative described additional projects beyond those identified by Reclamation as part of their No Action Alternative. The projects were identified by reviewing all published water conservation plans for irrigation districts in the Yakima River Basin and contacting irrigation and conservation districts, as well as State and Federal agencies, to identify potential water conservation projects (Ecology 2009, Ecology 2007).

Projects were identified in 18 irrigation districts or companies, with a total estimated cost of over \$400 million. The types of projects are similar to those proposed by Reclamation, except that on-farm irrigation water conservation measures are also included in some irrigation districts. Table 2-3 of the Integrated Water Resource Management Alternative (Ecology 2009) contains a list of Ecology's enhanced water conservation projects.

Both the No Action Alternative and the Enhanced Water Conservation Alternative were previously modeled using the RiverWare hydrologic model to assess the effects on water supply and instream flow. The results from modeling those alternatives are described in the Water Storage Feasibility Study and the Integrated Water Resource Management Alternative.

The Enhanced Water Conservation Alternative was presented to the YRBWEP Workgroup in 2009. The Workgroup recommended that the list of conservation projects be used as a "placeholder" to determine an appropriate funding level the agricultural water conservation element. Specific projects may change when feasibility studies are completed or if priorities

change. If funding is secured under the Integrated Plan a process similar to that currently followed by the Yakima River Basin Conservation Advisory Group (CAG) would be used to determine which specific projects would be funded. The CAG is a workgroup comprised of representatives from Reclamation, Ecology, irrigation districts and fisheries agencies to provide advice on implementation of YRBWEP Phase II.

1.2 Water Conservation Measures in the Future Without Integrated Plan Scenario

The study team, the Modeling Subcommittee, the YRBWEP Workgroup and Reclamation reviewed the projects described in the No Action Alternative in the Water Storage Feasibility Study. This review was done to define which projects were to be included in the Future Without Integrated Plan (FWIP) scenario (see Volume 1, *Proposed Integrated Water Resource Management Plan*).

The FWIP scenario includes water conservation projects that are currently under consideration and likely to be funded in the next 10 years through the YRBWEP Phase II Water Conservation Program. Table 1 lists those projects and the projected water conservation estimates, which were obtained from Reclamation. Discussions were held with the Modeling Subcommittee to confirm the list of projects.

Table 1. Future Without Integrated Plan Scenario Projects

ENTITY	PROJECT DESCRIPTION	WATER CONSERVATION (ACRE-FEET, EXCEPT WHERE NOTED)		
		TOTAL	INSTREAM	IRRIGATION
Sunnyside Division	System Improvements (Phase I)	29,100	19,400	9,700
	System Improvements (Phase II)	25,480	17,000	8,480
Benton Irrigation District	Change in Diversion	21,000	21,000	None
	System Improvements	6,870	5,420	1,450
Wapato Irrigation Project	Change in Diversion	50 cfs	50 cfs	None

This project list in Table 1 is less extensive than the list developed in the No Action Alternative under the Water Storage Feasibility Study. The reason the project list in Table 1 is less extensive is because available funding for YRBWEP through Reclamation was described as the limiting factor in implementing the projects. Discussions with Reclamation and the subcommittee led to the reduced list that would fit into the available YRBWEP funding. Other projects originally developed in the No Action Alternative under the Water Storage Feasibility Study were placed in the Enhanced Water Conservation Element (see next section).

1.3 Water Conservation Measures in the Integrated Plan Scenario

The projects that were part of the No Action Alternative but not included as FWIP projects were combined with the projects from the Enhanced Water Conservation Alternative to comprise a full list of potential projects for the Enhanced Water Conservation Element of this study. Those projects were further evaluated and ranked based on the following criteria:

- **Type of water rights holder.** Water conservation projects in districts with proratable entitlements were ranked higher than projects in districts with non-proratable entitlements. This will allow districts with shortfalls in drought years to better manage water use and divert a greater proportion of water to crops.

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- **Reach benefits.** Water conservation projects that result in improvements in instream flow in high-priority reaches were ranked higher than other projects. High-priority river reaches are defined and described in Volume 2 technical memorandum – *Instream Flow Needs*.
 - **Cost.** Water conservation projects with a lower cost per acre-foot of water savings were ranked higher than those with a higher cost.

