# Technical and Physical Feasibility Fact Sheet
# Alternative 9: Agricultural Conveyance

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## 1. Definition of Alternative

A-9: Develop conveyance alternatives for water transportation in agricultural irrigation systems.

## 2. Summary of the Alternative Analysis

This alternative analysis examines "off-farm" irrigation conveyance system efficiency and strategies for its improvement both in the Middle Rio Grande Conservancy District (MRGCD) and the smaller community ditch systems in Sandoval County (Saavedra, 1987), referred to in this fact sheet as the "small Sandoval systems". Tables 9A-1 and 9A-2 in Exhibit 9A present irrigated area and flow data for the MRGCD system. Table 9A-3, also in Exhibit 9A, illustrates the same for the 21 smaller systems in Sandoval County. As noted in the fact sheet for Alternative 7, *Agricultural Metering*, data from Wilson (1999), the MRGCD (2000), and the recent MRGCD metering study carried out by SS Papadopulos & Associates (2002) are used as the basis for this alternative analysis. Also as discussed in the analysis of Alternative 7, using irrigation efficiency indicators as the only means to measure MRGCD overall efficiency may be misleading. Implementation of off-farm conveyance efficiency measures would reduce diverted irrigation water quantities. However, reduction in diversions will not result in "new" water.

On Table 9A-1 (Exhibit 9A), the number of farms listed (USDA and NMASS, Undated) appears to be much lower than the currently estimated number of farm turn-outs that are billed by MRGCD. This is probably related, but not fully explained, by the number of farmers who have listed their occupation as full-time farmers on their federal tax returns as opposed to the number of farmers who have other primary income jobs within the study area. Table 9A-3, which contains data from Saavedra (1987), has not been field checked; however Wilson (1999) notes non-MRGCD irrigated areas of similar total acreages in Sandoval County.

It is assumed, as for Alternative 7, *Agricultural Metering*, that this analysis applies to irrigation systems that rely on both groundwater and surface water within the MRGCD. Wilson (1999) notes that groundwater is used as a water source in the three-county MRGCD region as (1) a stand-alone source and (2) in conjunction with surface water as both a primary source and as a secondary source to surface water. In the MRGCD region, surface water is used exclusively on 71 percent of all acreage, groundwater only on less than 1 percent, surface water supplemented with ground water on 21 percent, and groundwater supplemented by surface water on less than 7 percent. (Wilson, 1999). Also, as for Alternative 7, reliable flow and physical irrigation infrastructure facility and control system data are difficult to obtain. Sources of off-farm conveyance data are listed in Exhibit 9A. As no discernable reduction in irrigated acreage has been noted over the past 10 years within the MRGCD system, it is assumed in this analysis that the acreage under irrigation today will remain constant over the next 40 years.

Irrigation flow accounting in the MRGCD is complex, as system drainage water or "return flow" from upstream canal units is used as diversion water for downstream canal units. This occurs from the Cochiti Division all the way through the system to the Socorro Division. Although it is not discussed at all in the OSE water reports (Wilson, 1997 and 1999), it is a feature of the water accounting exercise presented in the SSPA (2001) report. Each of these two reports present estimated data for off-farm conveyance efficiency ($E_c$) in the MRGCD system, however the values presented are widely different. $E_c$ is the factor that allows estimation mainly of water "lost" to seepage in the off-farm conveyance system. For MRGCD's irrigation system, the relationship and interplay between accounting for estimated return flow downstream from diversions and the system's $E_c$ estimates is a major issue as a large fraction of all diverted water that flows through the system results in either drainage water return flow and/or seepage. Seepage water might be reduced and is the subject of this Alternative 9 analysis. Drainage water return flow used as downstream diversions is beyond the scope of this analysis.

To minimize the effect of this issue on the analysis and focus more on possible seepage reduction, a value of 64 percent is used as the conveyance efficiency ($E_c$) for MRGCD canal units located in Sandoval, Bernalillo, and Valencia Counties. This value was adopted based on general information given in Wilson (1997), who states that overall in New Mexico, 36 percent of irrigation water is lost in off-farm conveyance.

There are several ways to improve off-farm conveyance efficiency ($E_c$). Most involve improvements to irrigation management systems that ensure water deliveries are scheduled and measured. Such management improvements keep water in the right farming units at the right time and ensure measured deliveries with minimal wastage. A second category of enhancements to irrigation conveyance systems is through improvements to the physical infrastructure (i.e., canals). Various canal lining and piping systems have been proposed, tested, and are in use today all over the world. The most common “improved” canal lining system employs simple non-reinforced concrete lining or reinforced concrete lining on larger canals. Other materials already in use in the project area include gunite (shotcrete) and geo-membranes. Compacted clay and/or clayey soils are also employed, and combinations of each of these are sometimes used together depending on the application, the size of the canal, the local geology, maintenance requirements, and cost.

