SUBMIT OPTION SUBMITTAL FORM BY:
1. EMAIL TO: COLORADORIVERBASINSTUDY@USBR.GOV
2. U.S. MAIL TO: BUREAU OF RECLAMATION, ATTENTION MS. PAM ADAMS, LC-2721, P.O. BOX 61470, BOULDER CITY, NV 89006-1470
3. FACSIMILE TO: 702-293-8418

# Option Submittal Form

**Contact Information (optional):** ☐ **Keep my contact information private.**

| | |
|---|---|
| Contact Name: | Title: |
| Affiliation: | |
| Address: | |
| Telephone: | E-mail Address: |

Date Option Submitted: February 1, 2012

**Option Name:**

Reduction of on-farm and conveyance evaporative losses and deep percolation.

**Description of Option:**

A significant portion of water applied to crops is lost to the system through evaporation and deep percolation that does not return to the stream. Under traditional flood or furrow irrigation, up to 30% of water applied to a field may be lost to evaporation.[1] Similarly, while some water that is not consumed by crops infiltrates into the soil and makes its way back to the river system in the form of return flows, other water infiltrates below the root systems and does not return to the river (deep percolation). Water may also be lost in these ways during conveyance, especially when delivered through open and unlined canal systems.

These losses can be minimized in a variety of ways:

(1) Conversion to more efficient irrigation, particularly subsurface drip irrigation
(2) Precision application and timing of irrigation water
(3) Conservation tillage and mulching
(4) Conversion of open canals to pipes

In different ways, each of these tools can reduce the amount of water consumed by evaporation or deep percolation and lost to the system. The percentage of applied water lost to evaporation depends on the irrigation system and frequency of water application as well as the ground covered either by crop foliage or conservation mulch and tillage systems. Conservation tillage practices and water applications that match soil moisture conditions can reduce evaporation by up to 80%.[2]

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[1] *Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures.* Colorado Agricultural Water Alliance, 2010. Available at: http://www.agwaterconservation.colostate.edu/Ag_water_conservation_paper_draftSept11.pdf

[2] Canessa, P., Green, S., Zoldoske, D., 2011. *Agricultural Water Use in California: A 2011 Update*. Center for Irrigation Technology, California State University, Fresno. Available at *http://www.californiawater.org/docs/CIT_AWU_Report_v2.pdf*

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Flood and furrow irrigation systems may result in overwatering which leads to high rates of evaporative loss during the irrigation event. These consumptive losses can be reduced significantly through the use of subsurface drip irrigation or other more efficient mechanisms. Measurement and precision application of the quantity and timing of irrigation events to match soil moisture conditions and crop water needs have also been shown to reduce evaporative losses.[3] Regulated deficit irrigation practices during drought tolerant growth stages of some plants will also reduce both total water demand and evaporative losses from over-watering.[4]

Evaporation and seepage losses may also occur during conveyance. These evaporative losses are relatively small but in aggregate across the Basin account for a significant amount of water lost to the system.[5] Water trusts in the Pacific Northwest have begun to pipe open canal systems to provide more reliable water delivery to irrigators and negate transmission losses, including evaporation.[6] Such a practice, if appropriately applied to negate impacts on downstream users that rely on return flows, may also be applicable in the Basin.

**Location:** Describe location(s) where option could be implemented and other areas that the option would affect, if applicable. Attach a map, if applicable.

These strategies can be applied throughout the basin. The potential water savings realized from more efficient irrigation and conservation tillage will depend upon the crop, length of growing season and temperature.

**Quantity and Timing:** Roughly quantify the range of the potential amount of water that the option could provide over the next 50 years and in what timeframe that amount could be available. If option could be implemented in phases, include quantity estimates associated with each phase. If known, specify any important seasonal (e.g., more water could be available in winter) and/or frequency (e.g., more water could likely be available during above-

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[3] Weather and Soil Moisture Based Landscape Irrigation Scheduling Devices: Technical Review Report - 2nd Edition: Bureau of Reclamation, Lower Colorado River Region, August 2007. Available at http://www.usbr.gov/waterconservation/docs/SmartController.pdf

[4] Canessa, P., Green, S., Zoldoske, D., 2011. *Agricultural Water Use in California: A 2011 Update*. Center for Irrigation Technology, California State University, Fresno. Available at *http://www.californiawater.org/docs/CIT_AWU_Report_v2.pdf*

[5] Dickens, J.M., Forbes, B.T., Cobean, D.S., and Tadayon, Saeid, 2011, Documentation of methods and inventory of irrigation data collected for the 2000 and 2005 U.S. Geological Survey *Estimated use of water in the United States*, comparison of USGS-compiled irrigation data to other sources, and recommendations for future compilations: U.S. Geological Survey Scientific Investigations Report 2011–5166, 60 p. Available at http://pubs.usgs.gov/sir/2011/5166/

[6] Natural Resources Conservation Service, Oregon, 2011. *Oregon Conservation Showcase*. United States Department of Agriculture. Available at http://www.or.nrcs.usda.gov/news/showcase/pdfs/conservation_showcase_glenn-cooper_02162011.pdf

average hydrologic years) considerations. If known, describe any key assumptions made in order to quantify the potential amount.

Conversion to more efficient irrigation systems, and management regimes required to take advantage of them, may require several years. Conservation tillage and mulching is a relatively simple management change that can be introduced within a growing season.

We are not able to quantify the amount of water these tools could provide at this time. A variety of studies have discussed consumptive loss from evaporation and deep percolation, but few have attempted to quantify the potential savings from conservation practices. On a larger scale, some cities have also begun to consider the amount of water lost in transit from the point of diversion to its eventual place of municipal use.[7] Such quantification studies may be appropriate in areas with exceptionally high rates of evaporative losses to determine the value of large-scale application of this option.