A list of project evaluations and ranking was submitted to the Modeling Subcommittee for review. Some adjustments to cost and estimated water savings were made to Roza Irrigation District projects based on their review (Van Gundy, personal communication). Table 2 contains the adjusted list of project evaluations and ranking.

Table 2 shows two categories of projects that are separated by a cut-off line based on the professional judgment of Anchor QEA with input from Reclamation and the Modeling Subcommittee. Projects listed above the cut-off line were recommended to be included in the Enhanced Water Conservation Element because of benefits to proratable water users, instream flow benefits to priority reaches and costs that are reasonable compared to other potential projects in Table 2. Projects listed below the cut-off line are not recommended to be included in the Enhanced Water Conservation Element because of high costs or instream flow benefits not accruing to high priority river reaches.

The costs listed in Table 2 were obtained from the previous technical report on the Enhanced Water Conservation Alternative (Ecology 2007) and input from Reclamation and the Modeling Subcommittee and were indexed to 2010 costs. About half of the projects listed in the technical report had detailed itemized cost estimates, which were indexed to 2010 costs using the Reclamation Construction Cost Index. A contingency of 25% and non-contract costs of 35% were added to the detailed cost estimates. Planning-level estimates available for the remaining projects were indexed to 2010 without contingencies or non-contract costs.

Projects that comprise the Enhanced Water Conservation Element of the Integrated Plan are estimated to cost a total of \$392 million. Because this element is programmatic in nature, it has been rounded up to \$400 million for planning purposes.

The estimated total water savings are 171,700 acre-feet. However those savings are not cumulative because water conservation projects reduce the amount of return flow to surface water, which is a source of supply for downstream water users. In addition, these water savings are estimated for years when water users have a full water supply. Therefore, in drought years the water savings would be reduced because less water would be conveyed through irrigation systems and applied to farms, which, in turn, reduces seepage and other losses and results in less return flow.

The RiverWare hydrologic model was used to test the effectiveness of the projects that comprise the Enhanced Water Conservation Element of the Integrated Plan and to determine the flow benefits to priority reaches. The results of the modeling are described in the Volume 2 technical memorandum: *Modeling of Reliability and Flows*.

The Enhanced Water Conservation Element represents an aggressive program of agricultural water conservation projects with reasonably obtainable benefits to proratable water users and instream flow in priority reaches. The overall average cost of the projects in the element is \$2,300 per acre-foot. The projects actually implemented in this element would be determined through detailed feasibility studies and evaluation by the CAG. Other projects may be added to this list as they are identified.

Table 2. Proposed Ranking of Enhanced Water Conservation Projects for Integrated Plan

ENTITY	PROJECT DESCRIPTION	PRIORITY REACH BENEFITS	PRORATABLE WATER USER	NON-PRORATABLE WATER USER	WATER CONSERVATION (ACRE-FEET/YR)	COST (2010 \$)	COST PER AC-FT (\$)
Wapato Irrigation Project	Bench unit re-regulation reservoir (370 acre-feet)	✓	✓	✓	700	628,000	897
Wapato Irrigation Project	Equip turnouts with water measuring devices (2,500 total)	✓	✓	✓	9,800	8,924,000	911
Kittitas Reclamation District	Piping high-loss laterals (53 miles), 2 re-regulation reservoirs, and North and South Branch Canal automation	✓	✓		40,735	47,531,000	1,167
Wapato Irrigation Project	Satus East and Satus West Canal lining	✓	✓	✓	4,600	6,949,000	1,511
Kittitas Reclamation District	Replace leaky Main Canal lining	✓	✓		2,000	3,422,000	1,711
Wapato Irrigation Project	Lateral 4 extension lining and corresponding sub-laterals lining or piping	✓	✓	✓	3,400	6,790,000	1,997
Wapato Irrigation Project	Track lateral lining and water structure replacement	✓	✓	✓	5,100	10,356,000	2,031
Roza Irrigation District	System improvements – re-regulation reservoir	✓	✓		5,000	11,003,000	2,201
Wapato Irrigation Project	Spencer Lateral improvement (10.5 miles)	✓	✓	✓	1,300	2,874,000	2,211
Wapato Irrigation Project	Voluntary incentive-based irrigation improvement program	✓	✓	✓	11,375	25,739,000	2,263
Roza Irrigation District	System improvements – “pay as you go”	✓	✓		10,000	27,508,000	2,751
Wapato Irrigation Project	East Highline Canal lining or piping (12,000 feet)	✓	✓	✓	700	2,874,000	4,106
Wapato Irrigation Project	West Highline Canal lining (24.5 miles)	✓	✓	✓	2,950	18,510,000	6,275
Wapato Irrigation Project	Unit 2 pump canal lining (15 miles)	✓	✓	✓	2,600	17,892,000	6,882
Wapato Irrigation Project	Island lateral and sub-lateral lining (10 miles)	✓	✓	✓	750	5,256,000	7,008
Wapato Irrigation Project	Main Extension Canal lining (73 miles)	✓	✓	✓	3,600	44,979,000	12,494