Canal lining systems, their costs, and their effectiveness at eliminating seepage have been extensively studied recently by the U.S. Bureau of Reclamation (Reclamation) Pacific Northwest Region, Water Conservation Field Services Program (2002). Over the past ten years Reclamation has constructed and evaluated over 30 test sections and canal lining projects that have addressed various materials and efficiencies. Although this work has been in a region with different geological characteristics, the experience can be useful in evaluating this alternative. Table 9A-6 (Exhibit 9A) summarizes some of the major findings of the program and provides cost information from the summary report produced as part of this study. It also includes an explanation of unit canal lining costs that are used in this analysis to project a conceptual canal lining project/program for MRGCD and the 21 small Sandoval systems.

Tables 9A-4 and 9A-5 (Exhibit 9A) summarize the diversion water reduction that would result if a canal lining project/program were to be funded and implemented on MRGCD canals and the small Sandoval systems. Note that for the MRGCD system in the three-county area, the conceptual program proposes to line only 50 percent of all main and lateral canals. This is to allow for seepage and to allow for watering of canal riparian flora in certain stretches of the canal system. The exercise takes incidental losses into account. It assumes the percentage of incidental loses (evapotranspiration) reported to be present today (U.S. BOR, 2002; Wilson, 1997) will remain after lining sections of the canal system. It is important to remember that incidental depletions are not diversions. Another major benefit that will accrue as a result of this work would be additional water available for canal “tail end” users within the MRGCD.

Seepage/lining studies need to be carried out to determine where and how much seepage is required, what type(s) of canal lining systems (concrete, liquid applied, and or geo-membrane) can be employed, and to establish the actual local unit costs that will be involved. Based on the findings of such a study, the "best choice" canal linings can be installed in appropriate areas of the Middle Rio Grande (MRG) region. Seepage studies, which are needed for both the MRGCD and the small Sandoval systems, should be based on a full hydraulic model of the intake, canal, farm, and drainage system. The cost of such studies is provided in Tables 9A-7 and 9A-8 (Exhibit 9A).

Other initiatives that could be implemented with this program include removing unwanted riparian vegetation along earthen-lined canals; straightening some sections of canal; improving canal structures; and retiring canals with few remaining users, where losses far exceed actual water deliveries. Farmers situated on retired canals could be converted to groundwater at additional savings of diverted surface water. The cost for these three activities in the MRGCD system is added in Table 9A-7 (Exhibit 9A).

The use of piping as a method to control seepage and evapotranspiration has been reviewed as part of this analysis. Although both seepage and evapotranspiration are positively affected, unless the irrigation water is free of silt and debris, there can be significant operations and maintenance (O&M) problems with the use of off-farm conveyance pipes. Pipes might be used at the tail ends of some laterals and farm canals or on-farm, but because of the O&M issues, they have been excluded from this analysis.

## 3. Alternative Evaluation

### *3.1 Technical Feasibility*

*Enabling New Technologies and Status*

Table 9A-6 (Exhibit 9A) summarizes the results of Reclamation's large canal lining study in the Pacific Northwest (U.S. BOR, 2002). Other canal lining studies that include cost benefit analysis and verify the diversion water savings estimates used in this analysis have been carried out in Texas through the Texas Cooperative Extension Program's District Management System Program (TCE, 2001). For this analysis, concrete is used as the primary lining material in the MRG region; however, more study is needed on this subject. Materials and methods of construction are well known. What might be seen as new is an approach to lining that does not seek simply to minimize seepage and losses, but to control and optimize it.

*Infrastructure Development Requirements*

Canal lining should occur in conjunction with a developed, system-wide water budget to ensure that the desired amount of seepage occurs in planned locations. Hydraulic studies for major existing canals and systems are also needed.

*Total Time to Implement*

For the small Sandoval systems, this program could be implemented over a five-year period. For MRGCD, such a program might last for 15 to 20 years.

### *3.1.1 Physical and Hydrological Impacts*

*Effect on Water Demand*

The amount of diverted water required for irrigation will be reduced as a result of this alternative. See "water saved/lost" below for a discussion of consumptive use.

*Effect on Water Supply (surface and groundwater)*

The amount of water diverted for irrigation would be reduced. The question of what happens to the water that is no longer being diverted would be determined by legal considerations. From a practical perspective, fewer water diversions would mean more water stays in El Vado reservoir since water used for irrigation in the MRGCD is stored there. If less water is needed for irrigation in the MRGCD, the result would be a reduction in the quantity of water released from the reservoir. Additional water in the reservoir could be used to extend the irrigation season and provide farmers with a full water supply. Administrative changes would likely be required before any water made available through efficiency improvements in the MRGCD could be acquired, leased, or purchased by other entities.