[7] City of Albuquerque Public Works Department, 2004-2007. *Estimating Evaporative Losses Incurred by Conveyance of City of Albuquerque San Juan-Chama Water: Jemez to Albuquerque*. Facilitated by USGS. Available at http://nm.water.usgs.gov/projects/evaploss/

## Additional Information

**Technical Feasibility:** Describe the maturity and feasibility of the concept/technology being proposed, and what research and/or technological development might first be needed.

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**Costs:** Provide cost and funding information, if available, including capital, operations, maintenance, repair, replacement, and any other costs and sources of funds (e.g., public, private, or both public and private). Identify what is and is not included in the provided cost numbers and provide references used for cost justification. Methodologies for calculating unit costs (e.g., $/acre-foot or $/million gallons) vary widely; therefore, do not provide unit costs without also providing the assumed capital and annual costs for the option, and the methodology used to calculate unit costs.

The cost of conversion to more efficient irrigation systems varies based on operational need and system chosen. Capital costs for such a conversion may require public investment to incentivize growers' decisions to replace aging infrastructure. The cost of conservation tillage should be negligible.

**Permitting:** List the permits and/or approvals required and status of any permits and/or approvals received.

N/A

**Legal / Public Policy Considerations:** Describe legal/public policy considerations associated with the option. Describe any agreements necessary for implementation and any potential water rights issues, if known.

The status of conserved water as a new source of supply is unclear in many basin states. Some western states have enacted statutory provisions allowing for the sale or lease of conserved water or, alternatively, exemptions from forfeiture for water saved through efficiency and conservation practices. Public subsidies for conservation practices and legal changes such as those listed may incentivize expanded adoption of practices that reduce consumptive use of

[8] City of Albuquerque Public Works Department, 2004-2007. *Estimating Evaporative Losses Incurred by Conveyance of City of Albuquerque San Juan-Chama Water: Jemez to Albuquerque.* Facilitated by USGS. Available at http://nm.water.usgs.gov/projects/evaploss/

water.

**Implementation Risk / Uncertainty:** Describe any aspects of the option that involves risk or uncertainty related to implementing the option.

Though we do not currently have data on the water saving potential of these tools at scale, reduction of evaporative and deep percolation losses provide a very reliable and true saving of water that would otherwise be consumed and lost to the system.

**Reliability:** Describe the anticipated reliability of the option and any known risks to supply or demand, such as: drought risk, water contamination risk, risk of infrastructure failure, etc.

These tools are accepted methods for reducing agricultural water demand without impacting yields. Enhanced monitoring of agricultural water use and application should decrease drought risk and contamination risk by avoiding overwatering that leads to rising groundwater levels and increased run-off.

**Water Quality:** Identify key water quality implications (salinity and other constituents) associated with the option in all of the locations the option may affect.

More efficient and precise irrigation methods should reduce run-off to receiving water bodies. This may decrease concentration of agricultural pollutants in basin rivers and streams.

**Energy Needs:** Describe, and quantify if known, the energy needs associated with the option. Include any energy required to obtain, treat, and deliver the water to the defined location at the defined quality.

| Energy Required | Source(s) of Energy |
|---|---|
| Ongoing energy needs may increase when operations are converted from gravity-fed irrigation to pressurized irrigation. This increase may be offset by reduced water demand through more efficient irrigation technologies and reduced evaporative losses. | |
| | |

**Hydroelectric Energy Generation:** Describe, and quantify if known, any anticipated increases or decreases in hydroelectric energy generation as a result of the option.

| Location of Generation | Impact to Generation |
|---|---|
| | To the extent that broad-scale reduction in evaporative and deep percolation losses would reduce the quantity of water diverted for agricultural use, additional water may be available to pass through hydroelectric turbines. |

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**Recreation:** Describe any anticipated positive or negative effects on recreation.

| Location(s) | Anticipate Benefits or Impacts |
|---|---|
| | To the extent that broad-scale reduction in evaporative and deep percolation losses would reduce the quantity of water diverted for agricultural use, river recreation resources would be expected to improve. |
| | |
| | |

**Environment:** Describe any anticipated positive or negative effects on ecosystems within or outside of the Colorado River Basin.

| Location(s) | Anticipated Benefits or Impacts |
|---|---|
| | To the extent that broad-scale reduction in evaporative and deep percolation losses would reduce the quantity of water diverted for agricultural use, environmental resources would be expected to improve. If applied properly, these methods should not interfere with return flows depended upon by downstream users as well as environmental and recreational users. |
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**Socioeconomics:** Describe anticipated positive or negative socioeconomic (social and economic factors) effects.

Conversion of aging irrigation systems to more efficient systems will provide general construction, engineering, and agricultural management jobs in the local communities. Increased efficiency may also increase agricultural yields and provide drought protections that will sustain rural economies.

**Other Information:** Provide other information as appropriate, including potential secondary benefits or considerations. Attach supporting documentation or references, if applicable.

Additional source materials are listed below:

Archer, D. W., Halvorson, A. D., Reule, C. A., 2008. *Economics of Irrigated Continuous Corn under Conventional-Till and No-Till in Northern Colorado*. Agronomy Journal, pp 1166-1172. Available at http://ddr.nal.usda.gov/bitstream/10113/18247/1/IND44074233.pdf

Cornelius, W. M., et al., 2009. *Conservation tillage practices for water conservation in the Chinese loess plateau*. EGU General Assembly 2009, held 19-24 April, 2009 in Vienna, Austria, p.11454. Available at http://meetings.copernicus.org/egu2009.