Table 2. Proposed Ranking of Enhanced Water Conservation Projects for Integrated Plan (Continued)

ENTITY	PROJECT DESCRIPTION	PRIORITY REACH BENEFITS	PRORATABLE WATER USER	NON-PRORATABLE WATER USER	WATER CONSERVATION (ACRE-FEET/YR)	COST (2010 \$)	COST PER AC-FT (\$)
Wapato Irrigation Project	Main Extension Canal lining (73 miles)	✓	✓	✓	3,600	44,979,000	12,494
Wapato Irrigation Project	Replace Unit 1 piped laterals (32 miles)	✓	✓	✓	800	11,449,000	14,311
Wapato Irrigation Project	Replace Unit 2 piped laterals (32 miles)	✓	✓	✓	500	12,801,000	25,602
Wapato Irrigation Project	Replace existing check structures	✓	✓	✓	minor	1,745,000	NA
Wapato Irrigation Project	Construct water measurement devices	✓	✓	✓	minor	1,745,000	NA
Cascade Irrigation District	Install Johnson drain pump and variable frequency drive	✓		✓	2,088	376,000	180
Outlook Irrigation District (SVID)	Pipe former Outlook Irrigation District (5 miles)	✓	✓ ¹	✓	4,265	1,542,000	362
Westside Irrigation	Canal piping (2 miles)	✓	✓ ¹	✓	600	502,000	837
Bull Canal Company	Canal piping (4,800 feet)	✓		✓	639	616,000	964
South Naches Irrigation District	Convert to pressure distribution system	✓		✓	9,733	11,035,000	1,134
Naches-Selah Irrigation District	Change point of diversion to Wapatox ditch diversion	✓	✓ ¹	✓	15,000	19,256,000	1,284
Naches-Selah Irrigation District	System improvements – re-regulation reservoir and lateral piping	✓	✓ ¹	✓	18,200	32,117,000	1,765
Union Gap Irrigation District	Canal piping (4 miles)	✓	✓ ¹	✓	200	570,000	2,850
Ellensburg Water Company	Convert from rill to sprinkler (7,100 acres)	✓		✓	5,325	20,251,000	3,803
Cascade Irrigation District	Convert from rill to sprinkler (9,000 acres)	✓		✓	6,750	25,672,000	3,803
Westside Irrigation	Convert from rill to sprinkler (3,300 acres)	✓	✓ ¹	✓	2,475	9,413,000	3,803
Bull Canal Company	Convert from rill to sprinkler (680 acres)	✓		✓	510	1,940,000	3,804

Projects listed above are recommended to be included in Enhanced Water Conservation Element. Projects listed below are not.

Table 2. Proposed Ranking of Enhanced Water Conservation Projects for Integrated Plan (Continued)

ENTITY	PROJECT DESCRIPTION	PRIORITY REACH BENEFITS	PRORATABLE WATER USER	NON-PRORATABLE WATER USER	WATER CONSERVATION (ACRE-FEET/YR)	COST (2010 \$)	COST PER AC-FT (\$)
Naches and Cowiche Canal Company	Pipe ditch to current points of use (5.5 miles)	✓		✓	600	17,114,000	28,523
Yakima Valley Canal Company	Pipe ditch to current points of use (15 miles)	✓	✓ ¹	✓	500	28,524,000	57,048
Gleed Ditch Company	Pipe ditch to current points of use (6.5 miles)	✓		✓	100	5,705,000	57,050
Kennewick Irrigation District	Columbia River pump exchange		✓	✓	64,500	59,278,000	919
Kiona Irrigation District	Complete pressurized system conversion			✓	4,124	5,231,000	1,268
Nile Valley Ditch Association	Canal piping (300 acres)			✓	395	570,000	1,443
Columbia Irrigation District	Columbia River pump exchange, Main Canal lining (16 miles), Lateral 1 and 2 piping			✓	26,000	40,466,000	1,556
Union Gap Irrigation District	Construct pump station to move point of diversion 11 miles downstream		✓ ¹	✓	5,600	18,155,000	3,242