The consumptive irrigation requirement (CIR) for the small Sandoval systems was just over 1 acre-foot per acre in 1999. Lining canals in these systems will allow for more diverted water to reach the farms. It will extend the irrigation season, thereby raising the CIR closer to or above 2.2 or 2.4 acre-feet per acre. Therefore, while the Tables 9A-4 and 9A-5 (Exhibit 9A) seem to indicate a higher conveyance efficiencies ($E_c$) resulting from lining, in reality such projects allow more diverted water to be delivered to system farms, especially to "tail end" farms. This would increase CIR, crop yields, and economic gain. However, Tables 9A-4 and 9A-5 do not reflect this; they simply project higher off-farm conveyance efficiencies.

This analysis projects that 25 percent of MRGCD canals and 35 percent of small Sandoval system canals will be lined to decrease seepage. Groundwater levels may be affected by this alternative through a reduction in seepage, however, the degree to which it would be affected is difficult to quantify in overall supply terms, Effects on surface water supply would seem to be substantial considering the quantity of diversion water that might be reduced.

Implementation of this alternative might result in a reduction of approximately 71,000 acre-feet of diverted water in MRGCD and the small Sandoval systems. Based on the OFWM program costs listed for the MRGCD in Table A9-7, it would cost approximately $1,700 to save 1 acre-foot of diverted water. In the small Sandoval systems, the cost to save 1 acre-foot of diverted water would be approximately $5,300.

*Water Saved/Lost (consumption and depletions)*

As discussed above, this alternative will primarily affect diversions. Some very minor reduction in consumptive use could occur because of slight reductions in riparian evapotranspiration on the order of 1,500 acre-feet per year (SSPA, 2003). Conversely, to the extent that this alternative results in an extension of the irrigation season, consumptive use could increase due to reservoir evaporation and additional crop irrigation.

In considering savings in seepage losses, it is important to note that water which seeps from canals is a source of recharge to the shallow groundwater in the area. With the exception of the slight reductions in riparian evapotranspiration described above, changes in seepage do not affect depletions.

*Impacts to Water Quality (and mitigations)*

Water quality impacts are unknown over the long term. Manageable impacts from increased silt may occur during construction.

*Watershed/Geologic Impacts*

Under this alternative, more water would be stored in El Vado reservoir or possibly available for other beneficial uses. Seepage reductions need further study to evaluate their impact on the Rio Grande bosque.

### *3.1.2 Environmental Impacts*

*Impact to Ecosystems*

These impacts should be minimal if lining project is planned to minimize impacts. Reductions in canal seepage could potentially affect the Rio Grande bosque and vegetation along canals. Impacts would need to be evaluated for specific canals. Overall, this impact could be mitigated by selective lining.

*Implications to Endangered Species*

Conserved water stored in upstream reservoirs would increase operational flexibility and may, therefore, increase management alternatives for maintaining endangered species habitat.

Financial Feasibility

### *3.1.3 Initial Cost to Implement*

Tables 9A-7 and 9A-8 (Exhibit 9A) summarize the capital costs for canal-lining projects/programs in the MRGCD and in the 21 small Sandoval systems. These programs are normally funded through bonding and user fees in irrigation districts that are focused on large-scale production agriculture. Canal lengths for MRGCD and the Sandoval systems have been extrapolated from data obtained from SSPA (2002) and from actual acequia reconnaissance surveys conducted by DBS&A in 2001 and 2002 (DBS&A, 2002).

### *3.1.4 Potential Funding Source*

For the MRGCD, financing could be obtained through federal government agencies and/or state of New Mexico agencies. Considering the large reduction in diversion water that might be realized, the costs may appear attractive. Participation from MRGCD users and city and county residents (non-users) who enjoy the benefits of the “valley garden” should be considered. See fact sheet for Alternative 59, *Severence Tax*.

The small Sandoval systems can obtain external funding now through the U.S. Army Corps of Engineers (USACE) irrigation system rehabilitation program as funded through the Water Resources Development Act of 1986 (Public Law 99662) and the NM Interstate Stream Commission Acequia Restoration Program funded through the state of New Mexico's Irrigation Works Construction Fund. The USACE program provides a federal grant that will cover 85 percent of costs with a 15 percent local entity participation requirement. The NM state program also allows for additional grant monies to be applied to the same project lowering the local share to 5 percent of the total construction and overall project cost.

#### *3.1.5 Ongoing Cost for Operation and Maintenance*

Because lined canals are less costly to maintain than earthen canals, this alternative should result in a lower annual maintenance cost for the system. This item has not been costed separately as it would be a net decrease in maintenance costs. In any irrigation system, however, operation and maintenance costs should be recouped from the beneficiaries of the irrigation system and its operation

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