¹ Water user has both non-proratable and proratable entitlements (mostly non-proratable) and was grouped with other non-proratable water users.
NA – Not Applicable

1.4 Other Water Conservation Projects

In addition to the FWIP (YRBWEP Phase II) scenario and Enhanced Water Conservation Element, other smaller water conservation efforts are ongoing and paid for outside of funding that may be secured for the Integrated Plan. Those efforts include on-farm irrigation improvements such as conversion to higher-efficiency sprinklers or drip irrigation, which have been occurring for decades and are one reason for reduced diversions by irrigation entities as shown in Figure 2 in the Volume 2 technical memorandum, *Water Needs for Out-of-Stream Uses*. The drivers for on-farm water conservation improvements include planting new crops (i.e., wine grapes, new orchards), reducing energy use, better control of fertilizer and chemical applications, reducing sediment runoff, and improving water quality, instream flow in tributaries, and reliability of available water supplies.

Tables 6 and 7 of the Volume 2 technical memorandum, *Water Needs for Out-of-Stream Uses*, provides estimates of irrigation type by district in the Yakima Project. They include the following:

- Roza Irrigation District – 90 percent of total acreage in sprinkler or drip systems.
- Sunnyside Valley Irrigation District – 68 percent sprinkler or drip irrigated. But they are currently installing new piped lateral systems that will deliver pressurized water to much of their acreage, which will facilitate conversion to higher-efficiency irrigation systems.

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- Yakima-Tieton Irrigation District – More than 90 percent sprinkler irrigated, which corresponds to the percentage of acreage in orchards that typically use higher-efficiency irrigation systems.
 - Wapato Irrigation Project (WIP) – An estimated 55 percent sprinkler or drip irrigated. However additional water conserved on-farm in WIP may not result in a corresponding reduction in diversion requirements because return flow is a supply to other WIP farmers. Diversions would be reduced by only about 0.2 acre-feet per acre with improved irrigation techniques – a total of 11,375 acre-feet for 55,750 acres improved (NRCE 2002). During drought years, the water savings would be even less because less water is applied to fields.
 - Kittitas Reclamation District (KRD) – Only 20 percent sprinkler or drip irrigated. However return flow from KRD farms flows back to the Yakima River and is a source of supply for water users downstream from the Kittitas Valley. A reduction in seepage on KRD farms would not improve water supply in the basin.
 - Outside of the Yakima Project – An estimated 75 percent of irrigated acreage is sprinkler or drip irrigated. Approximately 95 percent of the gravity (rill)-irrigated acreage outside of the Yakima Project is located in Kittitas County, and return flow from that acreage is a source of supply for water users downstream from the Kittitas Valley. A reduction of seepage on those farms would not improve water supply in the basin. However, on-farm water conservation improvements in the Kittitas Valley could have large benefits to instream flow in tributaries.

2.0 References

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2. Ecology 2007. *Technical Report on the Enhanced Water Conservation Alternative for the Yakima River Basin Water Storage Feasibility Study*. Ecology Publication #07-11-044.
3. NRCE (Natural Resources Consulting Engineers) 2002. *Priority Irrigation Water Conservation and Management Measures Plan for the Wapato Irrigation Project Yakama Reservation, Washington*.
4. Reclamation (United States Bureau of Reclamation) 2008. *Yakima River Basin Water Storage Feasibility Study: Final Planning Report/Environmental Impact Statement, Volume I*.
5. Van Gundy, Ron, 2010. Personal communication.

3.0 List of Preparers

NAME	BACKGROUND	RESPONSIBILITY
HDR ENGINEERING, INC.		
ROBERT MONTGOMERY	WATER RESOURCES ENGINEERING	AUTHOR
ADAM HILL	WATER RESOURCES ENGINEERING	AUTHOR